Integrated Access to Function Test Results from within a Cardiology Information System

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Abstract

A dedicated Cardiology Information System (CARIS) has been developed in our department to record all information pertaining to studies performed in the cathlab and pacemaker lab. However, information stored in other systems in the cardiac function lab was not available in CARIS. This includes ECGs (rest ECGs, stress ECGs and Holter ECGs), and reports from echo studies and stress ECG studies. Data obtained from these functional studies are stored in various database systems. For each of these systems a different, dedicated interface was developed to allow the cardiologist to obtain access to the data from within CARIS. These results show that integration of all information available in the Cardiology department is well feasible.

Presently, we are developing a completely new version of CARIS that will allow optimal integration of Cardiology based information (as well as in the CARIS database, as in separate systems) with the data in the Hospital Information System.

1. Introduction

Historically, the Hospital Information System (HIS) mainly stores general clinical information from patients, such as patient demographics, appointments, discharge letters and lab results. It is not possible to use the HIS to store more detailed information from investigations performed at the Cardiology department, for instance at the catheterisation lab or pacemaker lab. For this reason a dedicated Cardiology Information System (CARIS) has been developed by the IT-group of our department (Cardiology). The CARIS system consists of a central Oracle database server, and a client application developed in Borland Delphi. Angiographic images obtained in the cathlab are stored in DICOM format on an image server (CURAD). Echocardiographic images are stored on an image server in the GE-Vingmed ECHOPAC network. The images can be selected and viewed from within CARIS.

In contrast, information obtained in the cardiac function lab, which is stored in systems separate from the CARIS system, was not available in CARIS. This included ECGs (rest ECGs, stress ECGs and Holter ECGs), and reports from echo studies and stress ECG studies. Figure 1 gives an overview of some of the systems that are connected to CARIS.
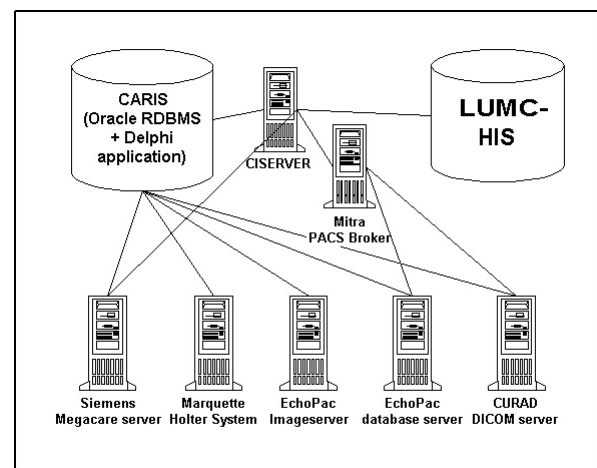

Figure 1. Schematic overview of all systems that are connected to CARIS and that contain clinical information.

2. Methods

Data obtained from the functional studies are stored in various systems. The rest-ECGs and reports are stored in a Siemens Megacare ECG-management system. Holter ECGs are analysed using a Marquette Muse system; the Holter-ECGs can be exported as (Adobe Acrobat) PDF files. Reports from echocardiography and stress-ECG studies are routinely stored in a FileMakerPro database. For each of these systems a different, dedicated interface was developed to allow the cardiologist to get access to this data from within CARIS. The interfaces that have been developed will be discussed below in more detail.

2.1. Rest-ECGs

The rest ECGs are stored in a Siemens Megacare ECG management system. It runs on a Microsoft SQL Server under Windows-NT. The retrieval of the ECGs is implemented as a two-stage process: first, the Megacare database is queried (using ODBC) whether data from a specific patient (which has been selected in CARIS) is available; the study instances that were found are displayed in CARIS in an 'Explorer'-like view as shown in figure 2 (left panel). Then, when the user selects one of the study instances by clicking on it, the ECG is retrieved via a Java applet and shown (as a PDF file) in the right panel (see figure 2). To get access to the database, and to be able to use the Java applet, two special accounts are created in the Megacare system. The username and password of both accounts are stored in the CARIS application. Users can only access the ECGs and reports via CARIS after logging in into CARIS with their CARIS username and password.
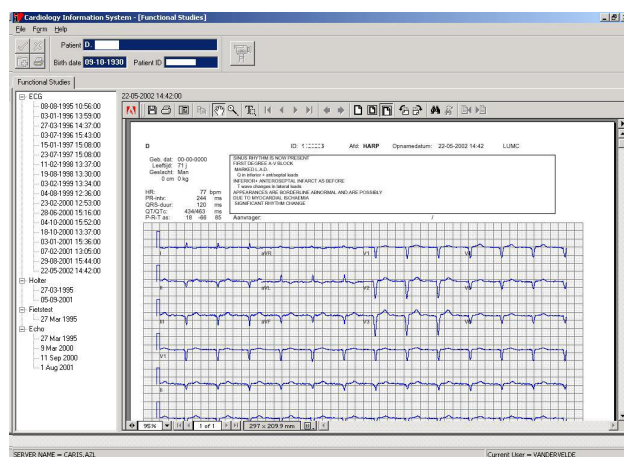

Figure 2. Screenshot of the functional test module in CARIS. At the left, all available studies for a specific patient are shown in an 'Explorer' view. One of the rest-ECG studies has been selected, and the corresponding ECG from the Siemens Megacare system is retrieved and shown in the right panel.

