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## Electronic Patient Record and Archive of Records in Cardio.net System for Telecardiology

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In modern medicine the well structured patient data set, fast access to it and reporting capability become an important question. With the dynamic development of information technology (IT) such question is solved *via* building electronic patient record (EPR) archives. We then obtain fast access to patient data, diagnostic and treatment protocols etc. It results in more efficient, better and cheaper treatment. The aim of the work was to design a uniform Electronic Patient Record, implemented in cardio.net system for telecardiology allowing the co-operation among regional hospitals and reference centers. It includes questionnaires for demographic data and questionnaires supporting doctor's work (initial diagnosis, final diagnosis, history and physical, ECG at the discharge, applied treatment, additional tests, drugs, daily and periodical reports). The browser is implemented in EPR archive to facilitate data retrieval. Several tools for creating EPR and EPR archive were used such as: XML, PHP, Java Script and MySQL. The separate question is the security of data on WWW server. The security is ensured via Security Socket Layer (SSL) protocols and other tools. EPR in Cardio.net system is a module enabling the co-work of many physicians and the communication among different medical centers.

### Introduction

Modern medicine, assisted by the latest achievements in the field of computer science, may nowadays help to cope with many diseases difficult to be treated before, prevent them and treat them quickly and effectively. Computer science tools such as hardware, software and high level of communication with the systems support physicians' work actively. Large medical centres using computer methods improve their ability both in medical and administrative aspects.

The project of the teleinformatic system Cardio.net for the complex cardiological care, is an example of making qualified healthcare. It's being more effective by using the latest developments in medical informatics, like Electronic Patient Record (EPR). The EPR ensures faster (real-time)

access to the medical data of patients, and thus lowering the hospital costs of treating patients. Unlike the paper medical record, the EPR will be easy to read, systematised, and more useful.

To work with the EPR, a potential user (a physician) will have to log to the database and to search it by writing a keyword in the web browser: the name of the patient, the disease, the drug, the date of birth and so on. Depending on search objectives, the results obtained will vary. When we search for a patient named Kowalski, we may obtain the relevant information if such patient exists in the EPR database and if he is the one we are looking for. If this is the patient we are searching for, there will be a possibility to read the record of his disease, to add a new disease for this patient without the necessity to fill in some data again (for example in case of another hospitalization, removal to another ward or another hospital), to add new data to his record and so on. If the patient does not exist in the database, a physician will be able to add such patient by filling in the electronic form written in PHP. An example of such a form is shown in Figure 1.

The developed EPR has forms of personal data (i.e. demographic ones, and those concerning the family doctor), and form supporting the physician's job (i.e. tentative diagnosis, the final diagnosis, case history - the so called anamnesis prior to hospitalization, physical examination - the so called anamnesis during hospitalization, the clinical course of hospitalization, ECG on admission to hospital and on discharge from hospital, additional tests and drugs). To make it more comfortable and to encourage the use of the EPR, physicians will have a possibility to print daily and periodical reports concerning treated patients. Such reports will not have to be filled in again by writing them manually. The database of the patients has drugs and diseases database built into the system. There will be a possibility to add both new drugs and diseases. There will also be a possi-

Fig. 1. The example of electronic forms.

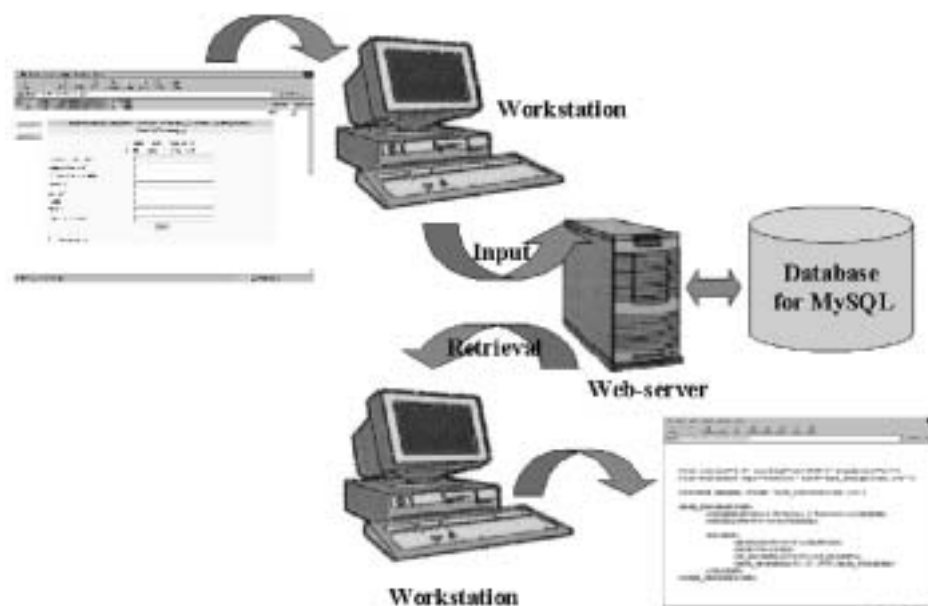


Fig. 2. Data acquisition and retrieval from database server.

bility to save the ECG printouts in electronic files such as jpeg, gif, or pdf.

