Radiology Information Systems and Electronic Medical Records

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Overview

The radiology information system (RIS) is considered the core system for the electronic management of imaging departments. The electronic medical record (EMR) is the core informational system for patient management across the health-care system. Within a radiology department, major functions of the RIS can include patient scheduling, resource management, examination performance tracking, examination interpretation, results distribution, and procedure billing. The widespread adoption of picture archiving and communication systems (PACS) requires additional practice management workflow coordination, including the creation and distribution of images within the imaging department and throughout the imaging enterprise. The introduction of PACS established a co-dependent relationship between the RIS and PACS. Optimal efficiency for the imaging department occurs when PACS and RIS integration enables seamless information sharing between RIS and PACS.

Traditionally, the workflow within many radiology departments was considered a closed system; the workflow began when the paper-based imaging order was received in radiology and ended when the paper-based result was delivered to the clinician. PACS fundamentally changed the relationship of radiology to the enterprise, as immediate availability of images to the enterprise was considered an equally important capability as distribution of the radiologist's interpretation. Today, many radiology departments have begun to transition from simply making images and reports available to the enterprise to using an integrated, enterprise-wide clinical workflow. Paper-based imaging requests are being supplanted by electronic orders originating in both RIS and EMR systems. In many practices, decision-support tools assist the clinician in requesting the appropriate procedure for the patient's clinical presentation. The ever-increasing influence of the EMR workflow for order entry and clinical management further affects the workflow within radiology departments; radiology workflow now often originates within hospital and office-based EMR systems and ends when the images and report are available in the same EMR systems.

By understanding the capabilities of RIS/PACS and EMR systems, radiologists can facilitate the implementation and optimization of these systems within their clinical practice. In this section of the IT Reference Guide, the reader will learn the transitional roles of the RIS and PACS, the interdependency of these systems leading to integrated RIS/PACS, and the potential impact of EMR systems on radiology practices.
Radiology Department Common Information Systems and Processes

In a radiology department, numerous processes manage procedure preparation for interpretation by the radiologist. Common clinical processes across imaging practices fulfill the requirements to not only produce an interpretation but also to manage results distribution and billing procedures.

Radiology Department Procedure Performance Workflow

1. **Order entry:** the process of capturing the clinician's request for performing a procedure. This includes the patient's clinical history and indications for the requested examination. The order entry process can be managed directly by the radiology department. This process is migrating to computer-based systems that directly capture the clinician's instructions. Computerized decision-support processes can be integrated into the selection and approval of appropriate procedures for a given clinical presentation.

2. **Preauthorization:** the process by which an insurance provider provisionally approves reimbursement for an examination. In some practices, using a third-party “appropriateness” tool or process provides required authorization. The specific requirements for approval vary by state, insurer, proposed examination, and patient's level of clinical acuity.

3. **Gathering patient demographic and insurance information:** this information is necessary to provide continuity of care, to access a patient's prior imaging studies, and to allow proper billing at the conclusion of the procedure.

4. **Creating an accession/procedure/exam order number:** a process to manage the performance of an examination. An accession number is typically issued by the time the patient arrives into the radiology department but could be issued when the imaging order is received. The accession number coordinates with PACS/RIS to ensure reports are linked to proper examinations in PACS.

5. **Scheduling ordered procedures:** involves the scheduling of the ordered procedure as well as maintaining a list of both scheduled procedures and available appointment openings.

6. **Performing procedure:** the technologist performs the scheduled procedure and tracks (time stamps) the process steps of examination performance.

7. **Managing the modality worklist:** a process of automatically transferring the patient's procedure information directly to the imaging modality. Utilization of the modality worklist eliminates the manual entry of patient information into the imaging console, which reduces manual data entry errors and facilitates greater fidelity of RIS/PACS data flow.

8. **Managing the interpretation workflow:** a process by which completed cases are provided to the radiologist for interpretation. Management systems create and maintain radiologist task lists (or worklists) of unread procedures available for interpretation.

9. **Distributing results:** the process that informs the ordering clinician of the availability and result of procedure interpretation. This also includes a process for making results available directly to the patient (required for Meaningful Use). Results include both images and report. The notification and communication of unexpected results are also an important component of the results distribution process.

