SESSION VIII: Evaluating the Reengineering Effort

Experience Measuring Performance Improvement in Multiphase Picture Archiving and Communications Systems Implementations

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When planning a picture archiving and communications system (PACS) implementation and determining which equipment will be implemented in earlier and later phases, collection and analysis of selected data will aid in setting implementation priorities. If baseline data are acquired relative to performance objectives, the same information used for implementation planning can be used to measure performance improvement and outcomes. The main categories of data to choose from are: (1) financial data; (2) productivity data; (3) operational parameters; (4) clinical data; and (5) information about customer satisfaction. In the authors' experience, detailed workflow data have not proved valuable in measuring PACS performance and outcomes. Reviewing only one category of data in planning will not provide adequate basis for targeting operational improvements that will lead to the most significant gains. Quality improvement takes into account all factors in production: human capacity, materials, operating capital and assets. Once we have identified key areas of focus for quality improvement in each phase, we can translate objectives into implementation requirements and finally into detailed functional and performance requirements. Here, *Integration Resources* reports its experience measuring PACS performance relative to phased implementation strategies for three large medical centers. Each medical center had its own objectives for overcoming image management, physical/geographical, and functional/technical barriers. The report outlines (1) principal financial and nonfinancial measures used as performance indicators; (2) implementation strategies chosen by each of the three medical centers; and (3) the results of those strategies as compared with baseline data.

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FEW INSTITUTIONS TODAY attempt to implement full-scale picture archiving and communications systems (PACS) in a single phase. The reasons for breaking an implementation into several phases are often as much financial as logistical. A multiphased implementation allows the institution to pay for the system and adapt to new methods of managing images over a period of years instead of months. Ideally, a phased-implementation approach will allow the radiology department to demonstrate success with PACS on an incremental

basis, building confidence in the new method of operations, and achieving some return on investment before moving to successive phases.

Competitive benchmarks—or standards of excellence—have not been yet developed for evaluating PACS performance. Without standards for PACS, administrators and users have difficulty determining whether they are getting all they should be from the systems they have implemented. Until more data have been acquired for competitive benchmarking, the best way to measure performance with PACS is to compare operations internally.¹ This involves acquiring baseline data in the film-based environment and comparing them with data acquired after the PACS has been implemented.

This report was written to share our experience evaluating performance improvement in various PACS implementation scenarios. When working with an institution, we begin with a departmental assessment that documents existing equipment, procedure volumes, operations, staffing levels, and costs. Operational parameters may include items such as examination time, report turnaround time, number of repeat examinations, number of retakes, and availability of images when requested from the file room.² Accessible data for baseline measurements vary from institution to institution, depending on statistics and reports generated by the radiology information systems (RIS) and/or manual methods. Some will have extensive costing data; some may have better quality assurance and customer satisfaction data; others may have better breakdown of productivity data by full-time equivalent (FTE) type and modality.

Even in institutions operating without an RIS, we have found sufficient quantifiable data on existing operations to develop a baseline for com-

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paring and documenting performance improvement. Institutions with limited access to performance data are generally more selective about the data they do collect, and their selection criteria are often dictated by the hospital's or department's strategic objectives.

METHODS

Integration Resources (Lebanon, NJ) assembles baseline data using financial and nonfinancial performance indicators. For purposes of this study, we report on three large medical centers that we have worked with, selected on the basis of implementation strategy, procedure volumes impacted, and availability of comparable outcomes data. When working with a client on a needs assessment for implementation planning or business case development, Integration Resources requests available data, then performs the necessary calculations to arrive at the metrics listed in Table 1. Before and after data are compared to determine whether or not performance has improved.

The 16 items listed in Table 1 are some of the measures used for cost-justifying a PACS implementation, and are designed to measure radiology operations in terms of cost reduction and productivity improvement objectives. This list is by no means exhaustive. A key factor in selecting performance metrics is that you measure the process in terms of the new process objectives,³ eg, if you were considering the implementation of a voice recognition system or a change in transcription methods, you would also want to measure time from dictation to radiologists' signature.

For the three medical centers discussed here, data are compared in the areas of reduction in film usage for the procedures impacted; improved report turnaround time for inpatients and the emergency room (ER); improved access to images in intensive care units (ICUs); improved technologist, radiologist, and file room FTE productivity; and reduction in storage space required. The results may help institutions planning for PACS to align implementation strategies with perfor-

mance objectives and realize the cost benefits projected in business case scenarios.

