The Web Browser as a Unifying Agent for Radiology and the Health Care Enterprise

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A variety of information systems in the health care enterprise are used to store patient information. The hospital information system (HIS), the picture archiving and communications system (PACS), the radiology information systems (RIS), and patient records, for example, are often supported by separate and distinct systems. A referring physician reviewing a radiologist's report often does not have convenient access to the original radiologic images. A radiologist interpreting a radiologic examination may not have convenient access to clinical information generated outside of the radiology department. Clearly, convenient and quick access to all relevant patient information is the ideal in delivering quality patient care. Recently, the web browser has become increasingly well accepted as the "universal client" for viewing a wide variety of information. We believe that the web browser may provide the universal "window" to the variety of distinct information sources required by the physician, and may provide unification of these information sources through hypertext links. We specifically looked at the feasibility of using the web browser to view scanned patient charts. A total of 5,200 patient charts (131,000 pages) were scanned into a structured query language (SQL) database. Access to these records was made available on the hospital local area network (LAN), and on the Internet over the worldwide web. Comparison measurements were made of the time required to access patient records using a dedicated viewing application and using a web browser.

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IT IS FREQUENTLY difficult for a physician to attain ready access to all available clinical information about a patient. Clinical reports and images are typically stored on different computer systems requiring different application programs to access, and the paper-based patient chart, by its very nature, can only be viewed at one place at one time.

The web browser has been developed as a universal viewer for information on the Internet. This same technology has promise as a universal viewer for accessing patient information.

We have previously reported on use of the web browser at the radiologic modality.¹ Others have reported on the use of the web browser for viewing radiologic images² and reports,³ and commercial picture archiving and communication systems (PACS) are available that support web clients (eg, VirtualRad from Canon Medical Systems, Irvine, CA). Perhaps the most difficult information to

make web-accessible is the paper-based patient chart, since it is not intrinsically in electronic format.

Our objective was to investigate the feasibility of using the web browser as a universal viewer of patient information in the health care enterprise. We focused specifically on the patient chart since, absent a fully electronic medical record, this is probably the most difficult information to make web-accessible.

MATERIALS AND METHODS

A total of 5,200 patient charts were scanned by clinical personnel using a Canon DR5080-C scanner (Canon USA, Lake Success, NY) at a resolution of 200 dpi with 8 bits/pixel of grayscale. Each scanned page was compressed using the Joint Photographic Experts Group (JPEG) compression algorithm with a 13:1 compression ratio, and each compressed image was stored in an structured query language (SQL) database. This database was hosted on a computer server employing dual 333-MHz Pentium II processors (Intel Corp, Santa Clara, CA) and 512 Mbyte of RAM. Three different PC workstations with different processors (a Pentium I at 233 MHz, a Pentium II at 350 MHz, and a Pentium III at 500 MHz) were used for viewing the scanned records. Two different methods were used to view the scanned images in the database. The first was with a dedicated viewer, written in C++, that directly accessed the database records over a local area network (LAN) (using 100 baseT technology). The second method was to use a web browser (Internet Explorer 4.0; Microsoft Corp, Redmond, WA) to access the records. Web browser access was tested both over the LAN and at a remote site, 1,600 miles distant, over the Internet. Images sent over the Internet were encrypted using Secure Socket Layer protocol with 128-bit security. The time required to bring into view a single page of a patient record was measured.

RESULTS

Each scanned page of the patient chart required 3.74 Mbyte of storage before compression. After compression, each page required, on average, 288

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Kbyte of storage. A total of 131,000 pages were scanned from 5,200 patient charts. The total size of the resultant database was approximately 38 Gbyte.

The time required to access a single page of a patient chart is shown in Table 1. When viewed over the LAN, in each case the dedicated viewer provided quicker access than the web browser. However, as faster workstations were used, the difference in performance between the dedicated viewer and the web browser became less significant. For LAN viewing using a workstation with a Pentium III/500-MHz processor, the dedicated viewer could retrieve a page in 0.5 seconds, while the web browser required 1.0 seconds.

When viewing images remotely over the Internet, a single page could be retrieved in 12 seconds using a workstation with a Pentium II/350-MHz processor. No improvement in retrieval time was seen when a faster workstation was used.

DISCUSSION

We have investigated the possibility of using the web browser as a universal viewer for a wide range of information hosted by disparate systems throughout the health care enterprise. Since most institutions still rely on the paper-based chart as the primary patient record, we specifically investigated the feasibility of making such charts accessible with a web browser.

An argument against using a web browser for image data, such as radiologic images or scanned

Table 1. Time to Retrieve a Single Page of a Patient Chart for Workstations With Different Processor Speeds and With Either a Dedicated Viewer or a Web Browser Viewer

Workstation CPU/Clock Rate	Local Access Dedicated Viewer (written in C++)	Local Access Web Browser (Internet Explorer)	Remote Access Web Browser (Internet Explorer)
Pentium I/233 MHz	1.5 s/page	8.2 s/page	17.6 s/page
Pentium II/350 MHz	0.6 s/page	2.9 s/page	12.0 s/page
Pentium III/500 MHz	0.5 s/page	1.0 s/page	12.0 s/page

NOTE. Times are shown for web browser access on both the local area network and remotely over the internet.

patient records, is that the performance of such a viewer would be slower than that of a dedicated viewing application. Indeed, our results show that the browser performance was slower than that of a dedicated viewer. However, the results also show that as faster processor speeds were used for the workstation, the added overhead required by the browser becomes less significant.

The advantages of the browser as a universal viewer are many. Ideally, from this single viewing application a physician could have access to all relevant clinical information about a patient. A radiologist, for example, could potentially peruse a patient's chart from the same workstation that is used for reading radiologic images while a referring physician could have ready access not only to the radiologist's report, but the radiologic images as well. Such information would be available both locally and, through the Internet, potentially to physicians anywhere in the world.

REFERENCES

1. Garland HT, Cavanaugh BJ, Cecil R, et al: Interfacing RIS to the modality: An integrated approach. *J Digit Imaging* 12:91-92, 1999 (suppl 1)
2. Bennett WF, Sigos DG, Tzalonikou MT, et al: Web-based viewing of picture archiving and communications systems images—Part I: Optimal personal computer configuration. *J Digit Imaging* 12:116-118, 1999 (suppl 1)
3. Adelhard K, Swoboda N, Nissen-Meyer S, et al: Uniform access to clinical data in a distributed system: The radiology example. *Radiologe* 39:298-303, 1999