Clinical Radiology

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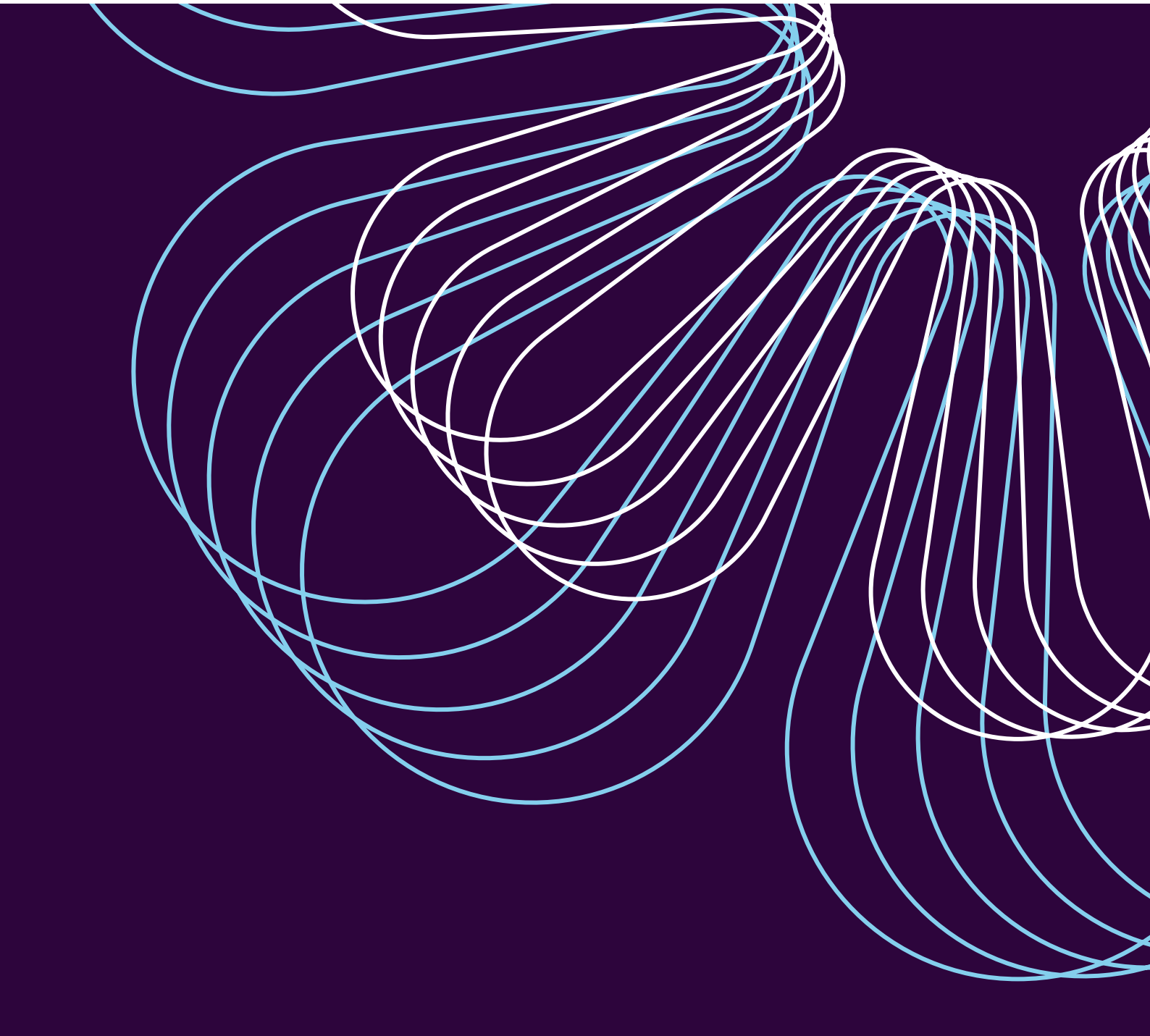
The diagnostic radiology life cycle

The Royal College of Radiologists



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01 Executive summary

Diagnostic radiology contains a large body of specialist terminology relating to its business processes and workflow that are not standardised in usage across organisations. This makes communication error prone, especially for clinical and management teams working with and assessing performance between radiology services.

