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A Medical Device Domain Analysis Model Based on HL7 RIM

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Abstract. Clinical investigations (CIs) are carried out to demonstrate safety and efficacy of new Medical Devices (MDs). The presence of many stakeholders participating in CIs makes it necessary to develop a common standard language to achieve semantic interoperability among systems and organizations. In Italy the National Research Council is carrying out a project supported by Ministry of Health aiming to develop an information system (MEDIS) that manages MD clinical investigations. In order to develop a flexible and interoperable system, MEDIS design has been based on the application of HL7 (Health Level 7) v.3 standards. This paper presents the results of the MEDIS design: the MD DAM based on HL7 RIM.

Keywords. medical device, clinical investigation, domain analysis model, HL7

1. Introduction

Innovation and development of new medical devices (MDs) are carried out establishing a body of evidence that demonstrates their safety and efficacy. Clinical investigations (CIs) are one of the most important methods of testing MD safety and performance on humans before its regulatory approval and commercialization. European directives [1], national laws as well as a body of international technical norms, regulate these complex procedures. These regulations tend to implement similar approaches, in order to monitor an increasing number and types of MDs commercialized in a global market. Unlike clinical trials on pharmaceuticals, there is no European registry that gathers information on MD clinical research yet, and only few countries have developed their own information system to monitor clinical investigations. Also the use of standardized clinical data is at its initial stage in the MD domain, while this is becoming a common practice in the field of pharmaceutical clinical trials, as evident in the development of CDISC standards [2] or in the models proposed by BRIDG [3] and caBIG [4]. However, a simple application of the standards proposed for pharmaceutical clinical research is not possible due to the great variety of MDs as well as differences in CI approval and commercialization procedures.

Therefore, information sharing on MDs has to be based on the identification of a standard set of data able to describe MD characteristics and track them in interoperable information systems. The need of information sharing among National Competent

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Authorities (NCAs) and CI proposers as well as among the different stakeholders participating in CIs, makes it necessary to develop a common standard language to achieve semantic interoperability among systems and organizations.

In Europe the EUDAMED (European Database for Medical Devices) project is planning an information system with the aim to support Member States in the information exchange related to MD placed on the market. In Italy the National Research Council is carrying out a project supported by Ministry of Health aiming to develop an information system (MEDIS) that manages MD clinical investigations. The core of MEDIS is composed by a registry of clinical investigation data and content repository of documents submitted by the manufacturer to the NCA to obtain the approval for the clinical investigation start-up. Moreover, MEDIS supports manufacturers in the documentation submission process as well as the NCA evaluators in assessing the data received. It also manages the communication among the different stakeholders and collects the data produced during the whole lifecycle of CIs.

In order to develop a flexible and interoperable system, MEDIS design and development have been based on the application of HL7 (Health Level 7) v.3 standards. This paper presents the results of the MEDIS design focusing in particular on the use of HL7 RIM [5] in the MD domain.

2. The MEDIS System

MEDIS is primary a registry that collects the data and documents during the whole lifecycle of a CI, from the phase of notification, i.e., the submission of regulatory data and documents to obtain the approval of CI start-up to the phase of collecting the final results of a CI. In particular MEDIS manages: (1) The acquisition of data and documents required by the national and European Directives to obtain the approval for the activation of a CI (notification phase), providing a CI proposer with an electronic submission form that guides him/her to the correct insertion of information; (2) Communication exchanges between CI proposer and NCA evaluators that manage the requests of further information for assessment aims as well as the updating of CI data and documents occurring both in evaluation and experimentation phases; (3) Communication exchange among the NCA evaluators that manages the assignments of roles as well as the agenda of the evaluation phase by means of a workflow of the activities carried out during the evaluation process performed by the NCA evaluators.

Particular attention has been posed on issues related to data security and privacy.

3. HL7

HL7 provides standards for the exchange, management and integration of electronic healthcare related data based on a conceptual model (Reference Information Model, RIM), an exchange model for clinical documents (CDA), clinical content management specifications (CCOW) and messaging exchange (Domain Message Information Model, DMIM). Such standards set the language, structure and data types required for seamless integration among different systems and organizations. RIM is the core of HL7 v.3; it represents a static model that covers both clinical data and administrative information in the healthcare context. Its abstract data model approach makes it possible to easily adapt it to other domains. Moreover, CDA standardization makes

HL7 particularly suitable for MEDIS requirements, as far as extraction and re-use of the information contained in the CI technical documents are concerned.

