



# The Royal College of Radiologists

Board of the Faculty of Clinical Radiology

## Radiology information systems

**This guidance forms part of a series on the developments in information technology in radiology. This is a fast-moving field and developments are occurring rapidly. Consequently, this guidance will be updated regularly and readers should check regularly that they are using the most up-to-date guidance available.**

These guidelines aim to help the radiologist pick out the important features in a radiology information system (RIS) which should be examined prior to any RIS procurement (even if the RIS is combined with picture archiving and communication systems [PACS] as a single product).

A RIS is a computer system designed to support operational workflow and business analysis within a radiology department. A RIS is also a repository of patient data and reports, and contributes to the electronic patient record.

As RIS have evolved, their application has widened to include other departments and imaging specialties such as nuclear medicine, radiotherapy, endoscopy and so on. Where a RIS supports these additional specialties, it may be more accurately described as an imaging information system (IIS).

## **1. Functional requirements**

- 1.1 A RIS supports a wide range of functional requirements which overlap with functionality provided by other hospital information systems and PACS (for example, appointment scheduling, work lists and digital dictation). In an integrated solution, it is acceptable for other systems to provide this functionality providing the overall operational workflow and business analysis requirements are satisfied by the integrated solution.

## **2. User access controls and patient consent**

- 2.1 A RIS must support individual user logon with password authentication. Role-based access controls (RBAC) should be implemented to restrict access to system functionality based on predefined user group privileges (such as system administrators, radiologists, radiographers, typists etc).
- 2.2 In a shared RIS instance across more than one organisation, the system should record patient consent or dissent to share data, and restrict access accordingly. Where this functionality does not exist, current guidance is that data may be shared on an informed implied consent model, providing data sharing agreements are in place between the organisations in line with local and national information governance policies. In the 'Connecting for Health' NHS Care Records Service (NHS CRS), patient consent to share data will be recorded within the integrated national Personal Demographics Service (PDS).
- 2.3 It should be possible to mark individual patient records as confidential, and restrict access to specific user groups. In the NHS CRS, it is planned that

access to patient records will be controlled through a national Legitimate Relationship Service (LRS).

- 2.4 The system should maintain an audit trail of all user access to, and modification of, patient data.

### **3. Patient demographics and alerts**

- 3.1 A RIS must support a patient demographic check to confirm patient identity. It is recommended that a minimum of a four-point check is employed including name, DOB, address and unique patient identifier number.
- 3.2 Patient demographics on an integrated RIS should be automatically updated from a common Master Patient Index (MPI), which is traditionally the hospital information system (HIS) or patient administration system (PAS). Patient demographics should only be manually updated on the RIS if the interface enables bidirectional update of the MPI. The NHS care record service in England has a national MPI called the Patient Demographic Service (PDS), and all integrated systems must be able to accommodate the NHS number as the unique patient identifier in addition to any local patient identifiers.
- 3.3 The RIS should record relevant patient alerts including communicable infection risks and allergies. Ideally, these should be integrated with a MPI so that all care record systems are updated together.

### **4. Electronic and paper-based requesting**

- 4.1 A RIS must be able to receive and process electronic referrals through integration with an [electronic remote requesting \(ERR\)](#) system.
- 4.2 It should be possible manually to enter non-electronic referrals so that they can be processed and reported in the same way as electronic requests. Where paper request cards are used, these should ideally be scanned into the system to provide an electronic record of the referral, and to avoid the limitations of paper-driven workflow.

### **5. Booking and scheduling**

- 5.1 A clinician may make a single imaging service request that includes more than one radiology procedure (such as x-ray chest and x-ray abdomen). At booking, these procedures should remain grouped to indicate their

association. It should also be possible to book and schedule requested procedures separately if required.