10. **Managing coding workflow:** the process by which completed results receive CPT® and ICD-9 coding information regarding performed examination, patient history, and indications required by insurance providers to receive reimbursement for the examination.
11. Managing reimbursement workflow: the process by which the completed and coded procedure is transmitted to the responsible insurance provider or patient for payment.

**Radiology Workflow Management**

The core functions of an RIS are to facilitate and document procedure performance, manage results, and generate a billing record. Prior to purchasing any IT system, decision makers should understand the existing core workflows of their clinical practice. These workflows are components of “Imaging Order Lifecycle Management.” The imaging practice needs to understand its current process of fulfilling the imaging order request — from image acquisition to delivery of report and study images to the clinician and finally the billing procedure. Workflow processes are improved when managed by systems that eliminate paper and automate the transfer of information between information systems. Digital workflows enable greater transparency of given processes and enable process changes that can further improve imaging operations.

**Order Scheduling and Resource Scheduling Management**

Patient scheduling for most outpatient imaging procedures involves identification of an available imaging location appointment at a time when the patient is available. For outpatient imaging, the time selected is ideally that most convenient to the patient’s schedule. Several commercially available scheduling systems allow patients, via secure Web access, to select a time to best fit their schedule. Regardless of the patient’s convenience, the scheduling system should provide guidance as to the proper sequencing of the procedure to avoid procedure cancellation.

Potential IT Options for Scheduling Systems

- Hospital-based system
- RIS-based system
- Third-party scheduling system

In addition, consider the following when researching possible scheduling systems:

- The scheduling system should prevent patient schedule conflicts.
- The system should also include logic to optimally sequence imaging assessment(s). For example, Barium-based imaging (UGI or BE) should occur after CT imaging procedure as residual contrast could result in procedure cancellation.

The scheduling process is fundamentally similar regardless of the practice setting: schedule an imaging appointment most efficient for the care of the patient. Scheduling must also aim to have patients’ scans sequenced as efficiently as possible to optimize imaging modality utilization. A further consideration is the acuity of the patient’s clinical presentation. For example, the prioritization of an emergency center patient could take precedence over a previously scheduled outpatient procedure. IT systems can greatly assist in coordinating limited scanning resources. To mitigate schedule disruptions for scheduled outpatient procedures, many institutions employ an operational strategy to locate CT scanners in emergency centers or inpatient area dedicated to acute patient care.
Further complexity in scheduling occurs when ancillary services must be coordinated in addition to scanner time (e.g., examinations that require the presence of anesthesiology personnel or direct availability of specific clinicians or if radiologists require resources potentially outside of the radiology department’s direct coordination). In these situations, enterprise scheduling systems, with information of available schedules for resources outside of the radiology department can coordinate with the imaging resource availability, becoming a component of the scheduling decision process.

Tracking: A Core Capability of the RIS

Each practice seeks to improve the quality and efficiency of its imaging operations. A key function of the RIS is to store procedure tracking data, which in turn produce tracking metrics. Metrics are derived from procedure tracking, i.e., time stamps, of key procedure performance milestones. The tracking steps are raw data needed to track practice metrics, such as the time from when a patient’s procedure was scheduled to occur compared to the time actually performed or the time from the conclusion of the procedure to the completion of the signed radiologist’s report.

Many practices desire an RIS able to define unique tracking steps specific to the practice. The tracking steps should be consistent across a given practice to allow comparison of operational performance. However, in implementing customized procedure tracking steps, key processes may not be effectively benchmarked, and inconsistent benchmarks may be produced across the practice; one result is the inability to benchmark the practice with peer organizations’ metrics. The Society for Imaging Informatics in Medicine Workflow Initiative in Medicine (SWIM) [1] seeks to standardize the procedure tracking steps and their definitions across radiology practices. When widely adopted, this initiative will allow metrics standardization across imaging practices as well as enable more robust analytics capabilities from vendors.

