PSO NAVIGATOR

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Misreads of Imaging Studies among Top Radiology Events

Executive Summary

Event reports submitted to ECRI Institute PSO suggest that diagnostic errors in radiology are among the most frequently reported type of radiology incident. The errors, involving problems in reading or interpreting radiology studies, can have severe consequences for patients when they lead to mistakes in diagnosing a condition or in a patient's treatment. Strategies to prevent radiology misreads are discussed.

Leadership

SYSTEM FAULTS CONTRIBUTE TO DIAGNOSTIC ERRORS IN RADIOLOGY

Diagnostic imaging can save lives and enhance patient care with the timely diagnosis of conditions ranging from appendicitis and bone fractures to cancer and stroke. As with any healthcare process, however, mistakes can occur in diagnostic imaging, especially when there are inadequate systems in place to help prevent radiologists from making unintentional errors in interpreting an image.

The radiology community has long confronted the risk of errors in image interpretation. Nearly 70 years ago, radiologist L. Henry Garland published his finding that experienced radiologists fail to identify nearly 30% of chest x-rays that have positive evidence of disease (Garland). Since then, numerous studies have reaffirmed Garland's report and extended the findings to a wide range of imaging modalities (Berlin 2014).*

Address System Faults that Contribute to Radiology Misreads

- Ensure ordering clinicians provide radiologists with the rationale for the requested imaging study.
- Consider clinical decision support with radiology ordering to document reasons for the study.
- Outline policies and procedures for optimal image acquisition.
- Redo inadequate studies, when possible, if better patient positioning or image acquisition can help.
- Provide the interpreting radiologist with access to the patient's clinical information and to previous radiology reports and images for review and comparison.
- Use structured radiology reports to communicate findings in an organized, consistent, and clear manner.
- Give patients access to the findings from their diagnostic imaging studies.
- Use peer review to learn from mistakes, and apply the lessons learned.
- Encourage reporting of events and near misses to improve the safety and quality of image interpretation.
- Periodically conduct self-assessments of the radiology department's processes to identify opportunities for improvement.

Event reports submitted to ECRI Institute PSO suggest that such diagnostic errors in radiology continue to occur and are among the most frequently reported type of radiology incident in ECRI Institute PSO's event database. The errors involve mistakes in reading or interpreting radiology studies. They can have severe consequences for patients when they lead to mistakes in diagnosing a condition and in treatment, such as the following:

- A delay in diagnosing cancer at its earliest, most treatable stage
- A delay in diagnosing and treating an emergency condition, such as appendicitis
- An unnecessary surgical procedure for a presumed condition that was incorrectly interpreted as positive on an imaging study

Diagnostic errors involving incorrect radiology findings are referred to as misreads and are defined as "any discrepancy in interpretation that differs substantially from the consensus of one's peers" (Bruno et al.). A radiologist may either overlook an abnormality on the exam or misinterpret the significance of the abnormality.

Consequences of Misreads

Although many misreads are either corrected or do not result in any patient harm, there are cases that have led to adverse effects on a patient's health or care management. Consider the following

* In these studies, the estimates of error rates are calculated using a preselected number of studies with abnormal findings. The denominator in the calculations is the total number of abnormal studies, and the numerator represents the number of studies that the radiologists missed as abnormal. If the denominator includes both normal and abnormal studies to reflect daily radiology practice, the error rate is lower, averaging about 3% to 4% in published studies (Berlin 2014).

Top Five Allegations in Lawsuits against Radiologists

1. Failure to diagnose
2. Procedural complication
3. Negligence
4. Peripheral role in lawsuit
5. Failure to communicate with another provider

Source: Whang JS, Baker SR, Patel R, Luk L, Castro A 3rd. The causes of medical malpractice suits against radiologists in the United States. *Radiology* 2013 Feb;266(2):548-54. http://pubs.rsna.org/doi/pdf/10.1148/radiol.12111119 PubMed: https://www.ncbi.nlm.nih.gov/pubmed/23204547

case, recently summarized in the Agency for Healthcare Research and Quality's (AHRQ) *WebM&M,* an online patient safety commentary (Siegel):

A woman who underwent a hysterectomy to remove fibroids developed a large pelvic abscess that was successfully treated before she was discharged. She returned to the hospital three days after her discharge for recurrent abdominal pain. A computed tomography (CT) image was ordered, and the radiologist reported a persistent large pelvic abscess. Based on the report's findings, the gynecologist took the patient to the operating room to treat the abscess but could not find it. Consulting the CT images for the first time from the operating room, the gynecologist realized that the radiologist had mistaken one of the patient's ovaries, which had not been removed, as the abscess. Given that there was no evidence of the abscess, the gynecologist aborted the surgery. The patient developed a wound infection from the second surgery, which delayed her healing and prolonged her hospital stay.

