Assisted prescription for improving treatments in Obstetrics-Gynecology Department

Mihaela Crişan-Vida, Oana Sorina Lupşe, Lăcrămioara Stoicu-Tivadar

Department of Automation and Applied Informatics
University Politehnica Timişoara, Romania
mihaela.vida@aut.upt.ro, oana.lupse@aut.upt.ro,
lacramioara.stoicu-tivadar@aut.upt.ro

Abstract. It is important to have all the medical information of the patient on electronic support. At this point it is important that all medical information to be available in real time. Working with a great amount of data the medical staff will need focused information to support their activities related to diagnosis and treatment. The paper presents a tool which supports these activities making suggestions regarding the patient treatments from which the doctor may select the most appropriate one. This tool is tested in the Obstetrics-Gynecology Department from County Hospital Timisoara. The physician can access the Obstetrics-Gynecology Department Information System where he inputs a treatment for the patient or receives suggestions from the system, based on the current diagnosis and specific characteristics of the patient. If the physician considers that the system suggested treatment is good he/she may acknowledge it as such or if not may assess it as not useful. Only in the case that the physician agrees the suggested treatment, it will be saved in the database. Using this information system the physician may use tested treatments that have good results. The big amount of data and economical reasons recommend as technical solution Cloud computing. The proposed solution is easy accessible and easy to disseminate potentially leading to better treatments for the patient improving care.

Keywords: prescription, treatments, xml, ob-gyn, cloud computing.

1 Introduction

Electronic health record systems become reality in the entire world. The computerized medical data and good management drives to more efficient healthcare systems. Using medical records reduces the delay in treatment and medical errors [1]. An electronic health record can be used in a large area, has more complex information, can be accessed from any place and can send information to other physicians when needed.

In Romania one of the most important eHealth projects started in 2003 with the Unique Integrated Information System (SIUI), still growing with other functionalities.

The SIUI platform has modules for accounting, inventory, payroll, finance, maintenance, etc. [2]. From 1 January 2012 National House of Insurance in Romania introduced also the electronic prescriptions in all medical fields. ePrescription is a set of three application, electronic medication records, decision support system and electronic transmission of prescriptions to pharmacy.

The ePrescription module is very important because with the prescription of the drugs occurs the most medical errors. In this process the physician needs to have information about all the characteristics of the patient and about the drugs. Each patient may have distinct reaction on certain drugs according to their specificity. The physician must consider the allergies, age, previous or current diseases, current treatments of the patient and also all the information about the prescribed drug.

It is very difficult for the physician to know all the information about the medication and its effect on a certain person according to their specificity. Also it is difficult to cooperate with physicians from others places for already best confirmed treatments.

In this paper we propose a support for the physicians regarding this issue. It is very important to physicians to interact with the others colleagues to consolidate their decision about certain treatments. The physicians have greater trust in their peers than in computers regarding treatment decision support.

The suggested system supports the physician who can view successful treatments gave from other physicians from anywhere by sending to a global database the diagnostic of the patient and their characteristics. To use a global database that can be accessed by many doctors is useful to benefit of the public cloud computing storage. All the information stored in this huge database in the cloud is not personal information and does not need special security. All treatments and patient characteristics are anonymous.

Cloud computing is already used in medical field with benefits related to accessibility of information and due to economical reasons. Cloud computing in health care services ensure sharing the information, scalability of data and provides more detailed analysis without additional computational infrastructure [3].

The paper is structured as follows: section 2 describes the system architecture. Section 3 presents the Obstetrics-Gynecology Department Information System. Section 4 presents the HL7 Clinical Document Architecture. Section 5 presents the suggested treatments module for the Obstetrics-Gynecology Department system. Section 6 presents the conclusions and sets the target for future work.

2 System description

Fig. 1 presents the system architecture where the Obstetrics-Gynecology Department Information System sends the data to the Windows Azure Cloud where the data are analyzed by the Global Treatments application.

