Experience with Comparative Picture Archiving and Communication System Baseline Data Collection at Four Veterans Affairs Medical Centers: Methodology, Lessons Learned, and Suggestions for Improvement

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IN SPITE of recent technological advancements, large-scale picture archiving and communication systems (PACS) were functioning in only 23 sites in 1995.¹ In order for PACS to become more widely accepted, it is important to conduct studies to assess technical and practitioner acceptability, radiology services accessibility, and costs and clinical acceptability.²

Four Veterans Affairs (VA) Medical Centers were used as a test bed to assess the impact of PACS and teleradiology with regard to the accessibility of radiology services and the costs of providing these services. Time motion studies were performed at four VA facilities, recording dates at the time of submission of a requisition for an imaging examination to the time of verification of the imaging report. Demographic data also was collected on each of the patients.

The study had two major components: (1) Assessment of the impact on the radiology services at two outlying hospitals before and after implementation of teleradiology to the Baltimore VA, which serves as their tertiary referral center; and (2) Comparison of radiology services at the Baltimore VA Medical Center, a filmless radiology department, to the Philadelphia VA Medical Center, which operates as a conventional film-based radiology department.

PLANNING THE DATA COLLECTION

Demographic information about each department is necessary to assure that the hospitals included in the study have comparable patient populations, numbers of studies per year, and types of studies. It is also important to document carefully staffing by technologists and radiologists at each facility by weekday and by shift. Such data will allow the assessment of possible differences among the control and study institutions. Additionally, information about workloads at a particular facility and within a certain imaging location/modality permit the investigators to assess the sample size needed, the duration of the study to

achieve this sample size, and the personnel needed to collect the data.

The data collection team included a site coordinator and an additional student who supervised the data collection. The full cooperation of the chief of the radiology department was essential. The coordinators initially met with the chief of radiology and all supervisors to go over the study design and obtain clinical feedback. This was very helpful in designing the forms and understanding differences in work flow at each hospital. They then presented the design to the technologists, receptionists, and radiologists for their input. Pilot data were collected once the forms and procedures were finalized.

The radiology personnel collected data in a manner designed to minimize the number of study coordinators required. It was important to convey the purpose of the study to all radiology personnel for two reasons: (1) to motivate them to participate in an important research study and obtain feedback from the different sections especially during the design of the study and (2) to assure the radiology personnel that the data collected would not be used to assess their personal performance and productivity in the radiology department.

The study coordinators were available on-site during the data collection period to answer questions and to perform daily quality assurance (compliance rates by imaging location and modality). Pilot studies were performed at each site for 24 hours to identify any problems. Data were collected by receptionists, technologists, film library clerks,

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and radiologists. In addition to these data, hospital information system (HIS) records for each patient were downloaded.

The data were entered into *Microsoft Access 7.0* (Microsoft Corp, Redmond, WA), a relational database that allowed us to create forms to facilitate the data entry. A uniform database for all study sites facilitated the analysis. Detailed filters for data entry that would not allow data that were out of bounds to be entered were found to be very useful. Quality assurance of the pilot data was helpful in identifying problems that may be related to a particular imaging location, modality, or a particular person. Further statistical analysis was performed using a statistical package.

DATA COLLECTED

There was a variable level of compliance among the four hospital with respect to different data elements collected. This is demonstrated in Table 1, which shows both the source and level of "compliance" for the various data elements collected from the four medical centers.

Patient Demographic Data

Patient demographic data were collected from the HIS. This was done by printing a paper requisition associated with an imaging examination and attaching it to the data collection form. This minimized the number of entries as well as the errors on the data collection form. These data also were downloaded from the HIS and entered into a relational database to minimize manual data entry.

Demographic information included name, social security number, case number, date of birth, diagnosis (only for in-patients), in/out patient status, referring clinic or ward, requesting time and date, requesting physician, examination description and urgency (see Table 1). Additional data collected from the HIS included whether the patient was new to the radiology department and whether a prior examination (same type of study) had been performed.

Patient Arrival and Imaging Data

Data were collected by the receptionist or the technologist, indicating the time and date on which

Table 1. Data Collected: Description, Source and Compliance

Data Description	Source	Compliance (%)			
		Hospital A	Hospital B	Hospital C	Hospital D
Patient name	Both	100	100	100	100
Social security number	Both	100	100	100	100
Study ID number	Study coordinator	100	100	100	100
Hospital	Study coordinator	100	100	100	100
Case number	HIS/technologist	100	100	100	100
In/out patient	HIS	100	100	100	100
Clinic/ward	HIS	100	100	100	100
Requesting physician	HIS	100	100	100	100
Examination description	HIS	100	100	100	100
Examination urgency	HIS	100	100	100	100
Examination request date & time	HIS	100	100	100	100
New patient	HIS	100	100	100	100
Arrival date & time	Technologist	99	99	85	91
Imaging begun date & time	Technologist	99	99	99	95
Imaging complete date & time	Technologist	98	98	96	92
Search for old examinations begun date & time	Film library clerk	80	76	N/A	N/A
Search for old examinations completed date & time	Film library clerk	80	76	N/A	43
Clinically related films found	Radiologist	93	95	N/A	N/A
Images presented for interpretation date & time	Film library clerk/PACS	98	96	N/A	53
Staff interpretation date & time	Radiologist or from	98	97	68	86
Transcription date & time	HIS	100	100	100	100
Verification date & time	HIS	100	100	100	100
Premature termination	Technologist	0	0	69	N/A
Portable	Technologist	100	100	99	100
Number of cases on same form	Technologist	100	100	100	100
Old films available	Film library clerk	93	95	99	40