The case commentary suggested that the radiologist reading the CT image incorrectly assumed that the patient's ovaries were removed during the hysterectomy. As a result, the radiologist concluded that the structure seen on the image was a recurring abscess. Ensuring that radiologists have access to an electronic health record (EHR) to review patients' clinical information, such as a patient's operative report, can prevent these mistakes, the commentary recommended along with other suggestions. (Siegel)

Claims and Lawsuits for Misreads

In addition to potential harm to patients, diagnostic errors such as the one summarized in AHRQ's *WebM&M* can lead to claims and lawsuits, damaged reputations, and unwanted media attention for healthcare professionals and their organizations. According to one study, one in every two U.S. radiologists will be involved in a medical malpractice claim by age 60 (Baker et al).

Diagnostic errors are the top allegation in radiology claims. In one study, they represented more than half (57.3%) of all 879 radiology claims closed from 2008 through 2012 and contained in a database of open and closed medical malpractice claims for ambulatory and hospital settings (Harvey et al.). A list of common allegations against radiologists is shown in "Top Five Allegations in Lawsuits against Radiologists."

Among all physician specialties, however, diagnostic radiologists are less likely to be sued, and rank seventeenth among 24 different specialties. Their ranking is below such specialties as surgery, obstetrics and gynecology, and internal medicine (Jena et al.). Further, many of the claims against radiologists may be dropped, denied, or dismissed. The analysis of the 879 closed radiology claims found that 37.7% of the claims resulted in a payment; the mean indemnity payment was $481,094. A large portion of the claims (60%) were for mistakes in diagnosing cancer and fractures. (Harvey et al.)

System Solutions

Although radiology claims may target the individual radiologist, the errors that lead to claims and lawsuits are typically the result of system faults that prevent individuals from performing at their best. According to one estimate, about 90% of medical errors are the result of system problems rather than individual factors (Brook et al.). Fortunately, organizations can address the system barriers, such as a poorly lit environment for reviewing the images, multiple distractions and interruptions of radiologists interpreting images, insufficient information available to radiologists about a patient's condition, and failure to learn from previous mistakes and near misses and to prevent similar mistakes from occurring.

This issue of the *PSO Navigator* describes events of radiology misreads reported to ECRI Institute PSO and its collaborating organizations and provides strategies that organizations can put in place to prevent these mistakes from occurring (for a summary of strategies, refer to "Address System Faults that Contribute to Radiology Misreads").

What We Are Seeing

ECRI INSTITUTE PSO'S ANALYSIS OF RADIOLOGY EVENTS

For its analysis of radiology misreads, ECRI Institute compiled all event reports submitted as a laboratory/radiology event to ECRI Institute PSO's database from the start of the program in 2008 through April 2016.* From the collection of 9,133 events, we limited our analysis to events identified as occurring in the radiology department and further narrowed the data to events submitted from 2011 through April 2016, resulting in 527 events. A patient safety analyst reviewed a random selection of those events (214 in total) and classified the events by the type of error, such as a wrong result (i.e., misread), wrong test, or wrong patient.

Given that event data from ECRI Institute PSO's database is voluntarily reported by healthcare organizations, no conclusions can be drawn about the frequency or severity of radiology events and trends over time. Nevertheless, radiology events represent a small percentage of all events that occur in healthcare organizations. In ECRI Institute PSO's database, the combined laboratory/radiology events represent about 7% of all events submitted to the PSO, and less than 20% of these events are reported as occurring in the radiology department.

A study by one large medical center found that radiology incident reports occurred at a rate of about one incident for every 400 imaging exams performed (Mansouri et al.). Most of the incidents (75%) did not result in patient harm.

The events described in this article provide a snapshot of radiology events that organizations chose to report and offer insights into diagnostic imaging errors.

Misreads Comprise More than 25% of Radiology Events

As illustrated in "Figure 1. Radiology Events by Error Type" wrong results, or misreads, comprised 27.6% of the 214 events in the analysis, and were the second most frequently reported type of radiology event, behind service coordination problems.

Researchers describe two broad types of errors that lead to misreads or wrong results. About 60% to 80% of misreads are called "perceptual errors," made as a result of missing an abnormality (Bruno et al.), as in the following event from ECRI Institute PSO's analysis.**

The patient came to the emergency department [ED] for acute abdominal pain and was discharged after a CT scan was done and read as negative. The patient returned the following day. The CT was read as acute appendicitis.

In this event, the findings of appendicitis were readily apparent when the CT images were reviewed a second time. With perceptual errors, an abnormality is retrospectively determined to have been present but was not seen by the interpreting radiologist (Bruno et al.). The underlying causes for these errors, although poorly understood, are attributed to the complex systems in which radiologists operate, including pressure to provide prompt image interpretation in an environment full of distractions. (Bruno et al.) When radiologists intently focus on getting a job done, they may miss what, upon further examination, is obvious, as described in one study, radiology's version of the so-called "invisible gorilla" (see "The Invisible Gorilla").

The balance of diagnostic errors in radiology are called "cognitive errors" and occur when an abnormality is detected, but its importance is misunderstood (Bruno et al.), as in the following event reported to ECRI Institute PSO:

A patient suspected of having a stroke underwent a noncontrast CT of the brain.

* ECRI Institute PSO's event reporting system uses an enhanced version of AHRQ's common definitions and reporting formats, which allow PSOs to collect information from providers and standardize how patient safety events are represented. ECRI Institute PSO has modified AHRQ's Common Formats to include an event category for laboratory tests and radiology events.

