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Design and Implementation of a Shared Treatment Plan in a Federated Health Information Exchange

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Abstract

This paper describes the design and implementation of a shared treatment plan for providing unified views of medications for professionals and patients as a new added-value service on the regional healthcare network "e-toile". Strategies for integrating this service with other institutions infrastructures are also presented.

Based on previous experiences of patient education about their medications, and through an iterative process involving all key stakeholders, a shared treatment plan tool has been developed. It is based on the e-toile secure architecture of federated documents, and is organized in a modular way to enable various interfaces with existing prescription and dispensation systems. While the first phase provided only a web-interface on the e-toile portal, the second phase introduces integration mechanisms which are used to streamline processes around medication reconciliation. It also supports the integration with larger projects such as epSOS, the European-wide interoperability eHealth platform.

Initial feedback from key stakeholders shows a high interest in this tool. Its feasibility has been demonstrated on the e-toile platform, where first version is in production since summer 2012.

Keywords

Shared treatment plan, e-prescription, healthcare network, IHE, CDA

Introduction

The State of Geneva has implemented a regional health information exchange (HIE) in collaboration with Swiss Post Solutions [1]. The HIE enables various healthcare providers (private practitioners, clinicians from the hospital, pharmacists, homecare nurses, etc.) to access medical information concerning their patients, as well as making their own documents available to others. Every patient participating to the project is equipped with a smartcard which enables him to grant access to the healthcare professionals [2]. The HIE already provides access to the following document types:

- Clinical documents from public hospitals and from private practitioners;
- Laboratory results;
- List of medications dispensed by the pharmacies;
- Homecare nurses' documentation.

In addition to facilitate access to distributed documents, the goal of this HIE is to improve the collaboration amongst the participants to the network. Several tools are being developed, including disease-specific shared dashboards for the management of chronic patients, and a complete view of the patient's medications. This paper presents the design and implementation of the latter tool, known as the "shared treatment plan".

Design

The shared treatment plan aims at providing a consistent, complete, and accurate consolidated view of current and past medications, to facilitate annotation by the various professionals involved in the medication loop (prescribers, pharmacists, home nurses), and to provide a didactic view of the medication plan for patients, in order to improve their understanding and compliance [3,4,5].

Constraints

Implementation of the shared treatment plan has to cope with several constraints coming from the structure – legal as well as technical – of the HIE platform.

The law establishing the HIE [6] specifies how access rights are managed: the patient himself decides who can have access to which information, and has the possibility to hide information to some care professionals, when disclosing such information might be felt stigmatizing and undesirable in a therapeutic relationship. The patient can therefore decide that e.g. all prescriptions made his psychiatrist cannot be seen by other healthcare providers, including his cardiologist or his general practitioner. As a consequence, the shared treatment plan can be incomplete due to a patient's decision and the fact that some information is not accessible has to be hidden as much as possible.

Another important constraint comes from the core structure of the system: the HIE is a platform for managing *documents*. Documents are structured according to the HL7 Common Document Architecture (CDA [7]) standard and are accessed through IHE-XDS (Integrating the Healthcare Enterprise – Cross-Enterprise Document Sharing [8]) and related profiles. Each document has a legal responsible, one or several authors and one or several recipients. A document can only be modified by one of its authors. In addition, the law establishing the e-toile regional network defines confidentiality levels to be associated to each document. These levels provide an additional way for the patient to control who can access which documents. Consequences of this document-based architecture on the design of the shared treatment plan will be seen in more details thereafter.

Development

In order not to have to address all problems at the same time, the realization of the shared treatment plan has been divided in several phases. The initial phase addressed the basic implementation of the shared treatment plan, with a single interface available through the network's web-based portals for healthcare professionals and patients. No interface with exter-

nal clients was implemented. The next phase, which is currently under implementation, is more ambitious and adds two key features: integration with existing drug prescription and dispensation systems, and access to a decision support system for prescribers.

In order to maximize the appropriation of the tool by its users, a multi-professionals group has been set up from the beginning. The group - composed of doctors (from private practices as well as from the public hospitals), pharmacists, pharmacologists, nurses and computer scientists - is responsible for the design, implementation and evolution of the tool.

Data structure

The representation and storage of the shared treatment plan is based on sets of distributed transactions. Indeed every action by each stakeholder can be represented by transactions like "add a new medication", "prescribe a certain number of packages of this medication", "dispense a medication", "add a comment about this medication", etc. The key advantages of such a structure are simplicity and extensibility. The underlying infrastructure being based on CDA documents, transactions are stored in a CDA level 3 document with a fully structured content.

In order to respect the basic constraints of the e-toile HIE platform (possibility to restrict the access to one contributor's actions, documents can only be modified by their authors), it has been decided to store transactions in a contributor-specific document (i.e. one document per patient and per contributor). As a consequence, the shared treatment plan is the union of the contributions (transactions) of all stakeholders for a specific patient.