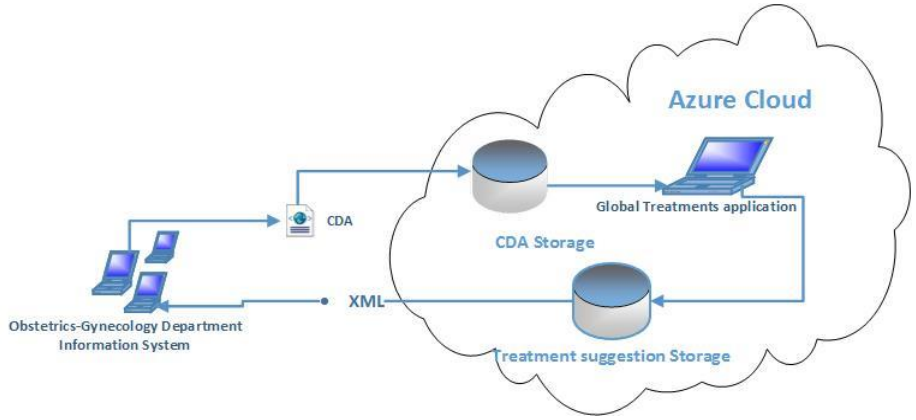

Fig. 1. System architecture

The communication between the OGD IS and the system in the cloud is using HL7 Clinical Document Architecture (CDA) standard and data is stored in a CDA Storage in the Cloud. The Global Treatments application verifies from time to time if any CDAs are available and if yes the next step is to extract the data and to analyze it. Following this, the Global Treatments application creates an XML where the suggested treatments will be added and stored in the Treatment suggestion Storage - database. The OGD IS verifies from time to time the Treatment suggestion Storage and when finds the XML files the application extracts the file and use it.

In the next lines is presented the UML model of the system. It presents one use case and the associated sequence diagram.

UML is a standardized general-purpose modeling language used in object-oriented software engineering field. The OMG (Object Management Group) creates and manages this standard and becomes the industry standard for modeling software-intensive systems [4].

Fig. 2 presents the use case for the treatment. The use case was created using Star UML.

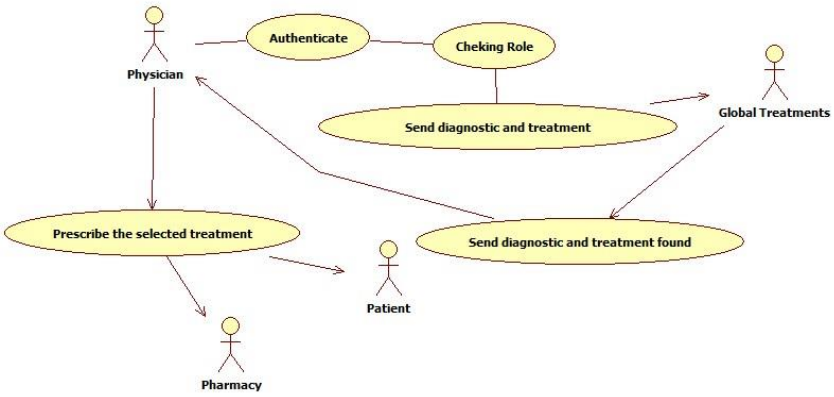

Fig. 2. Use case for how the physician sends diagnostic and treatment to the Global Treatments and after prescribe the selected treatment

Physician: The physician uses the OGD IS to add a diagnostic and a treatment for a patient and will communicate with a system which suggests previously recommended treatments.

Interaction: The scenario starts when a doctor wants to add a diagnostic and a treatment in the patient electronic record. Once the doctor has logged into the system and the system checks that he has the privileges to add information, he can add information to the medical records. After he completes the diagnostic and the treatment the OGD IS sends it to the Global Treatments system where will receive some suggested treatment from which the physician can choose the best fitting his current patient. The prescription will be sent to the patient and to the pharmacy.

Fig. 3 presents the sequence diagram associated to the use case presented in Fig. 2. It describes the actions performed by different actors during time.

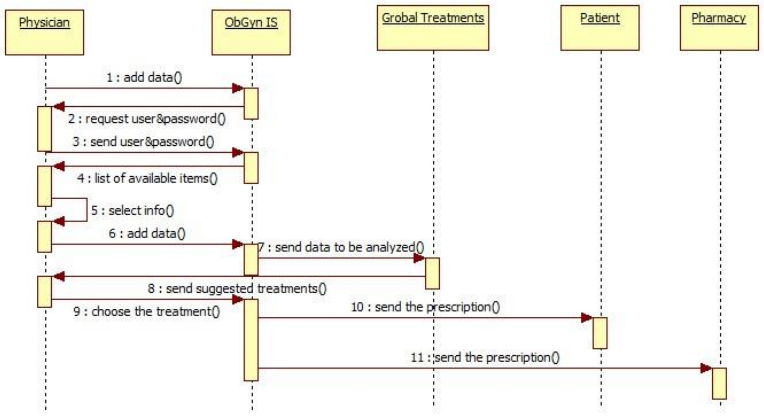

Fig. 3. Sequence diagram associated to the use case for receiving the suggested treatment

Table 1 presents the interaction which occurs in sequence diagram when a physician wants to access a suggested treatment.

