

Development and Implementation of a Fully Paperless Cardiology Information System (EPD-Vision)

ET van der Velde, DE Atsma, MJ Schalijs, TA Witteman,
H Foeken, FDB de Bruijn

Leiden University Medical Center, Leiden, The Netherlands

Abstract

Starting February 2006, the departments Cardiology and Thoracic Surgery of the Leiden University Medical Center use a self-developed Electronic Patient Record System: "EPD-Vision". EPD-Vision offers a complete replacement of the patient chart on paper. EPD-Vision provides an overview of all patient information at every moment and at any location. Patient information in other systems is directly available in EPD-Vision (ECG's, echocardiography and cathlab images and data, lab data).

The use of EPD-Vision has resulted in a significant improvement in the quality of care for cardiac patients. Substantial savings have been realized in the secretary staff. Various new modules of EPD-Vision are under development, such order management and an on-line appointment system. With the latter, patients can make appointments (e.g. for the outpatient clinic and pacemaker follow-up) through Internet. Also, parts of EPD-Vision will be available via Internet for patients and professionals.

1. Introduction

The main clinical focus of the departments of Cardiology and Thoracic Surgery of the Leiden University Medical Center (LUMC) is the treatment of patients with complex cardiac diseases, such as arrhythmia and severe heart failure. Per year, more than 450 ICD's are implanted and over 200 patients with severe heart failure are seen and treated. In addition, the LUMC provides regional care for patients with an acute myocardial infarct via the "MISSION!" project.

In recent years, this concentration on top-clinical care has resulted in a strong increase in the number of patients that are referred to the LUMC. Therefore the number of cardiac function studies, such as echocardiography, stress tests, pacemaker and ICD follow-up and Holter studies has increased dramatically. Due to these developments, the old manner in which patient data was registered and reported (on paper) was not satisfactory anymore. In

addition, the requirements for reporting on waiting lists, intervention outcomes have increased greatly.

For all the above reasons, a number of years ago our department has started the development of an Electronic Patient Record system for Cardiology: "EPD-Vision". The challenge was to create a complete paperless Patient Record System and to automate the complete medical process of the departments of Cardiology and Thoracic Surgery.

2. Methods

2.1. Previous situation

Until recently, for every new patient presented at the outpatient clinic (or ward) a new paper chart was created. The patient's folder had to be available with each visit of the patient. In between patient visits, the patient's folder was archived in the LUMC Central Medical Archive. Each time after the patient was dismissed from the ward, or after each visit to the outpatient clinic, a new letter had to be created. The process of creating this letter was cumbersome and time-consuming: the letter was dictated on tape by the cardiologist, typed by the secretary, then corrected by the cardiologist and updated by the secretary, and finally authorized by the supervisor, printed out and sent by mail to the referring physician. This whole process would take on average 14 weeks. In addition, waiting lists were compiled by hand; reports on functional studies were printed out on paper and added to the patient's folder. Information about studies and procedures performed were sent on paper to the billing department of the hospital. This was a very inefficient system that resulted in a large amount of paper folders, with in 2005 more than 75 meters shelf space only for the paper folders of the department of Cardiology.

2.2. Demands

In light of the problems described above, there was a great need for a fully electronic system in which all clinical patient information (medical as well as nursing) could be registered quickly and accurately. In addition,

the system should speed up the reporting on admissions and outpatient clinic visits, if possible with minimal secretary support. With the system we should be able to manage waiting lists, and should be able to send out procedure data to the billing system of the hospital. Existing paper patient folders should be scanned to circumvent the need for keeping the paper folders.

For already more than 10 years, the department has a complete digital echocardiography system at its disposal, with presently 12 echocardiography systems (GE Healthcare, Siemens) connected to a database and (echo) image server (GE Healthcare). Also, an ECG management system (Draeger Infinity Megacare) is available with more than 900,000 ECG's stored (as of 1985). All cathlab image data from 2000 on is on-line available on an image server (Curad BV). Via the new EPD system, all these images and ECG's should be made directly available.

2.3. The development of EPD-Vision

A project group consisting of cardiologists, nurses and IT specialists has supervised the development of EPD-Vision. EPD-Vision has been developed by three software developers who are employed by the departments Cardiology and Thoracic Surgery. EPD-Vision consists of a graphical user interface developed with Delphi (Borland), a business layer developed with Delphi and an Oracle version 9 database.

