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Using openEHR in XDS.b Environments – Opportunities and Challenges

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Abstract. The HiGHmed research project as part of Germany's Medical Informatics Initiative aims to establish Medical Data Integration Centers (MeDIC) at each participating institution to integrate data of multiple primary information systems in a single place. The MeDICs are based on an IHE XDS.b Affinity Domain in conjunction with an openEHR clinical data repository. This paper presents two ways of storing and retrieving structured and semantically annotated data from an openEHR repository whilst keeping data integrated in an existing IHE XDS.b infrastructure. Furthermore, the paper discusses multiple benefits of the presented approach as well as challenges and corresponding solutions.

Keywords. IHE, XDS.b, openEHR, HiGHmed

1. Introduction

HiGHmed [1] is a research project that was founded within the Medical Informatics Initiative [2] of the German Federal Ministry of Education and Research. The goal of the project is to promote digitalization in the German health care sector by supporting cross institutional use-cases in the domains of patient care and medical research. Therefore, a Medical Data Integration Center (MeDIC) is currently being constructed at every university hospital involved in the project. These MeDICs aim to integrate data of primary systems in one place and to facilitate data transfer into a research context [3, 4].

In order to support the cross institutional use-cases, HiGHmed developed a concept of a digital platform consisting of an Electronic Health Record (EHR) based on an IHE XDS.b Affinity Domain combined with an openEHR clinical data repository [1]. However, this concept does not specify how these two technologies can be used in conjunction. Therefore, this paper describes the selected implementation approach at the Heidelberg University Hospital's MeDIC for integration of an openEHR repository into the existing XDS.b environment. The resulting infrastructure should support the requirements of health care professionals to retrieve relevant documents of a patient during care, but also data delivery in pseudonymized form for research projects.

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2. State of the Art

IHE XDS.b [5] is used all over the world to establish EHRs that support provisioning of relevant documents in patient care. Many of them only provide unstructured documents such as PDF files. Occasionally, EHRs are based on structured documents, examples are HL7 CDAs in Austria's ELGA [6] or HL7 FHIR resources in Finland's Kanta [7].

OpenEHR data modelling is successfully used in many projects to ensure semantic interoperable data exchange for secondary use [8 - 10]. Possibilities for combining openEHR and IHE in Slovenia's eHealth environment are presented in [11].

To the best of our knowledge, there exists no publication describing a concrete EHR infrastructure based on IHE profiles which uses openEHR Template Data Documents (TDD) as the document standard and supports patient care and medical research likewise.

3. Concept and Implementation

This paper proposes a single infrastructure to support patient care and medical research. The applied IHE profiles are XDS.b, DSUB, PIX, SeR and APPC [5]. Figure 1 provides a high-level application overview, Figure 2 shows the implemented IHE actors and transactions of each application.

To ensure that correct patient identifiers are used in all applications, the PIX actors Patient Identity Cross Reference Manager, -Consumer and -Source as well as the transactions ITI-8 and ITI-9 are used.

There are two pathways for storing data in the MeDIC. In both cases, a communication server routes the documents from primary systems to the corresponding repositories. Semi-structured data (e.g. HL7 v2 format) is sent from the communication server to an ingest consumer. This application stores data in an initial data stage, that is monitored by an ETL tool which then transforms the data into TDDs and sends them to the openEHR repository using its Document Source actor's ITI-41 transaction. Then, the openEHR repository registers the TDD in the central XDS.b registry using the ITI-42 transaction. Documents that already have a structured form (e.g. dPDFs) are stored directly in a different XDS.b repository, but are also registered in the same XDS.b registry. To convert these documents into TDDs as well, the DSUB profile is used. A subscription is created in the Document Metadata (DM) Notification Broker of the XDS registry with an ITI-52 transaction using the DM Subscriber actor of the ingest consumer. When a new document is registered in the XDS repository, the broker sends an ITI-53 notification message to the DM Notification Recipient actor of the ingest consumer, which stores the message in the initial data stage. The ETL tool can then use this message to retrieve the actual document from the XDS.b repository using its Document Consumer's ITI-43 transaction. Afterwards, the ETL tool applies the same steps as for semi-structured data.