Interactions	Description
Interaction 1	Physician adds information to OGD IS
Interaction 2	OGD IS requests username and password to access the system
Interaction 3	Physician sends the credentials
Interaction 4	The OGD IS sends to the physician a menu which contains the sections from where he selects what he wants to complete or check (add obstetrics or gynecology data, or read a report)
Interaction 5	The physician selects from the menu
Interaction 6	The physician adds the patient data
Interaction 7	The OGD IS sends data to be analysed to the Global Treatments
Interaction 8	The Global Treatments sends suggested treatments to the physician
Interaction 9	The physician chooses the treatment
Interaction 10	The OGD IS creates a prescription for the patient
Interaction 11	The OGD IS sends a prescription to the pharmacy

Table 1. Interactions in sequence diagram

3 Obstetrics-Gynecology Department Information System

The system associated with our work is the Obstetrics-Gynecology Department IS. The care for a patient starts even before he/she is born, meaning that it starts during pregnancy. Supporting women's health during pregnancy and birth process based on Electronic Health Record can proove to be very beneficial, having all important lifelong information available [5]. Also, it is important that after birth to insure the continuity of care.

In order to improve the patient health it is important to have all the patient data available, and to use the tools which may improve the health status. Our solution is based on previously available diagnosis and treatments related to specific demographic and medical data of the patient that can be related to an actual case for which a suggested treatment is made available. Finally, the physician decides which treatment is considered more appropriate to his patient.

An Electronic Medical Record related the obstetrics-gynecology department is very helpful in managing the patient data. An EMR contains ultrasound analysis and other relevant information about the patient. It may include also data received by different home systems [5]. A good and useful example is the home fetal surveillance system - a mobile cardiotocograph.

The computer based suggestion for treatments supports the medical staff activity and the patient information (demographic and medical) will be available in real time and easy to access. To help the patient, the system will be available with certain limitations. The data available for the patient is: consultations, diagnostics, admission motivation, patient evolution, lab test results, legal correspondence, image investogations, patient's

photo [5]. The record is comprised from 2 parts, one for obstetrics and one for gynecology.

[6] presents the model of the Obstetrics-Gynecology Department system and [5] describes in detail the OGD IS. The OGD IS is developed in Visual Studio .NET 2010, using ASP.NET and C# language and it is published on Windows Azure cloud. The database is SQL Server available on the Windows Azure Cloud. The OGD IS can be accessed by the medical staff from different locations and the data is always available, the only requirement is the Internet connection. Fig. 4 presents an interface for adding the common gynecology and obstetrics data.