- 5.2 A single requested procedure may require several 'scheduled procedure steps' to support radiology workflow. For example, a nuclear medicine study taking several days may require several patient visits to the department, each requiring a scheduled appointment.
- 5.3 A RIS should support both imaging and non-imaging scheduled procedure steps. For example, it should be possible to schedule separate procedure step appointments for radioisotope injection and radioisotope imaging.
- 5.4 The system should provide diary functionality for each scheduled procedure step and allow authorised users to block off times when the service is unavailable (such as due to staff holidays or equipment maintenance).
- 5.5 The scheduling system should enable locally defined patient appointment letters to be printed for each patient attendance.
- 5.6 The appointment scheduling system should ideally be integrated with an enterprise-wide appointment system, to enable co-ordination of a patient's imaging appointments with their clinic appointments and other investigations.

## **6. Work lists and folders**

- 6.1 A RIS should provide a comprehensive range of work lists and folders to support radiology imaging workflow, meetings, teaching, audit and research. Folders and work lists are terms that are sometimes used synonymously, although there are some conceptual differences.
- 6.2 Folders are directories that can be used to group examinations for a particular purpose. Authorised users should be able to create and add radiology procedures to a folder, and display the contents folder as a work list. The system should support the creation of multiple folders to support radiology activity, including:
  - Multidisciplinary team meeting folders
  - Audit folders
  - Research folders

- Teaching folders.
- 6.3 Work lists are lists of examination procedures required for particular work sessions. The RIS should generate work lists automatically for each step in the workflow through the radiology department. These should include:
- Pre-procedure work lists (for example, for radioisotope injections)
  - Modality work lists (for each imaging modality and work area/room)
  - Post-processing work lists (for example, for CT 3D reconstructions)
  - Reporting work lists (for each modality and radiologist)
  - Typist work lists (for report transcription)
  - Report verification work lists (for radiologists to approve typed reports).
- 6.4 Work lists should display the priority status of the examination, and the system should allow exams with a higher priority to be moved automatically to the top of the work list. It should be possible to change the priority status of the examination at any time in the workflow; for example, on detection of significant pathology at the time of imaging acquisition or reporting.
- 6.5 For radiology reporting, transcription and verification work lists, it should be possible to move directly from one item in the work list to the next item, without having to select each item in turn from the work list.
- 6.6 On completion of a work item in a work list, the status of the item should change to indicate it has been completed. An audit trail should record when each work item was completed and by whom.
- 6.7 It should be possible to assign work to radiologists to create an individual reporting work lists. Radiologists should be able to filter their work lists and save their most frequently used work lists for ease of access.

## **7. Examination details**

- 7.1 A RIS should be capable of recording all procedure-related information required to meet the legal requirements of the *Ionising Radiation (Medical Exposures) Regulations (IR[ME]R)*,<sup>1</sup> and the business requirements of the trust and radiology department.

7.2 Some procedure-related information is common to all radiology departments, including:

- Administrative details (for example, exam category: NHS, PP etc)
- Persons involved in the procedure and their role
- Radiographic examination details (dose, technique etc)
- Contrast and other pharmaceuticals administered
- Equipment used in the procedure
- Modality-specific information fields
- Free text examination notes.

7.3 Other procedure-related information required for management, research and audit activity may be site-specific and should be defined locally on deployment. The needs for capturing data will inevitably change over time, and the RIS must therefore enable the introduction of new locally defined, procedure-related fields to capture this information as it is required. All data entry fields should ideally be coded to facilitate database queries and management reports.

## **8. Reporting and report coding**

8.1 A RIS should support all aspects of reporting workflow from the generation of reporting work lists through dictation, word processing, report verification and issuing. It must also support the same processes enabling any subsequent report on the same procedure to be added as an addendum to the original report. It should be possible to add multiple addenda sequentially and each addendum should be attributed to the radiologist responsible for adding that addendum.

8.2 A RIS should be integrated with a digital dictation engine and voice recognition software to enable transcription of reports made at a reporting workstation into the word processor, and play back of a dictated report at all RIS workstations. Digital dictation recording should be retained at least until the report has been issued.

8.3 It should be possible to set up user-specific report macros ('canned reports') either in the RIS or in the speech recognition system integrated to the RIS.