** The event details are deidentified for this and all other events summarized in this report.

The Invisible Gorilla

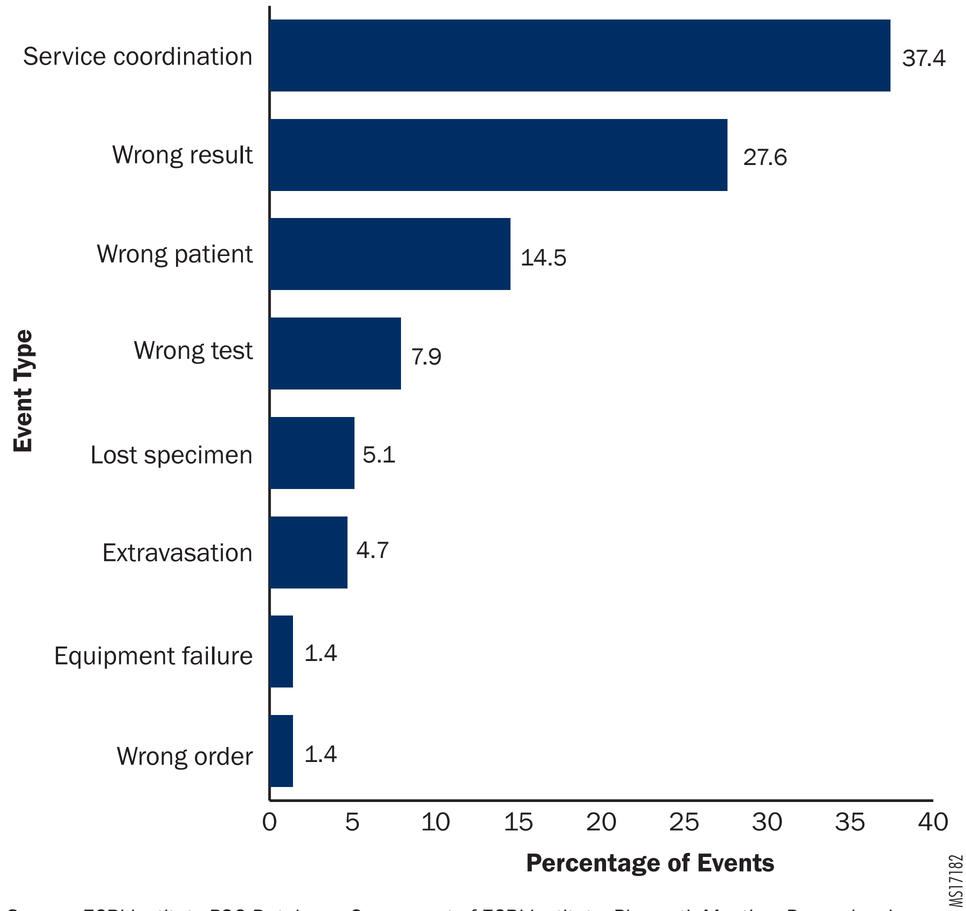
Anyone who has listened to a presentation on the science of patient safety is likely familiar with a video showing a group of individuals passing a basketball that is used to illustrate the limits of human attention. Many people who are asked to view the video for the first time and to count the number of times the basketball is passed report that they don't see a person in a gorilla suit stroll into the middle of the action for nine seconds and walk away; they are focused on counting the basketball passes and miss the gorilla.

In a study that applied the idea of the invisible gorilla to image interpretation, researchers inserted a gorilla-shaped figure, 48 times the size of an average lung nodule, or about the size of a matchbook, into a CT image from a chest CT examination. Twenty of 24 expert radiologists (83%) who were asked to examine the images for a lung nodule reported they did not see the gorilla when they were questioned (Drew et al.).

No one fully understands why a person may miss an abnormality that is clearly evident. One researcher called these errors in perception "an unavoidable hazard of the human condition." (Berlin 2014)

Sources: Berlin L. Radiologic errors, past, present and future. Diagnosis 2014 Jan;1(1):79-84; Drew T, Vo MLH, Wolfe JM. The invisible gorilla strikes again: sustained inattentional blindness in expert observers. Psychological science 2013;24(9):1848-53. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3964612/pdf/nihms563995.pdf PubMed: https://www.ncbi.nlm.nih.gov/pubmed/23863753

Figure 1. Radiology Events by Error Type (N = 214)



Source: ECRI Institute PSO Database. Component of ECRI Institute, Plymouth Meeting, Pennsylvania.

The preliminary findings indicated that there is hyperdensity on the scan, which may be due to the contrast. Another physician who reviewed the study said the area in question is bleeding in the right frontal portion of the brain.

In this case, the preliminary findings noted an abnormality, but incorrectly attributed the abnormality to contrast material even though the study did not use a contrast agent. The misread could have led to mistakes in managing the care of the patient, who was having a stroke.

