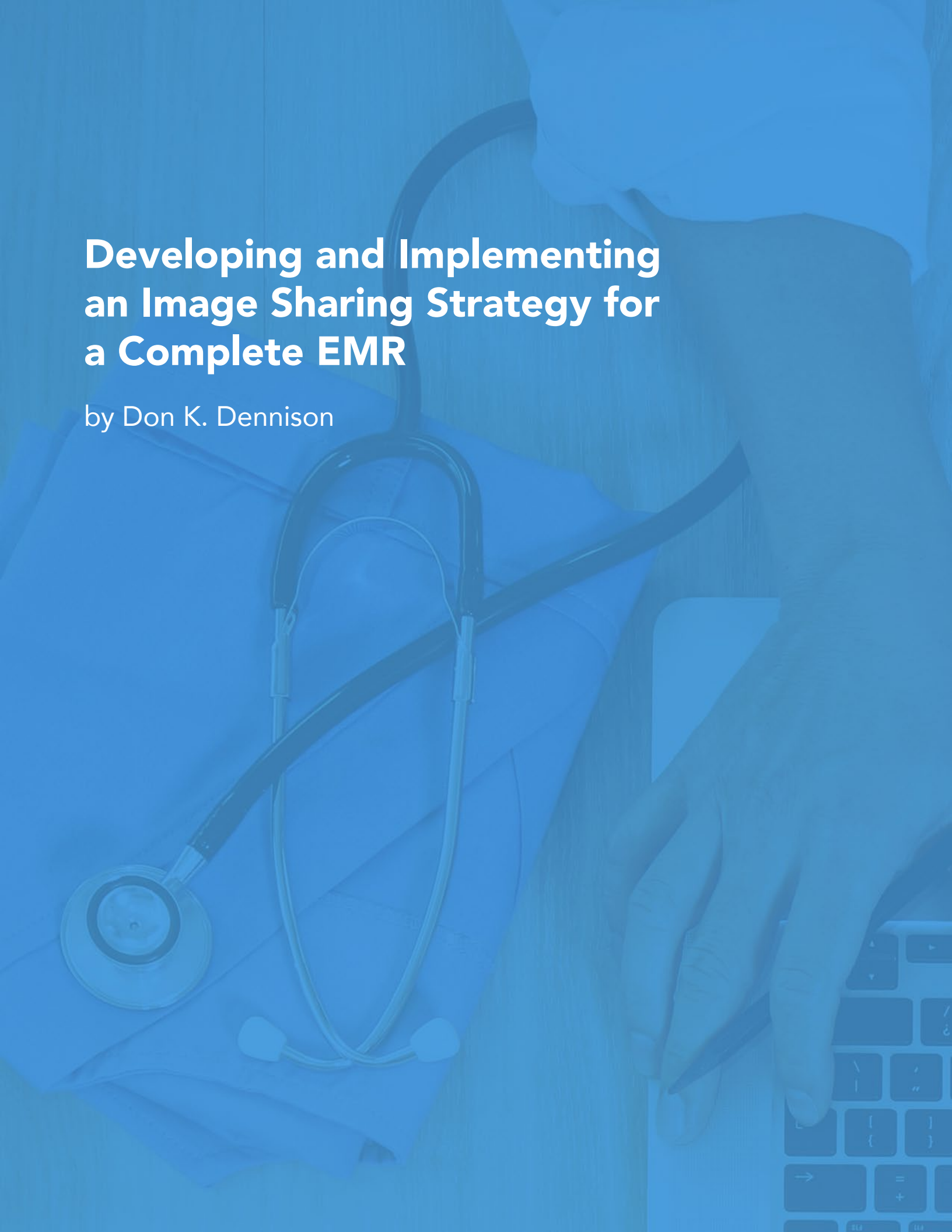


Developing and Implementing an Image Sharing Strategy for a Complete EMR

by Don K. Dennison

CONTENTS

The Importance of Image Sharing

If access to, and use of, prior exam images during diagnosis is considered clinical best practice, how can we provide the best possible care when the prior imaging is not made available?

Access to the right images at the right time and right location has long been the aim of medical image management and display solutions. From the advent of PACS [1] , getting newly acquired imaging exam data on screens with all relevant prior images, whenever and wherever they were needed, has been the goal. And it has been wildly successful within hospitals.

With faster computers and networks, and web-enabled applications, PACS has provided reliable access to images across large enterprises. Where there are multiple PACS in the enterprise, a VNA [2] can provide a consolidated image management hub, providing a single archive and integration point for the patient's longitudinal imaging record.

But patients don't get imaging services from only one health system. They get imaging procedures performed where it is convenient, near their home or work. They often have imaging performed in one system and then are referred to a specialist in another health system that does not have direct access to the images. In some cases, the historic images are in the hospital system, but the patient has new imaging done in an imaging center, and the Radiologist needs the prior images to effectively diagnose the patient.

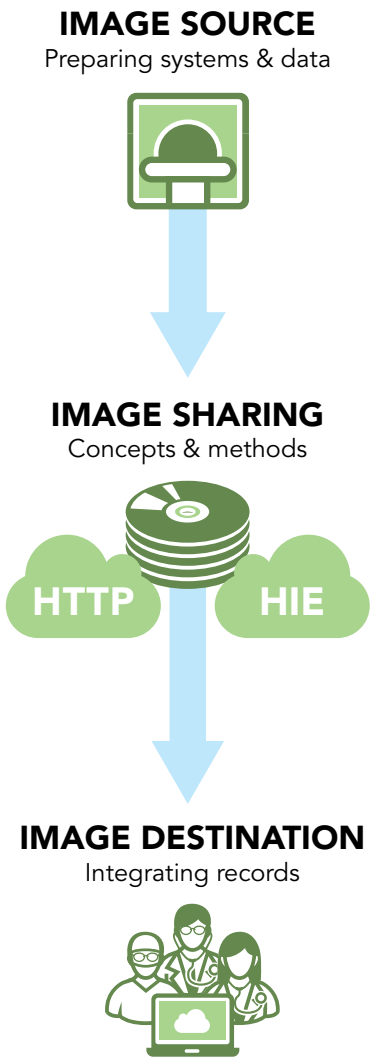
When this happens, some form of secure image sharing method is needed to broker the exchange of the patient's imaging record across different imaging systems.

The primer document, **Image Sharing: Is it missing from your Enterprise Imaging Strategy?**, details the motivation for ensuring a method for image sharing is part of a complete, enterprise-wide strategy.

In this paper, the methods to implement an effective image sharing program, and the merits of each approach, are described. Also, we will discuss what organizations can do to ensure the quality of imaging record data in preparation for image sharing. And finally, we cover proven methods to incorporate shared images into your PACS and, ultimately, your EMR.

[1] Picture Archiving and Communication System

[2] Vendor Neutral Archive



What Does this Whitepaper Cover?

This paper is focused on functional and technical methods for establishing a reliable image sharing program. It also discusses staffing, procedures and policies to support the program.

Who Should Read This?

Anyone tasked with ensuring that medical exam images are shared within and between organizations and systems. It's also for those who are seeking to implement tools and applications to share images more reliably, at a lower cost.

Learning Objectives

In this paper, you will learn about:

- The challenges in sharing imaging records from one organization and system to another
- Common approaches to image sharing and the merits of each technique, based on different situations
- How to ensure that your patients' imaging data is complete and consistent for the highest possible record quality
- The best methods for integrating imaging data within your PACS, VNA, and EMR

Who Needs Image Sharing?