Typical Radiology Department Tracking Steps

The following procedure steps are typically indentified in RIS systems (noting SWIM naming conventions):

1. Physician ordering of examination (order)
2. Insurance authorization for examination (precert)
3. Patient arrival in department (arrived)
   a. Delta time value = patient waiting time
4. Patient preparation completed (patient ready)
5. Examination imaging started at modality (first image)
   b. Delta time value = examination length
6. Examination finished (complete)
7. Patient leaves department
8. Images available (review)
9. Films read (dictated)
10. Critical results notification (critnotification)
11. Report transcribed (transcribed)
12. Report signed (reported)
13. Result reviewed by clinician (resultviewed)
As a core practice management requirement, RIS can store the start time and end time of an examination. However, the practice must establish the standard for recording these metrics for a given modality across modalities and imaging locations. This will enable consistency in comparison of operational performance across all areas of an imaging practice. An example of a tracking metric requiring specification is the “Exam Start” time. The practice should establish a standard for workflow tracking across the practice of one several possible workflow points:

- Time prior exam ended and the technologist began preparing for next patient
- Time technologist entered/loaded patient demographics into scan console
- Time patient arrived in procedure room
- Time when first image acquisition initiated

However, even with strict workflow process definitions, manual procedure tracking is hampered by potential inadvertent or incorrect manual data entry into RIS/PACS. Tracking steps are ideally captured as byproducts of an ongoing workflow. An option to standardize imaging metrics and improve tracking data fidelity is to supplant manual procedure tracking though the utilization of Digital Imaging and Communications in Medicine (DICOM) services. Pertinent DICOM process steps include Performed Procedure Step, Storage Commitment, and Instance Availability Notification. Modalities report back to RIS regarding start time, end time, and the number of images produced during an examination. Other pertinent data elements such as radiation dose data can also be transferred to RIS using a similar process.

The following DICOM services are available for acquisition workflow management:

- Modality Performed Procedure
  - In Progress: Time procedure acquisition started on modality
  - Completed: Time procedure acquisition ended on modality
  - Discontinued: Time procedure terminated prior to completion
- Storage Commitment
  - Request: Modality notes images ready for transfer
  - Confirmation: PACS confirms receipt and successful image storage
- Instance Availability Notification
  - PACS notifies RIS that images are available (online) for a given accession number

**Examination Tracking: The Need for a Standardized Tracking Number**

An examination number must be generated prior to imaging performance to synchronize image transfer to PACS and to link radiology reports to specific image studies. An exception to this process occurs in the event of either planned or unplanned EMR or RIS downtime when automated accession numbers are not available. During downtime it is possible to perform image studies on modalities without accession numbers; however a reconciliation process must occur when the system resumes normal function to ensure proper completion of all ordered imaging studies.
Generation of Imaging Study Tracking (Accession) Number

RIS vendors use different terms for this serial number, including accession number, PACS ID, study number, and study ID. For purposes of this document, we will refer to this as accession number. Additionally, a standard process must be in place to generate the accession number. This number can be generated when the order is created, when the order is transmitted to the RIS, or when the patient arrives in the imaging department.

Once generated, the accession number is then transmitted to downstream systems including PACS and, if employed, the standalone dictation system, as well as the EMR system. There is no "correct" time to issue the accession number, but the practice must fully understand at what step the accession number is being generated to ensure consistency of practice management.

Imaging Protocol Management System

Most radiology departments have a process for radiologists to review ordered examinations and to tailor the examination to the patient's clinical history and indications. In most instances, the protocol selected will correspond with the clinician's order. However, in cross-sectional imaging such as CT and MRI, specific exam prescriptions or protocols are employed to tailor the generic ordered examination to the clinical question at hand and obtain optimal imaging. This customization process may be facilitated by the RIS, which supports electronic protocoting by the radiologist. At the time of protocol, if a radiologist's opinion on an examination's appropriateness differs from the authorized examination, a reauthorization process may be required to mitigate the possibility of payment denial by the patient's insurance provider. For this reason, some practices have implemented a reconciliation process to mitigate study authorization conflicts following the radiologist's procedure protocol designation.

Documentation

Paper-based documentation processes are being supplanted by electronic processes. Procedure documentation requirements are specific to institutional requirements. For plain-film imaging, the technologist who performed the procedure should be indentified and stored in the RIS. For examinations requiring IV contrast administration a more in-depth clinical documentation process is usually recorded, especially when the procedure involves nurses and technologists. As prescreening procedures vary between imaging centers, the requirements for IT support of this process necessarily vary as well. The documentation processes may require updating the patient's institutional EMR record, especially in those organizations where an EMR has been implemented; this is especially true for contrast allergies.