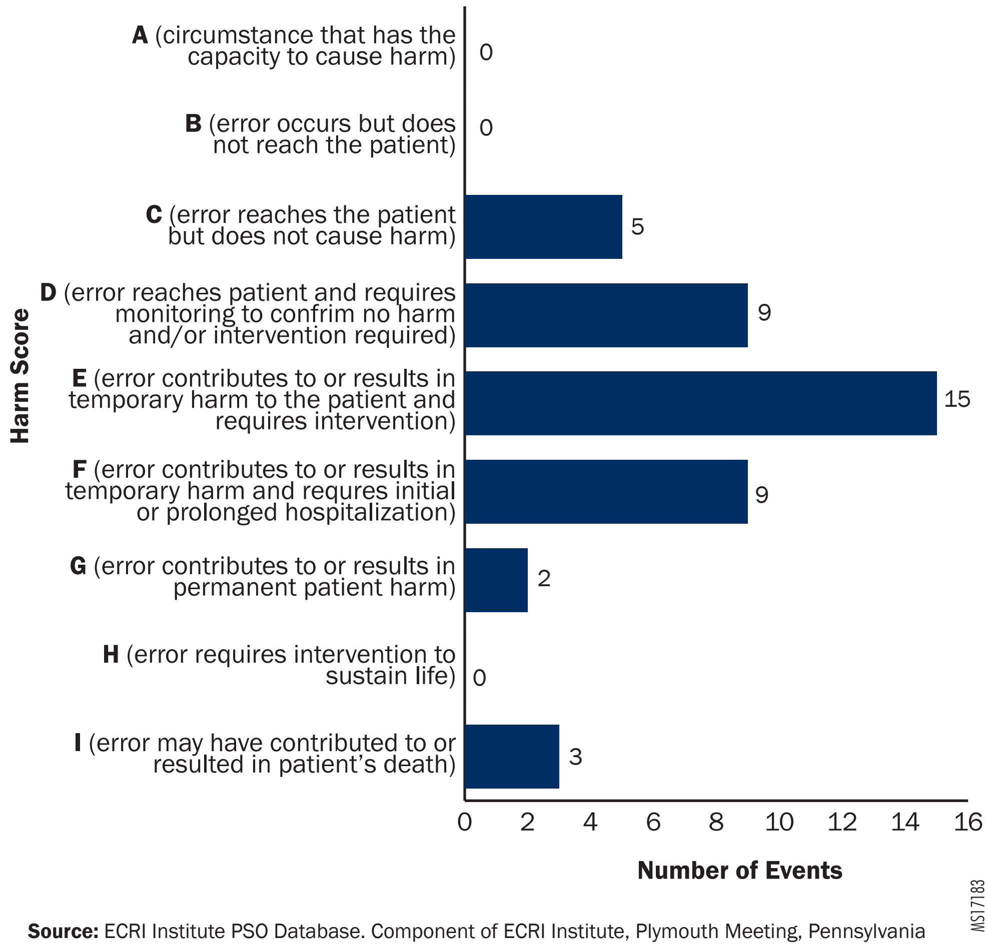
Harm Score

The harm score was provided for 43 of the 214 events analyzed (see "Figure 2. Radiology Misread Events by Harm Score"). ECRI Institute PSO's enhanced event reporting system incorporates the National Coordinating Council for Medication Error Reporting and Prevention (NCC MERP) Index for Categorizing Medication Errors to indicate harm levels.

The index—with its nine categories for harm, labeled A through I—is used to indicate an event's effect on the patient (e.g., an error reaches the patient but does not cause harm; an error contributes to temporary harm; an error contributes to permanent harm). Events with a harm score of E through I, using the NCC MERP index, are associated with patient harm.

Of the 43 events for which a harm score was provided, 67% resulted in patient harm (harm scores E through I). There were three deaths; two involved radiology misreads of patients who presented to the ED with pain. In one case, the patient's CT scan, which

Figure 2. Radiology Misread Events by Harm Score (N = 43)



Source: ECRI Institute PSO Database. Component of ECRI Institute, Plymouth Meeting, Pennsylvania

was first read as normal, was later reread as showing a possible aortic dissection. In the other case, the patient's abdominal x-ray was read as negative for free air even though air suggestive of a rupture was found during surgery. The patient rapidly declined during surgery and died the next day. It is unclear whether the patients' outcomes would have been different if the initial radiology findings had been correct.

The other high-harm events describe various consequences for patients from the diagnostic errors. The unanticipated outcomes (and a sample event for each outcome) are as follows:

- **Change in treatment plan.** *A patient in the ED had his wrist splinted based on x-ray findings of a fracture. The patient followed up with an orthopedist, who sent the patient back to the ED for a CT study, which found a lunate dislocation requiring surgery.*
- **Unnecessary surgery.** *The CT findings indicated the presence of a hernia. The patient was sent to surgery, but no hernia was found.*
- **Increase in severity of illness.** *The patient was admitted with suspected injuries to the femur and tibia. The patient's x-rays were read as negative. Another x-ray, performed two days later, showed a fracture. The previous x-ray was compared and also showed a fracture. Because of the misread from the first x-ray, the patient had been mobile since admission, possibly causing significant pain and tissue and bone damage.*

Education Teaser*

The use of _______________ may prevent the retention of foreign objects during interventional radiology procedures.

a. small incision size

b. radiopaque sponges

c. both small incision size and radiopaque sponges

d. None of the above.