Most of the time, when image sharing is discussed, it is centered on the use case of getting a patient's images from some external system into an organization's PACS so that the images can be used by the Radiologist, either as a prior or as a study to be read (Teleradiology).

There are other needs for image sharing, however. Some examples include:

- Clinics with a high volume of exams arriving on portable media
- Telemedicine initiatives or specific referral programs that would be more efficient with the addition of image sharing
- HIEs [3] or other such partnerships that are sharing patient data but not images (yet)
- Hospital initiatives focused on quality measures and/or patient satisfaction

[3] Health Information Exchanges

Image Sharing Methods by Scenario

The following table provides an analysis of approaches for organizations, in different scenarios, looking to share imaging records with external organizations.

○ Not Appropriate ◒ Somewhat Appropriate ● Appropriate

Scenario	Volume of Imaging	IT Resources	Portable Media [4]	Private HIE [5]	Cloud-Based Image Sharing	Notes
Physician's Office	Low	Low	◒	○	●	The low cost of setting up an individual cloud-sharing service account makes it attractive as a more reliable and functional alternative to portable media, but CDs are easy to give to patients.
Imaging Center	High	Low	○	◒	●	The imaging center will typically need to have an ADT system and interface to cross-index patient identities across domains in an HIE model. See also the *Alternative Image Sharing Methods* section.
Stand-alone Academic Hospital	High	High	○	●	●	As patients are often referred to their local Academic Hospital for treatment or advanced tests, the referral pattern is repeated, making an HIE more viable. Where referrals are outside of this fixed network, a cloud-based image sharing service is better than portable media.
Unintegrated Health System	High	Mixed	○	◒	●	In an unintegrated health system, facility systems are not sharing a common image repository/archive and so sharing of images within the enterprise is required. See the *Alternative Image Sharing Methods* section for notes on directly using a PACS-to-PACS transfer method.
Integrated Health System	High	High	○	◒	◒	In an integrated health system, the use of VNA or shared PACS is assumed to eliminate the need for image sharing within the enterprise. A portal can provide external user image viewing. Patient referrals will be encouraged within the enterprise facilities, reducing the need to share images externally. Cloud-based image sharing can be used for ad hoc image transfers, when needed.
Integrated Health Network in Public Health Jurisdiction	High	Mixed	○	●	◒	Where facilities are organized into an integrated health network, based on existing or directed patient referral patterns, as is common in public health jurisdictions, the effort to establish an HIE is often warranted. Cloud-based image sharing can be used for ad hoc image transfers outside the network.
Closed Health Network	High	High	○	●	○	Where the jurisdiction has strict rules regarding the sharing of patient records outside the network, for example in some military health systems, regulations may prevent any sharing by any means other than a private HIE.

[4] This assumes that the portable media produced and received adheres to DICOM standards and IHE integration profiles, such as Portable Data for Imaging (PDI).

[5] This assumes that an appropriate HIE is available and that the other participants include organizations the need to be shared with.

Methods for Image Sharing

The real cost and risk of portable media is borne by the recipient. Even organizations that lament the issue of importing data from portable media often continue to produce it themselves.

There are a number of methods for image sharing. While some people will debate the benefits of one approach over another, in reality, the method that is best for an organization highly depends on its situation.

Portable Media

The shortcomings of transporting images on portable media (CD, DVD, USB drive) are well documented and not worth repeating in detail here. Issues with reliability, lack of traceability, security and privacy, and efficiency and cost make this the least desirable—yet still popular—method of sharing imaging data.

So, why are so many organizations still exporting imaging data to portable media to share it? Its popularity is rooted in the simplicity by which the person sharing the data can produce the portable media.

If you are one of the organizations still producing portable media for sharing, there are industry guidelines to help you at least make the content easier for the recipient to import. Also, there are guidelines for how to ensure a more consistent record when importing.

What is IHE?

IHE, or **Integrating the Healthcare Enterprise**, is an initiative lead by healthcare providers, industry experts, and other stakeholders to define a published framework by which integration, interoperability and consistent presentation of data can be more easily achieved. Organized into integration profiles, systems can participate as one or more actor by supporting defined transactions. There are several integration profiles related to the sharing of images.

IHE Integration Profiles for Portable Media Exporting & Importing

The following IHE integration profiles exist to guide system developers, integrators and operators to export and import imaging data using portable media more reliably.

Integration Profile	Exporting Actors	Importing Actors	Notes
Portable Data for Imaging (PDI) [6]	Portable Media Creator	Portable Media Importer	Other actors that may be desirable are Display, Image Display, Report Reader, and Print Composer.
Import Reconciliation Workflow (IRWF) [7]	None	Importer, Image Manager/Archive	The Importer actor will rely on the DSS/Order Filler, and may depend on the Performed Procedure Step Manager and Patient Demographics Supplier actors.

[6] An extension to PDI provides options for different media types (DVD, USB), as well as data encryption: http://www.ihe.net/Technical_Framework/upload/IHE-RAD_TF_Suppl_PDI_Extensions_2009-06-21.pdf

[7] IHE has defined a new version of this integration profile called IRWF.b, which adds several options. As of the publication date of this paper, the IRWF.b integration profile is in Trial Implementation status, so is not finalized.

Health Information Exchange (HIE)

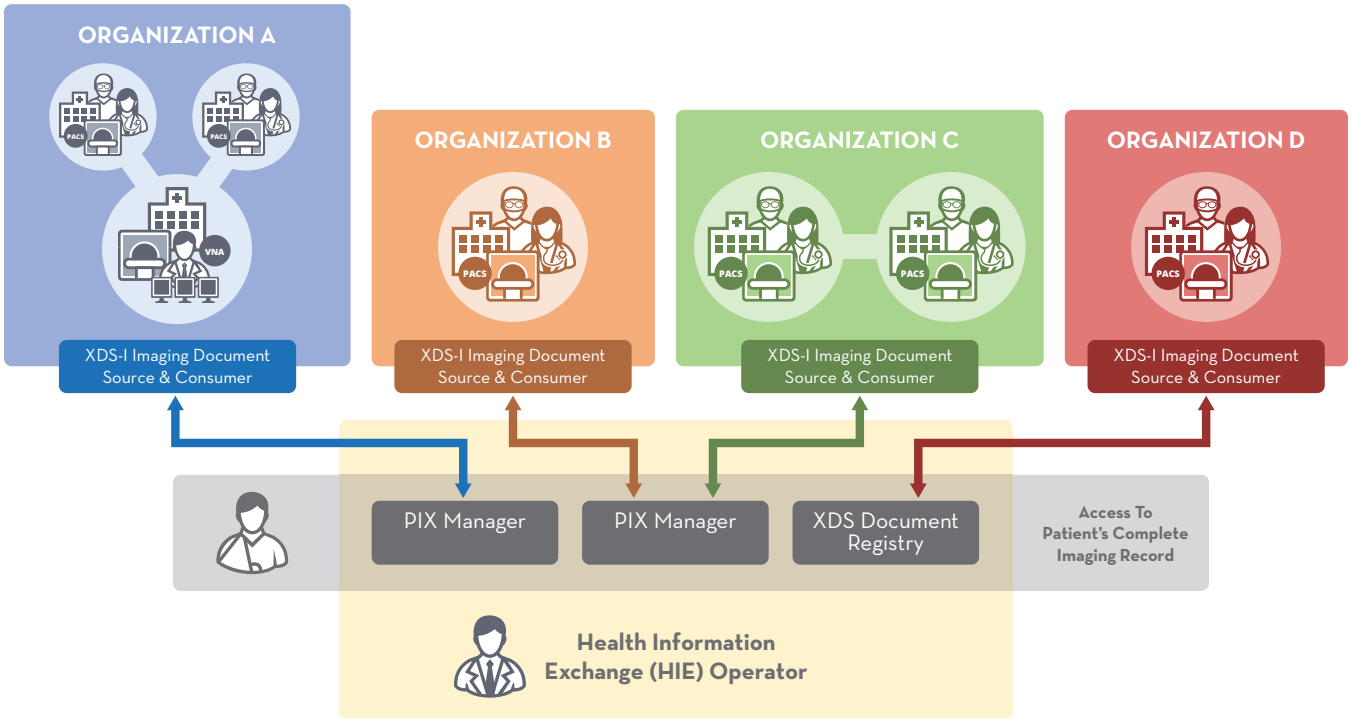
Often, when an HIE is mentioned, the data being exchanged is structured clinical data such as medical summaries, lab and imaging results, and clinical notes, among others. The purpose is to establish a trusted broker between organizations that receives and provides published content, often using HL7 messages.

