

Image Sharing in Radiology— A Primer

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By virtue of its information technology-oriented infrastructure, the specialty of radiology is uniquely positioned to be at the forefront of efforts to promote data sharing across the healthcare enterprise, including particularly image sharing. The potential benefits of image sharing for clinical, research, and educational applications in radiology are immense. In this work, our group—the Association of University Radiologists (AUR) Radiology Research Alliance Task Force on Image Sharing—reviews the benefits of implementing image sharing capability, introduces current image sharing platforms and details their unique requirements, and presents emerging platforms that may see greater adoption in the future. By understanding this complex ecosystem of image sharing solutions, radiologists can become important advocates for the successful implementation of these powerful image sharing resources.

Key Words: Radiology; informatics; image sharing; information systems; data sharing; PACS (Radiology); Radiology information system.

INTRODUCTION

Since the adoption of the Affordable Care Act, Health Information Technology for Economic and Clinical Health Act, and associated meaningful use guidelines (1,2), there has been tremendous interest in developing standards of healthcare data exchange and interoperability. Advocates of these technologies frequently cite the many benefits of data sharing for patients, providers, and institutions in terms of cost and efficiency of care.

These trends have been slower to mature in radiology, in part due to the greater complexity of sharing imaging data. Nevertheless, the potential benefits of medical image sharing are enormous, and emerging technological solutions and interoperability standards may soon take full advantage of the existing mature information technology infrastructure present in most clinical radiology departments and propel medical image sharing into a widely available tool.

In this report from the AUR Radiology Research Alliance Task Force on Image Sharing, we examine the benefits of image sharing in healthcare, review important consider-

ations that drive implementation decisions, and describe currently available tools to facilitate medical image sharing. Throughout this work, we place special focus on the sometimes-distinct demands presented by the clinical, research, and educational contexts. We hope that this report will help to inform radiologists, clinicians, administrators, researchers, patients, and any other advocates of medical image sharing so that they are equipped to undertake a complete, multidimensional assessment of emerging image sharing solutions.

BENEFITS OF IMAGE SHARING

Clinical Practice

One of the principal benefits of image sharing in the realm of clinical practice is its potential to reduce the frequency of unnecessary repeat imaging and lead to more timely and accurate diagnosis. Several studies have shown that more than 30% of patients transferred between hospitals underwent repeat diagnostic imaging at the receiving facility, whereas other studies suggest that between \$3 and \$10 billion is wasted on unnecessary and duplicate imaging (3–10). In these studies, patients with available imaging and formal reports from outside imaging examinations were less likely to undergo repeat imaging. Any such reductions in repeat imaging would benefit patients by reducing risks related to ionizing radiation exposure, contrast administration, and delays in treatment (3,11). These reductions also help mitigate the economic burdens to both the patient and the hospital that are attributable to the problem of healthcare-attributable bankruptcy (12). A regional trauma network in the northwest United States organized a secure point-to-point network for image exchange incorporating over

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TABLE 1. Benefits of Image Sharing**Benefits in clinical radiology**

- Reduce the frequency of unnecessary repeat imaging
- More timely and accurate diagnosis both with availability of comparisons and access to second opinion/subspecialty consultation
- More accurate monitoring of disease progression or response to treatment
- Risk reduction (ionizing radiation, contrast-related risk)
- Reduction of healthcare cost at patient and system levels
- Continuity of patient care across multiple institutions and multiple care providers
- Patient empowerment and improved patient satisfaction
- Ability to provide healthcare to remote/medically underserved areas

Benefits in radiology research

- Facilitate multicenter clinical trials
- Bias reduction with independent central review
- Facilitate image data archiving
- Reduce cost for subsequent studies through reduction in repeat imaging
- Facilitate radiogenomics and radiomics research and big data analysis

Benefits in education

- Expanded exposure to pathology and imaging methods and reducing the constraints of local referral and practice patterns
- More rapid distribution of educational material for resident and fellow examination and call preparation
- Improve quality standards among practitioners
- Facilitate collaborative education through multidisciplinary conferences and grand rounds
- Facilitate the sharing of material for regional, national, and international conferences

120 facilities and achieved a meaningful decrease in the rate of repeat imaging for patients transferred within the network (5). Although a recent comprehensive meta-analysis found that image sharing did not reduce imaging use overall due to a lack of available data, it did report a modest and statistically significant decrease in repeat and unnecessary imaging (13).

There are additional benefits beyond reducing the rate of repeat imaging (Table 1). Increased availability of historical studies can yield improvement in the quality of image interpretation (14), which in turn can lead to improved clinical decision making (13). Enhanced imaging sharing, particularly image sharing carried out under the control of patients, may facilitate patients' access to their own electronic health data. In turn, improved patient access to imaging may enhance feelings of empowerment, patient satisfaction, and patient care (15–17). Finally, a mature infrastructure for image exchange can obviate the need for insecure portable media, thereby providing additional cost savings and a reduced risk of unintended breaches of patient privacy (18).

Research

The benefits of interinstitutional image sharing for radiology research have become increasingly apparent as multicenter clinical trials have evolved and matured in recent years (Table 1). For example, independent, centralized review of radiological images in multicenter trials is known to produce more consistent and reliable results than local review by individual sites (19,20). Recognizing the benefits and efficiencies of image sharing as well as the role of secondary research efforts using existing data, the National Institutes of Health has placed

considerable emphasis on the sharing of research data by funded institutions, often requiring clinical and image data to be shared in order to fulfill grant obligations (21,22). Sharing of primary imaging data also makes further research more efficient and can substantially reduce the cost of subsequent studies (23). In research efforts utilizing extremely large data sets, such as those found in radiogenomics and radiomics research, sharing and exchange of images facilitates linking radiological data with large biological and genetic data sets, thereby enabling the use of big data analysis methods to uncover correlations between imaging phenotypes and underlying genetic and functional molecular expression profiles (22,24–26).

Education and Quality Improvement

Image sharing has long been a feature of resident and fellow training in radiology (Table 1). Most modern Picture Archiving and Communication Systems (PACS) allow radiologists to tag studies or portions thereof for later rapid access. These implementations often have a cumbersome and unreliable user interfaces limiting their adoption and widespread use. More robust and seamless sharing of these databases among educators, particularly between institutions, can allow students to overcome the constraints of local referral and practice patterns and be exposed to a greater variety of pathology and imaging methods. The transition of the American Board of Radiology CORE examination to an image-heavy, case-based format has created a need for the creation and distribution of instructional cases germane to examination and independent call preparation.

Radiology image sharing can also improve quality standards among practitioners in an institution or department. Such

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