The American College of Surgeons suggests that sponge, sharp, and instrument counts be used during any invasive interventional radiology procedure.

a. True

b. False

* Earn AMA PRA Category 1 credits! Access online courses on this topic through ECRI Institute's e-Learn at https://www.ecri.org/components/Pages/e-Learn.aspx.

- **Delay in treatment.** *The diagnosis of a hip fracture was delayed by the misreading of two x-rays of the hip performed a week apart. The director of radiology reviewed the x-rays and diagnosed the fracture. The patient was scheduled for hip surgery.*

Other Findings

The analysis provided other insights about misread events reported to ECRI Institute PSO:

- **Event location.** For events that provided sufficient information to determine where the event occurred, the location was split somewhat evenly between the inpatient setting and the ED.
- **Imaging modality.** The event narrative provided sufficient information to determine the imaging modality involved for 58 of the misread events. The majority of these events involved CT scanning (57%), followed by flat film x-ray (33%), and magnetic resonance imaging (MRI; 9%).
- **Teleradiology.** About 11% of the misread events occurred with teleradiology. The misreads were caught by a hospital radiologist reviewing the teleradiologist's interpretation, as in the following example of an event in the ED:

  A patient who arrived in the ED in the evening was nearly sent home with free air in the abdomen because of a misread by teleradiology. The hospital radiologist's reread of the image in the morning caught the free air, and the patient was sent to the operating room with a ruptured duodenal ulcer.

The high percentage of misreads in teleradiology likely reflects the fact that in most hospitals, teleradiology findings are considered preliminary interpretations until a hospital radiologist over-reads, or reexamines, the image and issues a final report. Any misreads may be reported to the organization's event reporting program. In contrast, only some radiology reports generated by a hospital's radiologists are reread for quality monitoring purposes and reviewed under peer review provisions.

Lessons Learned

MULTIPLE SAFEGUARDS ADDRESS MISREADS' MANY CAUSES

Radiology safety experts have described image interpretation as "a human enterprise subject to the limitations of human ability" (Bruno et al.). Although an effective way to minimize misreads would be to require that more than one radiologist independently interpret a study—a process called "double reading"—the approach is both impractical and costly. "Almost no one does this," says Hani H. Abujudeh, MD, MBA, FSIR, FACR, chief and chairman, department of radiology and outpatient diagnostic testing, Cooper University Health Care (Camden, New Jersey). "My radiologists are at full capacity for their work. I would need to hire more staff" just to double read studies, says Abujudeh, an ECRI Institute PSO Advisory Council member who has written and conducted research on radiology safety and quality.

ECRI Institute PSO recommends that facilities consider a combination of strategies to improve image interpretation. Some, such as providing continuing education and training for radiologists and other health professionals, while important, are considered low-impact strategies and, by themselves, will not prevent all radiology diagnostic errors. They must be used with other higher-impact strategies, such as ensuring radiologists' access to patients' electronic records, or with moderate-impact strategies, such as standardizing the format for documenting radiology findings.

A multi-pronged approach to radiology safety enables the organization to implement safeguards to target the multiple factors that may contribute to one event. "I've never seen a case where there is only one problem" that caused it to occur, says Abujudeh. "There's usually a lot going on."

James Reason's so-called "Swiss cheese model" illustrates how multiple system failures can lead to patient harm. A system, Reason suggested, is like a stack of Swiss cheese slices, with the holes representing opportunities for a process to fail and each slice representing a defense against the error impacting the system. For a catastrophic accident to occur, a series of holes in the slices must align to allow the defenses to be defeated by an error. (Reason)

As an example, say a CT study is misread by a junior resident who misses a subtle finding on the CT scan. In a properly functioning healthcare organization, an attending radiologist will catch the misread; common practice is for the attending to over-read the resident's findings and to provide the final report. But other factors beyond the resident's inexperience may have contributed to the error, including the following (Brook et al.):

- No protocol to optimize depiction of subtle findings
- A reading environment that is full of distractions, poorly lit, and cramped
- An inadequate process for ordering physicians to provide relevant clinical information to help with the radiologist's interpretation

By putting multiple safeguards in place to address the many breakdowns that can lead to an error, organizations increase the likelihood that the error will be prevented or caught before it reaches the patient. The strategies are described for various stages in diagnostic radiology: image ordering, study interpretation, report of findings, and quality monitoring.

Image Ordering

Rationale for diagnostic study. In his book, *The Digital Doctor*, ECRI Institute PSO Advisory Council member Robert Wachter, MD, describes the changing nature of radiology. Before the digital age, the radiology reading room was the epicenter of many hospitals, writes Wachter, professor and chair, department of medicine, University of California, San Francisco. Clinicians went to the radiology reading room to view images they had ordered and discussed the images with the radiologist. During the exchange, the radiologist might gain some insights about the patient that helped in interpreting the image, and the ordering clinician could come to a correct diagnosis or a thoughtful plan of care. Now that picture archiving and communication systems (PACS) are commonplace for storing and displaying images, that face-to-face collaboration can be circumvented. The ordering physician can review the studies from workstations throughout the organization without going to the reading room. (Wachter)

To ensure that the interpreting radiologist has the necessary patient information for interpreting a study, clinicians who order diagnostic imaging studies must understand the importance of providing that information so that the radiologist can deliver an informative and useful interpretation of the study (Siegel). Incorporating the required information into the ordering physician's request can ensure that the radiologist is provided key information, such as the reason for requesting the study and relevant patient data.