Contrast Allergy Documentation

Practices must have a method to track reported contrast allergies as well as to document a new allergy when it occurs. Many institutions, especially those with EMRs, require that the patient's master allergy record be updated regardless of the setting in which the patient reported the allergy or where the allergy event occurred. In practices without EMR support, the RIS will be essential to record and store this information. The allergy record can also
become a component of the decision-support process for future procedure ordering. For example, a patient with suspected renal cancer with a documented iodine contrast allergy could be sent directly to MR imaging with gadolinium contrast rather than have a noncontrast CT procedure performed.

Consent Form Documentation

Consent forms formally document the patient’s consent and are necessary prior to initiating invasive procedures. The consent form documents a conversation with the patient or responsible caregiver regarding the disclosed risks and benefits of the planned procedure and provides formal consent from the patient to undergo the procedure. Although the consent is typically captured on paper, electronic solutions are becoming more widely available to allow electronic signature capture using technology common in commercial point-of-sale systems.

Radiation Dose Administration

Beginning in July 2012, the State of California requires that radiology reports contain radiation dose administration information (the dose length product or the CT dose index). For maximal efficiency, a designated system is needed to record this information and populate it into the patients’ record and the radiology report. CT scanner manufacturers are beginning to equip scanners with means to electronically report this information and share it with other systems.

Contrast Medication Administration Record

With the availability of electronic medical administration systems as part of the EMR, contrast administration practices and documentation become subject to the same oversight as medication administration for the general patient population, particularly for hospital-based radiology departments. This will likely be first implemented in the inpatient setting where contrast fluid volumes need to be included in the patient’s overall fluid intake.

Automation of the contrast administration documentation is more feasible with the availability of contrast injectors, which automatically record the contrast administration parameters including time and amount of contrast administered. This data can then be accessed directly, stored in the procedure documentation system, and automatically populated into a radiologist’s report either directly from the documentation system or first transmitted to third-party system and then reported back to the documentation system within the radiologist’s report. Regardless of how these data are available for the radiologist’s report, the raw data from the injectors should be available for subsequent analysis as part of the department’s metrics tracking capabilities.

Medication Reconciliation

Medication reconciliation identifies the process that notes the patient’s current medications and tracks which medications must be discontinued and then restarted prior to and after procedures, clinical appointments, or hospital admissions. An active medication reconciliation process is a measurable component for Meaningful Use, documenting reconciliation events at the time of patient encounters and care transitions. Health-care
providers will be under increasing pressure to maintain an accurate status of patients’ medications. Radiology departments might be required to participate in the institution’s medication reconciliation process. Within interventional radiology areas, the reconciliation process is an important component of postprocedure management, ensuring necessary medications, which may have been discontinued in preparation for the procedure, are resumed after the procedure has been completed.

**Emergence of RIS/PACS Integration**

To understand the role of the RIS in radiology practice management, it is worthwhile to consider the evolving practice of radiology. Over the past several decades the role and capabilities of the RIS have evolved along with the practice of radiology. An RIS that once tracked a patient’s film jacket now operates in filmless environments. As radiology has evolved from film and manual transcription-based reporting to filmless and paperless practice, the capabilities of the RIS to manage digital practice have increased across all RIS vendors. For many vendors, the interdependence of their RIS and PACS offerings, as well as the expansion of features and functions, has resulted in a confluence of functionality in managing the RIS and PACS. In fact, several vendors have merged RIS/PACS into a single product offering with a single, integrated workflow.

When implementing a PACS and RIS from different vendors, workflows from both systems’ vendors must be managed. The terms “RIS-driven workflow” and “PACS-driven workflow” are often mentioned in the context of deciding how to most efficiently manage a practice’s imaging operations. In general, in an RIS-driven workflow, the RIS serves as the “source of truth” for procedure workflow for the technologists, nurses, and radiologists. In a PACS-driven workflow, the RIS issues accession numbers to be consumed by the PACS, technologists perform the procedure in the PACS, and radiologists manage workflow within worklists hosted on the PACS. A PACS-based workflow is advantageous for radiologists because the PACS houses the majority of their workflow. Various hybrids of RIS- and PACS-integrated workflows are also prevalent where technologists operate primarily in the RIS and radiologists primarily in the PACS. Regardless of the model selected, at the conclusion of every procedure, a report must be available, a bill must be generated, and procedure tracking must be completed. The clear disadvantage to shared RIS and PACS workflows is that imaging personnel need to operate in two different systems, which leads to inefficiencies in workflow compared to a single vendor RIS/PACS.