In this document, we define a standard workflow for diagnostic imaging episodes (the diagnostic radiology life cycle) from the point of referral to result delivery by defining and detailing each of the time points on the journey of an examination through three key stages: *pre-acquisition, image acquisition* and *post-acquisition*. Result delivery (delivery of the report to the referrer) is a further post-acquisition step, which follows as a separate phase. Result delivery is not in the scope of this document but important recommendations on alerting and notification of results are covered in the document *Alerts and notification of imaging reports: recommendations produced by the Academy of Medical Royal Colleges*.[1]

Standardised terminology is fundamental to effective patient care. It is required to facilitate working between institutions or across networks and is increasingly important as artificial intelligence (AI) is further integrated into radiology working practices.

We also consider common terms of reference used when prioritising radiology episodes, as well as signposting relevant legislation, such as the Ionising Radiation (Medical Exposure) Regulations (IR(ME)R).[2,3]

02 Introduction

Diagnostic radiology is heavily process driven, meaning that it is amenable to standardisation of the terminology used to describe the stages and status points in the workflow at a given time point between referral and result delivery. Many of the processes are designed to assure compliance with UK legislation (particularly IR(ME) R 2024[2] and IR(ME)R (NI) 2018[3]). Where possible, harmonised language is used in this document, but the intention is to provide an overview of standardised workflow within which such regulations must be considered and not to attempt to supersede the legislative requirements.

Individual patients may be referred for more than one radiological examination and the intention is to provide a structured workflow for them to have each examination effectively. Hence, for clarity, 'radiology examinations/episodes' rather than 'patients' are considered to avoid confusion that an individual patient may be at different stages of many different radiology episodes at the same time.

In spite of there being an unwritten recognition of the most common points of the workflow (*vetting, acquisition, reporting* etc) by those experienced in working in radiology services, it remains a largely undocumented business process that is lacking in standards of measurement and statistical reporting. In many instances, inferred terminology has been adopted through naming conventions used by vendors who supply radiology technology solutions (radiology information systems (RIS) and picture archiving and communication systems (PACS)). Variability between vendors therefore requires adoption of new terminologies with a change of vendor or solution. The radiology software industry has never been provided with a standard terminology as a point of reference, which would explain the inconsistency.

Diagnostic radiology lacks a common standardised language for the communication of processes, statistical analysis and performance benchmarking.

As a consequence, radiology is often perceived as confusing and difficult to understand by staff outside of the specialty. Mistakes in terminology, measurement and performance analysis are commonplace (eg, failing to appreciate the difference between acquisition and reporting of a study) when radiology services are externally benchmarked at a local, regional or national scale.

In a clinical setting, the lack of standardised terminology for important episode statuses such as *priority* (eg, routine, urgent) can have a damaging effect on care delivery. The importance of standardisation is particularly pertinent when radiology is scaled to a regional or national network level, where *study priorities* may be conflicting between participating sites. Prioritisation is consequently a complex area, beyond the scope of defining the steps in the process that are being followed, which is the purpose of this document.

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Scope of this standard

In this document, we define the following standards for diagnostic radiology:

- The stages a radiological examination passes through (the radiology life cycle)
- Standardised terms for the actions in the life cycle
- Standardised terms for statuses in the life cycle.

Result delivery (delivery of the report to the referrer) is not within the scope of this standard. It is a further post-acquisition step, which follows as a separate phase covered by the Academy of Medical Royal Colleges *Alerts and notification of imaging reports: recommendations*.[1]

Prioritisation

Although prioritisation is a complex area and beyond the scope of this document, it is helpful to consider some elements that will impact on standard business processes in radiology.

Broadly, the priority of a study will be determined both by the pathway which the patient is on and by the specific information within their referral; there will be some intrinsic urgency to certain pathways relative to others and also potential differences in urgency for individual patients within an individual pathway.

