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Electronic Patient Records: Dutch Domain Information Model Perinatology

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Abstract. Currently a national domain information model is developed to support information exchange via electronic patient records (EPR), and to support the adoption of the EPR in Dutch healthcare practice. This article describes a pilot for the domain information model for mother- and childcare (perinatology) that serves as a first 'use case'. The 'use case' is modeled using the Health Level 7 version 3 Reference Information Model (HL7 RIM) as the methodology and modeling tool.
The first results are promising, despite the fact that HL7 RIM is still in a draft version up to formal vote. The models of the 'use case' are both specific and generic at the same time, allowing professionals to recognize their domain specific content and work, and the EPR developers, or developers of messages for information exchange, to build practical implementations. The approach bridges professional content and technical issues.

1. Introduction

Dutch healthcare has been an early adopter of electronic systems in the administrative and the clinical area [1, 2]. However, by the end of the 1990ies, many challenges arose to exchange clinical information between disciplines, and across the continuum of care, to better coordinate care and to be more effective and efficient [3]. Also, there is a growing need to (re)use clinical information for purposes as quality assurance, clinical outcome research, management of services and support of health policy decisions.

A national taskforce was established to develop an information structure supporting the free, but safe exchange of health information [3]. The taskforce came to an agreement involving all stakeholders in Dutch healthcare (patient organizations, professional organizations, health institutions, insurers, industry and the ministries of healthcare and economic affairs) [3, 4]. A national institute has been established to lead further developments [5]. One part of this initiative is the VIZI project: Virtual Integration of Zorg (care) Information [6].

The agreement between the different stakeholders states the following to this issue [3]:

- Clause 5: Information structure (1): Testing, adapting, and using the prevailing national and international standards for data interchange and for terminology in health care and.
- Clause 6: Information structure (2): Building a care-oriented information and communication reference model for developments aimed at the availability of the correct and consistent information in each care professional – patient relationship.

The purpose of this article is to report on the HL7 modeling methodology and first results of a pilot for the information structure, as carried out in the VIZI project.

2. Towards a national healthcare reference information model

VIZI develops a generic national information model by means of building subsequent and integrated sets of domain reference information models. Each model reflects specific care areas. This model should support the secure exchange of patient related health information via current information systems, and stimulate further development of electronic patient record systems. VIZI started in the perinatology domain (pregnancy, childbirth, and neonatal care).

Given the current wide use of HL7 versions 2.x in almost all Dutch hospitals, the HL7 version 3.0 standard, especially its Reference Information Model, was chosen as the prime methodology for the project [6, 7]. A key factor for success is a timely start and quick results of the evolving domain model that adequately represents the perinatology care, allowing fast implementation in existing systems. At this stage the HL7 RIM, although not yet in its final ballot state, is the only feasible option to work with. The challenge is to transfer use cases into a domain information model, next into an Object Oriented Model and then define the exchange of information between care-providers, between care-providers and the supporting medical facilities. In the future, changes can be considered, following the harmonization process between CEN and HL7, and agreements between CEN and ISO.

HL 7 is a standards development organization, which provides standards for the exchange, management and integration of data that support clinical patient care and the management, delivery and evaluation of healthcare service [7]. HL 7 recently released the Reference Information Model (HL 7 RIM). This is a generic, non-discipline specific, Object Oriented information model of patient care and the providers, institutions, and activities involved. The HL 7 RIM represents all relevant data classes in health care for which information needs to be available and processed, and their mutual relationships. At the top level, the HL7 RIM data classes represent 'Entity' (any person, institution), 'Role' (the role the entity normally has), 'Participation' (the actual behavior of an entity in a specific act of care) and 'Acts' (any healthcare related activity) [8]. The 'Role' class has a 'Role_Relationship' class to link several roles to each other (e.g. a doctor to a patient). The 'Acts' class also has a 'Acts_Relationship' class, which allows combining several activities, e.g. for sequencing activities, or for detailing them. Most classes have subclasses, all classes have specific characteristics (the attributes and values), and these are related via the relationships. This specifies the basis of the Reference Information Model [7, 8].

