Improving Patient Safety: Avoiding Unread Imaging Exams in the National VA Enterprise Electronic Health Record

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Abstract In the current digital and filmless age of radiology, rates of unread radiology exams remain low, however, may still exist in unique environments. Veterans Affairs (VA) health care systems may experience higher rates of unread exams due to coexistence of Veterans Health Information Systems and Technology Architecture (VistA) imaging and commercial picture archiving and communication systems (PACS). The purpose of this patient safety initiative was to identify any unread exams and causes leading to unread exams. Following approval by departmental quality assurance committee, a comprehensive review was performed of all radiology exams within VistA imaging from July 1, 2009 to June 30, 2014 to identify unread radiology exams. Over the 5-year period, the total unread exam rate was calculated to be 0.17%, with the highest yearly unread exam rate of 0.25%. The leading majority of unread exam type was plain radiographs. Analysis revealed unfinished dictations, unassociated accession numbers, technologist errors, and inefficient radiologist work lists as top contributors to unread exams. Once

unread radiology exams were discovered and the causes identified, valuable process changes were implemented within our department to ensure simultaneous tracking of all unread exams in VistA imaging as well as the commercial PACS.

Keywords Electronic Medical Record (EMR) · PACS · Quality assurance · Unread exams

Abbreviations

CT	Computed tomography
VA	Veterans Affairs
PACS	Picture archiving and communication system
RCA	Root cause analysis
ACR	American college of radiology
VistA	Veterans Health Information Systems and Technology Architecture
IT	Information technology
HIPAA	Health Insurance Portability and Accountability Act
QA/QI	Quality assurance/quality initiative
RIS	Radiology information system
HIS	Health information system

Scope of the problem Identifying and monitoring unread radiology exams within the Veteran's Affairs (VA) hospital enterprise-wide filmless electronic health record and the commercial Picture Archiving and Communication Systems (PACS).

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A patient at our institution presented to primary care with hematuria. A computed tomography (CT) urography exam was ordered by the primary care provider and completed in our radiology department; however, the exam went unreported for several months. When the unread exam was discovered, it revealed a small, enhancing renal mass suspicious for renal cell carcinoma. This unnecessary delay in diagnosis and treatment was a direct result in the CT exam going unread for several months. This event prompted a quality improvement

project and root cause analysis (RCA) to identify causes of unread radiology exams and decrease the likelihood of similar adverse events occurring in the future.

The American College of Radiology (ACR) practice parameter for communication of diagnostic imaging findings states a critical component of diagnostic imaging is effective communication. However, communication of information is only as effective as the system that provides the information [1]. In the Veteran's Affairs (VA) or any health care system, unread or delayed read radiology exams have direct clinical and medico-legal implications, particularly when diseases go unrecognized [2, 3]. Unread exams also represent inefficient utilization of government resources. In the current era of alleged VA mismanagement and decreased patient access, we scrutinized potential system inefficiencies that lead to unread radiology exams and developed a robust and repeatable process for monitoring unread exams.

The Veterans Health Information Systems and Technology Architecture (VistA) is the VA's award winning health information technology (IT) system. VistA is an integrated, comprehensive health information system (HIS) used across all VA medical centers and outpatient clinics, which supports all clinical services [4, 5]. The radiology information system (RIS) is one of many subsystem specialty modules that make up VistA, and together with the VistA HIS, provide support for imaging management and infrastructure [5]. VistA imaging is the VA's image management system that allows VA hospitals to achieve an enterprise-wide, paperless, and filmless electronic health record, which includes multi-media, medical images, and scanned documents [6]. VistA imaging provides nationwide access to patient imaging studies across all VA health care facilities and distributes studies throughout the enterprise. Enterprise-wide imaging allows for centralized image-storage and management, making images available at the point of care and connecting them to a network of VA health care providers. The problem of unread radiology exams has the potential to be more prevalent at VA health care systems because in addition to VistA imaging, a commercial PACS is in place where local VA radiologists interpret imaging exams, perform their dictations, and issue final reports. Successful integration of commercial PACS systems with medical equipment and existing information systems across the VA network is essential. This interface permits automatic transfer of radiology and nuclear medicine images across the wide area network [6]. The VistA imaging and PACS interface is guided by business and technical requirements set forth by the VA Office of Information to ensure protection of patient information. Since VistA imaging is the VA's system of record for patient's imaging, all additions, deletions, and corrections to patient data must be performed on VistA first, then on the commercial PACS [7].

