Software Module for Clinics of Neurology as a Part of Medical Information System Medis.NET

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***Abstract* – This paper presents software module that provides all necessary functionalities for clinics of neurology. Module Medis.Neuro has been developed at Faculty of Electronic engineering in Niš as a part of goverment project which is funded by Ministry of Science and Technological Development of Serbia, for needs of Clinic of Neurology in Niš. Medical information system MEDIS.NET has been developed under mentioned goverment project that covered most of funcionality which one modern medical information system should provide for healthcare institutions in Serbia. One of developed moduls under MEDIS.NET is modul Medis.Neuro. Collaboration with primary healthcare institutions is also presented in this paper. Data exchanging between healthcare institutions is realized using web services on both sides.**

***Keywords* – software module, information system, clinic of neurology, health care, Medis.Neuro, Medis.NET, web services.**

I. INTRODUCTION

Neurology is a medical specialty concerned with diagnosis and treatment of all categories of disease involving the central, peripheral, and autonomic nervous systems, including their covering, blood vessels, and all effectors tissue, such as muscle [1]. Now it is common that each clinical center has special department for neurology. Modern department for neurology requires modern medical equipment which includes electronic devices such as contemporary scanners, MRI (magnetic resonance imaging), modern surgery room with precision medical instruments and sophisticated information system for tracking patient disease and treatment history (anamnesis).

The Clinic center of Niš is one of the bigest health care clinic centers in Serbia which also includes Clinic of Neurology. Number of patients that visited Clinic of neurology in Niš from 2000 to 2007 is shown on Figure 1.

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Patient at health center receives referral for hospital treatment. Referral usually contains information of location where patient is referred, date of referral validity, referral diagnose and referral text.

At the moment patient arrives at clinic of neurology, it is necessary to establish his anamneses. That includes examination of large number of parameters in order to determine correctness of discussion about current condition of the patient. After reception of patient at clinic of neurology, his condition is constantly monitored: different kind of analysis and tests are conducted. Large numbers of parameters are recorded. Some of the parameters need to be measured with great frequency and to be compared with previous parameters for observation of the course of treatment. All the facts mentioned above indicate on existence of a large amount of data stream that must be stored in efficient way. Data access must be efficient, as well. Chronic diseases as well as some specific (vital) diseases that patient had can be of great importance for further therapy. All that is stored in patient's health record which can be found in Health Center Niš. Data searching can be difficult and exhausting task with great possibility that such data is nonexistent or lost. There are some situations where patient has no possibility to bring necessary data from health center as well as to properly answer on relevant questions at clinic of neurology. After hospital treatments, patient receives discharge letter that need to be forwarded to chosen general practitioner at health center.

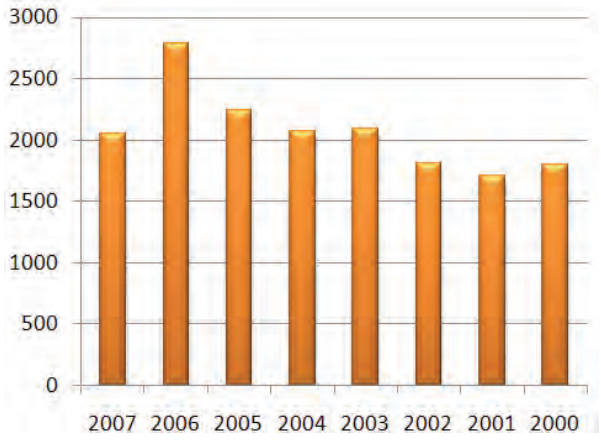

Fig. 1. Number of patients for period 2000 to 2007 at Clinic of Neurology Niš

All the facts mentioned above refer to conclusions that application of information system at clinic of neurology is essential as well as necessity in its modern conduct.

Information system should provide efficient input, review and searching of vast amount of data, to represent comfortable and user-friendly environment for the end users [2]. When applied, information system should provide and accelerate necessary data transfer. The fact mantionend above is refered to the use of information systems at clinic of neurology and at health center, as well as collaboration between them. At the same time it should provide access only to data (from electronic health record) which are significant for the clinic of neurology. During data exchange, it is necessary to encrypt sensitive data for the reasons of preventing abuse in case of their interception. At the end, OLAP cubes can be created against database to extract required statistics.