Different reasons for prioritisation exist, for instance direct clinical importance where a delay in medical imaging negatively impacts on morbidity or mortality for the condition being investigated. This should be distinguished from prioritisation based on internal or external performance factors where targets have been set against which performance is measured, or a target timescale introduced because medical imaging is considered the rate-limiting step for the intended care pathway. These distinctions may not be absolute; for instance, prioritisation to expedite presentation at an impending multidisciplinary team (MDT) meeting may be driven by clinical urgency, pathway target time urgency or both.

Appropriate prioritisation has an impact on efficiency and safety, and if terminology is not standardised then study priorities may be conflicting between different units. This is particularly important when radiology is scaled to a regional or national network level.

It is, however, important to recognise that not all studies can be afforded the highest priority and the cost of an urgent study is higher than that of a routine study – including additional administrative, radiological and radiographic overheads. Similarly, while some urgent work is a natural and expected part of the normal working day, a high number of unnecessary urgent studies is potentially disruptive or even harmful to other patients and the service as a whole.

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Terminology

Referral

Referral in medicine is a well-understood concept, whereby a patient is sent between departments or specialists with accompanying communication with the purpose of seeking an opinion. In radiology the term referral is synonymous with a *request*. The term *order* is also more commonplace outside of the UK.

Episode

An episode is a discrete event in a patient's timeline. It frequently comprises a single radiological examination or procedure but may include more than one (eg, an ultrasound scan and an injection procedure during the same visit). A radiology episode is also commonly referred to as an attendance, due to the need for the patient to physically be present for such studies.

Study/examination

Radiological studies and examinations are synonymous terms representing the individual tests carried out (eg, a computed tomography (CT) or magnetic resonance imaging (MRI) scan) during an episode. A single episode may contain more than one study (eg, an X-ray and an MRI scan).

Report

A radiology report is the formal medical report communicated by an appropriately trained and qualified individual to describe the findings in a study, reach a diagnosis (where possible) and offer advice and guidance for future management. It forms part of the patient's notes although it is usually archived within RIS with variable integration into the patient's wider record.

The benefits of standardising the radiology life cycle

Adoption of standard terms of reference for a radiological episode would offer a number of key benefits.

- Standard terminology for all vendors to incorporate into software processes.
- Improved communication around radiological episodes among radiology staff.
- Improved understanding of radiological processes by staff outside of radiology.
- Clear and consistent time points in a patient journey to measure progress.
- Standard time points to improve the accuracy of statistical analysis and benchmarking of radiology services at local, regional and national scale.
- Safer patient care due to the use of standardised statuses of radiological episode priority.
- Ability to see the impact of imaging on the total patient journey from presentation to formal diagnosis and initiation of treatment.
- Potentially improved understanding of duty holder responsibilities within diagnostic imaging and better compliance with the regulations under which we work.

03 The radiology life cycle

As a requested study passes through predictable process stages, it moves through a life cycle, which is completed at the point that acquired imaging has been reported and results have successfully been delivered. This document is concerned with the timeline until the report is created and ready for delivery.[1]

Broadly speaking, the main cycle up to the point of a report being completed can be divided into three stages (Figure 1).

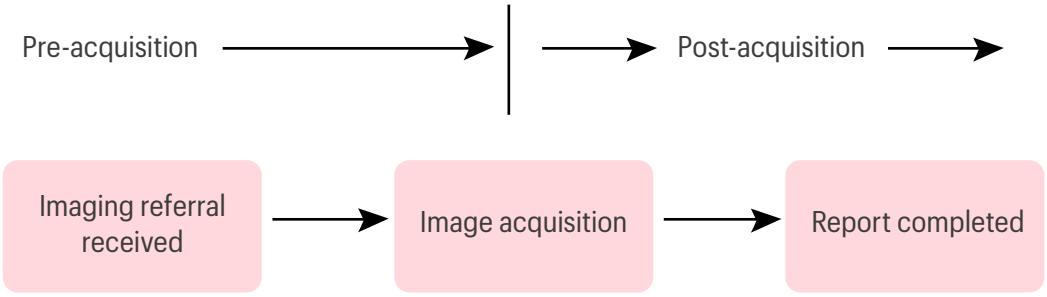

Figure 1. The radiology life cycle up to a report being complete in overview stages

Pre-acquisition refers to largely administrative tasks that are essential in the accurate preparation, planning and scheduling of the study.

