

## The Problem

Conversion from hard to soft copy (i.e., digital images on PACS systems) hasn't solved the problem of cases being "lost".

This is accentuated when PACS and RIS systems function independently as shown in Fig 1. A host of digital opportunities now exist for cases to be lost or hidden in the cyberspace of PACS systems.

**Why is this important?** Unread or delayed read cases may have clinical and even medico legal relevance, and also directly impact reimbursements.

### Background

For this quality improvement project, unread, lost or delayed read cases were defined as those cases performed but not completed within the five days mandated by our hospital.

Unread Cases before the Operation Dashboard Implementation (July 1, 2005)

Year	Imaging Volume	# Unread Cases (%)
2001	210292	220 (0.10%)
2002	229875	198 (0.09%)
2003	236574	276 (0.12%)
2004	256723	249 (0.10%)
2005	131991*	145 (0.11%)

[\*] Data for 2005 was calculated to June 30

While many institutions, including our own, exhibit a low unread case rate, i.e., less than .1%, the actual number by volume can run into the hundreds. Lost reports in PACS have been shown to have significant legal implications for radiologists, their departments and institutions.<sup>1</sup>

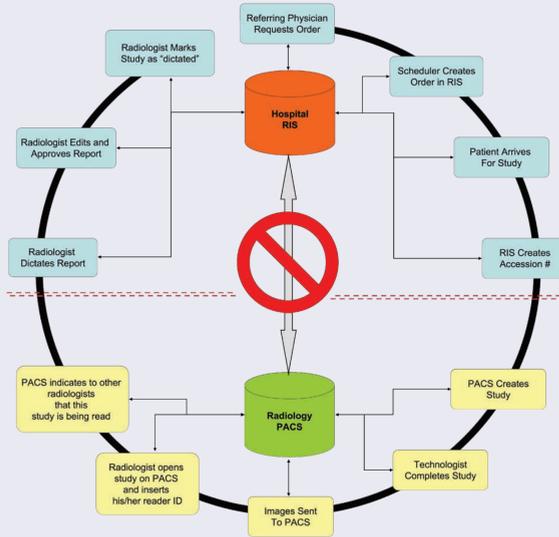


Fig 1. Radiology workflow at BIDMC shows the lack of communication between the PACS and RIS systems which function independently. This has led to one of the most common reasons for a lost report, e.g., when a report is deleted in RIS, this action is not reflected in the PACS workflow.

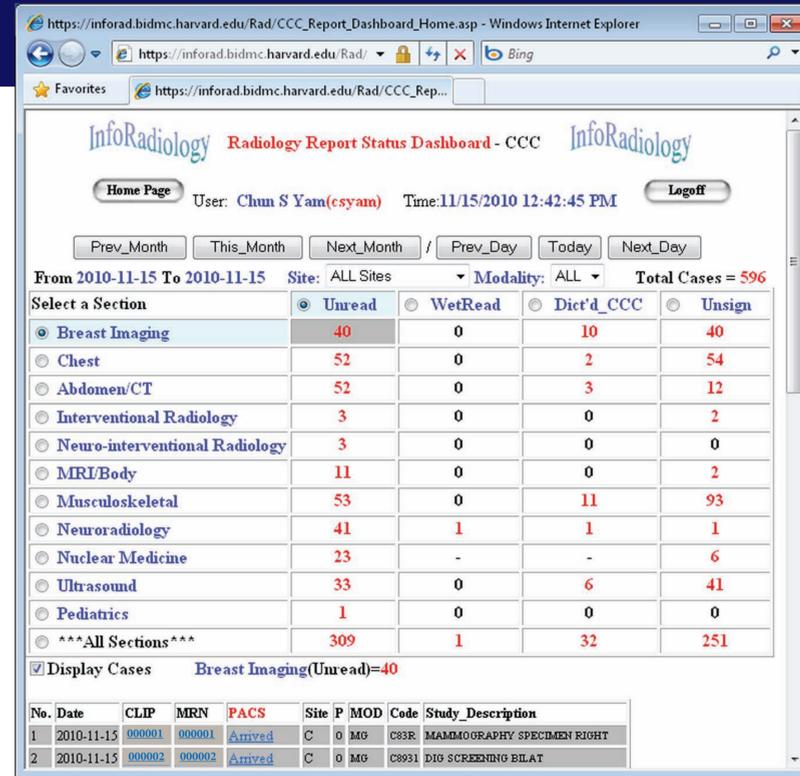


Fig 4. Radiology Report Status Dashboard

Daily tasks are actively monitored by:

User Group	Responsibility
Exam Managers	Unread column
Residents/Fellows	WetRead column
Transcriptionists	Dictation column
Attending Radiologists	Unsigned column

As an alternative to actively monitoring the dashboard, users can choose to receive auto-notification from the dashboard by section, modality and/or sites. This unique passive notification system sends automatic emails to alert the users responsible for unread cases, rather than relying on the users to actively check the dashboard. The default notification threshold of 4 hours is also adjustable.