**Interpretation Management**

In the PACS era, radiologists’ interpretation workflows are managed through interpretation worklists (also referred to as tasklists). Each imaging department has to make a fundamental decision on the optimal method to manage the radiologist’s interpretation workflow [2]. The interpretation workflow must be defined for a given practice predicated on the optimal distribution of interpretation workflow both for the patient’s clinical outcome and the operational efficiency of the imaging service. In general, imaging worklists are based on the available unread studies, which are then filtered or assigned into different sublists using parameters such as patient status (emergency, ICU, outpatient), referring clinician, referring practice location, or age of study, to name a new. Interpretation workflow could include
preassignment of cases to specific radiologists or shared selection of cases from a group worklist.

Numerous solutions are available to manage interpretation workflow: worklists can be hosted in the RIS (RIS-driven workflow), PACS (PACS-driven workflow), or in an RIS/PACS hybrid. Several vendors offer products that further supplement workflow options by enhancing the capabilities of the PACS or RIS/PACS and are of particular benefit in multisite or multiple institution imaging practices where there may be an RIS and PACS from the same or multiple vendors and the radiology practice requires a consolidated worklist for the unread studies regardless of originating location. A unified worklist could launch case display in either native PACS or in a universal PACS viewer. An alternative workflow used by some imaging practices, particularly teleradiology organizations, is to use a standard DICOM-based radiologist workstation, which presents studies on a single display platform regardless of the originating PACS’ display software.

**Radiologist Worklists**

Radiology worklists contain lists of all unread examinations and usually feature filters/case assignment parameters, such as the following:

- Age of examination
- Type of examination
- Modality
- Location and status of patient
  - Emergency, ICU, inpatient, outpatient
- Acuity of request
  - STAT versus routine
- Perceived acuity of patient
- Technologist feedback

**Interventional Radiology Systems**

Documentation requirements for interventional radiology parallel those of surgical subspecialties to a great degree. Institutional requirements for invasive procedure documentation will likely be applied to interventional radiology departments. The workflow in interventional radiology departments is more aligned with surgical subspecialties; direct involvement of the physician/radiologist in the performance of the examination with procedure documentation by performing/responsible radiologist at the conclusion of the examination.

Documentation of procedure can be accomplished with the existing radiology department documentation system. Specific requirements for surgical documentation (pre and postprocedure notes and universal protocol [“time out”] documentation as well as consent form management) may lead interventional radiologists to consider practice management in an alternative system specifically designed for interventional radiology or to look to the institution’s surgical management system or surgical EMR modules to meet operational requirements.
Downtime Procedures

Fundamental to the increasing integration and interdependency of IT-based imaging systems is the possibility of specific component failures. These failures can be mitigated through redundant systems and components but will occur in both planned and unplanned scenarios. For example, the version upgrades of the RIS, PACS, or EMR are usually associated with planned system downtime, with specific processes and procedures to mitigate the downstream impact. System vendors can greatly assist in suggesting recommended downtime processes and ensure they are communicated and consistently followed. It is recommended that planned and unplanned downtime events institute the same contingencies for procedure management during the event as well as restoration of normal operations following the event. Specific downtime contingencies to consider include the following:

- Failure of EMR (lack of electronic orders)
- Failure of RIS (lack of accession numbers, no modality worklists)
- Failure of network
- Failure of PACS (contingency to store images on modality)

Downtime Processes

Downtime processes must include downtime operations as well as processes to resume normal operations. The reconciliation process after the event should ensure all downtime-performed imaging procedures have images and reports that can be successfully retrieved by clinicians when normal operations resume. Typical downtime procedures provide a means to manually enter demographic information at the modality console without accession numbers.

Results Distribution

With the availability of EMR systems in both hospital and outpatient settings, demands will be placed on radiology departments to ensure imaging results are available directly within the EMR practice management system selected by the referring clinician. Hospital-based practices likely have a method to transfer clinical results to the EMR (usually via HL7-formatted messages). Imaging departments will likely face increased demands by referring clinicians who require solutions to ensure efficiency in practice management. With the emergence of EMR systems, the availability of patient data access portals is a specific requirement for Meaningful Use eligibility. Patients will expect, and federal reimbursement regulations will require, that results be available for their use. This transition has already occurred in many institutions and it is anticipated that the literature will soon demonstrate the impact of the availability of reports to patients.