However, sharing images through a trusted broker is also a form of HIE. Some of the content formats and protocols are different, but the purpose, concepts, and architecture are very similar.

The organization operating the HIE and the relationship between the participants vary based on the kind of HIE.

Private HIE Consortiums

In a private[8] HIE, the participants are part of a consortium formed for the purpose of exchanging data among themselves. The participants are often from within a shared jurisdiction, such as a region or state, or part of an extended affiliation network. Organizations wishing to join must often comply with the rules and policies of the HIE consortium, which will often cover data interfaces, messaging, networking, data formats, security controls, and patient consent directives. It often requires participants to provide not only a feed of clinical records, but also patient identity information, such as HL7 ADT messages. This is necessary to operate a Master Patient Index (MPI), as part of the HIE, to link and reconcile records among the various Patient ID domains[9].



[8] The use of the term "private" means that the members must be accepted, by some governance method, to participate, unlike portable media or a cloud-based service, where organizations or even individuals can opt to participate.

[9] Each patient is assigned a unique Patient ID, also known as a Medical Record Number (MRN), generated by the patient administration module within a given system, such as a HIS or EMR. Each directory of Patient IDs generated is sometimes referred to as a domain.

IHE Integration Profiles for Sharing Images in a Private HIE

The following IHE integration profiles exist to guide system developers, integrators and operators to exchange imaging data using a trusted broker.

Integration Profile	Publishing Actors	Consuming Actors	Notes
Cross Enterprise Document Sharing (XDS)	Document Source	Document Consumer	For sharing documents/files of any format
Cross Enterprise Document Sharing for Imaging (XDS-I)	Imaging Document Source	Imaging Document Consumer	For sharing DICOM imaging studies and documents, like reports
Patient Identifier Cross-Referencing (PIX)	Patient Identity Source[10]	Patient Identity Cross-reference (PIX) Consumer	Required if there is more than one Patient ID domain involved
Multiple Image Manager/Archive (MIMA)[11]	Image Manager/ Archive	Image Manager/ Archive	MIMA defines specific transactions as part of the foundational integration profile, Scheduled Workflow (SWF), that specify how to communicate and accept patient identity information between systems in a multiple Patient ID domain environment[12].

- The above XDS and XDS-I actors depend on the trusted broker system(s) to represent as some specific IHE actors; specifically, a Document Repository (one or more may be involved) and Document Registry (one involved). The Repository stores the documents and the Registry indexes them and their location within a given Repository.
- The above PIX actor depends on the trusted broker system(s) to represent as some specific IHE actors, specifically a PIX Manager. The PIX Manager often functions as a Master Patient Index (MPI), which normally uses algorithms to cross-index patient identities from different domains based on provided patient identity feeds (HL7 ADT) from each domain (HIS/EMR).
- There are other patient information related IHE integration profiles that may be valuable for imaging sharing, depending on the environment. Patient Demographics Query (PDQ) provides an interface to query for patient demographics based on some known information, such as patient name. Patient Administration Management (PAM) provides core ADT functionality such as patient registration, patient link and patient merge, encounter management, etc.
- Another IHE integration profile, Cross-Community Access (XCA), and its imaging specific variant, Cross-Community Access for Imaging (XCA-I)[13], defines how to discover and access patient records across different HIEs. If the HIEs are based on XDS, each HIE would have its own XDS Document Registry and PIX Manager.
- If the HIE will be expected to centralize audit records, it should adhere to the IHE Audit Trail and Node Authentication (ATNA) integration profile as both the Secure Application and Audit Repository actors.

[10] This is normally an ADT feed for all patients from the HIS/EMR (or interface engine)

[11] As of the publication date of this paper, the MIMA integration profile is in Trial Implementation status, so is not finalized

[12] Specifically, it defines transactions RAD-70 through RAD-73. See the IHE Technical Framework for further details.

[13] As of the publication date of this paper, the XCA-I integration profile is in Trial Implementation status, so is not finalized.

Private HIE Requirements

Given that HIEs often serve a regional jurisdiction, which can provide a high degree of coverage for patient referral patterns, some wonder why they are not more popular or successful. The reasons are varied, but often it is due to two primary ones:

- Lack of a business model to fund operations or a trusted broker
- Integration requirements

Lack of a Business Model to Fund Operations or a Trusted Broker

The cost of operating and maintaining a secure and performant HIE is not trivial. To maintain the resources required (people, systems, and services), some form of ongoing funding is required. Often an HIE is established based on some initial funding, such as a government grant, but subsequently struggle to get participants to pay fees for its ongoing operation and maintenance. While there are some success stories, there are also HIEs that have failed. And it is often these failures which give potential participants pause from joining an HIE. They need to trust that the HIE operator and its systems will continue to exist (and perform) for many years.

In public health jurisdictions, the operator may be a government agency, or an agent authorized and financially backed by the government, to assure participants of the long-term viability of the HIE.

Facilities on the border of two different HIEs' regional coverage (for instance, a facility on a state line) are often faced with the costs of integrating with, and participating within, more than one HIE (or choosing between them).

In addition to concerns over the HIE operator's financial viability, the participant needs to have a high degree of trust in the HIE operator. If the HIE operator is not a neutral party, the potential participant may perceive that the operator may use the shared data for purposes other than exchange, such as data mining to market clinical services to patients.

Some HIEs provide more than just data exchange, but also provide data archiving services. If participants use the HIE as their long-term archive—for example, for imaging exams—and delete their local copy, they have to have a very high degree of trust in the HIE operator's viability in order to be sure that they can get their data back.

Often the HIE operator does not have sufficient knowledge or experience with imaging data or their associated interfaces and protocols, leading to problematic integrations and unreliable operations.

Integration Requirements

For an HIE to reliably exchange data, some form of standard interfaces, protocols, data formats and schema, and publishing triggers need to be defined and adhered to by participants. The cost of preparing existing system interfaces and data to connect to the HIE may be very expensive and time consuming for the participant. If they lack the internal resources, or their systems or data cannot comply, they may be forced to hire outside contractors, upgrade or replace systems, and perform data migration and/or conversion.