- 8.4 The RIS should support the ability to flag a report as urgent, and for this to be communicated with the report message to the clinical report acknowledgement system.
- 8.5 It should be possible to assign predefined codes to reports to assist with audit, research, education and management activities. Report codes should be locally defined, with no restriction on the number of codes that can be assigned to an individual report.
- 8.6 A RIS should support ad hoc data mining, to search for a word or phrase within the text of the clinical report (see user-defined queries under the management reports section below).

## **9. Film and image tracking**

- 9.1 An effective 'film' tracking system will save time in searching for x-ray film packets and images and digital hardcopy archives (for example, magneto-optical discs). While trusts still retain hardcopy, there remains a requirement to support legacy image tracking through RIS.
- 9.2 In a digital environment, all images should be tracked and distributed through PACS, providing with a full audit trail. Whenever digital images are transferred between systems and organisations via teleradiology, there remains a requirement to track the movement of these images for information governance purposes. This role may be provided by the RIS.

## **10. Stock control**

- 10.1 A stock inventory module in RIS can assist with stock control and ordering. If staff are entering consumables used for each examination, the inventory can be updated dynamically and avoid having to take regular stock takes.

## **11. Billing**

- 11.1 Radiology billing requirements in the NHS have traditionally been relatively simple and may be satisfied by producing management reports of workload activity based on numbers of procedures performed, each mapped to a billing code (for example, NHS costing manual).
- 11.2 A RIS may support more sophisticated billing mechanisms by producing management reports based on activities performed in relation to a single radiology procedure (for example, on completion of acquisition, reporting

and potentially other scheduled procedure steps). Payment by Results (PbR) will require RIS to support separate tariffs for primary image acquisition and image reporting/review.

11.3 In integrated private healthcare systems, a RIS may support real-time billing by charge posting to an enterprise billing system on completion of defined activities related to a radiology procedure (for example, the IHE charge posting profile).

## **12. Management reports**

12.1 The justification for many early RIS systems was the need for Körner returns. Modern systems should provide a user-friendly but comprehensive business reporting solution enabling user-defined custom queries of the database and a range of predefined management reports. Predefined reports should include:

- Statutory radiology returns (for example, KH12, KH7)
- Workload activity based on numbers of attendances and examinations performed by operator, procedure, and work list (including modality work list and MDT meetings – see above)
- Waiting time returns for patients from the time of referral and turnaround times between changes in status in procedure workflow (for example, between procedure requested, booked, performed, reported, issued etc)
- Capacity and demand reports based on modality work area availability and usage in the scheduling system
- Reporting activity by reporting radiologist/radiographer and modality (note: a radiology procedure may result in zero, one or more reports, and can not be accurately represented by procedure workload activity)
- Staff training logbooks detailing the numbers of examinations observed, performed, reported and supervised by procedure and modality.

12.2 It should be possible to display user-defined database query results and reports in the RIS interface, and to export database query results in standard formats for further analysis using spreadsheet and statistical reporting packages (for example, as comma separated value files). Ideally, the RIS should support saving of locally defined queries so that they can be easily modified and repeated. Some queries are better designed into the user interface (for example, work list queries), while others should be under

system admin control (for example, audit and research queries, such as report text search).

12.3 The system must allow connection to other enterprise systems using standard database connection protocols (such as ODBC) to enable collation of statutory dataset returns where the information required is located in multiple systems (for example, commissioning datasets).

### **13. RIS integration**

13.1 RIS integration with other hospital information systems and PACS has become increasingly standardised in recent years as a result of the international Integrating the Healthcare Enterprise initiative (IHE).

13.2 IHE defines the transactions required between systems to achieve functional integrated solutions. These are grouped into integration profiles to address different aspects of radiology workflow. A RIS may support the following integration profiles:

- Scheduled workflow (SWF)
- Patient information reconciliation (PIR)
- Post-processing workflow (PWF)
- Reporting workflow (RWF)
- Charge posting (CHG)
- Presentation of grouped procedures (PGP)
- Evidence documents (ED)
- Simple image and numeric reports (SNR)
- Portable data for imaging (PDI)
- Access to radiology information (ARI).