## The Solution

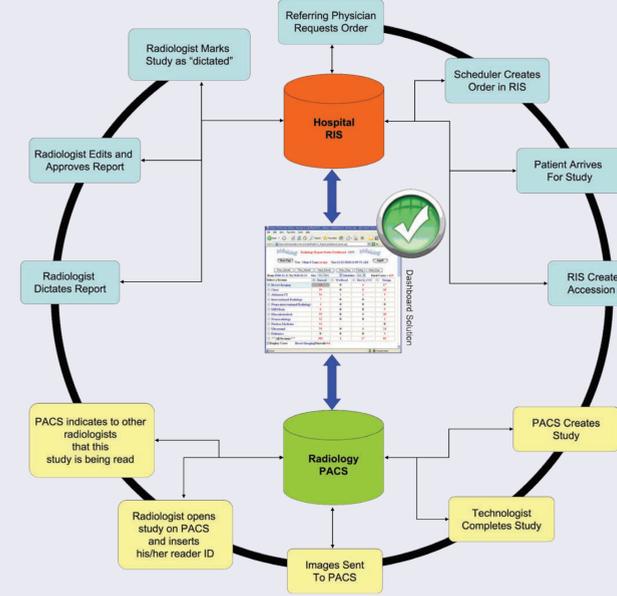


Fig 5. The current Radiology workflow at BIDMC shows the communication now available between the PACS and RIS systems using the Dashboard solution.

### System Design

With the top 12 reasons identified, a task force was formed between radiology and our hospital RIS liaison in Jan. 2005. Members included the radiology QA director, two section chiefs, the director of computing and the operations manager. The proposed solution was to create an online dashboard to share real time information of the radiology workflow. The basic infrastructure was a middle tiered interface to "bridge" the two separated systems, i.e., RIS and PACS (Fig 5). With this combined information system, the four major user groups, i.e., exam managers, residents/fellows, transcriptionists and attendings can now easily monitor (and promptly rectify) their unread cases.

### Implementation

With assistance from the hospital RIS group, a Windows based web server was purchased and installed in three weeks. In early February, the dashboard was able to receive HL7 messages from RIS and DICOM messages from PACS. Technical information for creating this HL7 interface has been published<sup>2</sup>. With technical support from our PACS vendor, a DICOM connection was established in late February. The dashboard went live in March 2005 for initial testing and implementation. The dashboard was finalized and officially launched in June 2005, featuring:

- Real time information from RIS and PACS
- Using the hospital single sign-on to eliminate redundant information
- Web based user interface for easy access
- Secure web access with standard audit trails
- Standard software & hardware (Windows Server 2003, SQL Server 2005, ASP)
- Standard infrastructure (HL7, HTTP and DICOM)
- Auto-email and auto-paging reminders to physicians

Unread Cases after Implementation (older than 5 days)

Year	Imaging Volume	# Unread Cases	%
2005	269862	0	0
2006	285818	0	0
2007	293304	0	0
2008	313062	0	0
2009	326656	0	0
2010	246332**	0	0

[\*\*] Data for 2010 was calculated to September 30

### Analysis of Implemented Change

Similar to other institutions, implementation of a dashboard signalled a cultural change for radiology users requiring new skills and change in workflow. Although we initially had the same experience, we attribute our success to open communication between the radiology QA team and the users whose feedback resulted in implementation of *passive notification features*, which were well-accepted:

- For different modalities and subspecialties, the section chiefs can tailor the dashboard to set the unread case notification criteria and triggering time as well as the means of notifications (i.e., email or pager) for their staff.
- Compulsory auto email and paging capability has been added to alert radiologists as soon as cases populate their approval log. This has led to shortened report turn around time (RTAT) and consequent positive financial impact.

### Current Status and Future Direction

Today, we have achieved our goal of no unread or incomplete cases older than 5 days in our department as well as our six community practice sites throughout Massachusetts. In total, 143 radiology users (75 radiology attendings, 50 residents/fellows, 6 transcriptionists and 12 exam managers) access the system daily. Average page hits to the radiology dashboard is ~1200 per day. Although we achieved our initial goal, we continue to welcome user feedback for future process improvements. For example, based on feedback from referring physicians, we are in the process of rolling out Blackberry push notification of unsigned reports to shorten report turn around time (RTAT).



The dashboard passive notification mimics the push technology used by Blackberry devices.