Billing and Reimbursement Management

RIS functionality typically allows technologists to enter specific procedure information into the billing system components. The RIS often communicates with hospital or practice being systems to generate billing files to have patients’ insurance or responsible party presented with the billing information required to initiate procedure payment.
EMR System

EMR system capabilities are diverse to manage the entirety of the patient’s clinical management within a given clinical practice. However, just as radiology has transitioned from film to primarily digital imaging, office-based and hospital-based clinical practices are transitioning from paper-based to electronic-based clinical practice. This transition is extremely important for radiology in that the imaging process will, or already has experienced, transition from a paper-based to electronic-based process.

With the EMR transition, the radiology workflow will necessarily change. Electronic order entry for all clinical procedures, including imaging, will be the norm. The transmission of results will send imaging results back to an electronic system from which the order originated. The radiologist will benefit as well; electronic access to the patient’s complete clinical information will allow more informed interpretations, which should lead to improved patient outcomes.

Order entry capabilities for patient clinical management can include the following components:

- Radiology, laboratory, pathology, etc.
- Order entry decision support
- Active order entry for individual procedures
- Appropriate exam for clinical history and indications
- Order set management
- Standardized treatment plans for clinical presentation
- Medication management and administration
- Order transmission to ancillary systems
- Usually mediated through HL7 messages
- Results review and tracking
- Clinical documentation generation and storage
- Clinical repository for clinical information

EMR Definition

The EMR is a secure, real-time, point-of-care resource of patient-centric information for clinicians. The EMR aids clinicians’ decision making by providing access to patient health record information where and when they need it and by incorporating evidence-based decision support. The EMR automates and streamlines the clinician’s workflow, closing loops in communication that result in delays or gaps in care. The EMR also supports the collection of data for uses other than direct clinical care, such as billing, quality management, outcomes reporting, resource planning, and public health disease surveillance and reporting.

Study Orders Management: Computerized Physician Order Entry

A computerized physician order entry (CPOE) system allows clinicians to direct the performance of an imaging examination as well as other tests, procedures, and consultations. Paper-based orders or fax systems do not follow the same CPOE process and do not allow for decision support. When implementing CPOE within an EMR system,
the radiology department must be involved in ensuring, at a minimum, that orderable examinations in the order entry system match the examinations list in the examination tracking system (typically the RIS). CPOE implementations allow clinicians to provide clinical history and examination indications. The provided indications can be further screened for appropriateness of requested procedures. CPOE rules could mandate that appropriate indications are provided at time of order entry. Precise indications are also necessary when insurance providers review procedures to ensure appropriate indications are specified by the radiologist in his or her interpretation. Clerical staff entering a clinician’s paper-based order into the hospital information system or RIS is not considered a CPOE process as it does not allow the use of decision support.

**Clinical Decision Support**

Systems provide clinical guidance to the clinician regarding examination appropriateness based on clinical indication. The ACR Appropriateness Criteria® could form the basis to guide support rules. CPOE features that may be useful for radiology include prior examination assessment, real-time display of recently performed procedure information—which can potentially avoid repeat examination, and presence of contrast allergy, which may lead the clinician to consider alternative examination. Timely information about documented allergies of patients scheduled to undergo an imaging exam can prompt initiation of appropriate premedication prior to the examination.

**Laboratory Values**

Parameters such as renal function are routinely checked in most radiology departments prior to patient scanning to determine whether compromised renal function exists and warrants contrast deferral. Decision-support systems may provide relevant information about contrast allergies and/or compromised renal function to ordering physicians. These may represent (relative) contraindications to the imaging exam and are best considered before ordering the test.

However, in order for contrast allergy information to be considered in the CPOE process, a patient’s contrast allergies must be available to the CPOE system. In larger institutions, allergy data is usually maintained by EMR or in pharmacy system. The “source of truth” for allergies must be determined by institutional policy.