13.3 IHE supports flexible system integration by defining functional roles generically as 'actors' instead of defining the name of the system that performs that role. A RIS may perform a number of IHE 'actor' roles including:

	SWF	PIR	PWF	RWF	CHG	PGP	ED	SNR	PDI	ARI
DSS/OF	X	X	X	X	X	X				
PPS manager	X	X		X	X	X				
Post-processing manager			X		X					
Report creator				X			X	X		
Report reader				X				X	X	X
Report manager		X		X	X			X		
Report repository		X						X		X

IHE actors and integration profiles supported; DSS/OF = department system scheduler and order filler; PPS = performed procedure step

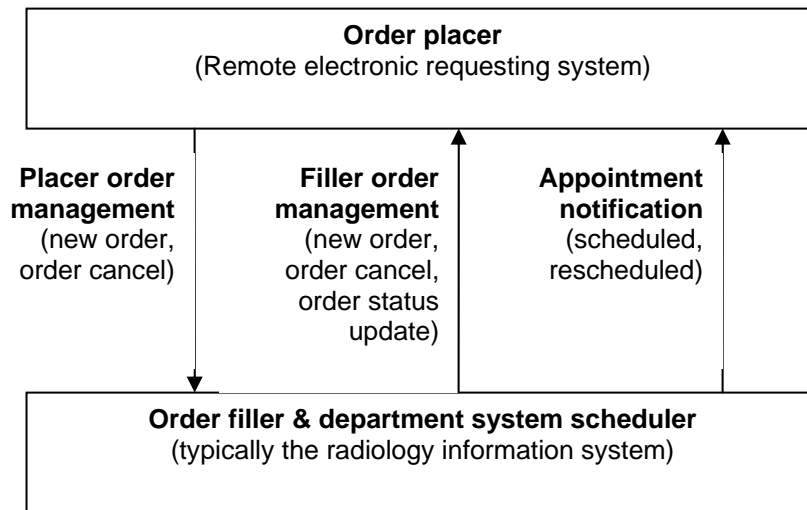
13.4 IHE RIS integration may be specified by in terms of actors, integration profiles and options supported. It is recommended that in any tendering process (request for proposal) that suppliers are asked to complete the table above, specifying any additional options supported in each profile. Further details of IHE can be found at [www.ihe.net](http://www.ihe.net)

#### **14. Integration between RIS and electronic remote requesting**

14.1 Bidirectional integration between RIS (IHE department system scheduler/order filler) and an ERR system (IHE order placer) is essential to maintain a consistent record of the status of requested radiology procedures in both systems. The standard transactions required to support this activity are defined in the scheduled workflow profile (Figure 1).

14.2 In addition to these scheduled workflow transactions, RIS may also send a copy of the report to the enterprise report repository, which is usually part of the clinical electronic patient record system linked to ERR. The transaction is defined in structured report export transaction in the IHE reporting workflow profile.

**Figure 1. IHE scheduled workflow transactions for order communications**



## 15. Integration between RIS and modalities

15.1 In IHE-scheduled workflow, an imaging modality queries a RIS to provide a DICOM modality work list (MWL). The work list ensures referential integrity by mapping RIS data to DICOM metadata in each DICOM image. In DICOM, it is a requirement that study instance UID (Unique Identifier) is provided in the modality work list. In unscheduled use cases or with modalities not supporting DICOM MWL, accession number may be used to reconcile study instance UID through modality-performed procedure step messages (see below).

15.2 On completion of an item in the modality work list (scheduled procedure step), the modality sends a DICOM modality-performed procedure step (MPPS) message to both RIS and PACS. This informs all systems of all the images have been obtained, and ensures referential integrity.

15.3 RIS which are not fully IHE conformant may require an interface engine (PACS broker) to convert HL7 messages into DICOM and vice versa.

