A DICOM based telemedicine record

Uwe Engelmann and team wanted to create a system that allowed locally distributed users to share DICOM images over the internet. Did they succeed?

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Modern PACS systems demonstrate a state-of-the-art ability to distribute medical images. But transfering images from clinics to referring providers or radiologists at home, requires additional data protection measures and performance improvements.

We have developed a web server that allows images to be distributed over slow and public networks. Further improvements include teleconferencing between web users and even between web clients and classical workstations. Our approach is well suited to distributing images to a range of consumers and runs as a commercial product (CHILI/Web) in many clinics.

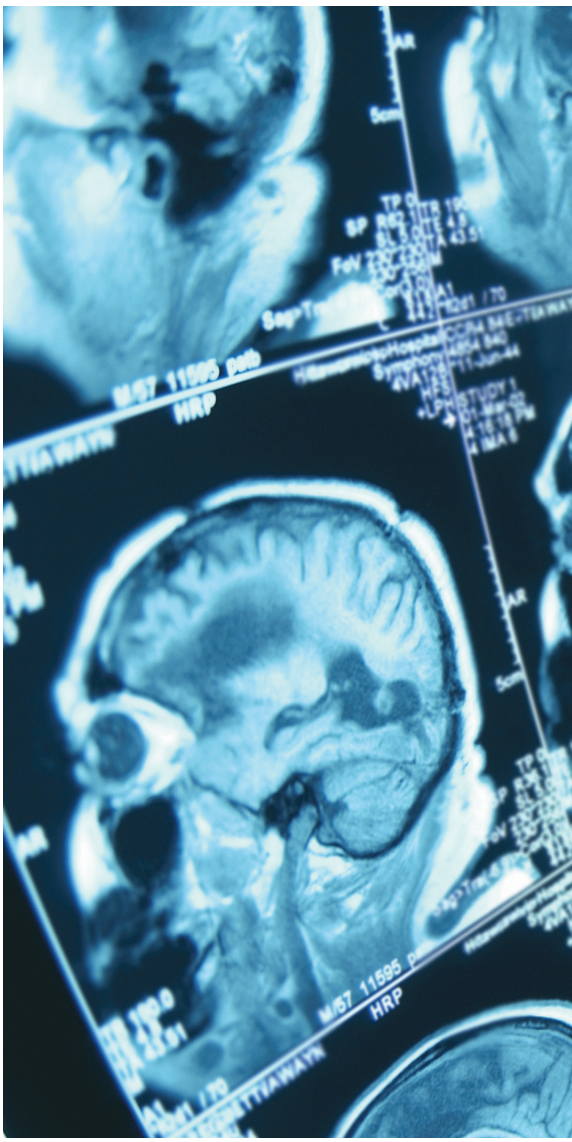
The web portal is an extension of the web server that collects together images from many potential sources and organisations at one central point. It provides web-based DICOM services and uploads images and other multimedia data to a central system.

Mixing image distribution and EPRs

In order to become patient not image oriented, the web-based image distribution and display system was added to an electronic patient record (EPR) system. The user interface and DICOM oriented database have also been extended to keep other textual and multimedia patient data. The data model was designed to be very flexible and easy to adapt and extend.

Data input

Data can either be typed into web-based forms in the medical record or can be uploaded or transmitted to the system. Data is then either stored in



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the database as individual items or as entire documents, such as medical reports, lab reports or discharge letters. Even biosignals (eg, ECGs) can be uploaded, stored, exported and displayed on the system.

Data storage and presentation

Usually all telemedical record data are stored on a central server using a SQL database management system (PostgreSQL). The system is web-based and can be accessed via a standard web browser. The graphical user interface is independent of the operating system and the user's brower. The only prerequisite is that the client site should support the Java runtime environment.

Access to data is patient oriented. Thus, the system displays a list of patients not images. Data is presented either as simple text items or multimedia documents that are encoded according to the mime standard. Specific (client- and browser-specific) helper applications are used to present the multimedia data (eg, waveforms, images, PDFs). The CHILI/Web applet is a specific java application that is used to display and process images in DICOM and other formats. This program is a medical product (Class IIb) and can be used for the diagnosis of medical images when used on appropriate monitors, according to the European Medical Device Directive (MDD).

Data output

It is possible to export DICOM images to the file system of the local web client either as DICOM image files (eg, gif, tif), to be dragged and dropped from the browser into another application (eg, MS Word or PowerPoint), or as event send image data, to be moved from a browser application to a DICOM device in the local network.

Integrating healthcare enterprise initiative (IHE)

Integration into the clinical workflow is an important requirement for the success of telemedicine in daily routine. The Integrating Healthcare Enterprise initiative (IHE) shows how this can be achieved in a standardised and vendor independent way. This means that data from external sources can be integrated into internal information systems and then processed like local data. We used the IHE compliant CHILI PACS system as the basis of this medical record. Thus, our data exchange is based on IHE profiles (based on DICOM and HL7) that ensure reliable interfaces between different vendour components.

Data protection and security

The system uses encrypted https protocol to exchange data between the central server and other systems. Client certificates can be used to provide more host-to-host security. Users need an account and password to access systems that have been configured specifically for each telemedicine record.

For security reasons, all personal data is changed into pseudonyms then imported into the system, while original personal patient information is kept in a different database. If a user has the right to view a patient's complete dataset, then the data can be decoded "on the fly" – but only for that specific user. Treating physicians typically have full access to all data while other users have restricted access.

Consultation and message system

The "owner" of a medical record (eg, the treating physician) can submit a record to another user of the same medical patient record system or to a different system altogether. The current user is then bestowed with the rights of the first user. He can them view all data without limitations and can also add additional information to the record. All users have a message box where they can send data or messages to other users, in a similar way to sending an email.

Teleconferencing

The CHILI/Web applet, which is used to display and analyse images, allows teleconferencing between users. During conferences, both users' mouse pointers are displayed and image functions are processed simultaneously on both sides.

Patient-centered forums

Users can open patient-centered forums and discuss case- or patient-specific aspects.

Results

The described system is a generic approach to establish specific electronic medical records. Each record system is customised for an individual purpose.

Nearly twenty different versions of this system are running in clinical routine in German hospitals and research institutions. One application area is the interdisciplinary cooperation between medical doctors in different hospitals. About fifteen hospitals run their own telemedicine record to encourage interdisciplinary cooperation inside their own hospital and also for the exchange of data and opinions with other hospitals.

Another popular scenario is to use the system as a data collection portal for clinical research studies of rare diseases. Many different hospitals all over Germany provide secure multimedia data over the internet in order to facilitate the study of specific telemedicine records.

Conclusion

The motivation for this work was to create a system that allows locally distributed users to collect and share multimedia data of patients in a web-based telemedicine record on the internet.

The realised system is based on an existing PACS and teleradiology system to ensure that it is able to communicate and display DICOM images. A flexible and customisable medical record has been built on top. Thus, the resulting system has a huge set of IHE-compatible communication features.

Our experience with the system in the existing installations proves that this is not only a feasible but also a successful approach. ■