

The Missing Abscess: Radiology Reads in the Digital Era

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Case Objectives

- Identify the most common complication of hysterectomy.
- Describe the impact of the implementation of the PACS on the frequency and quality of communication between providers and radiologists.
- State examples of errors associated with the current communication workflow between ordering providers and radiologists.
- List interventions that health care institutions can use to reduce the risk of error associated with the current workflow for radiology image interpretation.

The Case

A 45-year-old woman with type 2 diabetes and hypertension who had three previous cesarean deliveries presented with menorrhagia and anemia from large fibroids. She underwent a hysterectomy to remove the fibroids. To preserve hormonal function, the ovaries were not removed. The surgery was uncomplicated.

Postoperatively, she developed a fever and pelvic pain, and a computed tomography (CT) scan showed a large pelvic abscess. She was given antibiotics, and a percutaneous drain was placed. Over the next few days, her fever resolved and her pain improved. The infection was felt to be adequately treated, the drain was removed, and she was discharged.

The patient re-presented to the hospital 3 days later with recurrent abdominal pain. A repeat CT scan was performed and the radiologist reported a persistent large pelvic abscess. The gynecologist examined the patient and read the radiologist's report but did not personally review the CT scan images herself. Based on the report, she took the patient to the operating room for treatment of a presumed recurrent pelvic abscess.

In the operating room, the gynecologist had difficulty finding the abscess. She stopped the surgery and looked at the CT scan images on a computer in the operating room. She realized that what the radiologist had read as an abscess was actually one of the patient's ovaries, and that there was no evidence of a recurrent abscess or other infection. The surgery was aborted and the patient was taken to the recovery

room. The initial complaint of abdominal pain on this admission was felt to be related to the incision and not to any infection.

Unfortunately, the patient developed a wound infection related to this second surgery. The infection led to delayed wound healing and a prolonged hospital stay. She went on to develop chronic abdominal pain, some of which was thought to stem from the unnecessary exploratory surgery.

The Commentary

by Eliot L. Siegel, MD

This case provides an opportunity to consider how changes in the typical radiology workflow in the digital era may have affected the outcome of this patient's surgery. The patient underwent a hysterectomy for fibroids associated with abnormal uterine bleeding. While the surgery itself was uncomplicated, she developed an acute infection (abscess) associated with the surgery. Infection is the most common complication of hysterectomy, occurring in up to 13% of patients, depending on the operative approach.⁽¹⁾

In this case, the patient's ovaries were preserved to maintain hormonal function. The decision about whether to remove the ovaries in patients undergoing hysterectomy is controversial. Elective oophorectomy is performed for many reasons including elimination of ovarian cancer risk. Another advantage of elective oophorectomy is a 27% reduction in risk of breast cancer in women younger than 45 years.⁽²⁾ Those who support leaving the ovaries in place cite an increased risk of cardiovascular mortality, higher risk of osteoporosis, and decreased cognition and sexual function associated with elective oophorectomy.⁽³⁾ It is important to approach this decision on a case-by-case basis and engage the patient in shared decision-making. Whatever the merits of the decision, this particular case had a problematic outcome: after an uncomplicated initial surgery, this patient underwent an unnecessary second surgery at least partially due to how the radiology imaging was handled.

Radiology and Picture Archiving Communication System (PACS)

September 2016 marked the 25th anniversary of the purchase of the world's first hospital-wide Picture Archiving and Communication System (PACS). These systems, which are used to store, manage, and display images from various imaging modalities such as CT, MRI, conventional digital radiograph, etc., are now ubiquitous throughout the United States. This PACS was formally installed at the new Baltimore VA Medical Center 2 years later. At that time, the radiologists involved, including me, recognized that the installation could be opening a "Pandora's box": the PACS system might fundamentally change the radiology department from the beating heart of the hospital ⁽⁴⁾ to what has today turned out to be a relative isolation chamber. Nowadays, visits to the radiology reading room are perceived "by non-radiology clinicians as a 'waste of time' and by radiologists as an 'interruption.'"⁽⁵⁾ Many radiologists were also concerned about the potential for commoditization, as PACS images could be read and interpreted anywhere at any time. Since images could now be reviewed by nonradiologists, we worried about the potential for incorrect interpretation by nonradiologists reviewing studies without consultation with radiologists. Lastly, we were simultaneously excited and concerned about the potential for computer interpretation to supplant a subset of the work of diagnostic radiologists.