Furthermore, many HIEs do not offer image sharing until well after their initial launch, instead focusing on exchanging clinical data through HL7 integrations (inbound, outbound) and portals (user access). End users also often place a higher priority on clinical data access than images, which is understandable.

As this table shows, many of the perceptions regarding the challenges related to image sharing within an HIE are not well founded.

Perception	Reality
As composite binary objects, images are unwieldy to manage.	DICOM defines both the content and protocol, making interoperability more feasible than many other clinical domains with only text-based content.
Viewing images means downloading a viewer to desktop PC, and the roll out is time-consuming & problematic.	Using modern zero-footprint, web-based viewers, images may be viewed securely without requiring software to be installed on the client—only a browser is needed.
Users only need the text report, not the images.	Images add important context to findings in the report.

Cloud-Based Sharing

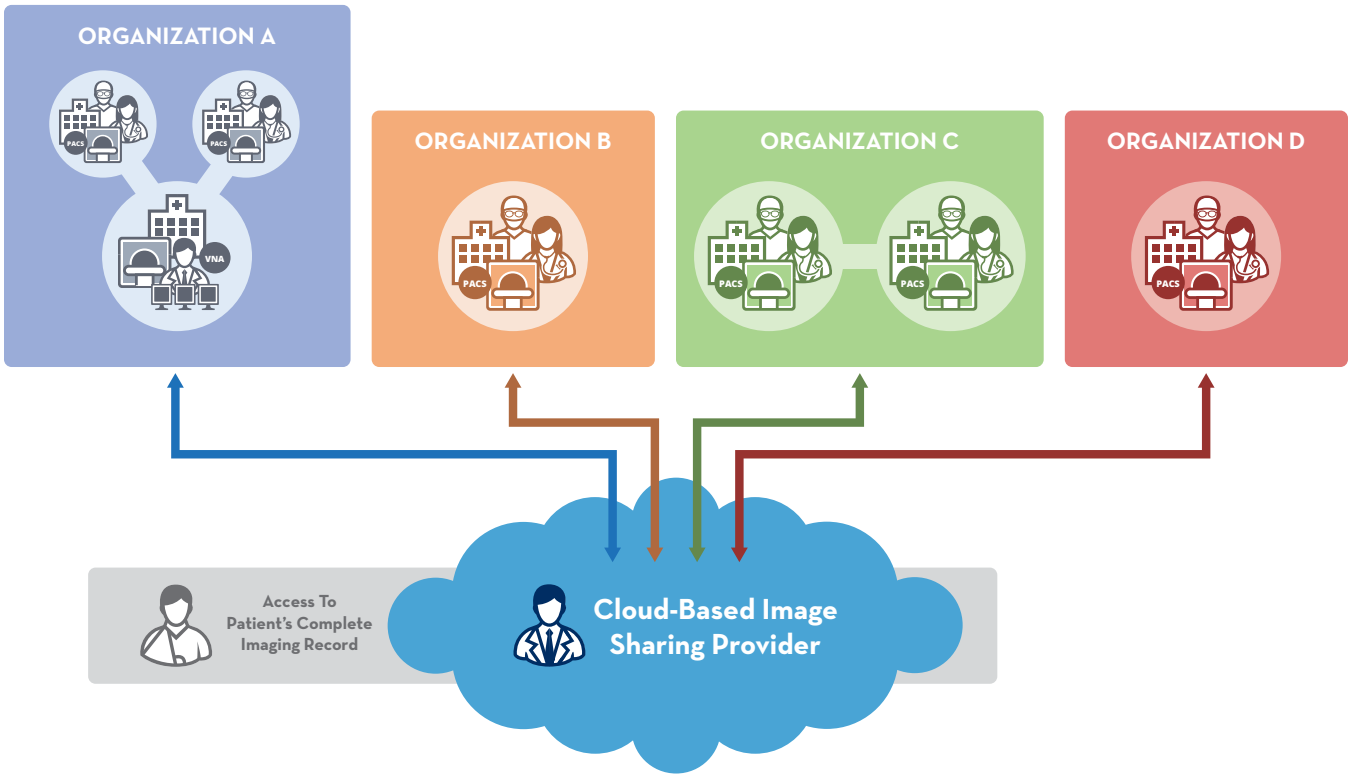
Using an independent cloud-based data sharing service presents some advantages—and some different challenges—compared to the above-described private HIE model.

The basic concept of cloud-based image sharing is that images pass through a broker application managed by a commercial service provider. Often multiple methods are made available for image transmission, including:

- Upload by an authorized user using a form on a web page
- The use of an edge server or app, interfaced with image and information management systems on the client organization's LAN, which brokers the shared content to the application in the cloud

Similar methods are available for downloading/retrieving data from the cloud-based broker application.

One of the primary advantages is that the cloud-based provider is an independent (typically) commercial entity that offers services to many different organizations in a shared, yet access-controlled, platform. Often called "multi-tenant" systems, these platforms have strict, yet adaptable, controls over which applications and users can access which data.



The flexible access control allows data to be shared between subscribing organizations and individuals, as business associate agreements allow. It is simple to adapt these access controls as relationships and needs change.

As participants' access and their data are effectively segregated, the need for strict adherence to specific interfaces and protocols is somewhat lessened. Also, as a commercial service competing in the market, they are often much more flexible in the methods by which they interface with their customer's systems, compared to a private HIE. Quite simply, customer service is always better when the consumer has choice.

Organizational vs. Individual Users

Unlike most private HIEs, the basic image-sharing features of a cloud-based service require no more than a valid user account and access to the Internet (with a browser). While both private HIEs and cloud-based imaging sharing services can be set up to manage transfer of large or small volumes of images among multiple facilities and organizations, the cloud-based service allows individuals to share images with no real IT support. This can be very useful for doctors in physician practices and patients. It is also useful for individuals in large organizations when they need to occasionally share images, ad hoc, outside of their typical network.

As the cloud-based image sharing provider gains subscribers, the costs of providing the sharing infrastructure is shared among an increasing number of participants, reducing the associated costs for each. A large subscriber base also means a source of ongoing funding to invest in new features, which are much easier to deliver through a cloud platform than on-premise systems (where each system must be upgraded).

IHE Integration Profiles for Cloud-based Image Sharing

The following IHE integration profiles are applicable to sharing imaging data using a cloud-based service.

Integration Profile	Exporting Actors	Importing Actors	Notes
Import Reconciliation Workflow (IRWF)	None	Importer, Image Manager/Archive	The Importer actor will rely on the DSS/Order Filler, and may depend on the Performed Procedure Step Manager and Patient Demographics Supplier actors.
Multiple Image Manager/Archive (MIMA)[14]	Image Manager/Archive	Image Manager/Archive	MIMA defines specific transactions as part of the foundational integration profile, Scheduled Workflow (SWF), that specify how to communicate and accept patient identity information between systems in a multiple Patient ID domain environment. [15]

It is important to note that the cloud-base service provider will often provide tools to reconcile patient identity and demographic data as part of their application. The consumer is advised to focus on the usability and reliability of these tools, as well as how well they provide patient record reconciliation, instead of adherence to an IHE integration profile simply for the sake of it. The IHE integration profiles above do provide solid guidance as to what DICOM attributes should be reconciled/localized with updated patient and study information when incorporating these images as part of the patient's record, so are worth reviewing.