The system will enable to use knowledge and experience of distinguished cardiology and cardiosurgery specialists *via* teleconsultations on the basis of the patient data collected within the EPR and using Internet. The system will also enable access to unified and distributed digital archives of cardiological data.

## Tools

A general outline of the EPR was designed at the Department of Medical Informatics in co-operation with the physicians of the Cardiology Clinic of the SP CSK University Hospital in Warsaw. The EPR is aimed

to be implemented on a separate server, under the Unix system. The Web server should have the PHP module <http://www.php.net> to the database server (Apache) <http://www.mysql.com>. This means that the PHP tool is built into the WWW server, which helps to search the website faster and at the same it time performs the role of a "glue" making it easier to connect WWW websites to the databases. The PHP [2] originates from Hypertext Preprocessor. It is a combination of the programming language and the application server. The term "application server" means a programme that connects a few techniques in one batch. Those techniques include:

- rich programming language,
- access to the database to save data permanently,
- internet protocol service, especially of e-mails, and HTTP.

```

<?xml version="1.0" encoding="iso-8859-2" standalone="no"?>
<?xml-stylesheet type="text/xsl" href="dane_demograficzne.xsl"?>

<!DOCTYPE BADANIA SYSTEM "DANE_DEMOGRAFICZNE.dtd">

<DANE_DEMOGRAFICZNE>
  <OSRODEK>Akademia Medycyna w Warszawie</OSRODEK>
  <ODDZIAŁ>Kardiologia</ODDZIAŁ>

  <PACJENT>
    <NAZWISKO>Kowalski</NAZWISKO>
    <IMIE>Jan</IMIE>
    <ID_PACJENTA>2022100</ID_PACJENTA>
    <DATA_URODZENIA>12.12.1962</DATA_URODZENIA>
  </PACJENT>
</DANE_DEMOGRAFICZNE>

```

Fig. 3. The example of an XML-file.

A relational database MySQL <http://www.apache.org/dist/>, constituting one of the Apache server parts is used to design the EPR structure. This database should be designed in such a way that the data would not have to be doubled (if only this is possible). Properly isolated data groups should be responsible for:

- keeping data about patients,
- navigation of the physician in the EPR,
- administrative functions.

Having a closer look at Internet applications one will find two streams of data: one to the web-server taking data from the presented forms and another out of the web-server when the collected data is usually presented in a textual style (Fig. 2).

Another tool used to create the EPR is Java Script (JS), <http://www.jsguide.simplenet.com>. It is a script language adapted to create interactive WWW websites. Scripts (that is simple, not compiled programmes) are most often coded in HTML and also in XML <http://www.w3c.org/XML>. The code of JS is similar to Java <http://java.sun.com>, but in contrary to that language, JS scripts are not compiled - the source code is interpreted by the web browser from basics. A set of built-in objects accessible by the web enables the JS to communicate with the user, to manipulate the websites' contents, to help in navigation and to be protected in some way from unexpected visitors.

The EPR will also use the XML language, which is the so-called basic data format intended for net services. XML is a simplified version of SGML intended for Internet publications. Its application is understandable because data in XML format are easy to save and read, and the language itself is independent from the provider and the platform. The only problem is that XML [1] does not have established data types and the net services may use for this purpose a few standards of data description: XML Schema (XSD), DTD (Document Type Definition), XML-data and so on. The, DTD standard, was chosen for EPR. The following style sheets can be used: CSS (Cascading Style Sheets), XSL

(Extensible Stylesheet Language), or DSSSL (Document Style Semantics and Specification Language) to present the XML document or to change its form. In the EPR XML is used to save documents and to send them with net protocols: HTTP, SMTP, FTP or others. Figure 3 shows an example of such an XML document.

Electronic Patient Record is ready to adapt quickly to HL7 (Health Level Seven), <http://www.hl7.de/> standard which includes exchange of intrahospital and interhospital information.

## Administrative Functions and Safety

These issues are the most important EPR aspects. They will decide about access rights and safety of the database. Administrative functions will be responsible for logging in and granting rights to particular users. In brief, they will decide about functionality and the quality of user interface in the service. The safety issue is very important because of the confidentiality of data. For that reason protections of both the WWW server by the communication protocol SSL (Secure Socket Layer) created to send data and to log in to the database will be introduced. The other applications using that server shall be protected additionally against potential hackers, starting from the data verification in the questionnaires and ending with the access to the database. The database will not be accessible to unauthorized persons.

## Conclusion

The EPR in the Cardio.net system is a tool linking the physicians' work and providing better communication among different medical centres. The EPR is also an electronic language of medical data exchange with the help of XML and Internet usage. Locally the EPR will contribute to better description and clarity of patients' records, faster access to both individual and multiple, similar cases. It will, no doubt, affect positively the exchange of experience and access to the knowl-

edge of highly qualified specialists in cardiology. The data collected in the EPR can be of use in numerous scientific works, in statistics as well as in medicine. Because of its global character and HL7 implementation the EPR will enable Polish doctors to benefit from western experience, as well as from the recommended management of individual cases.

### References

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