each patient arrived to the radiology department. The imaging examination beginning and completion date and time information was collected by the technologist. This time was defined as the interval required to image, process the images, assure adequate quality, and discharge the patient from the imaging room. The technologists on all shifts and locations received training in the proper way to fill out the forms. Initially, there was confusion about the terminology and definitions and, consequently, explanations were added to the back of the data collection form regarding each field. Compliance of the technologists in entering the data ranged from 85% to 99% (see Table 1). At one facility, we introduced "punch" clocks at each imaging location. We believe this resulted in more consistent and accurate data collection as the clocks all could be synchronized across the department (reception, imaging rooms, file room, interpretation areas). Examination that were repeated and the reason for repeating them were recorded for each study performed.

Data on imaging times were also available from the HIS. These were found to be unreliable because they were not completed contemporaneously as the examinations were completed but were instead recorded in clusters or at the end of a shift. This sporadic recording of the data, therefore, made time entries that were automatically recorded by the HIS inaccurate. Repeat examination rates were also available from the PACS. Although the PACS required a reason for rejecting an image it did not provide the user a uniform list to choose from which makes direct comparison with our data collection difficult.

Film Library Data

Once the examination was completed by the technologist, the forms and films were brought to the film library where a search for old examinations (if they existed) occurred. The date and time that the films were made available for interpretation to the radiologist were recorded. The worst compliance (40% to 53%) was seen at the facility in which forms were not used for each patient but instead the log sheet for entering films in and out of the film library was used to capture the data. Similar compliance problems were observed with the data collection from radiologists when no form was supplied and they were asked to dictate the information instead (see following section).

Staff Interpretation and Report Entry Data

The radiologist was again asked if relevant examinations were available for comparison. The compliance was lower (68% versus 98%) at the facilities in which we asked the radiologist to dictate this information instead of filling out a form. Interpretation time and date were either obtained from the radiologist or from the digital dictation system. This information also recorded if and how a preliminary report was provided. Report transcription and verification date and time were recorded. At the time of transcription, preliminary reports also were released to the referring physician. Unfortunately, we had no way of recording the date and time the imaging report was read by the referring physician and was acted upon.

METHODOLOGY PROBLEMS

There were several methodology problems:

1. Multiple imaging examinations of the same modality that had been performed on a patient during a single visit to one of the radiology locations were difficult to time separately. For example, abdomen and elbow radiographs occasionally were performed at the same time. It was impossible to separate the imaging times for each study because the images were processed and quality assurance had occurred simultaneously. We obtained imaging times for all examinations performed at one time and entered in the database as associated examinations. This allowed us to separate these studies and average the imaging times depending on the number of examinations associated with each "siting."
2. Similar problems also were encountered with portable examinations. Imaging time included the travel time to the ward. Sometimes multiple examinations were performed in one ward, and these were recorded as associated examinations. On other occasions, only one examination was performed. This would significantly vary the imaging time, as the travel time is included in the imaging time of a single examination.
3. Two of the four hospitals had digital dictation systems. Staff interpretation times were recorded at all facilities. If a digital dictation system was available, the dictated report could be heard by the referring physician. If, however, there is no digital dictation system,

then the report is only available after it has been transcribed into the HIS.

4. To facilitate data collection and satisfy various concerns about additional workload, several data points were not entered by the staff using separate study forms, but rather dictated or noted on already existing departmental log sheets. This resulted in lower compliance rates.

RECOMMENDATIONS FOR FUTURE DATA COLLECTIONS

It is important to obtain the full cooperation of all radiology staff in the department. A number of meetings prior to the study and input from personnel in attendance are essential. Feedback during and after the study is also very important to motivate staff to participate in ongoing and future studies. Some of the data collected manually during this study could be automated such as staff interpretation time either by the digital dictation system of the PACS when the examination is marked as interpreted by the radiologist. Repeat examinations and rejection rates could be determined relatively easily using the PACS database in a filmless environment. It is important to specify categories for rejection rather than allow entry of free text as currently is done on our system in order to be able to better classify reasons for repeated or rejected images.

The most difficult data to obtain in this study were the times the referring physicians read the

imaging report and also the times that they viewed the images. Additionally, it was difficult to determine the point at which the clinicians acted upon the results of the radiological examination. Because the HIS is the only source of radiological reports, it might be possible to use the system to keep an activity log as to who reads the radiology and when. The same is true for image access in a filmless hospital. Such data will allow us to assess the effect of the filmless environment on patient care.

CONCLUSION

Careful planning of the study and full support of the radiology staff are essential for collection of such data. It is important to obtain pilot data to identify potential problems and adequately train personnel. Such pilot data should be compared with data collected automatically from the HIS, RIS, or PACS to establish the reliability of various data sources. When data was collected without using a study form compliance was low. It is important to automate the data collection as much as possible in order to keep the forms simple and as short as possible. This will increase substantially the consistency at which accurate data are captured.

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