Twenty-five years later, PACS has indeed proved to be a game-changer with regard to image quality and complexity, efficiency, and innovation. Yet, some of the initial concerns about PACS have been borne out. First, PACS has negatively impacted communication between providers.⁽⁶⁾ Like many of my colleagues, one of the major things that initially attracted me to radiology was the reading room's status as the social hub of the hospital and the radiologist's status as the doctor's doctor. However, a few years after filmless operation began, we documented an 82% reduction in the in-person consultation rate for general radiography ("plain films") and other major reductions for cross section studies (such as CT).⁽⁷⁾ The profound drop in the rate of in-person consultations has resulted in a major reduction in communication between clinicians and radiologists, with a concomitant potential for miscommunication resulting in medical errors. This case illustrates the type of medical errors that can result from this lack of direct communication.

Workflow in radiology has changed substantially in the PACS/digital environment.⁽⁸⁾ Before the advent of PACS, a radiologist typically reviewed images on the same day they were acquired. The official reports were not available in the paper chart until a day or two later, and the films were stored in the radiology film room along with the reports in a "film jacket." In order to review the films in a timely manner, clinicians often had to visit the radiology department in person, where they engaged in an in-person consultation with the radiologist, including review of the film and discussion.

In today's digital department, images are available for interpretation within minutes after a study is completed, and the radiologists generate their own reports using speech recognition. These digitized reports are sent directly to the electronic health record (EHR). In most institutions, the PACS and EHR are separate software systems. As a consequence, many radiologists lack access to the patient's medical history from the EHR as they are interpreting the radiology study. Even if they do have access to the EHR, it is generally impractical for radiologists to review the patient's history for every study. Radiology reports are typically directly accessible within the EHR, but a separate sign-in is often required to review images in the PACS. This separation of the report (EHR) from the images (PACS) has increased the frequency with which reports are reviewed by clinicians without the images (as in this case) and images are reviewed without the report. In this age of digital imaging, clinicians rarely visit the radiology department for consultations or to review the images, instead the images and reports are viewed throughout the hospital.

The Case

In this case, the radiologist probably didn't know the history that the ovaries were not removed during the hysterectomy and assumed that the fluid-containing structure was an abscess rather than an ovary, given the history of previous abscess. While it would be standard procedure for the radiologist to have dictated whether the ovaries were present, in this case, he or she probably felt that this step wasn't necessary given the incorrect assumption that the patient had undergone a hysterectomy with removal of the ovaries. The gynecologist likely then made the incorrect assumption that the radiologist saw both ovaries as well as an additional fluid collection, but just didn't mention the ovaries in the report.

One of the advantages of PACS is that it has made images available throughout the hospital and in the operating room (OR). In this case, the gynecologist should have reviewed the images personally before entering the OR for surgery, or at least in the OR prior to performing the procedure. CT scan images should always be available, and when possible displayed, in the OR during surgery in addition to reviewing the

images prior to surgery.

Interventions and Solutions

A former chief of medicine at the Baltimore VA joked that the "hospital has always been 'filmless' even before PACS, because you could never find the films." PACS has not only made images available anywhere at any time but has also enabled radiologists to review greater volumes of increasingly complex radiologic studies. This change has resulted in more sophisticated CT, MRI, and other imaging modalities; it has improved efficiency, including shortening turnaround times for reports; and it has made it easier to provide quantitative measurements with imaging studies (e.g., tumor size seen on CT scan).