**Clinical Information Repository**

In addition to clinical information stored in the EMR, many institutions have implemented a clinical information repository (also referred to clinical data warehouse). The clinical information repository usually contains all available clinical data as well as billing information. Although PACS images are usually not included in the repository, several institutions have included PACS DICOM metadata as a component of the data warehouse. The benefit of the repository is that clinical information can be aggregated across the institution’s entire patient population. Complex clinical queries can then be performed utilizing the data warehouse that do not impact the system performance of the institution’s EMR system. In the future, it is anticipated that the clinical data warehouse infrastructure will be important to track clinical metrics, which are needed to report to regulatory agencies.
Universal Availability of EMR Systems: Implications for Future Radiology Workflow

With the increasing availability of EMR systems in both hospital and office-based practices, further evolution of radiology information technology systems will affect the workflow within the ordering caregiver's scope of practice. With widespread availability of CPOE, the relationship of radiology to the enterprise will also fundamentally transform with electronic order transmission to the imaging department. To this point, Stage II Meaningful Use guidelines require that 50% of imaging orders be initiated via CPOE systems (see the IT guide section on Meaningful Use). This requirement effectively ensures that the radiology workflow will begin at CPOE entry rather than at the point of order receipt.

EMR/PACS Workflow Within Radiology

The fundamental clinical transformation enabled by ubiquitous access to EMRs has not yet been fully realized. However, with institutions' clinical workflow housed entirely within EMR systems, it is very likely that radiologists will be asked to consider and participate in EMR/PACS workflow integration scenarios to allow future enterprise efficiencies. With the growing maturity of EMR systems, it is reasonable to speculate that radiology practices, especially practices associated with integrated delivery networks, will experience a further evolution of practice management with EMR/PACS integration. In such an evolution, traditional functions of the RIS will be subsumed within EMR documentation and workflow management. There will likely be opportunities for radiology practices to measure positive operational impact not only within the imaging department but across the hospital enterprise and, in the future, across the entire accountable care organization with collaboration from the imaging service.

In the ongoing transition to EMR systems at many institutions, the radiologist must take an active role in EMR implementation. The current trend in IT systems strategy is for the preponderance of an institution's clinical IT systems to be on the same clinical vendor platform. CPOE implementation and results delivery notification are obvious areas where the expertise of the radiology community can assist in implementing a system to improve the imaging practice. However, these EMR systems provide the radiologists with instant access to the entirety of the patient's clinical record and to become a more informed clinical consultant while managing the patient. When effectively leveraged for clinical data retrieval, EMR systems can generate imaging reporting results, which demonstrably and measurably impact the patient's clinical outcome, demonstrating the value of the imaging process to the overall patient outcome and experience.

RIS Purchasing: Key Questions

- Your organizational roadmap: Is an EHR purchase on the horizon? Consider potentially consolidating systems (RIS and EHR) to a single platform.
- Order entry workflow: Does the RIS require order entry directly in RIS or can it process an order entry message from an EMR system?
- Scheduling features: Is the RIS expected to manage procedure scheduling, or is this function centrally managed? Does the system have features to integrate into the expected scheduling workflow?
• Examination performance: How does the system manage radiology nursing and technologist workflow? Note workflow features that distinguish one vendor from another.
• Does the RIS support modality worklist management for the currently installed modality vendors?
• Does the RIS include the examination documentation feature to manage the imaging practice? Is the documentation functionality standardized, or does the customer have the ability to efficiently customize data entry screens?
• Examination interpretation: Are radiologist worklists expected to be managed by RIS, PACS, or a third-party solution? Does the RIS have an existing feature to manage the expected workflow?
• Examination report generation: Does the RIS vendor have an existing voice-recognition solution, or is this implemented by a third-party vendor?
• Results distribution: Can the RIS support the expected clinician workflow? What capabilities are available to provide results to a clinician’s EMR solution?
• Billing: Does the proposed RIS have the functionality to support current billing practices?

Summary
The RIS, PACS, and EMR are fundamental IT clinical systems to enable effective and efficient clinical operations in imaging practices. Although there are clear differences in the size and scope of imaging practices, the core requirements of PACS, RIS, and EMR systems are similar across imaging practices. This allows the practice to receive physician orders, safely and efficiently perform the requested imaging procedure, and then deliver the images and result to the referring clinician and, finally, to the patient. As in the past, clinical informational technology systems will continue to evolve to meet ever-changing practice patterns and regulatory and reimbursement requirements. Radiologists should actively participate in the implementation and updating of RIS, PACS, and EMR systems to allow these systems to continue to meet the clinical imaging requirements of imaging practices as well as those of referring clinicians and, ultimately, the patient in need of imaging services.

References


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