Data and Knowledge for Medical Decision Support
B. Blobel et al. (Eds.)
IOS Press, 2013

doi:10.3233/978-1-61499-240-0-177

Interoperability Evaluation Case Study: An Obstetrics-Gynecology Department and Related Information Systems

Mihaela VIDA[a,1], Lăcrămioara STOICU-TIVADAR[a], Bernd BLOBEL[b] and Elena BERNAD[c]
[a] *Department of Automation and Applied Informatics/University "Politehnica" Timisoara, Romania*
[b] *eHealth Competence Center, University Hospital Regensburg, Regensburg, Germany*
[c] *Department of Obstetrics and Gynecology/University of Medicine and Pharmacy "Victor Babes", Timisoara, Romania*

Abstract. The paper presents the steps and metrics for evaluating the interoperability of an Obstetrics-Gynecology Department Information System applied on Bega Clinic Timisoara regarding its readiness for interoperability in relation with similar systems. The developed OGD IS was modeled starting from the Generic Component Model and sends information to other medical units using the HL7 Clinical Document Architecture and Continuity of Care Document standards. The data for evaluation are real, collected between 2009 and 2010 from Bega Clinic Timisoara. The results were relatively good for the investigated data and structure.

Keywords. Obstetrics-Gynecology Department Information System, HL7 CDA, GCM, quality, evaluation

Introduction

Interoperability between different medical information systems facilitates access to information and enhances the safety and quality of patient care despite its location. Information about patients is available much easier electronically and at the same time provides patients and medical professionals with updated and relevant information.

To meet the challenge for efficient, high quality, safe and sustainable care in developing countries, there is a need to extend and improve communication and cooperation between all actors participating in better patients' care by creating interoperable health information systems.

Communication between the information systems under study is critical and has real benefits if the interoperability grade is high. Based on related information from the discussed systems, Clinical Decision Support Systems can be improved during the real process and better medical recommendations can be issued.

[1] Corresponding Author. Vida Mihaela, PhD; University "Politehnica" Timisoara, Romania, Faculty of Automation and Computers; Bd. Vasile Parvan 2, 300223, Timisoara, Romania; Email: mihaela.vida@aut.upt.ro

Communication between different systems and their components in a complex and highly dynamic environment must fulfill several requirements [1], [2]: openness, scalability, flexibility, portability; distribution at Internet level; standard conformance; business process orientation; consideration of timing aspects of data and information exchanged; user acceptance; lawfulness; appropriate security and privacy services

The paper presents the possibility to evaluate, after modeling and developing, the Obstetrics-Gynecology Department Information System (OGD IS) from a quality point of view regarding its interoperability readiness. Resulted information is relevant knowing where improvements can be made to raise the interoperability rate.

1. Modeling, designing and developing the OGD IS

The Generic Component Model (GCM) provided the modeling framework for an obstetrics-gynecology department [3].

The real world workflow of the OGD is described in [4], thereby representing the Enterprise View of the RM-ODP standard.

The steps reflecting the system development process based on the RM-ODP views are:

- defining the analyzed system, in this particular case the OGD IS.
- separation of the domain of current interest (here the medical one) from other domains which are not relevant for the moment (e.g., financial, administrative, security).
- composition/decomposition of the analyzed system, considering four granularity levels (business concepts, relations network, aggregations and details).
- model-driven development of the real OGD system based on the five RM-ODP views previously mentioned.

The OGD was modeled using Business Process Modeling and Notation and using UML from IT perspective [4]. The OGD IS design and developed was presented in [5], [6].

2. OGD IS interoperability

OGD IS is an application developed in Visual Studio.NET 2010, using ASP.NET and C# language. The database design and the application development represent the Engineering and Technology view of RM-ODP standard.

It is important that the OGD IS has the possibility to communicate with other medical units, based on assured interoperability between medical information systems. Figure 1 presents the communication framework between the OGD IS and other medical units.