What We Did

This Health Insurance Portability and Accountability Act (HIPAA)-compliant study was approved by the departmental quality assurance/quality initiative (QA/QI) committee. The need to obtain informed consent was waived. To ensure compliance with best practices set by the national VA radiology program, an internal audit of our local facility's radiology exams was performed. A comprehensive review to identify all unread radiology exams within VistA imaging from July 1, 2009 to June 30, 2014 was performed. Unread exams were defined as locally performed (non-imported) exams where images had been acquired, however, lacked a final report in the electronic health record. For each of these exams in unread status, we further confirmed that images were present both in VistA imaging and in the commercial PACS. We excluded exams that did not have images and exams in the "waiting for exam" status where an order had been received but no images acquired.

Before data analysis began, VA staff radiologists interpreted all unread exams and unrecognized findings were promptly reported to ordering providers. Then, data analysis and collection consisted of categorizing the number of unread exams by year and imaging modality and calculating the yearly percentage of unread exams based on total radiology exams performed per year. A root cause analysis was performed on the aggregate unread exam group to identify top contributors to unread exams and cause and effect relationships based on our radiology workflow. A team was then organized to study workflow processes, collect further data and implement necessary changes.

Results

From July 1, 2009 to June 30, 2014, absolute numbers of unread studies were compared and our yearly unread exam rate was calculated to be as high as 0.25% depending on the year and total radiology exam volume. No adjustment was made for increased total study volume over time or inpatient versus outpatient studies. Over the 5-year period investigated, our total unread exam rate was calculated to be 0.17%. The leading majority of unread exam type was plain radiographs, with fluoroscopic/angiographic exams having the second highest unread rate (Fig. 1). These fluoroscopic/angiographic exams included procedures performed by groups outside of our service line such as operating room surgical staff, gastroenterologists, and pain clinic personnel where imaging guidance was required. The modality with the least number of unread exams was ultrasound, likely because our radiologist staff reviews each ultrasound with the performing technologist before patients leave the department. This allows for direct oversight of most, if not all ultrasounds performed.

Percent of Unread Exams by Modality

Fig. 1 Percentage of unread radiology exams by modality

Cause and effect analysis revealed several potential contributors that lead to unread exams with multiple user groups involved. The diverse contributions to unread exams were graphically displayed in a fishbone diagram, illustrated in Fig. 2. Our analysis revealed one top contributor of unread exams to be unfinished dictations. This includes empty dictations, partial dictations, or preliminary resident reports that were not correctly finalized by an attending or inadvertently sent to the incorrect attending. Another cause of dictation errors was erroneously marking an exam dictated, which causes it to disappear from the work list. Unassociated accession numbers was another factor that contributed to unread exams. These were studies that had been interpreted, however, did not have all of the accession numbers associated, and these accession numbers remain in VistA imaging as unread. For example, the abdomen and pelvis portion of a chest-abdomen-pelvis CT were finalized only under the chest accession number, which left the abdomen and pelvis studies in incomplete status. We also discovered that the filters used to create the PACS unread work lists did not effectively capture all unread exams. For example, if the radiologist started a dictation, however, inadvertently did not complete the dictation, it will disappear from the PACS unread list and no longer is visible for future reading. Also, many of the PACS unread work lists did not include a wide enough date range to continuously display unread exams. Resident and trainee dictation errors were also contributing factors. For example, trainees may have assigned the report to an incorrect attending for approval or associated

an incorrect accession number that belonged to an incorrect exam. Technologist errors such as performing the incorrect exam or protocol and not verifying exam completion in PACS also lead to unread studies. A small fraction of the unread exams represented studies that failed transmission to PACS due to system outages or unexpected downtimes. Our results showed that most radiologists were not aware of the volume of unread exams and were relying on the unread work lists on the commercial PACS. Also, most radiologists were not aware that VistA is a more comprehensive way to identify unread exams and can sort unread studies by location, modality, and age of examination, exam priority status, among other criteria.

