Implementation and Day-to-Day Usage of a Client-Server-Based Radiology Information System

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Implementation of a second-generation radiology information system (RIS) requires attention to many issues, including work flow, system design, training, consideration for emerging technologies, and support. This presentation covers the issues, and solutions, involved in implementation and subsequent day-to-day usage of a client-server-based RIS tightly integrated with a hospital information system (HIS) using "thin client" software to limit hardware requirements for the client computers. The software and hardware implementation had to be designed for potential enterprise-wide scalability of the RIS for a system involving 11 hospitals. Issues arose regarding initial increased turnaround times, errors in importation of historical data, and problems with implementation of interfaces between the RIS and the billing system and between the RIS and the digital dictation system. Network errors and difficulties in using a thin client implementation had to be overcome. Hierarchical training was implemented, as support was switched from an "on-site" support group to a central Information System Division with responsibility to the entire enterprise.

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UPGRADING TO A NEW radiology information system (RIS) raises many issues.^{1,2} This presentation documents issues, and solutions, encountered in the implementation and use of a client-server-based RIS system integrated with a hospital information system (HIS).

ORIGINAL RIS: HARDWARE AND SOFTWARE

The Radiology Department of Memorial-Hermann Hospital (Houston, TX) performs 200,000 examinations per year, including services for a Level I trauma center, a pediatric hospital, and an outpatient center. The original RIS was a terminal-based, multi-user system, based on Images 3000 software from ADAC/HCIS (Houston, TX). The central computer was a Hewlett Packard (Palo Alto, CA) 3000 minicomputer, accessed by any of 70 MS-DOS (Microsoft, Redmond, WA)-based "dumb-terminals."

DESIGN OF NEW RIS SYSTEM

Software Design

The Cerner (Kansas City, MO) Millennium Radnet RIS software is based on a relational database client-server structure with a graphic user interface (GUI). Cerner has agreements with several picture

archiving and communication system (PACS) vendors, a consideration as a PACS will be installed in the children's hospital. Because of the potential need to cover an enterprise of 11 hospitals, installation considerations included enterprise-wide compatible patient record numbers, multiple film libraries, and an enterprise-wide order catalogue.

Hardware Design

Because of potential enterprise-wide implementation, a multiserver, multiclient hardware installation was chosen to accommodate 1,800 to 2,400 users. Three Compaq (Houston, TX) Alpha 8400 series servers, 23 Windows NT (Microsoft,) servers, and two IBM (Armonk, NY) RISC 6000 interface servers were installed for the HIS/RIS. The Cerner RIS was designed as a "fat" client-server system. To minimize both the demands of updating user software on client computers and the load on an existing flat, shared, 10baseT network, a "thin" client-server implementation was developed using Citrix (Ft Lauderdale, FL) software.

Multisystem Upgrade

The department's Lanier dictation system was upgraded because of year 2000 compatibility issues. The University of Texas Houston Medical School (a separate entity from the hospital, but responsible for staffing many of its departments) had implemented a new billing system for professional fees from IDX (Burlington, VT), which would be interfaced with the RIS via a Health Level 7 (HL-7) engine.

New Cerner Radnet RIS software was provided to the transcription service that contracted with Memorial-Hermann Hospital. Software and hardware installation and training were the responsibility of the transcription service.

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ISSUES AND SOLUTIONS

It was decided to go "live" with the new Cerner RIS alone on September 7, 1999, because of the demands necessary to run two systems in parallel. All hardware and software installations were completed, and successful tests had been performed with "dummy" data prior to this date. Several issues arose following installation.

Radiology reports from the old system had been imported to the Cerner RIS. Issues that surfaced included: (1) some data (eg, "dictating physician") not being imported or imported into the wrong field; and (2) the Cerner RIS not correctly performing a date sort. The first issue was dealt with by a second import of the historical data. The second issue required a Cerner software upgrade.

Following the Cerner RIS installation, the transcription backlog increased within a few days to 2,000 jobs ($\approx$ 2,000 to 8,000 reports since each "job" could hold multiple dictations). Under the old RIS, the average time from study completion to final approval had been 14 hours. Under the new RIS, it increased to several days, due to several reasons. Installation of the software by the transcription service to access the new RIS had been delayed. Network access problems for the transcriptionists were not detected until the new software was installed. The new transcription software could not incorporate previously used software transcription aids ("word expanders," etc).

The replacement of the dictation system was delayed. The Memorial-Hermann Imaging Council, responsible for approving purchases, could not agree on a single vendor appropriate for the entire enterprise, and in July 1999, allowed for decisions to be made on a per-hospital basis. Because time before implementation was too short, an interface between the new Lanier dictation system and the RIS could not be developed. Without the interface, it was not possible to determine, from the RIS, which cases had yet to be dictated, and which were dictated but not transcribed. Because of the delayed transcription times, many cases were erroneously submitted for redictation.

The transcription backlog was addressed by multiple meetings with the transcription service, by using additional transcription services, by finding compatible transcription aids, and by accelerating a voice recognition pilot project. The interface issue was addressed by meetings with Cerner and Lanier with plans for a software solution.

Initially, multiple network errors occurred, and users had difficulty accessing the system. The radiology network was then upgraded to a 10/100baseT switched network connected directly to a switched gigabit network core. A user survey showed radiologists required rapid RIS access, and remained on the systems for variable time periods. The number of NT servers dedicated to radiology was increased to three to allow for longer periods before software would "time out" due to user inactivity. Subsequently, total downtime for a thirty day period was 40 minutes.

Initial testing with "dummy" data of the interface of the University of Texas Houston Medical School IDX billing system and the Cerner RIS had been successful. However, following implementation, several errors were encountered. Multiple repeating elements were identified in fields. File communication transfer protocols caused repeated transmission of the same lines of data. In several thousand records, residents were incorrectly assigned, attending status, requiring manual correction of the data. These problems were carefully tracked, and the software packages reconfigured. However, data collected before the reconfiguration required manual correction, significantly delaying billing.

Training was done hierarchically. A small number of users were selected from each Radiology Department section and were trained as superusers. These superusers trained the majority of radiology personnel and became a resource for routine problems.

CONCLUSION

New RIS installations are challenging due to RIS complexity, enterprise deployment, legacy data, and interfaces. Sophisticated testing, using real data, can reveal problems missed by using limited data. Scaled implementation, with old and new systems first running in parallel in a low volume environment can limit the impact of discovered problems. Finally, system implementers, software and hardware providers, and third party service providers need to work closely together for a successful installation.

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