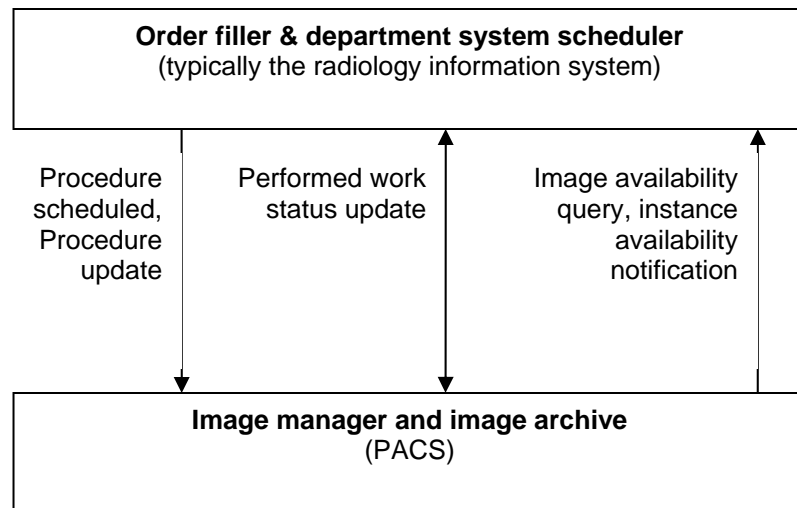
## 16. Integration between RIS and PACS

16.1 IHE integration between RIS (IHE department system scheduler/order filler) and PACS (IHE image manager and archive) enables the systems to maintain full referential integrity on all patients and procedures (see Figure

2). Conceptually, a single requested procedure on RIS corresponds to a single study on PACS.

16.2 Referential integrity between RIS and PACS is achieved through key system identifiers (KSI). Within a single RIS/PACS instance, the accession number identifies the scheduled radiology request/order and the study instance UID uniquely identifies the procedure/study. When images are shared between organisations for reporting or review, a new accession number is generated for the order but the study instance UID should remain unchanged. IHE specifies all images and reports should include the study instance UID to maintain referential integrity between systems. Study instance UID is based on the OSI object identification defined by an ISO standard, and as such is guaranteed to be globally unique.

**Figure 2. IHE scheduled workflow transactions for RIS PACS integration**



16.3 The IHE 'procedure scheduled' and 'procedure update' transactions from RIS to PACS transmit scheduled examination details and key system identifiers including accession number and study instance UID. As this information is received by PACS in advance of the images, it may be used to pre-fetch relevant previous images from the archive.

16.4 The bidirectional 'performed work status update' transactions between RIS and PACS enable the systems to update each other on any change in status of a requested procedure/PACS study. In conjunction with the procedure scheduled transaction, this permits both systems to provide dynamic work lists to support operational workflow.

16.5 The image availability query and instance availability notification messages between PACS and RIS enable RIS to be updated and notified when new images are available on PACS. This helps maintain referential integrity and can enhance reporting work lists on RIS.

16.6 In addition to scheduled workflow transactions, RIS may issue reports to PACS and vice versa using IHE reporting workflow transactions. These enable PACS to act as a report manager, allowing direct access to reports through PACS.

## **17. Integration between RIS and workstations**

17.1 A RIS is normally accessed through a dedicated RIS application running on the desktop. This provides rich functionality, albeit in a proprietary way.

17.2 IHE defines DICOM general purpose work list as the standard non-proprietary method of providing work lists to independent workstations. Work items can be locked during access and flagged on completion.

17.3 IHE reporting workflow specifies a standard method of non-proprietary access to reports through DICOM. This requires reports to be generated as DICOM structured reports (SR). This has the advantage that reports and images can be stored and distributed in the same way, including on portable media (for example, CD/DVD)

17.4 The IHE 'back end' integration of RIS and PACS enables PACS to provide access to work lists and reports directly, and it may not therefore be necessary to run RIS on the desktop. This is called PACS 'desktop emulation' of RIS.

17.5 True desktop integration between RIS and other workstation applications typically employs proprietary routines that, while functional, do not encourage wider desktop integration. IHE recommends that HL7 CCOW should be used as the standard for desktop integration, as specified in the IHE infrastructure technical framework 'patient synchronised applications' profile.