[14] As of the publication date of this paper, the MIMA integration profile is in Trial Implementation status, so is not finalized.

[15] Specifically, it defines transactions RAD-70 through RAD-73. See the IHE Technical Framework for further details.

Alternative Image Sharing Methods

Though not covered in this paper, there are other methods for sharing images. Each has its own set of shortcomings.

- **Direct DICOM transfer via LAN or VPN (or other secure connection method)**. This can be common among facilities within the same organization, especially if the involved facilities share a patient identity domain or an EMPI value is included in all imaging records. However, where a common patient identity domain is not used, reconciliation (or data segregation) controls are needed. Other issues arise when different procedure code sets are used. Also, this method provides little management or communication tools, so it is often not known why (clinical reason) a patient's images were transferred from one system to another.
- **Privately managed image sharing broker**. In this approach, a standalone system is installed between each system, typically at one of the participating sites. It is not in the cloud, but managed (and maintained) by staff. It primarily acts as a neutral "sandbox" where imaging records can be pushed so that other facilities can pull the imaging down (if and when desired). It may or may not provide methods to reconcile imaging records.

It is not uncommon for a combination of image sharing methods to be involved in a data transfer. For example, even if a private HIE or cloud-based imaging sharing service is used, a receiving organization may employ their own on-site image sharing broker to act as a sandbox, as their PACS or VNA cannot support such a concept. Obviously, the more that image sharing participants can converge on the same method, the less variability and complexity there is, so less effort is required and fewer errors occur.

Sharing Imaging Exam-related Documents

Often, there are documents related to the acquisition, such as scanned requisitions, or the reading, such as the report, which are desired to share, along with the images. While all the methods have the ability to move the documents, the format may vary. In the example of reports, there are some options that the healthcare or IT industry has defined, such as DICOM Structured Report (SR), PDF, DICOM Encapsulated PDF, plain text, and Clinical Document Architecture (CDA), but organizations have not converged on a common format. This can make importing of the external documents a challenge.

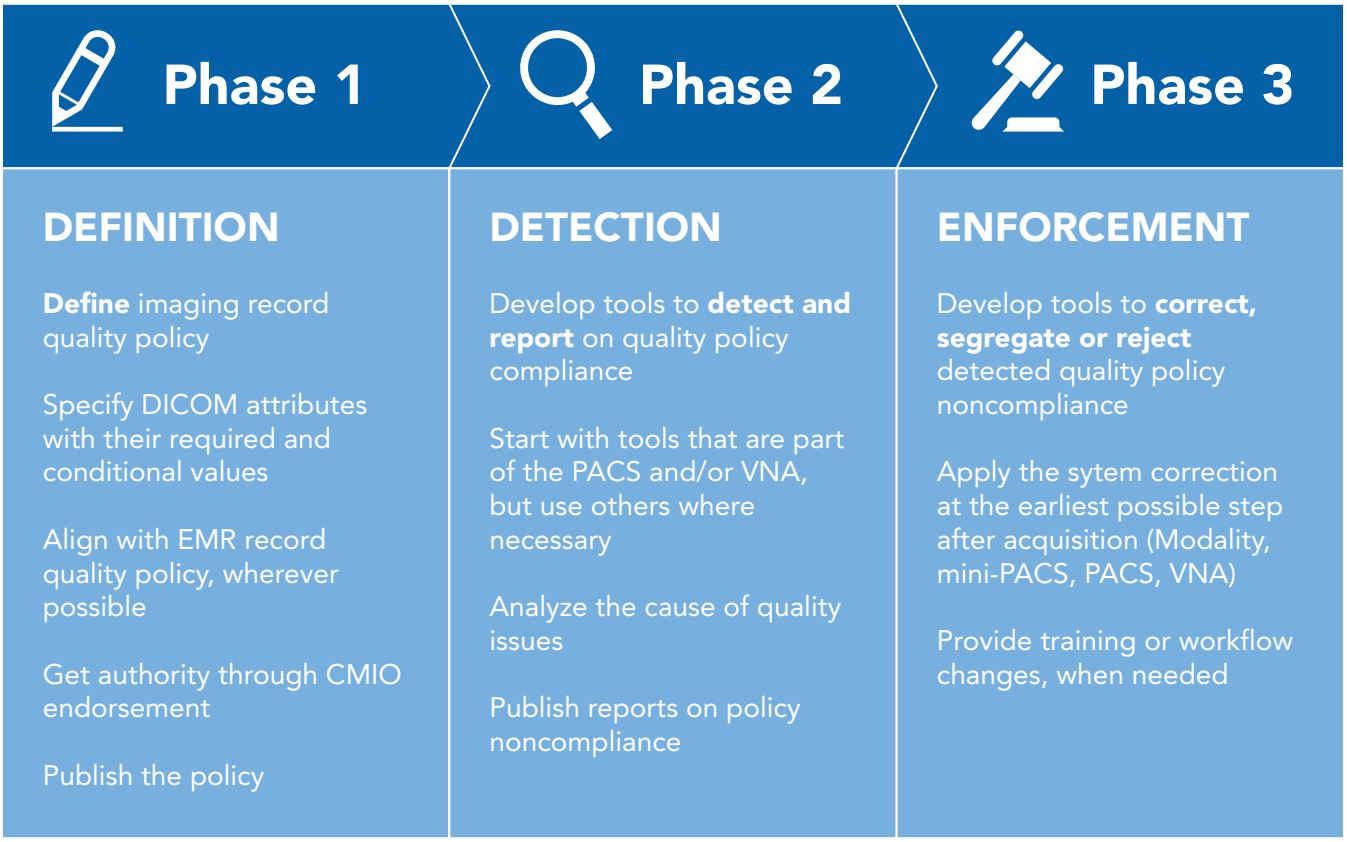
Preparing to Share Images

Recipients of poor quality imaging data realize the impact and cost associated with cleaning it up to ensure it is complete and consistent before making it available in the patient's record (in the PACS, VNA, EMR, or other access point). So, how does a provider of imaging data ensure that they are providing high quality, interoperable imaging records?

Imaging Record Quality Program

To ensure that imaging records are complete and consistent—not only for sharing with other organizations or patients, but also for internal use—a program is required that:

- Establishes detailed record quality policies specific to imaging record
- Provides tools to detect and measure quality issues
- Defines procedures to correct the data and/or systems that are causing the quality issue



System Preparation and Network Assessment

Before sharing images, it is important have an inventory of all systems that create and manage images. This may include one or more Radiology PACS, Cardiology PACS, VNA and other departmental or enterprise imaging systems. It is also necessary to determine which ones will be used to initiate the imaging data sharing, and what capabilities the system has to connect to an image-sharing interface.

Before sharing imaging data, which contains Protected Health Information (PHI), the security of the network connections need to be assessed and verified as secure (per organizational IT policies). The bandwidth also needs to be assessed to ensure that the imaging data can be transferred at the desired rate. As average study sizes increase, for instance, when Breast Tomosynthesis studies begin to be acquired, this assessment should be periodically repeated.

Operational Readiness

An often-overlooked aspect of sharing data is the staff impact. While online image sharing methods, such as XDS-I or cloud-based methods, may provide greater efficiencies than portable media, imaging informatics skills are still required when troubleshooting an image quality or incompatibility issue. Training should be provided along with education about imaging concepts and standards.