In the design and development of Medical information system MEDIS.NET (realized at Faculty of Electronic Engineering in Niš, as part of the project of Ministry of Science and Technological Development of Serbia and Health Center Niš as one of the project participants) there was a requirement for developing clinic of neurology module [3]. Proposed solution demonstrates most of functionalities that one modern and efficient module for clinics of neurology should have. Part of mentioned functionalities will be described in the following section.

After introduction, same functionalities of module for clinics of neurology are presented in this paper. Architecture view of module is given after the section which describes module functionalities. At the end of the paper, after architecture view, there is a short conclusion.

II. Overview of Module Medis.Neuro Functionality

After correct logging on the system, user enters application Medis.Prijemna. Application interface appearance is different for different users. It depends on user privileges which are defined by the system administrator [4]. If active user is an employer at clinic of neurology, and if he has privileges which are defined by module for user privileges configuration, module Medis.Neuro will appear. Medical nurses and doctors should not have access to the same patient's medical data (some of them should have access to read data, other to create new records and to update existing). All data entered and stored in database are without possibility of physical removing. Instead of deleting record, flag invalid data is set in database tables for all rows which became invalid. Most of the data are sensitive so it is recommended to add status attributes for each row: who added record, date and time of adding record, who set status flag for specific record (record is valid, record is invalid, new version of it exists, record is deleted) and timestamp when this action was executed. This is necessity for tracking all changes in done against the data source.

When receiving patient at clinic of neurology, the action of searching and finding patient's data need to be performed by the system. Searching the patient can be done using following search criteria: unique personal number (JMBG), insurance number (LBO), first name, last name. Different combinations of the mentioned filters for searching can be used. Usage of barcode reader is also available. When searching for patient through database does not give results, adding the new one is possible. Updating all demographic patient information found in the database is also allowed. After finding (or adding) the patient, user can access all functionalities of the module of neurology Medis.Neuro by clicking to the button "Active history of diseases". After that, main form of mentioned module appears on the screen. Appearance of the main form is shown in Figure 2. Functionalities of this module are organized by tabs (*Reception*, *Clinical findings*, *Diagnostic methods*, *CTM*, *Scale for patient evaluation*, *Temperature list*, *Drugs and materials*, *Discharge*, *Exitus*). All forms show basic information about selected patient for the reason of notifying user about the patient constantly. Software tool for rapid development and customization of medical information systems, developed at Faculty of Electronic Engineering Niš (in mentioned government project), is used to generate some of module forms [5].

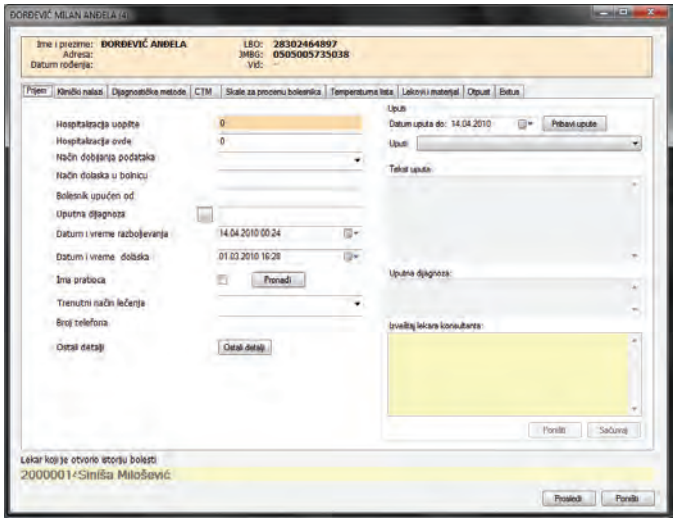

Fig 2. View of the module Medis.Neuro main form

Reception tab refers to patient's reception at clinic of neurology. It is necessary to fill all basic information about the way of patient's arrival, who brought him, number of patient's arrivals at clinic of neurology (it is assumed that he was there before, but not necessary), date when patient came, date when disease begun, patient's phone number. By mouse click on the button *Other Details*, special form will appear for more details. The right side of the main form contains details about the patient's referrals. The referral that was written by doctor at health center can be retrieve to the clinic of neurology by using web service which is the property of health center. This action can be done from the module Medis.Neuro main form, but the assumption is that health center uses our information system MEDIS.NET also. On this way doctor at clinic of neurology is immediately able to see referral from the health center with details: date when referral was created, referral expiring date, referral's text and reception diagnoses. Also, doctor can give his opinion that will be saved at the health center database over available web service (right side of the main form).