HL7 RIM describes a health business process decomposing it into elementary descriptions, which model: a) the subject/object involved in the process, b) the role played by the subject/object, c) the aim, and d) the action performed or scheduled. This description is based on a speech act [6], represented by the 4thple <Entity, Role, Participation, Act>. Therefore, in the HL7 RIM data are represented in Entities (e.g., people places and things, nouns) related in Roles (relators) to other Entities, which interact in Acts (verbs) through their Participations (prepositions). Through ActRelationship it is possible to represent different associations, for instance a temporal, logical or structural order, composition, etc. Through RoleLink, it is possible to connect for example a physician with its belonging organization, relation between organizations, etc. This conceptual model makes it possible to describe data and their attributes as well as static procedural information that characterize a process.

An example of the application of RIM to MEDIS stakeholders is described by the sentence "A MD manufacturing enterprise submits a notification through its legal representative" by mean of the following 4thples: <*Organization, Proposer environment, Manufacturer, Notification*> and <*Person, Proposer, Legal representative, Notification*>.

4. MEDIS Business Process

The life cycle of a CI on MDs can be divided into three main sub-processes: (1) In the notification sub-process, the CI proposer sends the NCA the documentation composed by administrative documents (letter of designation of an authorized representative, signed statement, etc.) and technical documentation (clinical protocol, the risk analysis document, etc.); (2) In the evaluation sub-process, the NCA assigns the notification to an evaluation team, a medical and a technical evaluator, which can also benefit from an external specialized advisory board to assess special aspects of CI performance and MD safety requirements. This sub-process entails an administrative review that verifies the completeness and the consistency of documentation and a content review that assesses MD safety requirements as well as the scientific, clinical and ethical fulfillments of the clinical protocol; (3) If the CI is approved, in the investigation sub-process, the proposer can start the clinical study. He/she also communicates with the NCA about amendments in the clinical protocol and/or reports adverse events.

5. MEDIS Domain Analysis Model (DAM)

The MEDIS DAM entails five Entities: *Organization, Person, Committee, Document* and *Artifact* (Figure 1). *Organization*, *Person* and *Committee* represent the stakeholders taking part in the CI lifecycle, each one playing a specific Role with precise intentions (Participation). For instance each *Person* can play either the Role of *Proposer, Evaluator*, *Performer* or *Patient.* In particular the Role *Proposer* is associated with the Participations *Legal representative* (responsible for the notification submission and CI performance) and *Contact person* (responsible for the communication exchange with the NCA). Their Participation is connected with the whole process, i.e., the *Notifying*, *Evaluating* and *Investigating* Acts. The Role *Evaluator* is linked to the Participations *Notification supervisor*, *Medical evaluator* and *Technical evaluator* involved in the

processes of assessment and CI monitoring (i.e., Acts: *Evaluating process* and *Investigating process*).

The Entity *Document* identifies the information exchanged during the whole CI lifecycle, associating each document type to its Role on the basis on its aim (Participation) in a specific Act. For instance the Role *Notification* has the function of participating as an *Evaluation object* in the whole CI process. Similarly the Role *Technical document,* such as clinical protocol, participates as an *Activity plan* sent by the *Proposer* in the *Notifying process*, assessed by the *Evaluation team* in the *Evaluating process*, and followed by the *Performer* in the *Investigating process*. Note that HL7 RIM describes the subject and the object of an act through two different 4thples. For this reason it is necessary to develop system constrains to associate these classes to each Act. The Role *Update* describes the set of documents composing the *Dossier* together with those contained in the *Notification,* modeling the information exchange necessary to manage changes occurring during the whole CI process (for example different versions of a document, protocol amendments, etc.).