As with data ingestion, there are also two possibilities to retrieve MeDIC data. In a patient care context, data is requested by the controlled data consumer using the ITI-18 transaction of its Document Consumer Actor. Thereby, permission to access data is decided by the XACML actors Policy Enforcement Point (PEP), Policy Decision Point (PDP) and Policy Administration Point (PAP) that are integrated into the corresponding SeR and APPC actors. Once the data has been released, it can be retrieved from the respective repositories using the ITI-43 transaction. Since both repositories represent XDS.b

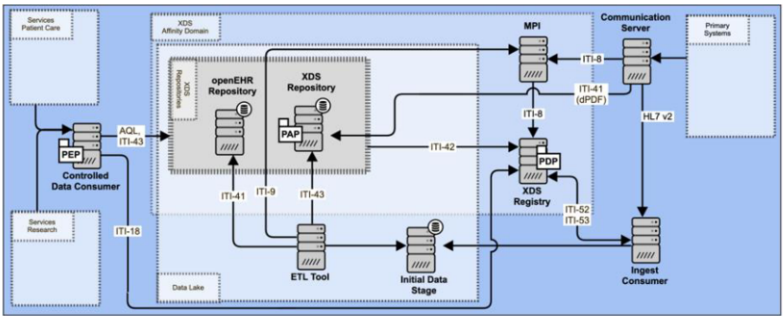

Figure 1. Application based view on the combined XDS.b openEHR infrastructure at the Heidelberg University Hospital MeDIC including XACML authorization actors PEP, PDP and PAP.

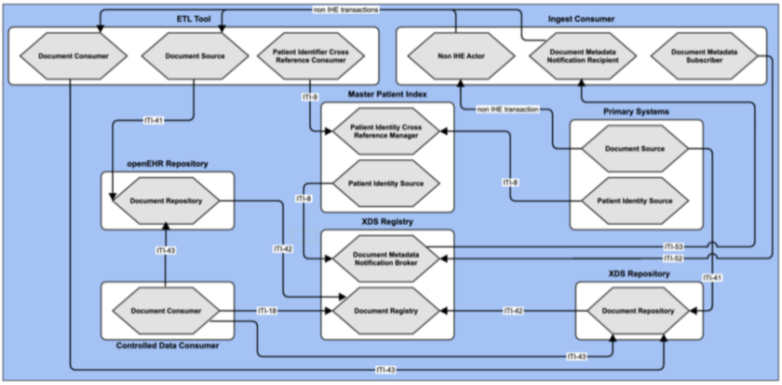

Figure 2. Detailed view on IHE actors (hexagons) and their interaction. White boxes group actors and represent applications from Figure 1.

actors, they can be queried with the same type of request, only the returned data format varies. For data queries of patient cohorts in a research context, non IHE compliant requests can be made via the controlled data consumer to the openEHR AQL interface.

4. Discussion

This paper proposes a solution for integration of standardized data management using an openEHR repository into an existing IHE XDS.b based EHR infrastructure. The implementation revealed several opportunities and challenges.

First, the selected approach enables that data used in patient care and medical research is kept in a single infrastructure and does not require any duplication. This promotes the principles of data avoidance and data economy. Furthermore, no additional data processing for transfer into a research context is necessary. For retrospective studies, data is pseudonymized on demand and only then made available. Additionally, fully structured data storage and standardized application programming interfaces facilitate integration of decision support systems into the infrastructure.

A major challenge of the presented approach is modelling of openEHR compositions from which TDDs are derived. On one hand, they have to be defined as small as possible so that they do not have to be constantly updated. On the other hand, they must not be too small so that they cause many entries in the XDS.b registry. Additionally, documents must contain references to openEHR archetypes of other documents for accurate linking. Therefore, the presented approach is ideal for classical documents such as diagnostic reports. For documents that can change frequently such as laboratory reports, IHE On-Demand Document types should be used and registered in the XDS.b registry. In the presented approach, this document type is associated with an AQL query that is executed to construct the specific document during retrieval.

The use of TDDs limits granting of access permissions to the level of documents. Authorization for single document values is difficult, unless a TDD consists of exactly one value. However, this would create a significantly higher quantity of registry entries, which could lead to a loss of performance.

A further challenge exists when patient consent must be checked during retrieval of cohort data in a research context because non IHE compliant AQL queries are executed. Therefore, an additional ITI-18 transaction must be sent from the controlled data consumer to the XDS.b registry, containing all document identifiers retrieved in the AQL query result set. This transaction then returns all document identifiers for which a positive authorization decision exists. The ITI-18 result must then be used to filter the AQL query result set before data is transferred to a researcher.

In the future, other standardized data formats such as HL7 FHIR repositories could be integrated into existing XDS.b infrastructures using the same generic approach.

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