The American College of Radiology's (ACR) practice parameter for communication in diagnostic imaging recommends that the ordering physician provide the following (ACR):

- Relevant clinical information
- Working diagnosis
- Pertinent clinical signs and symptoms
- Specific questions to be answered
- Refer to "Online Resources" for information on accessing ACR's practice parameter.

Clinical decision support. Starting in January 2018, the Centers for Medicare and Medicaid Services (CMS) will require ordering clinicians to use clinical decision support (CDS) software for certain

Online Resources

- American College of Radiology (ACR) practice parameter for communicating radiology findings: https://www.acr.org/~/media/C5D1443C9EA4424AA12477D1AD1D927D.pdf
- Office of the National Coordinator for Health Information Technology (ONC) safer guide for test-results reporting and follow-up: https://www.healthit.gov/safer/guide/sg008
- Radiological Society of North America (RSNA) radiology report templates: http://www.radreport.org/index.php
- RSNA's RadLex (unified language to organize and retrieve radiology information resources): https://www.rsna.org/RadLex.aspx

ECRI Institute Resources*

- Clinical decision support (ECRI Institute PSO Compass Points): https://www.ecri.org/components/PSOCore/Pages/e-lert010317.aspx
- Diagnostic errors (guidance article): https://www.ecri.org/components/HRC/Pages/RMRep1016.aspx
- Diagnostic radiation risks (guidance article): https://www.ecri.org/components/HRC/Pages/Rad1.aspx
- INsight Assessment Services: https://www.ecri.org/components/Pages/insight_risk_assessment_services.aspx
- Self-assessment questionnaire for radiology: https://www.ecri.org/components/HRC/Pages/SAQ29.aspx

* For information on obtaining ECRI Institute resources, contact ECRI Institute PSO at psohelpdesk@ecri.org.

diagnostic imaging services; otherwise, the agency will not reimburse for the service. Using the software, the ordering clinician provides clinical information about the patient and receives feedback about the appropriateness of the imaging service requested. The provisions are outlined in the agency's final rule for the physician fee schedule for calendar year 2017 (CMS). As stated in its rule, CMS will identify software programs that meet its criteria for CDS in diagnostic imaging before the payment provision goes into effect.

Although CDS is intended to ensure appropriate test use and minimize unnecessary testing, it may go further in supporting quality care, says Abujudeh. "A chronic problem for radiologists is that we had no information about the patient."

With CDS, the ordering physician's rationale for the study is available to the radiologist, who may better understand the reason for the study and can address those concerns while viewing the image and reporting the findings. (Alkasab et al.)

ECRI Institute cautions that CDS must be implemented with appropriate planning and clinical end-user input to achieve the intended benefits (see "ECRI Institute Resources" for more information). Experts advise that healthcare organizations involve their radiologists in designing and implementing these systems so that they prompt ordering clinicians to provide the necessary information for radiologists to deliver an interpretation that suits the clinicians' needs (Alkasab et al.).

Study Interpretation

Image quality. A radiologist's accuracy depends on the quality of images presented for interpretation. Organizations must have policies outlining the procedures for conducting diagnostic imaging studies. If the image is suboptimal, the radiologist may be able to make adjustments to the image display to improve its diagnostic quality. If not, the radiologist should determine whether the study should be redone with better patient positioning or image acquisition and document any shortcomings with the image quality in the findings. (Berlin 1996)

With PACS, which store, manage, and display images in digital format from several different diagnostic imaging modalities, the radiologist can use computer image processing techniques to change the image contrast and improve detection of abnormal findings (Bruno et al.). Since their introduction more than two decades ago, the systems are now "ubiquitous" in hospitals (Siegel).

Access to patient records. In addition to requiring that the ordering physician provide relevant patient information, the interpreting radiologist should have access to the patient's medical record and to previous radiology reports and images for review and comparison.

With the availability of PACS, the radiologist can pull up previous images to make comparisons. "Every attempt must be made to retrieve and review all prior pertinent radiologic examinations before rendering a final interpretation," write the authors of a study on perceptual errors in radiology (Kim and Mansfield). Indeed, ACR's practice parameter for communication in diagnostic imaging recommends "[w]henever possible, previous reports and images should be available for review and comparison with the current study."

In addition to access to the patient's previous studies, radiologists should have access to the patient's clinical information. "This is changing quickly" with the deployment of EHRs, says Abujudeh, noting that in the past year, his organization has adopted an EHR system that is integrated with its PACS for accessing studies and its radiology information system for patient registration, results reporting, and other functions. When the radiologist opens a case, a synopsis of the patient's record also automatically opens. Previously, a radiologist had to log on to three different systems to view and interpret a study: the PACS to access to the study, the radiology information system for results reporting, and the hospital information system for patient information. “We think that improved access to patient information will reduce errors,” says Abujudeh.