2.2. Holter ECGs

Holter ECGs are analysed using a Marquette Muse system; the Holter-ECGs can be exported as (Adobe Acrobat) PDF files. These Holter ECG PDF files are then stored in a temporary directory on a fileserver. The PDF file is given a name that contains the patient's hospital ID and the study date ('hook-up date'). A special polling

application has been created that checks regularly whether Holter PDF files available on the fileserver. If so, the application checks whether the patient ID and study date are valid. If so, the Holter PDF file is moved to another server; the patient ID, study date and the location of the PDF file are stored in the CARIS database. If the patient ID / study date were already in CARIS, the original PDF file is overwritten.

Since information about the presence of Holter data is already stored in the CARIS database, the availability of Holter ECGs for a specific patient can be easily looked up and displayed in the left panel of the application (see Figure 3). When the user selects a certain study, the corresponding PDF file is retrieved from the server and shown in the right panel (Figure 3).
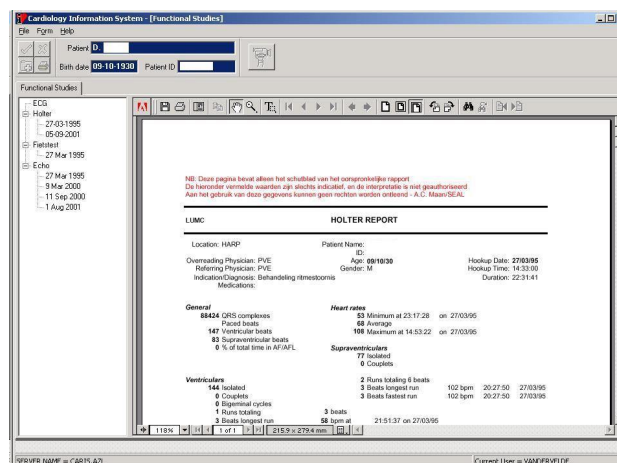

Figure 3. Screenshot of the functional test module in CARIS, now showing the Holter report for a specific patient and a specific study date.

2.3. Echocardiography and Stress-ECG reports

Reports from echocardiography and stress-ECG studies are routinely stored in a FileMakerPro database. In the echo lab, a GE-Vingmed EchoPac network has been implemented, with 3 echocardiography scanners, and a number of (Macintosh) EchoPac workstations to analyse the images. All echocardiographic images from 1994 until today are on-line available on a Macintosh server.

Since the cardiac function lab has traditionally used FileMaker as their database software, the measurements and report are copied from the EchoPac database to the FileMakerPro database. Furthermore, reports from the stress-ECG tests are entered in a separate stress-ECG

module in the FileMakerPro database. The clinical information in the FileMakerPro database has been made available through the whole department via a web services implemented with Lasso and Lasso scripts on a dedicated web server.

To access the information in the FileMakerPro database from CARIS, a similar two-stage process as for the Megacare connection has been implemented. Using a NMHTTP component (in Delphi) a HTML script file is created and stored on the Lasso web server. When this script is run, it retrieves the echo or stress-ECG study-instances from the FileMakerPro database. If available, they are shown in the left panel with the other study instances found (see Figure 4). Then, when the user selects one of these studies, another Lasso script is run that retrieves the report and sends it as a HTML page to CARIS. CARIS then displays this as a web page in the right panel (see Figure 4).
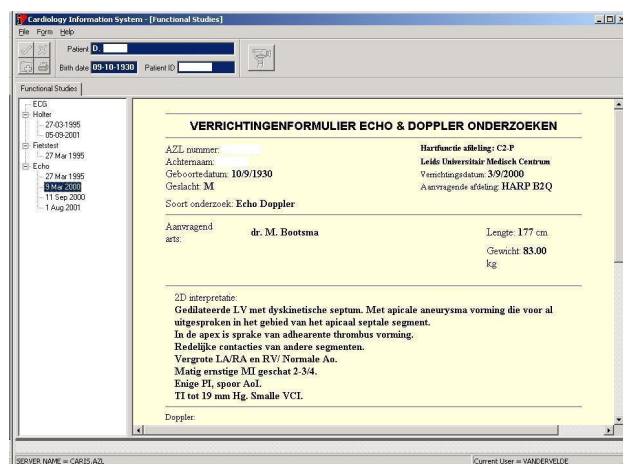

Figure 4. Screenshot of the functional test module in CARIS, with the report of an echocardiography study displayed as a HTML page (in the right panel). The Lasso web server has created the HTML web page on the fly.

3.   Discussion, future developments

The availability in CARIS of the results from all cardiology function tests has proven to be valuable and often crucial in the evaluation of patients. However, integration with information from other departments and the central hospital (mostly stored in the Hospital Information System) is still not optimal.

Presently, a new version of CARIS is being developed based on a new, three-tier architecture, as part of a nationwide project: the Electronic Patient Record for Cardiology (EPDCAR). This new architecture will allow optimal integration of Cardiology based information (as well as in the CARIS database, as in separate systems) with the data in the Hospital Information System. It will also allow cardiologists from other hospitals to get access to the clinical information that is available in CARIS.

The Apple Macintosh echo network is presently being migrated to a completely Windows2000 platform. Furthermore, the FileMakerPro database and client software will be phased out. Instead of the web server based module in CARIS to connect to the FileMakerPro information, an interface directly to the GE-Vingmed EchoPac Sybase server is under development.

4.   Conclusions

These results show that integration of all clinical information available in the department of Cardiology is feasible. The availability in CARIS of the results from all cardiology function tests has proven to be valuable and sometimes crucial in the evaluation of patients. Presently, a new version of CARIS is being developed based on three-tier system architecture. This will allow integration with information from other departments and the central hospital (mostly stored in the Hospital Information System), as well as access from other hospitals.

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