Imaging Record Sharing and Retention Policies

If a technical solution for image sharing is available, organizations often also need to determine which roles have the authority to initiate share imaging with other organizations. If patient consent is required by policy, staff will need to understand procedures for capturing or verifying this. Where rules for automated imaging data sharing are used, such as with a routing rule from the PACS or VNA, policies should govern them.

When incorporating imaging data acquired by a different organization, it is advisable to establish a policy as to how long these records will be retained. Some organizations may treat shared images equally as imaging records they acquired. In some cases, such as for inbound Teleradiology exams, a different retention policy may be defined.

It is important to keep in mind that the more efficiently and simply images are shared, the more imaging data will be received and stored. Traditional imaging data storage consumption projections, based solely on an organization's own acquisitions, may need to be revised (and periodically reviewed).

Sharing Every Study for a Patient

In the days of film, as the cost of printing images was borne by the sending organization, care was taken to select the most important studies to be shared. As portable media export got faster, and shifted to central "burners" on the network, and media got larger (from CD to DVD), organizations started to include more and more of a patient's imaging exams. Often, they would include every study that they had, even if it was not relevant to the patient's ongoing care (for instance, a 9-year-old x-ray, negative for an ankle sprain). As organizations increasingly use online methods to share imaging data, the trend to send more data will naturally occur. Having methods to assess which exams are important to be imported, such as being able to view the images before downloading them, will save costs.

An HIE or cloud-based service provider should be able to provide statistics and analytics tools to monitor imaging data sharing patterns to help project resource usage and evaluate policy compliance, or as input to policy development.

System Interface and Data Integration Specifications

As part of an integration of an organization's systems with an HIE or cloud-based service, specifications as to how the data will be exchanged between systems need to be developed. The HIE or cloud-based service provider staff will have experience in this type of integration and should be able to provide guidance.

Image Sharing Process and Procedure Development

Documenting the process for sharing images, including guidance for troubleshooting and frequently asked questions (FAQ), is advised. Help desk and/or system administrator contact information should be included. The more broadly the authority to share images is distributed across the organization, the more important this documentation will be.

Change Management – Educating Users

As users discover the inclusion of externally acquired imaging records within the systems they use, some education may be required. For example, external images may have been acquired using a very different acquisition protocol, or use very different series descriptions and different terminology and procedure codes, than locally acquired exams. This may lead to confusion or frustration by users, and may cause unexpected behavior in systems that have rules, such as display protocols, based on the values in specific attributes. Some organizations intentionally include a label (such as "outside films") in the DICOM metadata, indicating that the exam was not acquired internally.

Integrating Shared Images within PACS and the EMR

As anyone who has imported imaging exams from portable media can attest, sharing is more than just copying the DICOM files from one system to another. The imaging record, specifically many of the values in the DICOM attributes, need to be changed to reflect the receiving organization's information standards.

Reconciling Imaging Records

Both patient and study/procedure information are often required to be updated prior to making the images available to users within your imaging systems.

Patient Information

Failure to update patient-related information may result in imaging records that are not linked to the same patient identity as locally acquired exams.

Patient demographic data (name, date of birth, gender, and so on) in the received exam may be incomplete or incorrect, especially if the acquiring facility used manual data entry methods at the modality[16]. To avoid any information conflicts, the demographic values are often overwritten with values from the receiving organizations information systems (HIS/EMR).

Study/Procedure Information

Several study-specific DICOM attributes are used by application logic in a PACS application (and other image management and viewing software). These include information about the procedure. This information can be used in mapping tables to assign a value for the anatomy imaged, which is used in relevancy rules for prefetching and possibly display protocols when viewing the study.

These values are often quite specific to an organization and their ordering systems, so it's best to reconcile to values that work with the receiving organization's systems and records.

New Guidance from IHE on Patient and Study Reconciliation

Recently, IHE revised the Scheduled Workflow (SWF) integration profile to include, among other things, direction for including information on the Issuer of a Patient ID and Accession number, making the identification of the source facility and information systems much more explicit in DICOM and HL7 communication. The revision is called SWF.b[17], and is important in making this fundamental integration profile appropriate in today's consolidated enterprise environment, as well as in image sharing transactions.

[16] Versus using DICOM Modality Worklist to avoid data entry errors by the Technologist.

[17] http://www.ihe.net/uploadedFiles/Documents/Radiology/IHE_RAD_Suppl_SWF.b.pdf

Reconciliation Methods

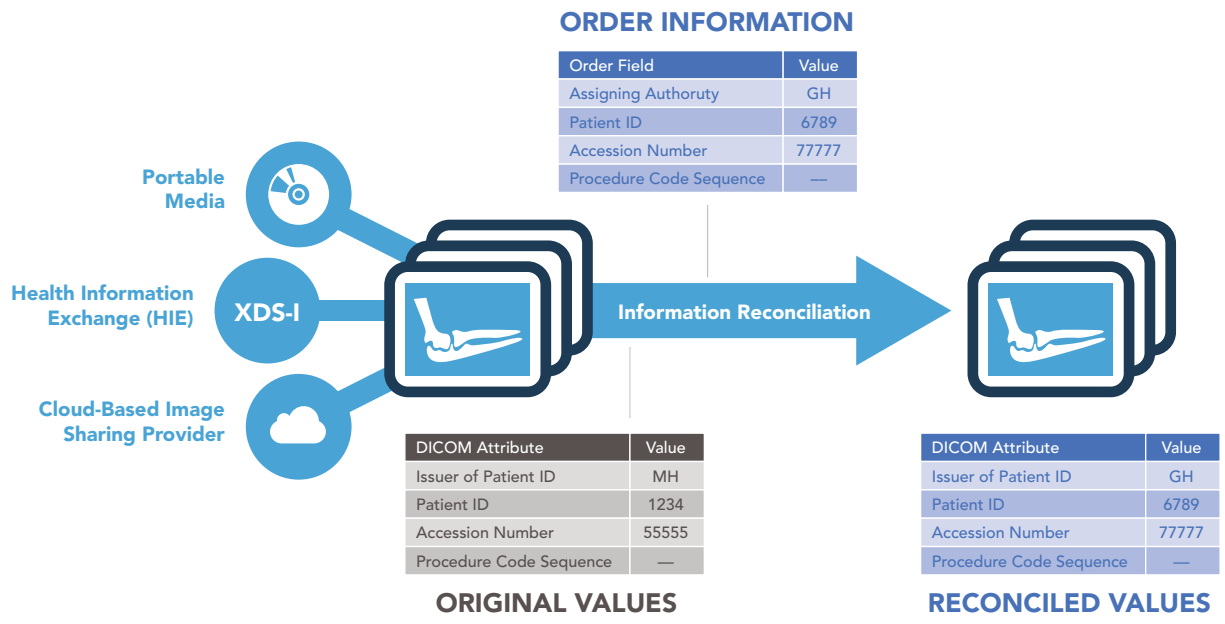
How this update of DICOM attribute values is performed will vary. Sometimes it is done in a system external to the PACS or VNA, before sending the reconciled data to that system for storage. However, some PACS and VNA have reconciliation tools built in that allow the imaging data to be received, but held in a queue for reconciliation, before making it generally accessible.