Our calculated unread exam rate varied per year, from 0.09 to 0.25%. The highest rate of 0.25% occurred in a year when our department changed PACS vendors and experienced several planned and unplanned PACS downtimes. Our analysis revealed that during this time, several exams failed to send to the PACS from the modality due to the downtimes and service outages. When these failed exams were subsequently sent to PACS, they were outside of the configured date range to capture unread exams and did not appear on the unread or daily work lists.

System Redesign and Future Directions

Despite our best efforts to prevent harm, adverse events in health care organization still occur. When such events occur, our first priority is to manage the patient appropriately [8]. Then, radiologists and health care providers can achieve great impact by objectively identifying factors associated with the adverse event and implement effective procedural changes to prevent them from recurring [8, 9].

Understanding the multiple factors that potentially contribute to a radiology exam becoming unread is an imperative first step in eliminating and preventing unread radiology studies. This understanding required team-level collaboration with radiology staff including PACS administrators, radiologic technologists, and staff radiologists. Following root cause analysis, a rigorous departmental process was swiftly created to include participation from chief and lead technologists, PACS administrators, and radiologists to significantly decrease the likelihood of similar events occurring in the future (Table 1). This new process did not require users to learn new skills and did not significantly change workflow. Our success was a direct result of open communication between our radiology team and feedback from users of the new process, which was well accepted.

It was clear that our radiologists were unaware that several exams had gone unread as simultaneous tracking of unread exams in VistA as well as the commercial PACS was not regularly performed. Also, since the advent of PACS, there are fewer reasons for clinicians to visit radiology reading

Cause and Effect Diagram: Unread Radiology Studies

Fig. 2 Fishbone diagram, also known as cause-and-effect diagram or Ishikawa chart, showing cause and effect analysis of potential contributors of unread radiology exams and the multiple user groups involved

rooms, and unread exams may not be brought to the radiologist's attention. As such, our first step was to increase visibility and awareness of any unread exams. PACS administrators reconfigured our PACS daily work lists to include a broader date range of 10 days, rather than 3 days. This prevented studies from "falling off" the daily work list due to long

holiday weekends, or studies transmitted late from the modality. The master, all inclusive exam unread work list was reconfigured to capture exams performed over a 3-month time frame, rather than 30 days as initially configured. This included exams where a dictation may have been started but not completed. Modality specific unread exam work lists were

Table 1 Root cause analysis action plan

Issue	Steps taken
Awareness of unread exams	Reconfigured daily PACS work lists to include wider date range and exams with unfinished dictations. Single master unread exam PACS work list created for radiologists to view with increased date range.
Unread exams not tracked	Developed process for routine tracking of unread exams in both PACS and VistA to include quarterly, weekly, and daily reports. Verification of images and exam status assigned to technologist and administrative staff. Quarterly report reviewed by radiology chief to identify causes of untimely reporting. Outstanding unread exams are individually assigned for reporting.
Unfinished dictations	Routine review of radiology transcription system for failed reports within the RIS.
Non-radiology fluoroscopic exams	Brief and simple report template created for ease of dictation. Fluoroscopic only unread exam work list created to view angiographic and fluoroscopic exams performed outside of the department.
Unassociated accession numbers	Automatic association of parent and descendent procedure accession numbers was enabled to prevent unassociated accession numbers in VistA.
Exams not in PACS	Utilization of auto send feature on modalities to prevent exams from failing to reach the PACS.

also created specifically to capture angiographic and fluoroscopic exams that are performed outside of the radiology department. A brief, standardized reporting template was implemented to address fluoroscopic exams performed outside of the radiology department, where a radiologist's interpretation was not requested. PACS administrators enabled automatic association of parent and descendent procedure accession numbers for exams such as CT of the chest, abdomen, and pelvis to prevent unassociated accession numbers in VistA. PACS administrators also regularly review the radiology transcription system for failed transmission of reports to the RIS.