Acquisition refers to the patient's attendance for the capture of medical images, and the post-processing of these images to make them ready for reporting.

Post-acquisition tasks take place after image acquisition has been completed. The images are post-processed, interpreted and formally reported. Only then are results ready to be delivered. Result delivery is a further component of the post-acquisition phase but is beyond the scope of this document.

Breaking down the process of diagnostic radiology into these three main stages creates two natural points of measurement for the monitoring of performance of a radiology service, comparison and benchmarking.

Time to acquisition (tAcquisition) is the time between referral and image acquisition. It is frequently misinterpreted as the endpoint for the measure of completion in radiology by patients, clinicians and other staff monitoring performance. However, it merely results in images being ready to progress to the post-acquisition stage.

Time to report (tReport) is the time interval between completion of the acquisition stage and the report being ready for delivery back to the referrer. This is not synonymous with the report being read and acted on, and it may be appropriate to also include that step

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in any metric being considered, but the processes to achieve that subsequent step have been described elsewhere.[1]

We feel that these two important points of measurement offer a good performance overview of diagnostic imaging services, appreciating the different challenges to reach timely image acquisition and to then interpret the images and issue a report. However, it is possible to be much more granular about the process, using the constituent stages in any phase of the life cycle, as described below, to highlight points of specific delay within the overall process flow.

Existing terminology may vary. For instance, tReport is known by NHS England as the turnaround time (TAT) in its work on diagnostic imaging reporting times. We favour the terms *tAcquisition* and *tReport* for clarity.

For some studies there may additionally be evaluation of the images by clinicians directly treating the patient (eg, immediate interpretation of a suspected fracture in the emergency department.) This is a parallel process with the radiology processes described in this document. Such an opinion should be documented appropriately, and best practice is that it should also be available when the radiology report is produced as part of the patient's clinical record.

Result delivery is an additional important stage infrequently benchmarked despite the widespread adoption of digital result delivery systems.

Division of the radiology life cycle into these key stages allows a service to monitor the balance of capacity against demand for both image acquisition and reporting capacity. Business intelligence (BI) tools may be used to monitor these metrics of performance in real time and alert service managers to reductions in performance against any defined standard.

With the added help of AI tools, heuristic monitoring of these metrics against historical performance trends may act as an early warning system to predict future service delays. Using longer-term predictive modelling, AI tools could also help to forecast growth needs in service provision for acquisition (equipment and staff) and reporting (staff, equipment and estate) providing useful data for business cases and financial planning.

All these steps will be subject to local refinement and may be more or less complex depending on the modality and various operational factors. The intention of this document is to provide an overview and standardised terminology applicable to all imaging tests.

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The radiology life cycle – stages and steps in detail