In either case, organizations receiving imaging data acquired at another organization need to decide which tool(s) that they will use, and develop their reconciliation methods based on its capabilities and their policies.

If imaging data shared with an organization is intended to be stored in different imaging management systems—for example, one of several Radiology or Cardiology PACS, a VNA, or a specialty workstation—based on the type of data it is, it is often advisable to centralize the reconciliation tools. Otherwise, each of the receiving systems will require these tools to be present, and the staff using them will need to consistently follow similar procedures or the quality of resulting imaging records will vary.

Source of Information Used in Reconciling Shared Imaging Data

One of the most common methods for reconciling externally acquired imaging data is to generate a local order for an imaging procedure for the patient and to update the information in the DICOM header with the values from the order. This is similar to the DICOM Modality Worklist technique used when acquiring new images on a Modality, so it is normally easy for staff to understand.



Often, an organization will define specific procedures within the order set in their HIS/EMR for reconciling studies. This is because these orders are typically flagged not to be included in charge masters for billing, and because the order information can then be mapped in the image management system. For example, a simplified display protocol could be defined for an externally acquired exam, because the original series level information, which is often used in the display logic, is often inconsistent. Rules to determine prior study relevancy are also dependent on common procedure and body part terminology.

Alternatives to Reconciling Shared Imaging Data

Other, less effective methods are sometimes used, such as prefixing (or suffixing) original patient and study level values with a fixed string (such as "OUT_") or a defined string based on the source facility (such as "MH_" for Mercy Hospital, "GH" for General Hospital). This is done to prevent the imaged patient's identifier from conflicting with another patient's identifier, which is a patient safety issue and must be avoided. It is also done to make external studies easy to identify and sort or filter on (for example, in a worklist). The prefix may be applied to exam level attribute values, such as the Accession Number, as well. This prefix method is more often used in Teleradiology where linking images to priors, or retaining the imaging record for future reference (past a few months), is not intended. There are other limitations when incorporating exams with prefixed attribute value in the EMR, as discussed later in this paper.

Cloud-based Service

A cloud-based image sharing service may include reconciliation tools that allow the data to be updated in the cloud prior to being downloaded and stored to the local image management system (PACS, VNA).

Private HIE

IHE XDS(-I) mandates reconciliation upfront at the time of submission by requiring the use of an Affinity Domain Patient ID, which may be different from the local Patient ID. The Document Registry enforces policies on metadata such that submissions that do not adhere are rejected[18]. With controls such as these in place, it helps ensure that consistent and predictable data is being exchanged.

It may be that systems that provide XDS(-I) capabilities also provide their own patient and study reconciliation tools, but this will depend on the implementation/product.

[18] XDS allows the local source patient demographics to be provided, but it does not require the complete set of linked patient identifiers. Only the affinity domain patient ID is required.

Shared Imaging Record Access in the EMR

Another reason to properly reconcile imaging exam data is to ensure that the attribute values match ones used by, and known to, the EMR.

Imaging Record Availability Notification to (and Discovery by) the EMR

For an EMR to provide a link/button to launch an image viewer, such as an Enterprise Viewer[19] or PACS client, it needs to be aware of the availability of the study in the imaging system, and have some specific attribute values to address the imaging exam to be viewed.

Notifications

The most common method employed is to have the image manager (PACS, VNA) generate a specific type of HL7 result message (such as ORU), which contains information about the patient and exam. The EMR uses the arrival of this special message to trigger the inclusion of a link in the EMR's user interface to launch the viewer, when the patient's records are viewed. The message is sometimes called a Basic Study Content Notification (BSCN) message[20].

If shared imaging data is not reconciled, the BSCN message will contain patient and order/exam identifier values that are not known to the EMR and the link/button has no patient record to which it can be added. Essentially, the clinical record and imaging record are disconnected, in this case.

Note that, depending on the EMR and its configuration, it may not accept results (remembering that the BSCN is a type of result, per HL7 message type) that contain order information, such as the Accession number, that it did not already have. It will view the BSCN as an unsolicited result and may reject it or log an error.

On-Demand Discovery

Far less common, but a more efficient method, is for the EMR to query the image manager(s), using a patient or study context, and discovery the available imaging records, using an API[21]. A list of matching records is then presented within the EMR user interface and the user can select one or more to be viewed in the integrated image viewer.

To support such an imaging record discovery on-demand, the image manager and the EMR have to support a common interface method. Web-based APIs that allow such discovery on demand have been defined by the DICOM (DICOMweb™ QIDO-RS) and the HL7 (FHIR®) standards committees.

Similar to the unreconciled exam issue described above in Notifications, if the attribute values in the imaging record do not match those in the EMR, the records are not discoverable by the EMR and they will not be otherwise linked to the rest of the patient's clinical record.

Relying on the EMR access controls

Regardless of the method of discovery, by using the EMR (or similar portal) to access imaging records, for example by launching an Enterprise Viewer in a patient or study context, instead of having users log in, search for patients or studies and then view them, an organization can rely on the EMR's existing access controls and rules to restrict access per policy or patient consent directive.

This requires that the organization limit image viewing access, as much as possible, through the EMR. It also requires the image viewer to limit users' ability to search for, and view, records that the EMR has not instructed the application to.

The image access control policies in a cloud-based image sharing application can work in a similar fashion, limiting discovery and access to imaging records to organizations or individuals that have been authorized. There are often similar controls in an HIE.

Whenever possible, organizations should keep information from the EMR in sync with their image management systems for consistent record metadata.

[19] Sometimes called a Universal Viewer.

[20] Or Study Availability Notification or Instance Availability Notification.

[21] Application Programming Interface

Sharing Images and Imaging Related Documents Not in DICOM Format

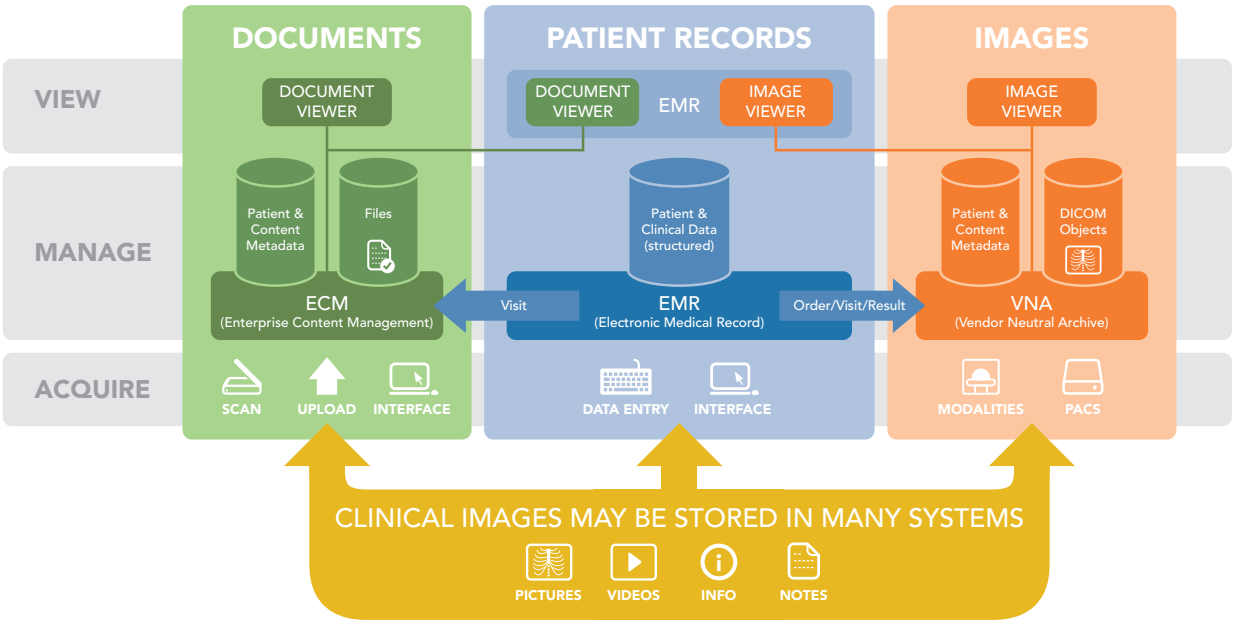
The DICOM standard provides many benefits, including a defined format for images, an information model to capture exam specific metadata, and a protocol for communication and information exchange. While virtually all popular diagnostic imaging exams are produced in DICOM format and managed in systems with DICOM-compliant interfaces, many clinical images are not.