Computer-aided detection. Computer-aided detection (CAD) is intended to use data analysis capabilities to identify suspicious features and bring them to the attention of the radiologist to reduce misreads, particularly false-negative readings. With mammography, for example, commercially available CAD systems are used after the initial reading to analyze digital mammograms to detect abnormalities, such as microcalcifications and masses, and flag them for the radiologist. (ECRI Institute)

The technology has also been studied for other imaging applications, including the detection of fractures, collapsed lungs, and colon polyps. Although a “promising” technology, CAD is not widely used in diagnostic imaging because most of its applications are not yet covered by third-party payers (Bruno et al.). Its role in reducing misreads “could be on the horizon,” says Abujudeh.

Report of Findings

Structured radiology reports. Error-prevention techniques using checklists and standardization can be incorporated into the results report to communicate information to the ordering clinician in an organized, consistent, and clear manner. The Radiological Society of North America (RSNA) has created a library of more than 250 radiology report templates that standardize the format, language, and reported elements of each report. Radiologists are encouraged to adapt and use the templates in their clinical practice (see “Online Resources” for a link to RSNA’s template report library).

Intended to promote better communication between the referring physician and radiologist, the standardized format enables the referring physician to easily find information and focus on any abnormal findings. “With a structured report, the clinician can flip through it quickly to find what is different from a normal report,” says Abujudeh.

There are also benefits for the radiologist. For each type of study, the template serves as a checklist for the radiologist to provide the necessary information for the report. For example, for a chest CT study, the template prompts the radiologist to indicate whether contrast was used, to provide any relevant clinical information, to compare the image to previous images, to report the findings of various organs seen in the study, and to provide an impression.

Not only does the structured report ensure that essential information is included in each report, it also helps keep a radiologist focused despite interruptions. “Sometimes when I’m reading a report, I get interrupted and forget where I am in my reporting. The structured report guides me on what I’ve done and what remains to be done, regardless of the number of interruptions,” says Abujudeh.

When a children’s hospital purchased a speech recognition software product that used structured reporting, it began a consensus-building initiative to identify the contents for 228 reports and adopt them for radiology department reporting. Although the project’s goal was to improve the consistency and efficiency of results reporting, other benefits included minimizing the likelihood of errors from interruptions. (Larson et al.)

Standardized terminology. Except for limited applications, radiologists do not have a standardized language for reporting their findings to referring physicians. One medical center found that its radiologists and referring physicians rarely agree on the meaning of commonly used terms in radiology reports. Although there was consensus about the meaning conveyed by the phrase “diagnostic of,” there was poor agreement between the two groups of physicians about other commonly used terms such as “consistent with,” “worrisome for,” “suspicious for,” “may represent,” “probably,” and “possibly.” (Khorasani et al.)

The study authors suggest that ambiguity about the meaning of commonly used phrases in radiology reports could contribute to misunderstandings about the findings. Although standardized terminology is used to report mammography findings, the study authors suggest the need for further studies to determine how to apply standardized terminology to all types of radiology studies. (Khorasani et al.)

RSNA's RadLex, an informatics project, is designed to create a single source for medical imaging terminology, including a consistent vocabulary to improve clinical communication. For more information about RadLex, refer to "Online Resources."

Access to radiologists. With the demise of the reading room's status as the social hub of the hospital, some safety experts have suggested that hospitals consider strategies to encourage more face-to-face collaboration with radiologists. For example, there might be more interaction and communication between radiologists and ordering clinicians if radiologists are embedded in clinical areas where demand for radiology studies is high, such as the emergency department and critical care units. Alternatively, organizations can schedule radiology rounds when ordering clinicians and radiologists can meet, or they can designate a radiologist as the consultant of the day for ordering clinicians (Siegel).

Nevertheless, ordering clinicians should avoid over-relying on the radiologists' report and separately confirm the findings. As in the case described in AHRQ's *WebM&M*, the surgeon would likely have caught the radiologist's incorrect assumption that the patient's ovaries were removed by reviewing the patient's images before surgery.

Patient engagement. The Mammography Quality Standards Act of 1992, introduced a requirement to communicate mammography findings to patients in a summary report (42 USC § 263b). Since then patients have been given increased access to their electronic medical records with patient portals. Knowing that patients have access to the radiology report, typically after the findings are provided to the ordering clinician, radiologists have an incentive "to produce reports that are organized and clear" (Abujudeh et al. 2016). The reports must also be tailored to patients' health literacy skills. The National Assessment of Adult Literacy, which was most recently conducted in 2003, found that only 12% of U.S. adults have proficient health literacy (Kutner et al.).

Giving patients the opportunity to review the radiology findings also provides an additional safety check for patients to ask questions about their diagnosis and plan of care that may have been overlooked if there are breakdowns in communication between the radiologist and referring clinician (Bruno et al.).

Quality Monitoring

Peer review. An important error-prevention strategy, says Abujudeh, "is to learn from our mistakes." This can partly be accomplished with peer review. Accreditation programs, such as those offered by the Joint Commission and ACR, require peer review as part of an organization's credentialing and privileging process to assess a radiologist's competence. Peer review entails asking a peer radiologist to reread other radiologists' cases and determine whether he or she agrees with the original findings.