Data obtained by patient examinations can be entered at form tab *Clinical findings* (Figure 3) (*headaches*, *current*

disease, personal anamneses, family anamneses, psychological status, status praesens, status neurologicus, internist examination, decursus). Each form has numerous parameters. That is the reason that clear and good design of the forms with numerous parameters in exactly defined order is required, so the end users could have an easy way of navigation through the forms. There are possibilities to add new data record for each examination. Any new entries are always stored with a new date. Depending on available privileges, logged user can update examination records for selected date.

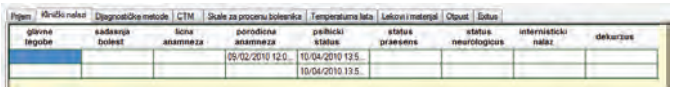

Fig 3. Example of some *Clinical findings* for selected patient

The patient's examinations, using diagnostic devices and diagnostic skills, are provided by *Diagnostic findings* and *CTM* tabs on the main form. These tabs support next examinations: *fundus, liquor, biochemical tests, haemostatic status, urine, acid-base status, Doppler, angiography, CTM infractus cerebri, CTM haemorrhagio, CTM of reduction changes*. Module can be integrated with biochemical laboratory information system (LIS) for accepting results after performed analysis [6].

Scales for evaluating patient's condition are *Glasgow coma scale, European stroke scale* and *Barthel's index*. All scales are on the tab *Scale for patient evaluation.* Each scale is presented as special form with parameters which can be chose from combo box list. Each parameter's value has specific weight. After filing parameters, the sum of them all represents evaluating factor.

merenja	16/02/2010 11:31:27 AM	16/02/2010 11:31:11 AM	16/02/2010 11:30:55 AM
temperatura	40.000	38.900	37.500
sistolni_pritisak	70.000	100.000	120.000
dijastolni_pritisak	40.000	60.000	89.000
puls	40.000	60.000	75.000
napomene			

Fig 4. Graphical representation for measured *temperature*, *blood pressure* and *pulls* as part of tab *Temperature list*

Tab *Temperature list* is graphical representation for measured *temperature, blood pressure* and *pulls* on the specific date (Figure 4). This way monitoring of mentioned parameters at selected date is very easy.

Tab *Drugs and materials* is referred to applied therapy and given therapy. Monitoring of prescribed and used medication can be done with this tab.

If patient dies at clinic of neurology, it is necessary to write some note about that at tab *Exitus* at the main form. Tab *Discharge* covers all necessary data that must be entered when patient ends his treatment(s) at clinic of neurology. Discharge date, in what condition patient was discharged from hospital as well as discharge letter, is necessary to be filled out. When patient comes at health center, doctor, using the web service from clinic of neurology can get discharge letter at the patient's electronic health record (EHR).

Finally, OLAP cubes can be created on database to extract required statistics for improving quality of given medical care and service as well as improving methods of patient treatments.

III. Architecture View

For module developing we have utilized a classic three-tier architecture which includes three logical layers (data layer, business layer and presentation layer). The logical layers are shown in Figure 5.

