INTEGRATING CLINICAL INFORMATION FROM A PERSONAL HEALTH RECORD INTO THE VIRTUAL HEALTHCARE RECORD

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Abstract: In this paper we describe our proposed architecture for an integrated eHealth solution based on a patient-centric electronic health record called Virtual HealthCare Record (VHCR). VHCR is a central, unifying, internet-based entity acting as a flagship in the eHealth ecosystem and integrating different sources of medical information in a longitudinal record. The focus of this paper is how VHCR interacts and integrates data from a Personal Health Record.

1 INTRODUCTION

In the previous years e-Health has become a major concern in the academic, medical and business worlds. In the context of an ageing population in the developed countries e-Health promises to be a solution for the increasing costs demanded by healthcare. An important concept in e-Health is the use of the Electronic Health Record (EHR), that is an individual patient's medical record in digital format. It enables a doctor to keep better track of her/his patients, to issue documents that can be interpreted by other doctors and other EHRs. EHR systems reduce medical errors, increase physician efficiency and reduce costs, as well as promote standardization of care.

Another concept is the patient empowering, namely involving the patient in his/her treatment process by giving him the means to make informed decisions. One of the ways to support patient empowering is the use of Patient Health Records (PHR), IT applications designed to allow the patient to manage his/her clinical information

From the many fields of e-Health we choose to concentrate on improving the continuity of care, by designing and implementing a shared, electronic record which we named Virtual HealthCare Record.(Contenti et al., 2010) VHCR is a longitudinal record, spanning over the whole life of the patient and integrating distributed and heterogeneous sources of information. VHCR is designed as a multiagent system in which stakeholders involved in the healthcare process centered on a patient are represented by agents organized in agencies cooperating to maintain a complete and accurate virtual representation of the patient‘s health state and clinical history as well as to support distributed health care processes.(Luzi et al., 2006)

From the many sources of information which the VHCR mediates and integrates this paper focuses on the interaction with a personal health care record, managed by the patient, with the purpose of involving the patient as a proactive party in the health care process.

In the following a more detailed view of VHCR is presented and the PHR is introduced. Then we propose a methodology for the interoperability between the PHR and VHCR highlighting advantages as well as the factors resisting to change, the potential pitfalls in implementation and usage.

2 VHCR

The Virtual HealthCare Record is the flagship in our envisioned digital health ecosystem(Kim et al., 2007).VHCR is not a document repository; instead it is a provider of electronic services supporting health-

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care processes. It holds data extracted from medical documents from various sources in a finer grained model than the documental model permits. The model is derived from HL7 RIM v3 and European Continuity of Care standards like CONTSYS and based on a dedicated ontology. In this model medical data is organized into episodes of care which are initiated or appended during encounters with the healthcare providers by accessing the VHR services.

VHCR's purpose is to maintain a unified, coherent and consistent view on the clinical status of the patient by integrating healthcare events generated throughout the whole life of the patient by different entities. These documents can derive from the healthcare applications of the healthcare providers like general practitioners or specialists in the form of prescriptions, procedures and referrals organized into care plans, from laboratories in the form of blood tests or x-ray images or from medical devices like intelligent measurement devices for blood pressure of glicemy which can send the results wirelessly to a proxy.

These documents are digitally signed by an authorized healthcare provider before being integrated within VHCR. Once the data has been integrated, and a "snapshot" of the patient clinical status is available, VHCR becomes a complex e-service provider, generating and providing customized views on this integrated status to the stakeholders involved in the healthcare process and responding to complex queries. Before presenting how we can also integrate data from PHRs let us describe in detail what PHRs represent.