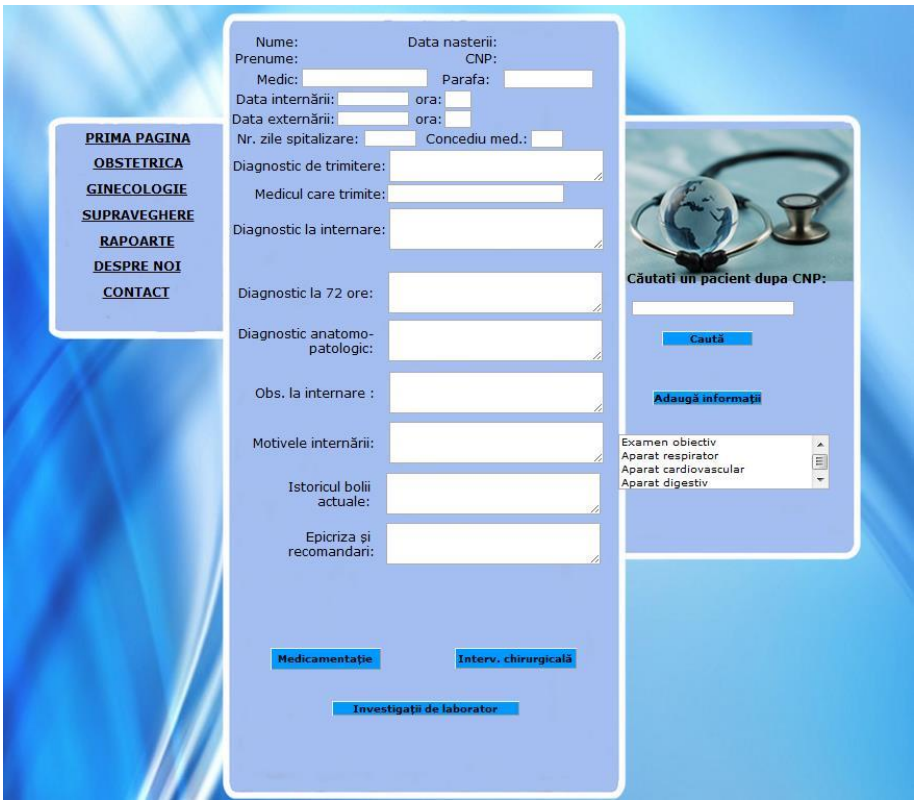

Fig. 4. User interface for adding data into OGD IS

The OGD works with vital and sensitive data related to maternal complications such as severe maternal hypertension, abruption placentae, or endangered fetal well-being, such as intrauterine growth retardation, or non-reassuring fetal state [7]. Reported risk factors include personal obstetrical history, social factors and lifestyle. Currently recognized aetiological risk factors associated with clinical presentation of preterm birth are: medically induced preterm birth, which is maternal (pregnancy hypertension and vascular disorder, medical acute illness or chronic conditions, obstetrical complications, antepartum bleeding or maternal age greater than 35 years); PPROM

(infection, uterine distension, cervical anomalies, Afro-American ethnicity, or disadvantaged population), and spontaneous preterm birth (previous preterm birth, preterm labor, low body mass, poor weight gain, strenuous physical workload, ergonomic factors, uterine anomalies, psychosocial stress, lifestyle, smoking, drug abuse, maternal age less than 18 years). This important cases motivate our application. Recommended treatment plans will be received from the Global Treatments application, and patients who need to complete additional treatments can be identified. In the end, the risk factors can be identified for diseases and conditions [7].

4 Using HL7 Clinical Document Arhitecture

HL7 CDA is a document markup standard that specifies the structure and semantics of a clinical documents [8]. It is an XML file composed from two parts presented in Fig. 5 after [9], the header and the body. It is important that each time a CDA is created, all the information to be present in the header. The body can contain different sections, for example: Medical History or Laboratory Results. This standard is derived from the HL7 Reference Information Model (RIM). This arhitecture can be adapted for progress notes, medications, laboratory results and patient summaries.

```
<ClinicalDocument>
  ... CDA Header ...
  <structuredBody>
    <section>
      <text>(a.k.a. "narrative block")</text>
      <observation>...</observation>
      <substanceAdministration>
        <supply>...</supply>
      </substanceAdministration>
      <observation>
        <externalObservation>...
        </externalObservation>
      </observation>
    </section>
    <section>
        <section>...</section>
    </section>
  </structuredBody>
</ClinicalDocument>
```

Fig. 5. HL7 CDA

For our application the HL7 CDA is uploaded on cloud with treatment information related to a certain disease, and the characteristics of the patient. The CDA is read by the cloud application Global Suggest Treatments. The information is compared with stored characteristics of ohers patients with the same disease. A part of the structure of the CDA is presented in the next figure.

```
<?xml version="1.0" encoding="ISO-8859-1"?>
- <root>
  - <ClinicalDocument xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xmlns="urn:hl7-org:v3">
      <id assigningAuthorityName="Obstetrics-Gynecology" extension="01" root="111"/>
      <code codeSystem="222" code="Obstetrics-Gynecology"/>
      <effectiveTime value="20110609"/>
    - <author>
        <time value="20110609"/>
      - <assignedAuthor>
          <id extension="1" root="1.3.6.4.1.4.1.2835.1"/>
          <code codeSystem="2.16.840.1.113883.5.11" code="SELF"/>
        - <assignedPerson>
            <name>Dumitrescu</name>
            <id>123454</id>
          </assignedPerson>
        </assignedAuthor>
      </author>
    - <custodian>
      - <assignedCustodian>
        - <representedCustodianOrganization>
            <id extension="1" root="1.3.6.4.1.4.1.2835.3"/>
            <name>Departamentul de Obstetrica-Ginecologie</name>
          </representedCustodianOrganization>
        </assignedCustodian>
      </custodian>
        <!--******************Demographics*****************-->
    - <recordTarget>
      - <patientRole>
          <id extension="12345" root="2.16.1.113883.3.933"/>
        - <addr>
            <Judet>Arad</Judet>
            <Localitatea>Arad</Localitatea>
            <Strada>fluturilor</Strada>
            <Numar>2</Numar>
            <Bloc>B45</Bloc>
            <Scara>B</Scara>
            <Apartament>21</Apartament>
          </addr>
        - <patient>
          - <name>
              <Nume>Popescu</Nume>
              <Prenume>Maria</Prenume>
```