It is possible to further specialize the available HL7 RIM classes in order to give it a more domain specific character [8]. However, there is a drawback to this: the more it is detailed in a domain specific way, the more it looses its general, reusable character. Thus, it must be modeled in a domain specific way to sufficiently address the domain specific needs, but after that, it should be re-modeled and mapped to represent all domain specific information consistently in existing HL7 classes and models. If anything is not represented in the current RIM, a voting and balloting procedure could lead to alterations in the RIM, via current international HL7 procedures. Given the voting status of the RIM, we considered it sufficient to model the perinatology domain to the level of the domain specialization, and to wait until after the balloting for the consistency check.

3. Methodology

In the pilot for the perinatology domain, several 'use cases' have been modeled. A use case is a clinically relevant patient category, for which the involved persons and institutions, and the communication and information in the care process are elicited from

clinicians via interviews. VIZI started with the development of a domain information model for perinatology, and will validate this for other areas such as general surgery and lung diseases. The 'use case' material is written up in a text file and sent to the clinician to correct, enhance and verify its content.

In a second phase, the use case was broken down into smaller so-called "storyboards". A storyboard can be a referral of a pregnant woman from the midwife to a hospital, or, alternatively, the medical orders to the nurse for a premature baby admitted to a Neonatal Intensive Care Unit (NICU). Next, an HL7 interaction table [7] is prepared in a spreadsheet. When the interaction table is finished, a complete set of dialogues is available. Within HL7 this is used to automatically derive messages between different applications using Rose Tree tooling products.

However, the information sent and resent is often duplication from the viewpoint of a data model. E.g., the information about pregnancy is transferred from the general practitioner or midwife to the obstetrician, and the same information goes to the nurse on the maternity ward, to the pediatrician, and to the pediatric nurse. That information needs to be modeled only once. Therefore, in an intermediate step duplications are removed and similar information is clustered. E.g., different lab results are grouped, as are medications, or observations of the baby after birth.

At the time this has been sorted out, it becomes feasible to compare the material from the clinician, which represents the domain information, with the existing classes in the RIM. For each information cluster, the appropriate RIM class is looked up, attributes are compared, and the specialized class name is suggested.

The final step of this phase is to draw up the classes in Unified Modeling Language. For the purpose of the first 'use case' the intra-uterine transport of a baby to a NICU, we used the UML Studio ® software package for this. At this moment, Rational Rose ® is used for the other 'use cases', because it accesses and includes the entire HL7 RIM specifications and definitions available, thus reducing the time necessary to draw every items as a new model.

Following to this pilot, series of next 'use cases' will be developed with the same approach, until there is saturation (more 'use cases' do not bring new information), and the domain information model for perinatology is finished. In a later stage, the model will then be tested against other medical specialties, to complete it into a national domain information model.

4. Results

The results of the 'use case' intrauterine transport of a baby to a NICU are presented in this section. Fragment of the interview:

"After the baby is born via a sectio ceasarea, it is important to observe it. Determine the gender, is the baby complete / are there visible disabilities, how is it functioning, what is the Apgar score."

A part of a storyboard and interaction table is presented in table 1. This interaction table includes the subject(s) of each storyboard, the sender, the receiver, a meaningful name for the interaction, preferably its goal (like 'referral', 'physical examination', and 'nursing assessment'). Then, the trigger for the interaction is listed (e.g. 'growth of the baby is behind the prognosis date'). The content of the message is listed, which is the complete and detailed set of information that is exchanged between sender and receiver (e.g. number of weeks of pregnancy, skin color of the baby, the Apgar score after 5 minutes). In addition, the current and the preferred means of communication are described (e.g. phone call, EPR).

Finally, the last column contains the expected result of the interaction (e.g. admission, lab value, etc.).

Table 1: Interaction table with fragments of 'Admission to Neonatal intensive care unit (NICU) of the baby'.

Description	#	Sender	Receiver	Name	Trigger event	Information	Form		Expected reaction
							Current	Future	
Admission baby on NICU	7c	Lab	Doctor neonatology	Results	Results available	Values of the different tests	Forms	EPR	Follow up in treatment
	7e	Doctor Neonatology	Röntgen	X-Ray thorax	medical order	Picture of thorax Findings	Form	Order communication	Picture with details of disease
	7j	Nurse	Parents	Instruction	Dangers for baby on NICU	Infection prevention	Verbal Brochure	Verbal brochure EPR	Parents follow procedures

Once the information is clustered, the HL7 RIM classes can be determined. For instance the vital signs of the baby are presented as follows: The relevant top class from HL7 RIM is 'Acts', the relevant subclass of 'Acts' is 'Observation' and a suggestion for a name of the specialization is 'Vitals'. The class 'Vitals' groups the domain information. Then the vitals are listed as the attributes of the class, and the type of value, and if necessary, the value range will be stated. For instance, heart rhythm can be an attribute, and normal, irregular etc, can be the values. (Table 2).