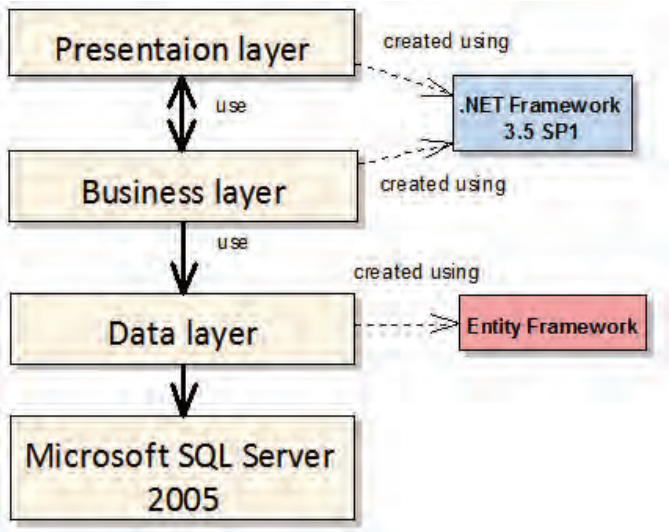

Fig. 5. Three-tier architecture of module for clinics of neurology

Data layer is implemented under business logic layer. The function of this layer is to access directly the database, i.e. to accept data from database and forwards them to a higher layer. On the other hand, it is necessary to accept data from business logic layer and store them to the database. Data layer is implemented by using Microsoft Entity Framework [7]. Microsoft SQL Server 2005 is used for database platform. With small changes in this layer there is possibility to connect module with different database platforms.

Business logic layer contains all the necessary functionality of this module.

Presentation logic layer was implemented by using .NET Framework 3.5 SP1. This layer should provide easy and simple way of using application by end users. Primary objective of this layer is fast and easy data entry.

The doctor from health center can write referral for patient's hospital treatment by using electronic health record (EHR). When patient arrives at the hospital for treatment, (clinic of neurology in this case), doctor can receive written referral from health center by using web service which is the property of health center where referral is originally made. Web service at clinic of neurology provides to doctors in health center possibility of receiving discharge letter over the internet. Received data from clinic of neurology (discharge letter) is available to doctor at health center as any data in electronic health record. All sensitive data (method parameters) are encrypted within the request sent to web service. Web service decrypts data in calling method which was called by client application. After that, web service processes request and try to find searching data in the database. Required data are sent as a response to the request of client application. Before sending data, sensitive data are encrypted in web service method and then sent over the internet to the client application in health center. Client application must decrypt received data. Finally, data can be shown to doctor through client application (EHR) in health center. At the end of the process, health center doctor can see patient's discharge letter. DES algorithm is used for data encrypting. In this way interception of sensitive data and their abuse is prevented. Figure 6 shows entities which participate in data exchange and their interconnection.

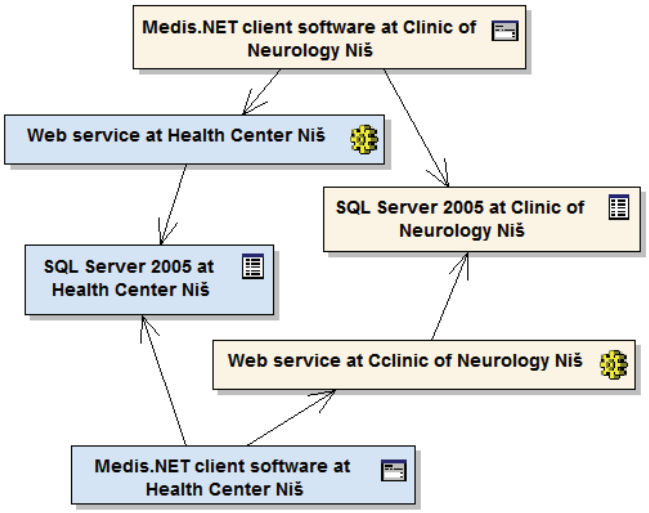

Fig. 6. Data exchange between information system at Health Center of Niš on one side and information system at Clinic of Neurology of Niš on the other side

IV. Conclusion

The existence of modern working processes at clinics of neurology demands using of modern information system. This paper describes software module Medis.Neuro as a part of medical information system MEDIS.NET that provides most of the required functionalities of clinic of neurology. Application of module Medis.Neuro should improve business of clinic of neurology trough accelerating working process (avoiding multiple data input), easy monitoring patients' condition, easy access to the large amount of important data for patient treatments to doctor, extracting statistics for improving quality of given medical care and service. The daily routine of work is established, so this module should not come upon to resistant of the medical personal (end system users) [2]. It is in coordinated with natural input of data as well as with natural order of necessary examination. Medis.Neuro is reliable for all clinics of neurology in secondary health care. A complete adjustment of this module has been done for concrete necessities at Clinic of Neurology in the Clinical Center Niš.

Created module is in the test phase and experimental work, in order of showing advantages and disadvantages. After the optimization phase, it will be implemented at the Clinic of Neurology Nis.

Thanking Note

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