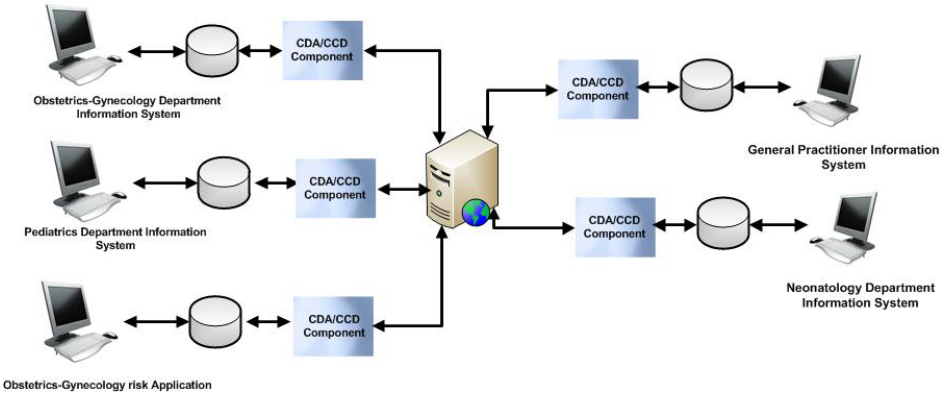

Figure 1. Communication between OGD IS and other medical units

OGD IS is exchanging information with other medical units using two standards: HL7 Clinical Document Architecture (CDA) and Continuity of Care Document (CCD). A standardized communication is needed to ensure a high interoperability degree and to interpret the information in the right manner. The OGD IS communicates using HL7 CDA with: Pediatrics Department, Neonatology Department, Obstetrics-Gynecology risk Application, General Practitioner and using CCD if a medical unit doesn't have information about the patient.

3. Evaluation of the OGD IS

The OGD IS sends patient data to the Pediatrics Department Information System. Figure 2 shows the exchanged data, where the XML's in CDA format contain the data about the birth status during 2009 – 2010. The data is used to compute the interoperability quality of OGD IS. The X – axis represents the number of messages and the Y-axis represents the moths when the data was exchanged.

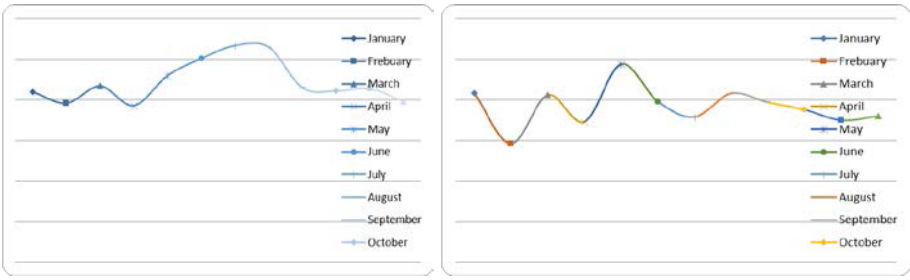

Figure 2. Obstetrics data transmitted from OGD IS in 2009 and in 2010

In order to evaluate the product quality ISO defines eight characteristics [7]: functional suitability, performance efficiency, compatibility, usability, reliability, security, maintainability and portability. In this paper is taken into consideration the interoperability, which is a sub characteristic of the compatibility characteristic.

In order to evaluate the interoperability from a quality point of view for OGD IS, two other applications are studied, one for the neonatology department [8] and the

other one for calculating the risk in an obstetrics-gynecology department [9]. Details about the applications will follow.

The neonatology application has the possibility to retain information about the new born baby, such as: APGAR score, vaccination, consultations. This information can be viewed by physicians or the patient [8].

The second application predicts the pregnancy risk [9]. Knowledge of the risk during pregnancy is extremely important for proper follow-up of mother and fetus with the possibility to intervene promptly and to increase the rate of born children without problems. The system can be accessed under related rights by both obstetricians and by the parents. The management module will act as an administrator's account for users such as health professionals and patients. For privacy reasons, a doctor will have access only to his patients' data. After a physician logs in, he is allowed to process patient data available both from laboratory and from the general database for calculating the pregnancy risk, displaying it in text or graphical form. The Patient module is intended for patients who can view or enter minimal data.

The quality of OGD IS interoperability is investigated after 3 metrics. These metrics are based on ISO/IEC FDIS 25010 [7]. The analysis is made for the interoperability between OGD IS and neonatology department information system, OGD IS and the application computing the pregnancy risk and OGD IS and Pediatrics Department Information System.