Increasingly, Radiologists with access to EMRs that include these clinical images in the patient's record are reporting benefits from correlating them with diagnostic imagery. For example, wound care, trauma, or surgical images may provide important clues as to what a potential finding in the diagnostic images is actually a result of.

Sharing images when the format, metadata, and source system interface are not consistent is a challenge.

Common systems for managing clinical images include:

- Diagnostic Image Management (PACS and/or VNA)
- Enterprise Content Management (ECM)[22]
- The EMR



Hopefully, your organization has a strategy for how these clinical images are being captured, stored, indexed, and presented. If not, sharing them with other organizations will be an even greater challenge.

[22] Sometimes referred to more simply as a Document Management System

The Old, Reliable Way: Manual Upload

If no appropriate interface is available between your organization's clinical image management system(s), the most pragmatic way to share them using your secure image sharing solution is to export them from the system that they are in, and upload them to the solution.

In a private HIE, some form of client with a user interface (ideally web-based) that allows the authorized user to select the patient and upload the images would normally be provided. If the HIE is based on IHE XDS, the client would play the role of *Document Source* in that integration profile.

With a cloud-based image sharing service, a web form is normally provided to the authorized user for uploading clinical images. As these platforms are designed to share imaging exam data, clinical images can often be associated with a patient or an exam.

Case Study: University of Rochester Medical Center

The "CD factory" had to go. That was the consensus reached by all parties involved in the management of diagnostic images at the University of Rochester Medical Center (URMC), the regional healthcare hub in Western New York anchored by 800-bed Strong Memorial Hospital. URMC also sought a better way to exchange exams electronically with the small community hospitals in its region - VPN tunnels were a challenge on both ends.

URMC decided to implement a cloud-based image exchange platform across its enterprise. Clinical departments reliant on diagnostic imaging for transfers and referrals, namely cardiology, surgery, trauma, and neurology, were trained to access exams directly.

Now, clinicians at URMC have faster access to critical imaging histories. They can instantly connect with providers, patients and facilities outside the URMC network to receive studies, and have straightforward workflow to view and share exams that arrive on CD.

Read The Full Story

Sharing vs. Viewing Images

Depending on the need, it may be necessary to simply view the imaging data, while in other cases, it is required that the image files themselves are exchanged.

If the organization managing the images can provide a portal with an Enterprise Viewer to authorized users in other organizations, they can view the data without the need to move and reconcile it.

Image Exchange

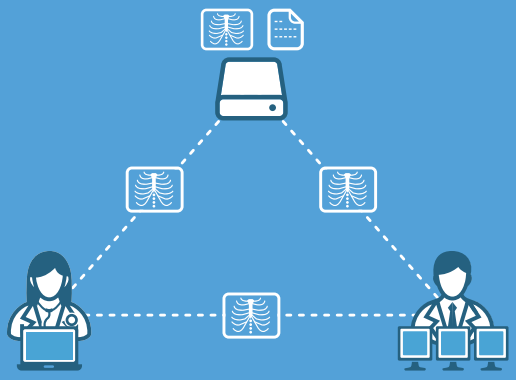
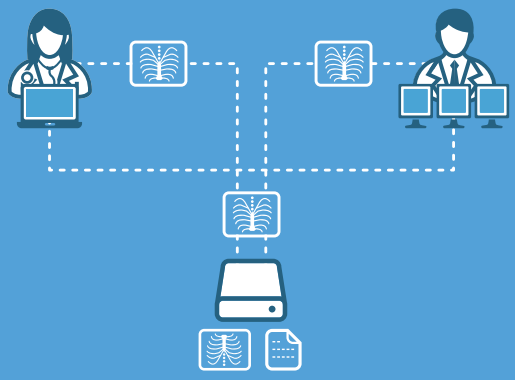


Image Viewing



However, if the organization managing the images cannot provide such an image-enabled portal to users in other organizations, a cloud-based image sharing service (or private HIE, if available) can often be used as an alternative. As most image sharing services include the ability to view data that is cached in their cloud-based applications, users can view the images there, provided they have a user account with the service.

These applications can also provide additional value-added services to users, such as notifications (e.g. email) that images have been shared with them.

And, of course, if copies of the images are needed in the receiving organization's image management system—for example, in a patient Transfer of Care scenario—they can always be downloaded and incorporated.

The ability to preview imaging data and assess its importance before integrating the images in the local patient record can avoid a lot of unnecessary costs related to moving and reconciling imaging records. This is especially true if the sending organization staff chooses to send all of a patient's studies, and many are not relevant or useful.

What to Remember about Image Sharing

The imaging IT industry and imaging informatics community have reached the level of maturity and capability that allows image sharing to be an integrated part of patient care transition scenarios, while complementing clinical information exchange.

When developing your image sharing strategy and implementation plan, the key takeaways are:

- Different imaging sharing methods are more or less appropriate depending on the scenario. Often you will need to have more than one method of image sharing available, depending on the volume and the nature of the facilities with whom you need to share.
- Ensuring your imaging records are complete and consistent, as well as conformant to standards, reduces issues when sharing them. It also helps the recipient when incorporating them into their records management systems (PACS, VNA, and EMR).
- IHE provides valuable guidance, not only on data communication and exchange, but also on content.
- Ensuring you understand how patient identifiers and study terminology is managed within your systems is important. Providing tools—as part of the image sharing platform, your image management systems, or as a standalone system—to staff to effectively integrate shared images into the patient record is essential.
- Increasingly, it is important to ensure that the patient and study data is reconciled to information in the EMR, so that it can be accessed from the patient's record. Simply getting the images into PACS as study, unlinked to the rest of the patient's exams, will not be sufficient in today's environment of patient record interoperability and enterprise-wide electronic access.
- Educating staff on imaging informatics concepts, as well as use of the tools, is very important to ensure quality of managed imaging records and avoid costly errors in data. Choosing image sharing methods that your staff find intuitive and easy-to-use, from wherever they are in the facility, is advisable.
- Developing a policy on who can share and/or view imaging records is important. Determining how you will enforce this policy through your internal tools, as well as with your image sharing method, is also important.
- Using analytics to assess image sharing, and image viewing, patterns to make optimizations and improve policies is recommended to assess the value of your solution on an ongoing basis.