## 18. RIS coding

- 18.1 A RIS is a relational database containing multiple tables. Tables contain fields (columns) and records (rows). Each record in a table has a unique identifier (primary key or code) enabling it to be referenced within other tables in the database. The power of a relational database is that by using the codes, data can be cross-referenced, collated and analysed as 'queries', and published as 'reports'.
- 18.2 Where possible all entries in a database should be coded to facilitate data analysis. In practice, this means field entries should ideally be selected from a predefined drop-down list or table, rather than being entered as free text.
- 18.3 It should be possible for authorised system administrators to modify reference tables to capture all activity required to support radiology operational workflow and business analysis. This allows the system to adapt over time to support the changing business requirements of the department.
- 18.4 Where specific data are required to be collected across organisations, a referencing authority will define standard codes that must be used. In these circumstances the code set must not be altered or customised for local use.
- 18.5 A standard code set is normally part of a coding scheme, and may be part of a classification system.
- A coding scheme defines codes as unique identifiers of concepts. A concept may be defined by an unambiguous term or descriptor (for example, a radiology procedure short code 'CPELV' has an unambiguous descriptor 'CT scan of the pelvis'). Coding schema may support synonyms (two or more ways of saying the same thing, for example, 'CT scan of the pelvis' and 'pelvic CT scan'), but care should be taken to avoid homonyms (the same term meaning different things depending on context) unless the context is made explicit (for example, a 'femoral angiogram' could mean a 'fluoroscopic femoral angiogram' or a 'MR femoral angiogram', depending on the context).
  - A classification is a predefined system of grouping codes to indicate conceptual relationships.
    - i. A taxonomy is a hierarchical (tree structure) classification system. The relationship may be indicated in the code (for example, ICD-10 code S420 'fracture of the clavicle' is a subtype of code S42 'fracture of the shoulder and upper arm').

- ii. A multidimensional relational classification system enables any code and concept to be related to any another code and concept. This is a powerful relational model analogous to a relational database, and enables computer systems to query data for analysis in many different ways.

#### 18.6 Coding schema and classifications in use in RIS include:

- SNOMED CT (Systemized Nomenclature of MEDicine) is both a coding scheme and multidimensional relational classification system. It was established in 1999 when the NHS combined its Clinical Terms version 3 (READ codes) with the College of American Pathologists SNOMED classification. SNOMED CT contains over 300,000 concepts, 1 million descriptions and 1.5 million relationships. The Royal College of Radiologists (RCR) in conjunction with the NHS terminology service and other stakeholders have developed a subset of SNOMED CT for use as a standard set of procedure codes in RIS.
- The RCR has developed a short code coding scheme and classification where each radiology procedure is assigned a unique 5 or 6 digit short code (for example, XANKR = x-ray of right ankle). These short codes have been mapped to SNOMED CT for use in RIS that are unable to fully support SNOMED CT functionality.
- The OPCS coding scheme, originally for surgical procedures, is another standard clinical procedure classification in use in the NHS. Version 4.3 enhanced this to capture additional codes and interventions, including interventional radiology, to support Healthcare Resource Groups (HRGs) and PbR (Payment by Results). OPCS 4.3 is being mapped to SNOMED CT for use in RIS.
- ICD-10 (International Classification of Diseases) constructed by the World Health Organization may be used to code patient diagnoses in requests or reports.
- Other national codes in use in RIS include the NHS number ('CHI' number in Scotland), codes for NHS organisations (NACS codes), GMC registered medical staff (GMC number) etc.

18.7 NHS data standards, guidance and rules are published in the NHS Data Dictionary to support the recording, sharing, exchange and comparison of data and information across the NHS. The NHS Data Dictionary is regularly updated by Data Set Change Notices (DSCN). For further details see <http://www.connectingforhealth.nhs.uk/datastandards>.

Approved by the Board of the Faculty of Clinical Radiology 29 February 2008

## Reference

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A Charity registered with the Charity Commission No. 211540

Citation details:

The Royal College of Radiologists. *Radiology information systems*. London: The Royal College of Radiologists, 2008.

Ref No. BFCR(08)6 © The Royal College of Radiologists, April 2008

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