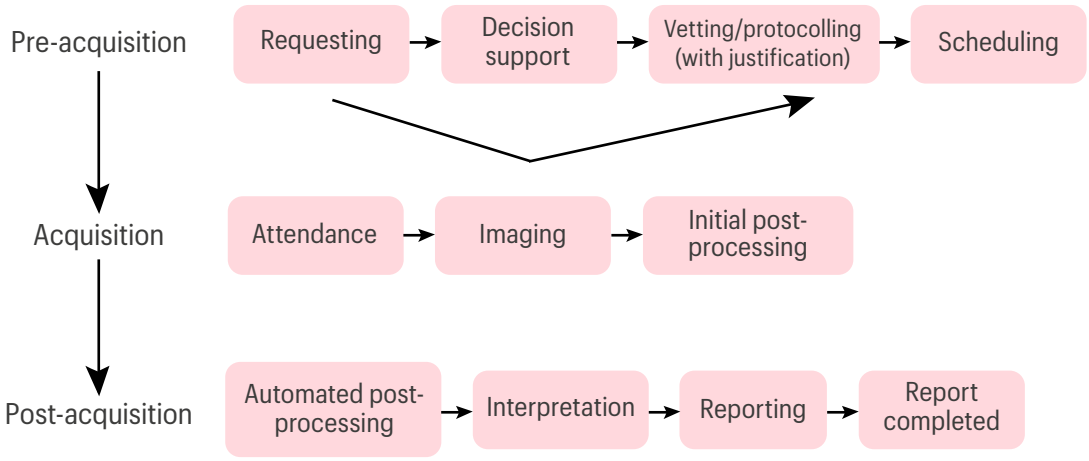

Figure 2. The radiology life cycle in detail: standardised terminology for the journey of a diagnostic radiology episode from request to result delivery

Pre-acquisition stage

Throughout this life cycle stage, the patient's status may be considered to be *waiting* or *on a waiting list*.

Requesting and decision support

A radiological episode usually begins with a request (also commonly known as a *referral* or *order*), which is increasingly created by a referrer using an electronic referral system, or where that is not available by using paper-based forms. In some instances, it may be preceded and informed by Advice and Guidance. In an electronic referral pipeline, there may be clinical decision support software that provides assistance in choosing the most appropriate modality[4] and examination for patient presentation. The Royal College of Radiologists (RCR) referral guidelines system iRefer[5] is widely available.

When available, conditional logic in electronic forms can help the radiology department to gather mandatory data at the point of referral, which reduces the burden of administrative work and limits or restricts referrals missing process-critical, safety or legally required information (eg, affected side, pregnancy status). There is also an opportunity to detect duplicated requests.

Vetting, justification and protocolling

Requests are interpreted to ascertain whether the information provided allows the study to progress to scheduling. Vetting, justification and protocolling are frequently carried out as a single step and terminology can vary by location.

Vetting describes different activities for different imaging departments. It can describe, for example, booking or scheduling, setting protocols, justifying or authorising, or

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reviewing previous imaging. If the term vetting is to be used it is important to clarify whether this refers to the justification, authorisation or protocolling of a referral. This should be clearly described in the employer's procedures.

Justification (the act of justifying a study) is a defined step within IR(ME)R for studies that use radiation, and legally it must be carried out by humans, who naturally apply authorisation and judgement criteria to the process. Most departments adopt the same terminology and requirements for other modalities rather than having different processes for tests requiring or not requiring radiation, although the legal basis does differ. This provides a similar opportunity to consider risk and benefit of other modalities, and typical checks encompass the following.

- The referrer (or associated team) is entitled to request the examination and is capable of and responsible for receiving, interpreting and appropriately acting on the radiological report.
- Mandatory information has been accurately completed.
- The imaging modality and examination appear correct for the clinical situation and a question that might reasonably be answered by the test proposed is within the information provided.

Protocolling is usually linked to vetting and justification and relates to the selection of the correct study modality and specific imaging protocol to best answer the clinical questions in the referral. The urgency of a study may be assigned or edited at this stage according to locally agreed standards.

Triage is the relative prioritisation of patients on the basis of clinical need and is required if demand exceeds capacity, often considered as part of protocolling.

During the process, the modality and/or study will be optimised to better address the indication and answer the specific questions pertinent to the clinical situation. This is a fundamental part of radiology practice and the decision is made based on a wide range of available information from the referral prose, imaging history, non-radiological test results and medical notes. Further dialogue with a referrer may be required if additional information is needed or the referral information is unclear. Provision of clear clinical information and a question to answer are requirements of referral to radiology and should not be bypassed in favour of an attempt to second-guess how a study might be performed.

Some electronic referral systems offer a mechanism for electronic feedback, though the commonplace default terminology used (rejection) is not recommended. See the 'Communication of cancellations and advice' section below.

The chosen protocol acts as a means of communication between teams in radiology, specifically those that carry out resource booking and radiographic staff who will acquire the images. The protocol often dictates when and how the episode can be fulfilled, and who is suitable to carry it out.