Table 2: HL7 RIM class specialization for vitals of the baby, representing the domain.

Class	Subtype of	Attributes	data type	Characteristics
	Observation	All from Acts and all from Observation	Type of values	Values
Vitals		Heart frequency	(1) Quantitative measurements	:: PQ ::Physical quantity (real number with unit.)
		Breathing rhythm	(6) Nominal results	Regular/irregular
		Nose thrills	(6) Nominal results	Present/absent
		temperature	(1) Quantitative measurements	:: PQ ::Physical quantity

Now this and other specialized classes can be represented in the original HL7 RIM class model, representing the domain specific classes, attributes and relations for perinatology. An example is given for nursing care on the neonatal intensive care unit (Figure 1).

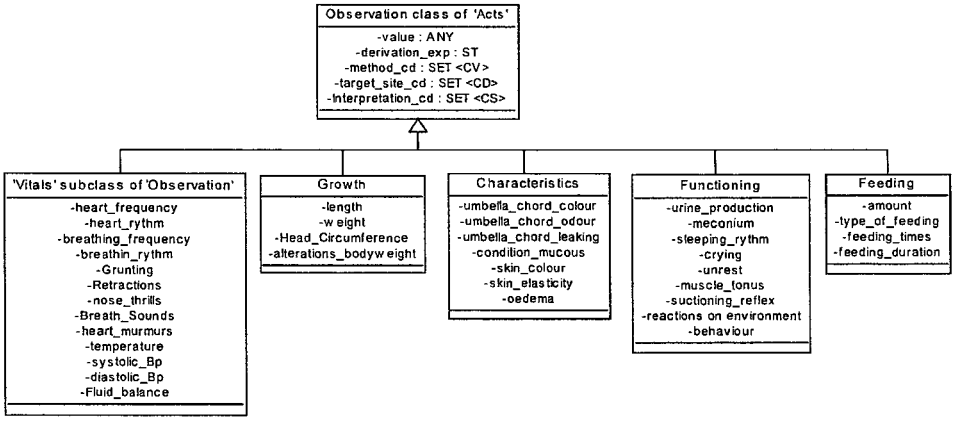

Figure 1: Observations of the baby in neonatal care, representing domain information in HL7 RIM.

5. Conclusion

This paper described developments in the area of a national ICT strategy in the Netherlands focusing on safe health information exchange and to support the development of the EPR. A domain reference information model, fitting with Dutch healthcare and international standards such as from CEN, ISO and HL7 RIM, is considered essential as part of the info structure.

We presented a practical methodology for modeling information from the domain of perinatology, which serves as a first pilot for this work. It proved to be possible to use the HL7 RIM as a tool for drawing up a model representing the information in the domain. In fact, we use the RIM as a design tool for the EPR via specialization of several RIM classes.

However, it is important to know that the specialization described here is not always necessary, or the best approach. Especially in the sense of HL7 as communication standard, the information must be broken down in messages. HL7 RIM facilitates most attributes that are now placed in the specialized classes for this project. It is required to individually analyze each attribute and value in the domain and map it to existing HL7 RIM classes, attributes and vocabularies. However, for the time being the current approach was chosen to allow clinicians to understand better where 'their' information is in the overall model. Verification of the first results with clinicians suggests that this is a feasible approach. Currently, the mapping of the domain information with the existing RIM classes and attributes is underway, resulting in eliminating the specialization and the further identification of classes, attributes and vocabularies adequately representing the domain information in the HL7 RIM.

The most promising result from this approach is the conclusion that the HL7 RIM and modeling methodology bridges the often existing gap between health professionals and ICT technicians. Important aspects are also that the HL7 methodology can be learned and implemented relatively quickly and is maintained and supported by an international organization.

Ongoing work involves additional 'use cases' in the perinatology domain, and further modeling of HL7 Interaction Models and Refined Message Information Models [7, 8]. In the near future we expect to continue this work in other medical domains.

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