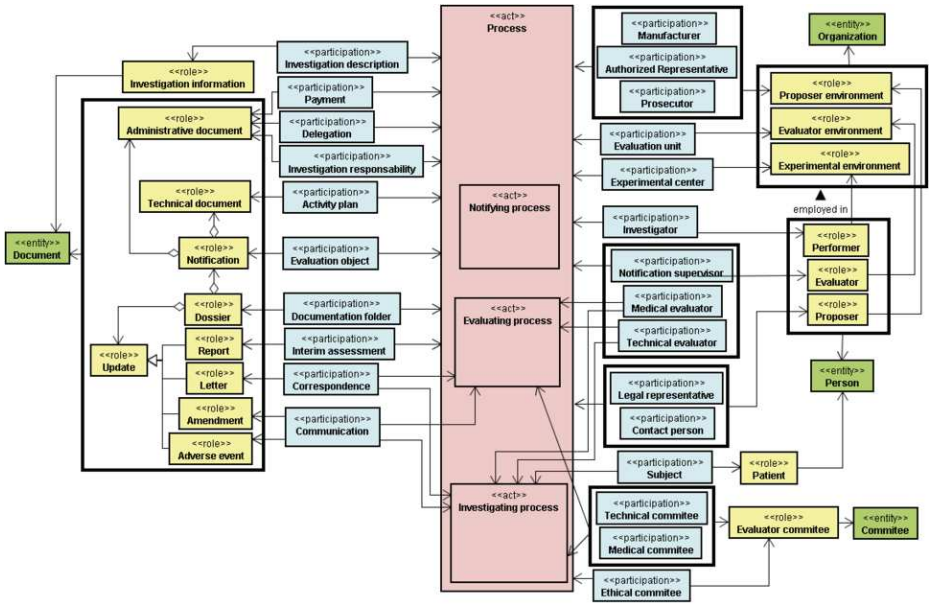

Figure 1. MEDIS domain analysis model

Figure 2 shows the part of the MEDIS DAM focusing on the representation of MDs, modeled in two different perspectives. In the first one, detailed MD information is contained in the technical documents submitted by the notification proposer to obtain the approval of the CI start-up, as described in the box *Evaluated MD*. In the second one, each single investigational product used in real investigating conditions is represented by the role MD associated to the Entity *Artifacts*, as described in the box *Tested MD*. In this way it is possible to manage information gathered during the investigating process, for instance the identification of a specific MD involved in a precise adverse event. This splitting up creates an isomorphism in which the Roles related with the Entity *Artifact* are mirrored in the Entity *Document*. Similar conceptual differentiations have been adopted in the BRIDG model to distinguish the description of a "scheduled" clinical trial protocol from a "performed" one [3].

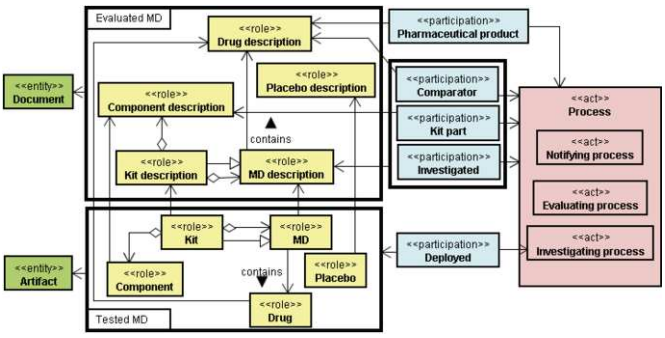

Figure 2. MEDIS domain analysis model: Representation of an investigational product

The Entity *Document* is associated with the Role *MD description* along with the description of the other elements related to the investigational product (*Kit description, Component description, Drug description, Placebo description*). Each of them has a specific Participation: the Role *MD description* participates to the whole CI process either as *Investigated, Comparator* or *Kit part*. The investigational product can be either a MD or a Kit, which is a composition of different MDs and/or Components. Moreover, MDs can incorporate a medicinal substance described in the Role *Drug description*. A CI can evaluate the safety and efficacy of an investigational MD comparing it with another MD, or with a drug or a placebo. In these cases these Roles participate as *Comparator* in the whole CI process.

The Entity *Artifact* has the analogous Roles of those described in Evaluated MD, but it is associated with the Participation *Deployed* and the Act *Investigating process*.

6. Conclusion and Future Work

The paper describes the MEDIS DAM based on HL7 RIM. This standard has proved to be useful for the representation of CI lifecycle ranging from the notification sub-process to the collection of the CI results. Its adoption represents a first step forward the development of a common standard language, which improves information sharing among different stakeholders. This is particularly important in a domain where standardization is at its initial stage. At the moment the notification module has been developed and is actually under a testing phase. The database design was based on our HL7 DAM, which makes it possible to easily change, upgrade and expand future interacting information systems. These features allow the different stakeholders to develop their own information system and eventually adapt it to changes due to new European regulation and/or local requirements.

References

[1] *Directive 2007/47/EC of the European Parliament and of the Council L 247/21*, 21 September 2007.
[2] CDISC. *Clinical Data Interchange Standards Consortium*. http://www.cdisc.org.
[3] Fridsma, B.D., Evans, J. et al. (2007) The BRIDG project. A technical report. *JAMIA* 15:130–137.
[4] caBIG. *Cancer Biomedical Informatics Grid*. http://cabig.nci.nih.gov.
[5] Health Level Seven, Inc. *HL7 Reference Information Model*. http://www.hl7.org.
[6] Schadow, G., Mead, C.N., Walker, D.M. (2006) The HL7 Reference Information Model under scrutiny. *Studies in Health Technology and Informatics* 124:151–156.