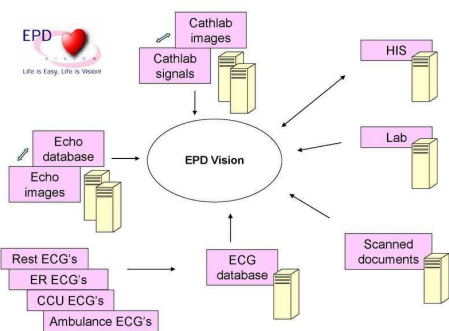


Figure 1: Connections with other information systems

Various connections have been developed with other systems that were already available with the department (figure 1), such as a Sybase database for data from the echocardiography studies (GE Healthcare), and a Microsoft SQL server database with all ECG's (Draeger Infinity Megacare). Via these connections data from the above mentioned systems can be viewed within EPD-Vision, such as ECG's created on cardiographs, ECG's from the patient monitoring systems at the CCU and ER, stress-ECG's and ECG recorded in the ambulances (sent

to the LUMC via mobile phone).

In EPD-Vision, moving cathlab images can be requested from the DICOM image server (Curad) and displayed on any workplace. Via a connection with the HIS patient demographics, lab data and medication data can be retrieved. EPD-Vision sends information about the performed procedures back to the HIS, as well as the patient discharge letters.

Registration of clinical information

The introduction of EPD-Vision in our department has brought on many changes in the daily workflow of cardiologists and nurses: all patient information must be entered directly in the computer. The objective of EPD-Vision was to gain as much as effect as possible with as little as much mouse clicks. Only in this way, patient data can be entered with sufficient speed not to interfere with busy patient visits. And of course acceptance by the users benefits from good performance of the software. Quick data entry is accomplished by the use of text macro's, and structured data entry using buttons instead of pull-down menus. This applies for the various parts of the patient chart, such as medical history, physical examination, risk factors, and medication. Data that has been entered earlier (such as medication and patient's sensitivity) is already available. In the course of registering the patient data, the final outpatient clinic or discharge letter is compiled automatically. Information from additional studies, such as echocardiography and lab results can be added with one mouse-click. When the resulting letter is finished, it is authorized by a staff member. The electronic letter is then automatically sent to the HIS and from there to the referring doctor (in the Netherlands, this is usually the general practioner). At the outpatient clinic EPD-Vision is used with a dual-screen setup (photo 1).

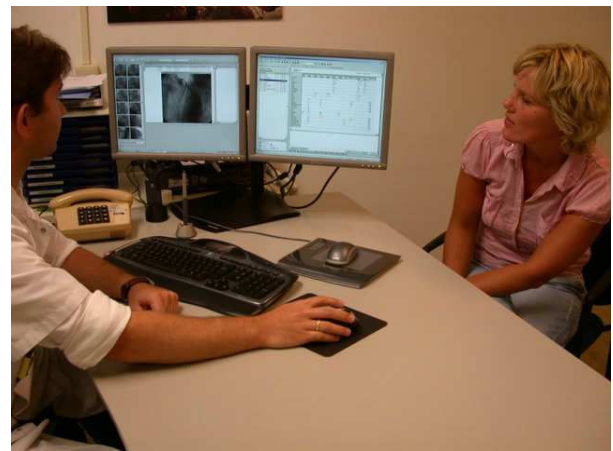


Photo 1: cardiologist and patient at outpatient clinic

Surprisingly, patients did not find this annoying; in contrast, patients are usually very interested in the possibility to view their data together with the cardiologist. At the ward, physicians and nurses use laptop's on a special cart (photo 2), which can be used to go from bed to bed.



Photo 2: cardiologist and nurse at bedside with both an EPD-Vision laptop.

Registration of nursing information

The nurse folder has also been completely replaced by an electronic module in EPD-Vision. As with the clinical patient chart, all information that has been entered in the past, such as family members, home situation, need for care and sensitivities are automatically available. Part of the information in the electronic nursing module, such as medical history, medication and sensitivities, is shared with the clinical modules. Also, heart rate and blood pressure data is visible in the clinical module as well as in the nursing module. Also of great importance is the fact that a patient's notice on e.g. reanimation is always available.