In large, multisite departments and regional imaging networks, standardised, published imaging protocols for appropriate pathways are considered best practice to help

achieve consistency in imaging services. This is especially helpful in pathway-driven care, during review at MDT meetings and in cross-network reporting environments.

Standard operating procedures (SOP) in imaging departments should ensure that protocolling is undertaken in a timely manner following receipt of the imaging referral to prevent delay in progressing the request to the scheduling stage. This is best achieved by allocating dedicated time for this important process in job plans.

Communication of cancellations and advice

Cancelling studies is sometimes necessary but it is an emotive topic, requiring careful selection of language, process design and communication.

It is often possible to correct or change the requested study to something more appropriate based on the known clinical details, rather than returning it without action, thus allowing patient care to progress. Where possible this should be preferred over the alternative of not proceeding, but where a request is not taken forward a *recommendation* or *return with advice* are the recommended terms. The term rejection is not recommended, especially in the era of enhanced patient access to their own medical records.

In some instances, the provided information is insufficient to progress a study and cancellation is necessary. This is especially true where referral criteria do not meet IR(ME)R and a study cannot be legally justified based on known information.

When cancellation is necessary, it is important to clearly communicate with a referrer in a timely manner. Communication may be digital (eg, by clinical software, email) or traditional (phone call, letter) but should include:

- A reference to the specific patient and the referral being cancelled
- A reason for the cancellation
- Advice for a suggested alternative investigation where possible
- The name, designation and role of the person who evaluated and cancelled the referral.

Scheduling

Most departments operate some form of booking diary, which is often connected to the digital imaging and communications in medicine (DICOM) modality worklist for each resource. Episodes that have been accepted, vetted and protocolled can be progressed to the booking diary or waiting list until the appropriate appointment can be offered to the patient. In the case of walk-in services this process may be abbreviated.

Scheduling should generally take place as soon as possible following receipt of the imaging request although may be delayed for planned imaging far in advance, conditional imaging or at a patient's request.

Acquisition stage

When the patient attends the imaging department, undergoes pre-study checks and has successfully been imaged, acquisition is complete. The administrative process

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is often straightforward, but this depends on the accuracy and thoroughness of the pre-acquisition stage to prevent unexpected cancellation or rescheduling. It is often a more challenging process in the acute clinical setting with more unexpected and unpredictable presentations and will be much more involved for some modalities (eg, nuclear medicine) than others.

Attendance

When the patient arrives in the department, there must be a pause and check process to confirm their identity, relevant clinical history and previous imaging events. This process typically captures these details so that staff are made aware that a patient has arrived and is ready to be imaged.

Imaging

This is the acquisition of medical images for the episode. An *on-table* review of images means that a decision can be made that sufficient data have been acquired to reach an appropriate diagnosis. If a suspected critical finding is observed then, if required, immediate care should be provided while an appropriate clinician is alerted.

Initial post-processing

Diagnostic radiographers may then carry out image post-processing to improve presentation of the study: cropping, planar alignment, windowing and labelling. Multiplanar reformatting or other reconstructions may also be carried out for cross-sectional modalities.

The final images are sent to PACS ready for review on a radiology workstation. The status of the study is usually changed at this stage, sometimes automatically by the RIS/PACS software, to indicate readiness for reporting. In some instances, the study may be assigned to a specific worklist or reporter for their attention.

Post-acquisition stage

Once a patient has attended for an examination and images have been acquired and processed into a format ready for review, the study enters the post-acquisition stage. Review and reporting are a pivotal part of the radiology life cycle yet are often overlooked or miscalculated in benchmarks that consider acquisition to be the end of the process.

Post-acquisition workflow may or may not be immediately coupled to acquisition for any individual study, and when measuring time from acquisition to reporting, any delay will keep a patient waiting.

For emergency studies there is typically the minimum possible delay between acquisition and reporting. Not all studies benefit from such handling and it would be detrimental to patients to attempt to report elective work at all times around the clock. Consequently, it may be appropriate to select different metrics depending on what report turnaround is clinically required or operationally possible.