...

```
                    .
                - <tr>
                    <td>Data nasterii</td>
                    <td>15.05.1967</td>
                  </tr>
                - <tr>
                    <td>Alergii</td>
                    <td>ibuprofen</td>
                  </tr>
                - <tr>
                    <td>Boli curente</td>
                    <td>Diabet</td>
                    <td>Anemie</td>
                  </tr>
                - <tr>
                    <td>Tratament curent</td>
                    <td>Insulina</td>
                    <td>Fier</td>
                  </tr>
                - <tr>
                    <td>Simptome</td>
                    <td>febra</td>
                  </tr>
                - <tr>
                    <td>Antecedente familiale</td>
                    <td>nu</td>
                  </tr>
                </tbody>
              </table>
            </text>
          </section>
        - <component>
          - <section>
              <code codeSystem="2.16.1.113883.6.1" code="10155-0" displayName="History of Allergies"/>
              <title>Alergies and Adverse Reactions</title>
              <text/>
            </section>
          </component>
        </component>
      </structuredBody>
    </ClinicalDocument>
  </root>
```

Fig. 6. HL7 CDA with patient characteristics and related disease

The document contains important information about the medical history of the patient: current disease, curent treatments, allergies and personal characteristics: date of birth.

5 Treatments suggestion for the Obstetrics-Gynecology Department IS

The most important contribution of this paper is the suggestion of treatments for the assisted prescription to improve activity in the Obstetrics-Gynecology Department. The Obstetrics-Gynecology Department IS sends enquires to the cloud regarding certain treatments for specific patient characteristics and disease in HL7 CDA format. The CDAs and a database with successful treatments are on the cloud (Fig. 7).