Business logic vs. user interface

Another key implementation choice for the shared treatment plan is the clear separation between the user interface and the business logic, handled by different components:

- The business logic component has the role of *computing* the unified view of the shared treatment plan, aggregating the transactions made by all stakeholders and producing something that can be displayed. Different views can be computed, like the clinician's view (the shared treatment plan itself), the patient's treatment card, ordinances, etc.
- The user interface has to display the information, interact with the user (e.g. for the prescription of a new medication) and interact with the underlying platform *on behalf of the user*. The last point is crucial for a sound implementation of the access mechanisms defined in the platform: transactions that will be taken into account are only those which can be retrieved by the user. Implementing the retrieval of the transaction on the user interface component has the clear advantage of benefiting from the existing access mechanisms, no additional implementation of access restriction being necessary. The user interface also makes use of external databases [9] for gathering the up-to-date detailed knowledge of which medications are available on the market.

Figure 1 shows the global architecture of the components in relation with the shared treatment plan. The "WebServices portal" is the portal used by applications interacting with the e-toile platform.

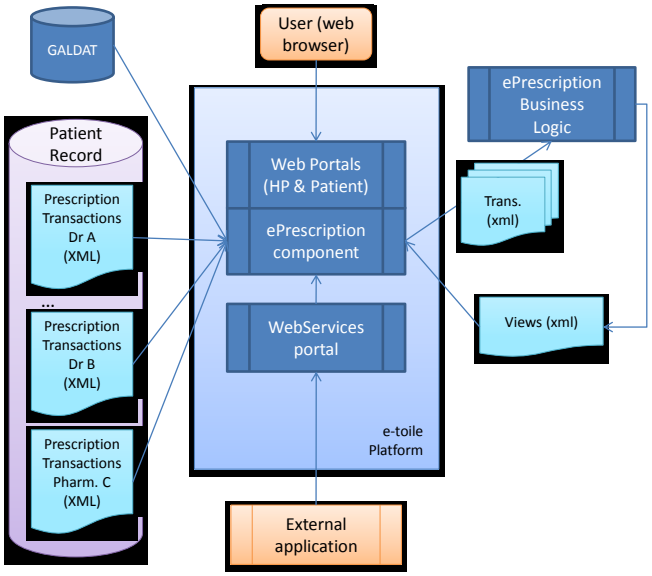

Figure 1- Architecture of the shared treatment plan

Communication with external stakeholders

There needs to be a clear interface between the HIE platform and external applications that may be using these functions. These interfaces with the "outside world" are specified in a way that is independent from the internal transactional model. As providing the current treatment plan is like computing an additional specific view, the work of mapping transactions to and from an external representation is performed by the business logic component.

Standards are emerging in the field of e-prescription and medication summary [10]. The definitions of the specific views are of course using them as it will ease the integration with potentially many different vendors of external solutions.

Communication with external users has to be made two-ways, i.e. an external client has not only to be able to retrieve the current content of the shared treatment plan but also to be able to modify the treatment plan. While the retrieval is similar to getting a medication summary, the modification is close to an e-prescription with possibilities of altering existing medication.

Decision support services

Decision support services (DSS) are part of the business logic. Indeed the decisions of retrieving relevant information from the DSS and of filtering what the DSS provide in order to limit the noise are related to the core business of the prescription. It is therefore logical to interface these services at the business logic level.

DSS are strongly related to the deep knowledge of the medicaments. In order to avoid developing and maintain such an expertise, existing services provided by specialized companies are used.

Decision support services are called at two stages:

- When a new treatment plan is computed for being displayed DSS are called in order to detect potential problems (drug-drug interactions, counter-indications, dosage problems, etc.);
- When a new medication is added, DSS are called in order to detect possible conflicts and to possibly retrieve information about recommended doses or substitutes that could limit the undesired side effects.

Additional information about the patient (age, weight, pregnancy and lactation information, laboratory results) required by the decision support services are provided to the business logic along with the transactions. The information is retrieved

by the e-prescription component, avoiding any direct interaction between the business logic and the patient record.

Results

First phase

The implementation of the shared treatment plan did, as is often observed in such developments, make visible the complex nature of the prescription process involving multiple care professionals, and raising challenging issues about the roles and responsibilities of each. Such issues included the ability to change another physician's prescription, or the possibility for pharmacists or home nurses to document medications that are obtained without prescriptions. Pragmatic solutions were defined collaboratively, with the understanding that the system would not change or hinder existing practices, but would make them more visible.

The computation in "real time" of the displayed views from transactions extracted by the user-side component proved to be adequate: it avoided to have any specific handling of user's restrictions on the business logic side, enabled a fine tuning of what has to be displayed without having to modify the user interface component and did not cause any performance issue. The implication of the users from the beginning proved to be very effective as it enabled a quick and efficient design of the content of the views, taking into account the requirements and expectations of the various categories of users.

Figure 2 shows the main screen with the current shared treatment plan along with the form for prescribing a new medication.