Although viewed by some radiologists as a "punitive exercise" (Johnson et al.), Abujudeh prefers to use the term "peer learning" and to use the process to ask, "What did we learn and how can we change things from what we learned?" The goal, he says, is to "get everyone to be high performers" and not just to focus on those whose performance is subpar.

Radiologists' interpretation of an image can vary—even amongst themselves. In a study he and others conducted while at Massachusetts General Hospital (MGH), Abujudeh found that experienced radiologists interpreting abdominal and pelvic CT studies disagreed with each other 30% of the time and disagreed with themselves more than 25% of the time (Abujudeh et al. 2010).

Peer review creates a steady stream of cases for analyzing trends and identifying improvements, says Abujudeh. At Cooper, he requires that every radiologist conducts peer review on one to two cases each day. "I encourage doing more," he adds, noting that at MGH, radiologists review 2% to 5% of their workload. Citing the psychologic phenomenon known as the "Hawthorne" or observer effect, Abujudeh suggests that peer review may even improve performance with the knowledge that one's work is being observed.

Just culture. Radiology departments cannot fix problems and unsafe conditions that lead to errors if they are unaware of the incidents. Abujudeh advocates cultivating a just culture in which organizations can learn from errors and overcome system failings. "I like to encourage this as much as possible, and I talk about it [a just culture] all the time," he says.

A just culture balances the need to foster open event reporting with ensuring individual accountability for risky or reckless behavior. The organization applies engineering principles and human factors analysis to design systems in which individual practitioners can deliver safe and reliable care. (Griffith et al.)

In addition to supporting event reporting, organizations must share the findings of what they have learned from event investigations so everyone benefits—particularly members of the radiology department. In his 2011 book, *Thinking Fast and Slow*, Nobel-prize winner Daniel Kahneman noted that radiologists typically do not receive immediate feedback about their diagnostic accuracy. In contrast, an anesthesiologist, for example, closely monitors a patient, knows when an emergency may arise, and can learn from those situations. To provide more feedback to its radiologists, one organization's radiology department conducts quarterly incident report conferences with its staff to review selected incidents, discuss possible system deficiencies contributing to the incidents, and explore process improvements. Radiologists receive important feedback about the correlation of their interpretation to a patient's eventual

Ten Key Questions Address Misreads

Radiology departments and facilities should periodically evaluate their processes to ensure they are designed to promote patient safety and quality. Listed below are 10 important self-assessment questions directing at processes to prevent diagnostic errors in interpreting radiology images. The questions are provided as examples and are not intended to be all inclusive. For additional questions, refer to ECRI Institute's self-assessment questionnaire for radiology and its Insight Assessment Services (see ECRI Institute Resources).

1. Does the system for ordering radiology studies incorporate clinical decision support to help determine the appropriateness of the study?
2. Are indications for the diagnostic imaging study and relevant patient history communicated to the facility and radiologist responsible before the study is performed?
3. Are a patient's relevant prior imaging studies always reviewed by the radiologist reading a new study?
4. Do radiologists access the patient's clinical information from the electronic health record while reviewing the imaging study?
5. Are all preliminary radiology interpretations finalized by a board-certified radiologist?
6. Do radiologists participate in an ongoing peer-review program such as the American College of Radiology's RADPEER program or an equivalent, and is the information used to identify improvement opportunities?
7. Do the radiologists performing procedures or interpreting studies involving a particular modality (e.g., mammography, interventional radiology, nuclear medicine) participate in continuing education programs to maintain competence in that field?
8. Do all radiologists maintain their primary and specialty board certifications?
9. Are providers encouraged to report adverse events and near misses without fear of reprisal?
10. When an event occurs, is the information about the event reviewed to identify opportunities to improve patient care and procedures?

diagnosis. The department also sends e-mails to its staff to share the lessons learned from near-miss incidents. (Donnelly et al.)

Periodic assessments. ECRI Institute recommends that radiology departments periodically assess their processes to identify opportunities for improvement. One way is to conduct a self assessment of the department's processes and procedures. For example, the Department of Health and Human Services' Office of the National Coordinator for Health Information Technology's (ONC) recommended safe practices for the use of health information technology includes an assessment tool for test results reporting and follow-up. It could be used to assess the radiology department's processes for electronic ordering and results reporting of radiology studies (see "Online Resources" for information on accessing the tool).

Sample questions intended to address issues with radiology misreads are listed in "Ten Key Questions Address Misreads."

Other strategies to assess and improve department processes include the following:

- Engage the radiology department leadership team in executive walkrounds to meet with frontline staff and ask about concerns and system failures that may contribute to diagnostic errors. (Donnelly et al.)
- Conduct failure mode and effects analysis of radiology processes, such as the radiologist's access to patient information when interpreting images, to identify process breakdowns and strategies to overcome these failures. (Abujudeh and Kaewlai)
- Implement solutions in a systematic manner using an approach such as the plan-do-study-act (PDSA) cycle to test changes on a small scale before applying them to the larger system. (Abujudeh et al. 2017)

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42 USC § 263b

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