3 PATIENT EMPOWERMENT AND PHR

A trend in healthcare is to involve the patient as a pro-active party in his/her own treatment. Patient empowerment involves raising the health literacy, providing customized, sanctioned medical information to the patient as required by his/her condition or level of training with the purpose of giving the patient the means to make informed decisions regarding the treatment. Health literacy denotes the skills necessary to understand and use health information. Patients with chronic illnesses will be able to follow and manage their diseases in cooperation with their care providers, promoting earlier interventions when they encounter a deviation or problem. Parents can also monitor the immunizations, diet and treatment of their children. Also, using evolved search engines, they can search and retrieve information from credible medical knowledge basis including advices regarding emergency interventions in domestic accidents, simple medical conditions (common colds, indigestions) or tending to very young children.

Another issue is supporting the patient in preventing illness by raising the awareness to a healthy lifestyle. Taking into consideration that while at the turn of the last century most of the deaths were caused by acute diseases while at the moment 2/3 of the deaths are caused by chronic diseases and that these chronic diseases are caused not by one but by many risk factors, hard to quantify and deriving from the environment and lifestyle of the patient, it becomes ever more important to inform the patient in leading a healthy lifestyle. These concerns are addressed by a concept and family of products called Personal Health Records or Patient-centered Health Records. A definition for PHR can be the following:

> an electronic application through which individuals can access, manage, and share their information, and that of others for whom they are authorized, in a private, secure environment.

(Brennan et al., 2007)

In addition to conditions, medications, appointments PHRs also provide a repository for self-monitoring information or nutritional facts.

As we can see the main difference between an EHR and PHR is the fact that in a PHR data is introduced and governed mainly by the patient. At the moment different commercial PHR solutions exist on the market, from which we mention the products from important players like Google - Google Health and Microsoft -Microsoft Health Vault.

4 INTEROPERABILITY BETWEEN PHR AND VHCR

Since VHCR aims to aggregate and integrate relevant clinical information for a patient it is clear that the PHR is an important source which should not be left out. Also, since PHR represents the patient's view into his health status, important clinical events from the VHCR should be integrated as well into the PHR.

4.1 VHCR to PHR

The main concern when importing data from VHCR to PHR is translating medical data from a health care provider representation to a patient representation. The data organization in VHCR into health issues, episodes of care and contacts could prove not very relevant to the patient and should be reorganized in a

more intuitive way. Also the specificity of medical information should be adapted to the health literacy of each patient, health literacy which changes in time.

4.2 PHR to VHCR

The main obstacle is the fact that for clinical information to be imported into VHCR it needs to be approved via signing by a healthcare professional, in this case the general practitioner. The general practitioner has objective but also subjective reasons to refuse to do so:

- Not reimbursed to do it. Doctors can view spending time in filtering information from the PHR to VHCR as a waste of their time since it is an activity for which they are not financed. One way to encourage doctors to guide their patient in using IT-enabled, patient empowering tools is to reimburse "e-Visits" (Tang et al., 2006), namely the virtual encounter between the doctor and the patient. Moreover, even without reimbursement, the previous virtual encounter with the healthcare provider can make the actual encounter more productive and more focused, using the provider's time more effectively and lowering the communication barrier.

  Also in the case of pediatric doctors with young children registered in their care, the PHR can prove very helpful as it frees them from continuous domestic visits or visits of the parents with their children to the cabinet, by being able to monitor remotely the children evolution and to raise the responsibility with the parents.
- Not willing to take responsibility for unchecked data. Once a fact from the PHR is integrated into VHCR via his signature, the doctor becomes responsible for that entry.

While some of these obstacles can be overcome by changing legislation (e.g. reimbursing eVisits) we believe that technology can also play a part in assisting the GP, by partially automizing the filtering process and using notifications.

5 IMPLEMENTATION

VHCR is implemented using a service oriented architecture(Serbanati and Vasilateanu, 2008). The POS uses a wrapper that transforms the output from the EHR application to a HL7 compliant message that is sent to the intelligent broker which forwards it to VHCR component. The broker is also responsible for sending notifications to the interested parties.

In the present prototype we add to the POS a filtration subsystem based on an automatic, rule based, system that analyzes the coherency of data (double submits, submits with no body, etc) which communicates directly with the PHR. The PHR chosen for this proof-of-concept was Google Health (McBride, 2008), which implements a partial subset of Continuity of Care Record (CCR)(Ferranti et al., 2006).