### Root Cause Analysis (RCA)

We performed RCA on lost cases between 2001-2005 starting with a cause and effect analysis (Fig 2) based on the categories in the Radiology Workflow Diagram (Fig 1). Results of this analysis (shown in Pareto chart Fig 3) identified potential reasons and contributions with the Top 12 contributors shown in the accompanying table.

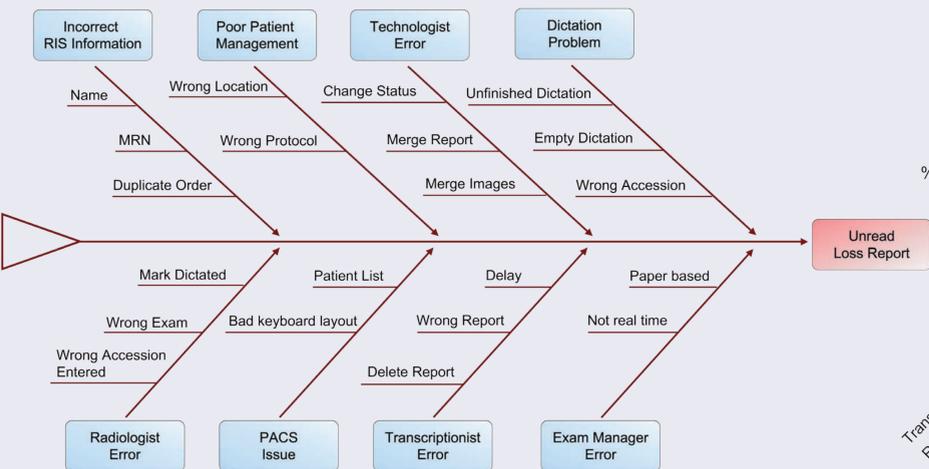


Fig 2.

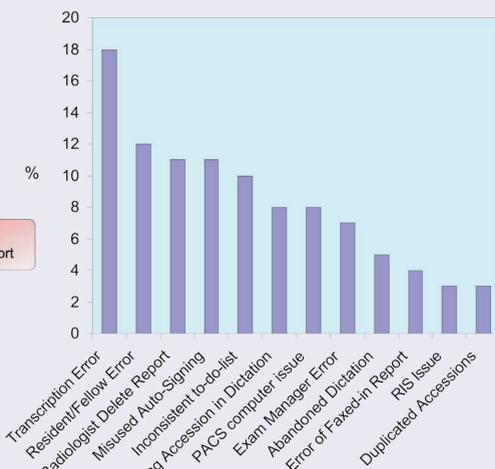


Fig 3.

### Top 12 Root Causes

Rank	Reason and Contributor	User Group	%
1	Transcriptionist failed to follow thru the unfinished dictation	Transcriptionist	18
2	Resident or Fellow entered Wet-Read into the ED system without a formal dictation	Radiologist	12
3	Report deleted by Radiologist in RIS without updating PACS Work List	RIS & PACS	11
4	The misuse of auto-signing function in RIS	RIS	11
5	Inconsistent information on printout-to-do list compared to real-time report status	All users - Paper based system	10
6	Radiologist entered wrong accession number into the dictation system, stopped and terminated the dictation "without" notifying the transcriptionist or exam manager to rectify the error	Radiologist	8
7	Radiologist marked exam as "dictated" accidentally by hitting the "F6" function on the PACS workstation keyboard	Radiologist	8
8	Exam Manager marked the exam completed by mistake	Exam Manager	7
9	Radiologist started a dictation and distracted by other reading room activities as such a curbside consultation and eventually forgot it	Radiologist	5
10	Transcriptionist entered faxed report without using the correct steps	Transcriptionist	4
11	RIS failed to merge the addendum into existing report but resulting in erasing the report	RIS	3
12	Wrong patient information entered into RIS resulting in duplication of accession number	RIS & PACS	3

### CONCLUSION

To minimize the number of unread cases in PACS, we have designed and successfully implemented a **Radiology Report Status Dashboard** in multiple hospitals and imaging centers. Using the dashboard, we have sustained and eliminated "lost" cases for the past five years while our monthly imaging volume has increased by 50% compared to 2005. The unique features of this dashboard are compatible with most of today's RIS/PACS systems and the infrastructure can be installed by standard hospital IT groups.

### References

1. Smith JJ, Berlin L. Picture archiving and communication systems (PACS) and the loss of patient examination records. AJR. 2001 Jun;176(6):1381-4.
2. Yam CS, Rofsky N, Kruskal J, Sitek A. Development of a radiology report monitoring system for case tracking. AJR. 2005 Jan;184(1):343-6.