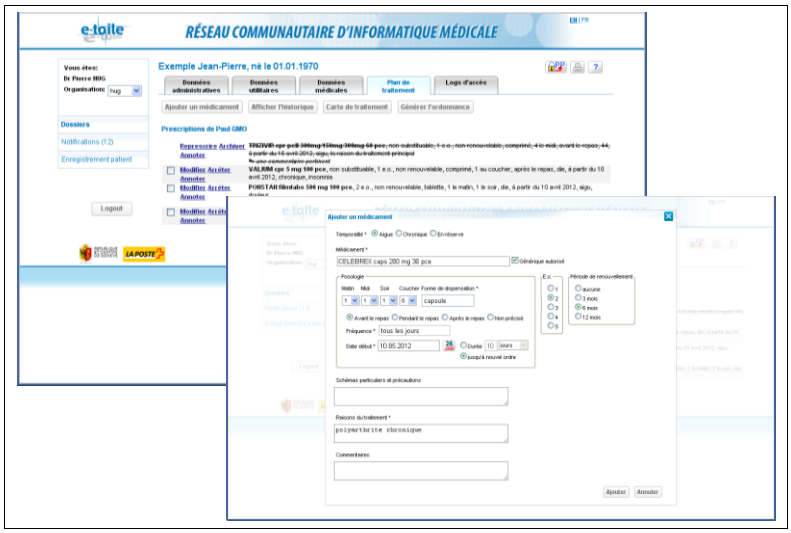

Figure 2 Shared treatment plan & new medication form

Transactions are stored in specific documents under the responsibility of each author. The e-prescription component loads all transactions files before querying for a specific view. This strategy has many advantages:

- The fact that all transactions of a specific author are in their own file enabled the use of the existing security mechanisms. The patient can hide one doctor's action to the others: if transactions of one practitioner are not visible, the business logic will simply not know these transactions and compute the views accordingly;
- With the transactions based strategy, an intervener has never to modify another user's transaction file: he just adds an "alter" transaction into his own transaction file – with a link to the reference transaction. It is then the role of the business logic to compute the "final" status of the initial prescription taking into account all modifications that were performed by other stakeholders;
- In case new operations have to be defined, they can simply be added to the model as new transactions types. Change of the design is not required.

One specific situation had however to be handled by the business logic: depending on which transactions the patient hides, a computed view may become incoherent. An example of such a situation is an initial medication by practitioner A that is not visible while a modification by practitioner B of the initial medication is. In such a situation, the computed view is partial and includes a message telling the user (who is a priori a doctor) that the result is not complete and not coherent, certainly due to hidden information by the patient. The doctor should then discuss with the patient and explain the possible consequences and adverse effects that this behavior could result in.

Second phase

The specification of the second phase was a challenge for the initial design, as it introduced external entities with different kinds of requirements, including the Geneva University Hospital's clinical information system [11], a group practice EHR, and an interface to the epSOS project [12].

While the shared treatment plan is using a proprietary structure, it has been considered as of primary importance to base the interface with the "external world" on existing or forthcoming international standards. This is especially true for the interconnection with epSOS services, which require the data to be encoded according to well-defined HL7-CDA documents [10]. A second requirement is to be able to feed back the shared treatment plan so that it enables the medication reconciliation workflow at admission and at discharge from hospitals. This can be done through the same document with the following workflow:

- The e-prescription application creates a new medication summary document containing all modifications (i.e. new medications, stopped medications, modified medications);
- The business logic module computes a delta in terms of transactions;
- The transactions are stored by the e-prescription component into the patient's record – creating if necessary

a new transaction file associated to the patient and the e-toile identity used by the external application.

The epSOS requirements can be handled by the same mechanisms:

- The medication section of the Patient Summary can be filled with the data coming from the medication summary view;
- The e-prescription document can be filled with the data coming from a specific view indicating prescribed but not fully dispensed medications;
- The e-dispensation feed-back can be handled by converting e-dispensation information into transactions, these being stored under the responsibility of Dr epSOS (a virtual doctor used by the epSOS national contact point to access e-toile patient's records).

Conclusion

The first phase of the shared treatment plan, aiming at providing a collaborative tool to the e-toile HIE users, has been successfully deployed. Users do recognize the value of the service and are satisfied with the design. Such a good acceptance has been reached in particular thanks to the strong involvement of the different categories of users from the beginning of the project.

The second phase is being developed and will be live by mid-2013. Two essential features are being added: the bi-directional communication with external e-prescription tools and decision support services.

Solutions for managing information with multiple contributors and complex access rules were designed and implemented. The resulting architecture fits the needs of the various entities while respecting in a clean way the legal and technical constraints. It is already envisaged to use the same kind of structure for other domains of activity, and in particular for laboratory results data. Indeed there are many laboratories that contribute to a laboratory summary and being able to show a consolidated view of the laboratory data will be a strong advantage for the e-toile platform.

Although the internal structure of the shared treatment plan is proprietary, IHE-XDS profiles based views of the information can be easily presented to external clients. Communication with external systems like e-prescription tools or epSOS national contact point is realized through standard HL7-CDA documents.

Acknowledgments

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