2.4. Working paperless: prerequisites

To be able to really work paperless, a number of logistic measures were necessary. For instance, all ECG's from in- and outside the department had to be available electronically as quickly as possible. Before, the ECG paper printout was put in the patient's chart right after the recording. In the present situation, all cardiographs needed to be permanently connected to the hospital network (either wired or wirelessly) and be able to send the ECG via the network to our ECG management system (Draeger Infinity Megacare).

Furthermore, on various locations throughout the department fast document scanners have been installed.

Documents can be scanned and stored on a document server. After adding some index data to the scanned document, such as patient number, type of document and date the documents are directly available in EPD-Vision. Document types are for instance referral letters, paper reports from other departments, and the complete contents of the old paper chart.

Before, the nurse meetings were done with the paper patient chart. Because the paper chart does not exist any more, all meeting rooms at the ward have been equipped with large LCD screens to display EPD-Vision (photo 3).



Photo 3: nursing staff during their meeting discussing patient status.

3. Results and discussion

3.1. Availability of Information

The use of an electronic patient record system has proven to have a large number of advantages. The patient chart is always available. The information is always readable, which is often not the case with the paper patient chart. The information is available at the same time at different places. This means that an assistant can consult the supervisor while both are looking at the same information.

At this moment, EPD-Vision can be used in a number of hospitals in the region of the LUMC via Internet. For instance, in 2 hospitals where PTCA procedures are performed under supervision of the LUMC, all information about the study and the procedures performed can be entered on-line.

The department of Thoracic Surgery now also uses EPD-Vision. This means that all information on Cardiology patients that have to undergo thoracic surgery is available for cardiologists and surgeons. The continuity and availability of information is essential for optimal

quality of care.

3.2. Quality of Care

Timely availability of relevant patient information can prevent mistakes and repeated studies. More and more often, different caretakers are involved in the care process for one patient, creating the need for adequate exchange of information. Because the time between discharge of the patient and reporting to the referring doctor or other caretakers has decreased from 14 weeks to 2 days, they are in time informed about the diagnosis and possible changes in medication. By implementing various checks in the discharge process and composing the discharge letter, essential items can no longer be forgotten, which improves the quality of care. The availability in EPD-Vision of departmental treatment guidelines, many of these with 'decision support', ensures that cardiologist-trainees can quickly provide adequate care. By systematically registering complications, structural errors in the way of working at the department can be detected and prevented.

3.3. Workflow improvement

Because the patient chart with reports on physical examination and functional tests is now electronically available, the outpatient clinic secretary office no longer needs to prepare the patient's visits. The original paper patient folders are scanned (and disposed of) by the Central Medical Archive department before an outpatient clinic session. Because during the patient's visit, in the process of registering the medical data the letter for the referring doctor is automatically composed, dictation of the letter is no longer necessary. Presently, the 3000 clinical admissions per year are planned by one (0.6 FTU) secretary, with EPD-Vision generating all correspondence for the referring doctor and other people involved in the care process.

There is no longer the need to retrieve the paper patient folder from the archive, saving time and money.

3.4. Security

The broad availability of patient data via an electronic health record system such as EPD-Vision requires optimal security of this confidential information. The EPD-Vision system is only available for qualified people with authorized access. EPD-Vision has been extensively reviewed by the 'Security Officer' of the LUMC and no problems were found.

4. Discussion and conclusions

In the 6 months that the departments of Cardiology and Thoracic Surgery have worked with the EPD-Vision system, it has been shown a great improvement in delivering quality of care for cardiac patients. Substantial savings have been realized in the secretary staff.

Availability of information for other departments

All patient data that are registered in EPD-Vision are available for authorized users in the departments of Cardiology and Thoracic Surgery. The 'end-product' of a study or a patient's visit is the discharge letter, which is automatically sent to the Hospital Information System (HIS), and in that way is available for all (authorized) caretakers in other departments in the hospital.

Future developments

Various new modules of EPD-Vision are under development, such as order management and an on-line appointment system. With the latter, patients can make appointments (e.g. for the outpatient clinic and pacemaker follow-up) through Internet. Also, parts of EPD-Vision will be available via Internet for patients and professionals.

Address for correspondence

Enno T. van der Velde, PhD
Leiden University Medical Center, C5-P
P.O. BOX 9600, 2300 RC Leiden
The Netherlands
E-mail address: ETvanderVelde@lumc.nl