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Automated post-processing

AI tools can carry out a *primary read* of studies by parsing image data and metadata relating to the episode to offer a result based on machine learning algorithms. When implemented, the result is often delivered as a labelled secondary capture, which the reporter can observe as supporting data during the formal review process. AI tools may also be used to automate escalation of reporting priority on a worklist when important findings are observed by the algorithms.

Interpretation

The person carrying out the review process opens the image set for the episode in a DICOM viewer (often part of a PACS) and uses the inbuilt tools to review the different image series. Historical images and reports should be automatically retrieved and made available to the reporter.

During the interpretation process, the reviewer may also make use of additional tools such as 3D and multiplanar reconstruction of original source data, as well as tools for advanced and specialist study review (CT colonography, vascular imaging, bone modelling etc).

Reporting

The authoring of a report that will form a part of the patient medical record is one of the most important steps in the completion of the imaging life cycle. It is a recording of the interpretation that has been made by the report author. This is further considered in the RCR publication *Standards for interpretation* and *reporting of imaging investigations*.[6]

Either after or during review of the image set a report is authored to describe the findings, reach a differential diagnosis and advise on management or further investigations. This process usually incorporates the use of voice recognition (VR) software to translate speech to text. Text macros also increase productivity.

This seemingly simple sequence of events may become more complex with the introduction of multiple report authors, either for additional specialist opinion or supervision of training.

Associated terminology is also confusing and has not been standardised: *checking, co-authoring, provisional reporting* etc.

Checking reports

Assumes a report authored by one person that is read, reviewed and issued by another who is usually acting as a supervisor.

Co-authoring

Implies two or more authors contribute to a single text report. Final review and issue are carried out either by the original author, having received additional opinions *or* by a supervising author with adequate privileges to issue the final report. Co-authoring is a complex workflow but should respect the following principles in its implementation.

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- There should be a robust audit trail.
- Each author's identity and role should be captured against the part of the report to which they contributed.
- A timestamp should exist for each author's contribution and for the overall final report completion.

Provisional reporting

A report is authored containing a standardised phrase and/or having a separate status indicating it to be a *provisional report* that will be reviewed and double-read by a second reader (often a supervisor). Depending on local practice, the provisional report can be made visible to referrers immediately it is written and prior to that second review. This enables the referrer to act on the findings to guide immediate care while also being asked to await and read the final report after the second review. Provisional reporting is common in the emergency setting.

Addendum reporting

An additional report is added to the end of the original report without editing the original report. Addenda are used in a wide range of contexts (MDT meeting outcomes, secondary specialist reading and supervision being common examples).

Report completion and result delivery

When a report has been authored, it enters a state of completion for which we observe a wide range of terms to describe this state: completed, verified, authorised, signed off. Our recommended term is *completed*, which conveys the clearest meaning in simple, non-technical language of when a report is available to be transmitted.

After report completion there is a wide range of variability in the mechanisms used to deliver results dependent on integrations with other information systems used in the service, their features and compatibility. This is a key step in safe care: there is no point in doing the study if the report is not delivered, read or acted upon. This step, however, has been covered elsewhere and is beyond the scope of this document.[1]

Notifications

Critical alerts are an important component of the result delivery process, which allows important and unexpected findings in the report to be delivered to the referrer with increased priority, in an attempt to expedite timely care. The ability to deliver a critical alert in a reliable and automated manner is highly dependent on the downstream information systems being capable of receiving alert messages in an appropriate technical format and initiating an appropriate push notification to the referrer.

Manual alerting methods dependent on human factors should be considered a last resort, and they are far more prone to failure and inconsistency. Failsafe critical alerts, with delivery receipt and acknowledgement, is a complex topic also addressed in the *Alerts and notification of imaging reports: recommendations guidance* published in 2022 by the Academy of Medical Royal Colleges.[1]

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The Royal College of Radiologists. *AI deployment fundamentals for medical imaging*. London: The Royal College of Radiologists, 2025.

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