Valuable process implementation and quality assurance monitoring was performed by our radiology technologist staff as well. Chief technologist and PACS administrators are tasked with reviewing the unread and incomplete report from VistA on a daily basis, which covers a 7-day time period. Modality specific lead and QA technologists are assigned to verify the status of any incomplete exam and to ensure correct images are available for viewing. The auto send feature on each modality is routinely utilized to prevent any studies from failing to reach the PACS.

Weekly and quarterly unread exam reports are also generated to ensure overlap of the daily report. The assumption is that the quarterly report will yield zero studies. The daily and weekly reports are designed to identify unread exams given the ongoing, constant turnover of radiology exams and reports. The quarterly report is reviewed with the radiology chief to identify any new process issues that prevent timely reporting. Any radiology exams identified without a report are specifically assigned for rapid completion.

Our process improvements were re-measured after initial implementation. Unread exams over a 6-month period from July 1, 2014 to December 31, 2014 were identified and reviewed. Criteria for defining unread exams remained the same as the initial review. Our inherent goal was to have zero unread exams; however, we discovered that unread exams persisted despite process implementation. The calculated unread exam rate for the first 6 months following implementation was 0.08%. The majority of unread exams were fluoroscopic and angiographic studies. The second highest unread exam types were plain radiographs and nuclear medicine, equally. There were zero unread ultrasound exams. Analysis revealed that certain exams were not undergoing automatic association of parent and descendent procedures and nearly half of the discovered unread studies were due to open accession numbers in VistA. Additionally, many of the unread nuclear medicine exams were due to patients who did not return for additional delayed imaging. Our process implementation for identification of unread exams is streamlined; however, it remains immature and re-measurement allowed for areas of further improvement.

In conclusion, we identified contributing factors that lead to unread radiology exams at our VA health care system and outlined meaningful risk reduction strategies to prevent unread radiology exams. Our thorough process evaluation will allow for improved healthcare services delivered to the veteran population and ultimately increase patient safety and health outcomes by reducing errors of unread exams. One of the most important and impactful changes made was regimented and repeatable monitoring of unread exams and tracking all exams to completion within VistA. Monitoring two concurrently operating parallel systems posed a challenge when identifying unread exams, and there is little information in the published literature to guide this process. Key adjustments to our workflow and routine audits will effectively identify and prevent any future unread exams.

Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflict of interest.

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References

1. ACR. ACR Practice Parameter for Communication of Diagnostic Imaging Findings. Available at: http://www.acr.org/~media/ACR/Documents/PGTS/guidelines/Comm_Diag_Imaging.pdf. Accessed September 30, 2015
2. Evers RW, Yousem DM, Deluca T, Beauchamp NJ Jr, Smith S: PACS and unread images. *Acad Radiol* 9:1326–1330, 2002
3. Smith JJ, Berlin L: Picture archiving and communication systems (PACS) and the loss of patient examination records. *Am J Roentgenol* 176:1381–1384, 2001
4. US Department of Veterans Affairs. Introduction to the VistA Monograph. Available at: <http://www.ehealth.va.gov/vista.asp>. Accessed June 10, 2015
5. Kuzmak PM, Dayhoff RE: The use of digital imaging and communications in medicine (DICOM) in the integration of imaging into the electronic patient record at the Department of Veterans Affairs. *J Digit Imaging* 13:133–137, 2000
6. Siegel EL: Economic and clinical impact of filmless operation in a multifacility environment. *J Digit Imaging* 11:42–47, 1998
7. US Department of Veterans Affairs. Radiology Picture Archiving and Communication Systems (PACS). VHA Directive 2011–005. Available at: <http://www.va.gov/vhapublications/publications.cfm?pub=1>. Accessed June 10, 2015
8. Brook OR, Kruskal JB, Eisenberg RL, Larson DB: Root cause analysis: learning from adverse safety events. *Radiographics* 35:1655–1667, 2015
9. Siegle RL: From errors to process improvement. *J Am Coll Radiol* 1: 133–134, 2004