The information inspected for validation is represented by the Problems element and Medication element. The PHR used does not allow an asynchronous retrieval of medical information introduced therefore a synchronous retrieval of data must be implemented; the data is retrieved by a worker thread created and started on the start of the application. The POSDigester is responsible for retrieving data for all patients marked as registered at the logged in physician, afterwards for all new information it generates notifications which are processed by the filtration system. The flow of the validation process from PHR to VHCR is presented in fig 1. The system receives notifications when in PHR either a new medicine is added or a new symptom is added and these two types of notifications are processed differently:

- If the notification is a symptom and its syntax is correct, it is displayed as an alert to the physician in charge; the physician can either classify it medically irrelevant and the flow stops, or it can be classified medically relevant and an encounter event is created (ADT) and sent to the VHCR. The encounter can be later appended to an existing medical episode, or it can generate a new medical episode on its own.
- If the notification is a new medicine its counter indications are checked; if there are no known interactions between the medicine and other drugs or conditions than it is disregarded. If the previous condition is not fulfilled then a check is made to see if the new drug has interactions with an existing patient condition and if this is so then an encounter(ADT) should be created automatically and an alert displayed; if the medication has interactions with other drugs , therefore this information should be taken into account for further prescriptions, the information is appended to the VHCR and the physician is alerted.

To include data from VHCR to PHR, PHR must register as a client to the notifications dispatched by the VHCR. To make a customized selections of what types of events should be included in PHR, we have devised a proxy service between the PHR and VHCR. In effect the proxy registers to VHCR notifications and it forwards them selectively to PHR. The proxy also acts as a translator, transforming HL7 messages

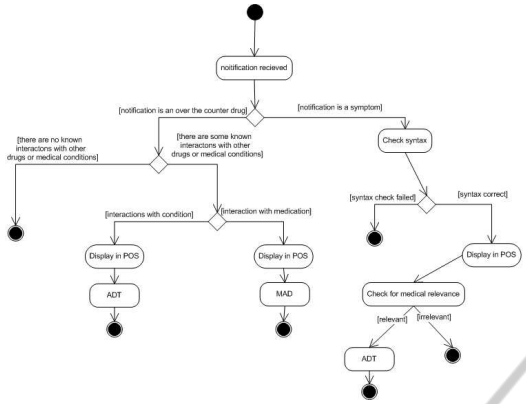

Figure 1: PHR to VHCR validation.

to CCR standard, which can be interpreted and integrated by Google Health. The process is described in detail in fig 2.

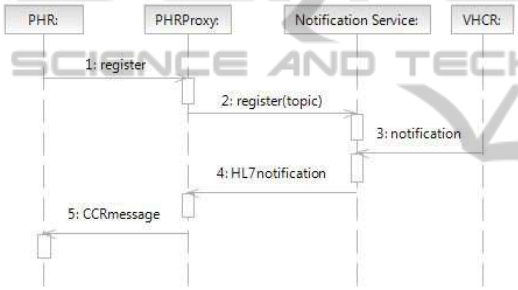

Figure 2: PHR notification through proxy.

6 CONCLUSIONS AND FURTHER IMPROVEMENT

PHR represents an important source of information for having a comprehensive view on the patient‘s health. It not only allows to raise the patient‘s responsibility to health issues in general, and his/her treatment in particular, but it can be used to obtain information from a primary, direct interested source. Our prototype filtration system and PHR proxy act in fact as semantic mediators between the patient‘s view and the healthcare professionals‘ views on the curative process, overcoming the language barriers to bring them together in a virtual, reconciled space.

Further improvements can be made in raising the autonomy of the filtration system by using intelligent, adaptive agents, which can learn from the patient’s preferences and previous choices. Also we are extending the number of PHR applications which can be integrated in the system. Contemporarly we are designing vocabularies and a general ontology describing concepts belonging to PHR functions, from which a general filtration system can be customized autonomously.

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