RESULTS

Medical center 1 implemented a PACS that consisted primarily of computed radiography (CR) and clinical review workstations. CR systems were installed in three locations: (1) the ER, (2) ICU/Critical Care Unit (CCU), and (3) a remote care facility. Two CR readers/quality-control (QC) stations were installed in Radiology. Four clinical review workstations were installed in the ER and two installed in the ICU/CCUs. A single four-monitor diagnostic review workstation was placed in Radiology for reading ICU/CCU images, ER images, and after-hour readings from the remote facility. A PACS network was installed and CR readers and workstations were hooked up to the network. The PACS was interfaced to the RIS, but the interface did not permit downloading of patient data. Images were stored on the workstation's hard drive until it reached capacity, then they were dropped off by aging criteria. No long-term archive was included in this phase, so film continued to be produced for all procedures.

With this implementation, the only reduction in film usage came from sending soft copy images instead of film copies to the ER and one ICU. Although costs were not reduced significantly because film continued to be produced for all procedures, report turnaround times to the ER went from 22.7 hours to 12.9 hours, and clinicians in the ICU were able to access their patients' images more readily. Technologist productivity was not improved because the technologist still had to enter patient demographics at the CR system, and file room productivity remained constant because there was not a significant reduction in film.

Medical center 2 took an entirely different approach to implementing phase 1. This implementation was designed to reduce film usage for computed tomography (CT) and magnetic resonance imaging (MRI). The file room had reached full capacity and CT and MRI combined were generating 962,000 films per year. Also, radiologists performed interpretations for two remote MR sites, which required a courier service to transport 2,500 studies per month. In addition to the cost of this service, extra steps were required to pull films and deliver them, and this resulted in unacceptable time delays in communicating diagnoses.

Table 1. Metrics for the Evaluation of PACS Performance

1. Cost of film and associated supplies (film jackets, chemicals, etc), preferably by modality
2. Cost of storage space and/or square footage requirements
3. Cost of technologist and file room labor
4. Volume of studies per technologist FTE, by modality
5. Volume of studies per file room FTE
6. Average exam time, by modality
7. Image availability in ICUs/CCUs
8. Report turnaround time to ER
9. Report turnaround time for inpatients
10. Average ICU length of stay
11. Average inpatient length of stay
12. Exam repeat rate (due to improper exposure parameters)
13. Exam retake rate (due to images unavailable)
14. Percentage of studies requested from file room that are not available when requested
15. Percentage of exams completed but not interpreted
16. No. of complaints from referring physicians and/or patients

Table 2. Performance Results of PACS Implementations at Three Medical Centers

	Medical Center 1	Medical Center 2	Medical Center 3
Procedures impacted	32,000 portables	55,000 CT & MRI	132,000 all modalities
Reduction in film usage	Minimal	Yes, to 40%	Minimal
Improved report turnaround to ER	Yes	Yes	Yes
Improved report turnaround for inpatients	Yes	Yes	No
Improved access to new images in ICUs	Yes	No	Yes
Improved technologist productivity	No	Yes	No
Improved radiologist productivity	No	Yes	No
Improved file room FTE productivity	No	No	No
Reduction in storage space	No	Yes	No

Baseline measures were obtained, and a system was implemented that consisted primarily of a PACS network, modality interfaces, clinical and diagnostic workstations, and a CD archive. The PACS was not interfaced to the RIS, so all patient demographics had to be entered manually. Prior studies could be retrieved from the archive, but only by operator query: there was no automated prefetch capability. This created extra work for the radiologists, but the average number of reads per radiologist still increased substantially. Medical center 2's film usage is now at 40% of what it was 2 years ago, despite an increase in procedure volume. The institution achieved its objectives for reducing film costs and storage space requirements. Despite these reductions, no file room FTEs were eliminated because prefetch was not automated. Paper prints were used to satisfy hard-copy requests, except for orthopedic and neurosurgeons.

Medical center 3 implemented a large-scale PACS in phase 1, consisting of a central archive; PACS/RIS interface; CR units in the ER and ICU/CCUs; nuclear medicine, ultrasound, and CT interfaces; four diagnostic workstations in Radiology, and 11 clinical workstations in the ICUs and ER.

Baseline data were not acquired by the institution, or used to monitor results of the implementation. Nor were there specific objectives for the phase one implementation. Integration Resources collected data retrospectively, and found film usage had not been reduced significantly, costs had not been reduced, and there were no significant produc-

tivity gains. The only measurable improvements identified were shorter report turnaround to the ER and shorter access time for new images in the ICUs. The reason given for continuing to produce film was that the archive had proved unreliable, so the radiologists were still requiring film to be stored for comparison with newly acquired soft copy images. Table 2 tabulates results for the three medical centers.

DISCUSSION

The results suggest that performance improvement such as productivity gains and reductions in film cost are greatest when tied to clearly defined, short-term performance objectives for each phase in the implementation process. When objectives were not met in any particular phase, performance indicators enabled us to determine what further changes needed to be made before moving on to successive phases. Acquiring baseline data, measuring performance improvement in each phase, and further evolving the process may prove to be essential for the attainment of PACS goals and achieving the return on investment that can be critical in obtaining further financial approvals.

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