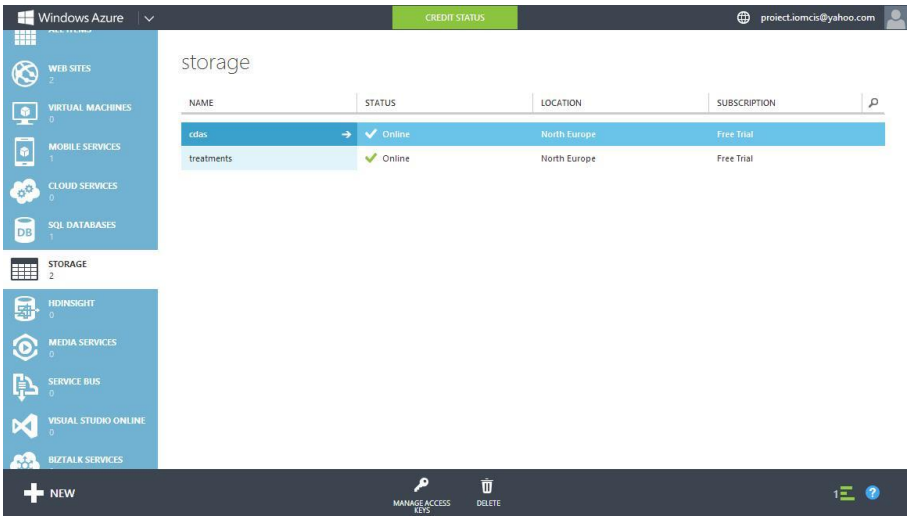

Fig. 7. Azure cloud database

The stored treatments are sent from different physicians information systems. There are the treatments considered successful for acertain disease. When the cloud application finds a treatment for the enquired disease, it builds an XML file with the found treatments. The treatments are expressed as a grammatical unit [10] consituted by name and dose of drugs which have a semantic relation. Treatments are modeled by <Treatment> XML elements. Treatments are formed of <Drug> and <Dose> XML elements that represent the name and the dose of the drug prescribed by the related successful treatment. Each treatment has aassociated the rate of succesefuly treated patients. Fig. 8 presents the XML file.

```
<Disease> pneumonie
<tabTreatment>
...
        <Treatment nState="90% of patients treted">
                <Drug id="1" nextDrug="2">
                        <Name>amoxiciclin </Name>
                        <Dose> 2g </Dose>
                </Drug>
                <Drug id="2" nextDrug="0">
                        <Name>paracetamol </Name>
                        <Dose> 3g </Dose>
                </Drug>
        </Treatment>
        <Treatment nState="80% of patients treted">
                <Drug id="1" nextDrug="2">
                        <Name>tetraciclin </Name>
                        <Dose> 2g </Dose>
                </Drug>
                <Drug id="2" nextDrug="0">
                        <Name>paracetamol </Name>
                        <Dose> 3g </Dose>
                </Drug>
        </Treatment>
...
</tabTreatment>
```

Fig. 8. XML with suggested treatments

This XML file is sent to physician and he/she may choose one of the suggested treatments from the cloud or may prescribe another treatment if considers that this treatment is not good for his patient.

6 Conclusions

The presented paper proposes a new method for the prescription module in Obstetrics-Gynecology Department IS. To help the communication between physicians we use a global database stored in the cloud with successful treatments built by different pyisicians. When a physician wants to consult the suggested treatments database in the cloud he/she sends a request to the cloud with the characteristics and the disease of the patient. If the database has a treatment for this disease and the patient has the same characteristics the application from the cloud sends a suggested treatment to the physician, adn he/she may accept it or not.

This method is more convenient for the physicians because all the suggestions are given from their peers and not from a computer diagnosis system. This aproach raises the confidence of the physician in the medical application.

As a future work we will develop the suggestion treatment system accordingly for each accordingly each particularity of medical departments and with more detailed information about the disease and the treatment, followed by statistical analysis of each treatment and suggesting physicians the best treatment from the available ones.

7 References

1. Patrick Kierkegaard, Electronic health record: Wiring Europe's healthcare, Computer Law & Security Review, Volume 27, Issue 5, September 2011, Pages 503-515, ISSN 0267-3649, http://dx.doi.org/10.1016/j.clsr.2011.07.013.
2. D. Farcas, J. Artmann, J. Heywood and Jos Dumortier, Country Brief: Romania, European Commissio, DG Information Society and Media, ICT for Health Unit, October 2010
3. Bens Pardamean and Rizal Ricky Rumanda. 2011. Integrated model of cloud-based E-medical record for health care organizations. In Proceedings of the 10th WSEAS international conference on E-Activities (E-ACTIVITIES'11), Ford Lumban Gaol and Jiri Strouhal (Eds.). World Scientific and Engineering Academy and Society (WSEAS), Stevens Point, Wisconsin, USA, 157-162.
4. UML, OMG Unified Modeling Language (OMG UML), Superstructure, Version 2.2, 2009
5. M. Vida, O. Lupse, L. Stoicu-Tivadar, V. Stoicu-Tivadar, ICT Solutions Supporting Continuity of Care in Obstretics-Gynecology and Pedriatics Department, Proc. 9th International Conference on Information Communication Technologies in Health, ICICTH 2011, Samos, Greece, ISBN: 978-960-466-083-4, Jul. 2011, pp. 108-120
6. M. Vida, L. Stoicu-Tivadar, B. Blobel, E. Bernad, Modeling the framework for obstetrics-gynecology department information systems, IHIC Conference, 2012, publicat in European Journal for Biomedical Informatics Vol. 8, Issue 3 "Standard and Solutions for ehealth Interoperability of the European Journal of Biomedical Informatics", 2012
7. J.M. Moutquin, Clasification and heterogeneity of preterm birth, International Journal of Obstetrics and Gynaecology, Vol. 110, 2003; 20 -33
8. HL7 Clinical Document Architecture, Release 2.0, HL7 version 3 Interoperability Standards, Normative Edition 2009, Disk 1 – Standards Publication.
9. R.H. Dolin, L. Alschuler, S. Boyer, C. Beebe, F. Behlen, P. Birol, A. Shabo, HL7 Clinical Document Architecture, Release 2, J. Am Med Inform Assoc., 2006, 13(1): 30-39
10. Ciprian-Bogdan Chirila, A Dialog Based Game Component for a Competencies Based E-Learning Framework, 8th IEEE International Symposium on Applied Computational Intelligence and Informatics (SACI), pp. 055-060, ISBN 978-1-4673-6398-3 (pendrive); 978-1-4673-6397-6 (printed), Timisoara, Romania, May, 2013