However, this progress has been accompanied by patient safety risks due to reduced face-to-face communication, as illustrated in this case. Errors may also be caused by a lack of adequate history provided to the radiologist and limited communication from the radiologist to the clinician. Lastly, having official radiology reports immediately available without a need to engage with the radiologist may lead providers to overly rely on the report itself. Although there are no definitive studies about associated medical errors, it seems clear that the new workflow has eliminated many errors due to lost images and reports, while introducing new errors due to poor communication and ubiquitous access to radiology images by nonimaging experts.

Clinicians who order radiology studies need to understand the importance of providing enough medical background or surgical information for the radiologist. This information allows radiologists to provide the most accurate and useful interpretation of diagnostic radiology tests. It should be provided during the ordering process, in some other written form (e.g., email), or as part of an in-person conversation. Key information to be provided includes (i) the reason that the current study was requested; (ii) when possible, specifically what the study is expected to evaluate; (iii) the relevant surgical procedures and patient diagnoses and risk factors; and (iv) how to communicate results directly in cases in which direct communication is required. PACS and EHR providers should collaborate to develop tools to automatically extract relevant information from the medical record and bring it into the routine workflow of radiologists. In a perfect state, key information would be immediately available to the radiologist during image interpretation.

Future systems should enable the PACS to allow clinicians performing preliminary interpretations to make those available to the radiologist, so communication can occur when there is a discrepancy. For example, if a pulmonologist was concerned about pulmonary edema while looking at a chest radiograph before the radiologist had read the film, his preliminary impression could be documented and available to the radiologist. The radiologist could then communicate more directly were his interpretation different. Complex or difficult cases should be discussed in person, by phone, or by videoconference whenever practical.

Although technological improvements can help, geography is important too. Hospitals should consider strategies to encourage in-person review or even to embed radiologists physically in subspecialty areas such as the intensive care unit and emergency department to increase interaction and communication. Institutions should consider having scheduled radiology rounds during which ordering providers and radiologists could formally meet. Some radiology departments designate a radiologist, fellow, or resident as the consultant of the day and actively encourage consultation on selection of the correct examination as

well as review of already performed studies. However, since in-person or telephone conversations are not always feasible between busy clinicians, providers and institutions should also consider developing other communication tools.

In response to some of the unintended negative consequences of PACS, many organizations have been developing tools to improve the workflow and enhance communications. PACS vendors and third-party providers have developed or are developing programs that can track recommendations and unexpected findings, record preliminary impressions, provide an audit of messages exchanged among health care providers (including preliminary impressions), and even triage cases by having the computer make a preliminary interpretation. Institutions should explore what interventions are available through their vendors.

Summary

The rush to implement PACS and EHRs, while well intentioned, has wrought many new communication challenges in radiology and beyond. In this case, it seems the radiologist may not have had all of the key information (the patient still had her ovaries), there was no higher-level communication between the surgeon and the radiologist, and the surgeon likely over-relied on the radiology report without reviewing the images personally prior to surgery.

Hopefully, the next several years will bring innovation that adapts the many tools available to vastly improve communication and follow-up among providers, including radiologists and those ordering the diagnostic tests. Even with such innovations, I'm "old school" enough to hope to see my clinical colleagues in the radiology department. Maybe an old-fashioned candy jar or a new school cappuccino machine would do the trick.

Take-Home Points

- Hospital-wide PACS has resulted in efficiency gains for radiologists and providers but has contributed to a drop in the frequency and quality of communication between frontline clinicians and radiologists.
- The decrease in in-person communication has been a source of medical errors associated with radiologists receiving less in clinical information, nonradiologists performing preliminary clinical interpretations without notifying radiologists of their impressions, and nonradiologists potentially over-relying on radiologists' report.
- Institutions should implement protocols and tools to track unexpected and urgent findings made by radiologists or clinicians on medical images as well as follow-up recommendations.
- PACS should either build data extraction tools from the EHR to provide radiologists with the pertinent and important medical information or have the ability to quickly and efficiently launch the EHR and find pertinent information based on the imaging study being reviewed by the radiologist.
- Strategies to encourage in-person review and even to embed radiologists physically in subspecialty areas such as the intensive care unit and emergency department can improve interaction and communication.

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