The first metric is **data exchangeability** (based on data formats) [7] reflecting how complete the downstream interface functions are for a specified data transfer:

$$X_e = A_e/B_e$$

where,

X_e – data exchange rate

A_e – number of data formats which are approved to be exchanged with other software or system during testing on data exchanges

B_e – Total number of data formats to be exchanged

The result for the neonatology department information system X_e is 0,49 on a scale from 0 to 1. This means that the neonatology department IS needs 49% from OGD IS data capacity. Data capacity means that the neonatology department information system needs 49% of available data from obstetrics-gynecology department information system.

For the application calculating the risk, X_e is 0,25 on a scale from 0 to 1. This means that application calculating the risk for pregnant woman needs 25% from OGD IS data capacity. This small percentage can be an indication that the actual data in the IS are more demographics and reimbursements than clinical data.

The second metric is **data exchangeability** (users' success attempt based) [7] reflecting how successful are the data transfers between the target software and other software applications:

$$Y = 1 - (A/B)$$

where,

Y – user successful data exchange ratio

A – number of cases when the user fails to exchange data with other software applications or systems

B – number of cases in which the user attempts to exchange data

The test was done related to communication between OGD IS and the Pediatrics Department Information System. Y resulted in 0.92 on a scale from 0 to 1 showing that the systems are interoperable in a high degree.

The third metric is **intersystem interface standard consistency** [7] indicating if the standard for the interface design identified in the specifications is followed consistently:

$$X = A/B$$

where,

X – interface standard consistency ratio

A – number of checked items of intersystem interface which are approved at testing that they are consistent with standard/rule of intersystem

B – total number of checked items of intersystem interface

This metric was calculated for the OGD IS and the Pediatrics Department Information System. The result was X = 1, which means that all the interfaces implied in the communication are working as specified.

In conclusion, the OGD IS is prepared to interconnect with the neonatology application and the application for calculation the pregnancy risk. Also, it communicates in a standardized manner with the Pediatrics Department Information System. All the results show that the OGD IS is interoperable with other medical information systems in quite a good proportion.

4. Conclusions

After describing in short how an OGD-IS can be modeled, designed and implemented, this work deploys three metrics to evaluate the interoperability of an OGD-IS from a quality point of view, demonstrating the readiness of the OGD-IS to interconnect with a neonatology application and an application assessing the pregnancy risk. Standardized communication with the Pediatrics Department Information System was investigated. The results show that the OGD-IS is interoperable in a good manner with other medical information systems.

References

[1] Blobel B. Advanced EHR architectures—promises or reality. Methods Inf. Med 2006; 45(1): 95–101.
[2] Lopez D., Blobel B. A development framework for semantically interoperable health information systems. International Journal of Medical Informatics 2009; 78:83-103.
[3] Lopez D. and Blobel B. Formal Design of Electronic Public Health Records. In: Bos L, et al. (eds) Medical and Care Compunetics 3, 337-348. Amsterdam: IOS Press; 2006.
[4] Vida M, Stoicu-Tivadar L, Blobel B, Bernad E. Modeling the framework for obstetrics-gynecology department information systems. European Journal for Biomedical Informatics 2012; 8(3):en57-en64.
[5] Vida M, Lupşe O, Stoicu-Tivadar L, Stoicu-Tivadar V. ICT Solution Supporting Continuity of Care in Children Healthcare Services, 6th IEEE International Symposium on Applied Computational Intelligence and Informatics, SACI, 2011, 635-639.
[6] Lupşe O, Vida M, Stoicu-Tivadar L, Stoicu-Tivadar V. Using HL7 CDA and CCD standards to improve communication between healthcare information systems, 9th IEEE International Symposium on Intelligent Systems and Informatics, SISY, Serbia, 2011, 435-457.
[7] ISO/IEC FDIS 25010, System and software engineering – Systems and software Quality Requirements and Evaluation (SQauRE) – System and software quality models, 2010.
[8] Floran R. Sistem informatic de monitorizare şi comunicare în neonatologie, Graduation work, University "Politehnica" Timisoara, Romania, 2012.
[9] Putan G. Sistem informatic de asistenţă pentru calculul riscului în obstetrică, Master thesis, University "Politehnica" Timisoara, Romania, 2012.