

Introduction: approaches to emergency radiology

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How to use this book 2

The role of the emergency radiologist 3

Thinking outside of the box 3

Emergency radiology as a subspecialty 4

Emergency requests 6

The role of the trainee in emergency radiology 10

Writing reports and radiological terminology 12

Radiological terminology 12

How to use this book

Emergencies in Radiology is divided into two diagnostic sections.

There are a number of **introductory chapters** which help define the scope of emergency radiology and advise on writing relevant radiological reports. This is followed by a chapter on the 'real' radiological emergencies, such as cardiac arrest and contrast medium reactions, as well as how to manage them in the setting of a radiology department. The final introductory chapters review how best to care for patients within the radiology department in the emergency situation.

The first diagnostic section covers the common clinical presentations for each body region and suggests diagnostic algorithms for emergency radiology. It is divided into anatomical areas of the body rather than systems as, in our experience, emergency problems requiring imaging generally present to the radiologist in this way. For instance, a common request is for imaging in the context of acute abdominal pain: imaging of the abdomen is usually what the clinician asks for rather than imaging of the gastrointestinal tract. In addition, there is a final chapter in this section on post-operative imaging, which often requires different imaging strategies from those of a patient that has not recently undergone surgery.

We advise clinicians to use this section to aid their approach to imaging strategies and enable them to request the most helpful test that will reveal the diagnosis most quickly and with the least harm to the patient. Radiologists will also find this section useful if presented with a clinical problem that the clinician has not refined into a differential diagnosis as it can provide a logical imaging investigation strategy.

The second diagnostic section details specific conditions. It outlines the clinical and radiological findings in specific clinical entities which have been organized in a systems-based manner. There are two chapters in this section which are not systems-based: paediatric and interventional radiology. These have been included because their practice tends to be led by specialists in these disciplines alone. References to page numbers for interventional techniques have been included in the systems chapters.

This second section will be useful to those who face a defined clinical problem and are unsure on how or when to approach imaging. It will also be invaluable to those who are interpreting imaging investigations in the emergency setting: both radiologists and clinicians reviewing imaging of their patients.

In the second diagnostic section, a series of icons have been used to help indicate the level of urgency for imaging in each condition described. These can be found on the inside of the front cover.

The role of the emergency radiologist

The provision of emergency radiology varies hugely between hospitals: some centres may have several consultants who specialize in emergency radiology while in many hospitals, a junior registrar may be primarily responsible for emergency imaging, especially out of hours. This book is aimed primarily at trainees in radiology and junior doctors in other specialties who refer patients for emergency imaging. The main aims of the book are to help all those involved in emergency radiological investigations to get the best and most appropriate use out of the radiology department and to provide patients requiring emergency imaging with the highest possible care.

Thinking outside of the box

Patients are usually referred to the radiologist with a request to image a particular body area, e.g. the head, thorax etc. Unfortunately, such an approach can sometimes be unhelpful and misleading when trying to understand a patient's problem. *The role of the radiologist is to make a diagnosis rather than just to image the requested area.* It is not uncommon for the radiologist to be the most experienced doctor to review the case on-call and in such scenarios, the radiologist can help the referring clinician by 'thinking outside of the box'. For example: is the patient with abdominal pain having a myocardial infarct? Does the patient with profuse vomiting have a brain tumour? Does the patient with diaphragmatic irritation have appendicitis? Such diagnoses are not only immensely satisfying to make but may also save a patient's life.

Further reading

1. Berrington de Gonzalez A and Darby S (2004) Risk of cancer from diagnostic X-rays: estimates for the UK and 14 other countries. *Lancet* **31**(363): 363–45.

Emergency radiology as a subspecialty

The importance of emergency radiology has increased dramatically over the last decade in parallel with the rapid advancement of medical imaging. In the past, emergency radiology consisted largely of plain films interpreted by the referring clinician and re-reported by a radiologist at a later time when the result was often of academic interest only, as emergency management had been performed many hours or days before. Today, the radiologist is very much at the centre of emergency care and the outcome of medical imaging is central to patient management. Emergency radiology is not a subspecialty but rather the acute practice of all the main radiological subspecialties.

Emergency radiology can be defined as imaging that needs to be performed urgently in order to determine the best management of the patient. It needs to be differentiated from on-call radiology which is the subset of emergency radiology that occurs outside normal working hours and cannot wait until the next working day. For example, ultrasound (US) of the abdomen in a patient with classic symptoms of biliary colic and normal liver function tests (LFTs) is emergency radiology but would not be indicated out of hours. The result of the imaging test will not change management significantly overnight and no harm will come to the patient by waiting until the following morning for the US. Alternatively, a head computed tomography (CT) scan to exclude an extradural haematoma post head injury is quite different. This is an example of an investigation that needs to be performed urgently out of hours as it could alter acute management dramatically.

Currently, staffing levels on-call tend to be greatly reduced compared to a normal working day. The radiologist is often non-resident and is employed to provide only out of hours emergency radiology, not a routine emergency radiology service. Furthermore, if an interventional procedure is to be performed there is often only very limited support staff available and some centres do not make provision for this at all. This has a significant impact on the safety of on-call procedures.

We are in a period of transition in health care provision and as more resources are allocated to radiology, a 24hr 'routine' service may evolve. The *status quo* in most centres, however, is that imaging which will not change patient management is not usually performed out of hours.



Emergency requests

A brief guide for both clinicians and radiologists

Key points for any 'emergency' study are as follows:

- The most appropriate examination should be performed using the correct modality, i.e. US, CT, magnetic resonance imaging (MRI) etc.
- Imaging should be performed in an appropriate timescale. In particular, does this test need to be performed as an out of hours study?
- There should be a swift transfer of the results to the referring clinician for appropriate action to be instigated.
- Radiologists are *imaging doctors*, not technicians.

Tips for the referring clinician

- **Clinical question.** Central to any radiological request should be the question that you wish answered. The clinical question may be critical in obtaining the correct answer: for instance a referral for a CT abdomen in a patient with right upper quadrant pain stating solely 'abdominal pain' may not reveal the true diagnosis. However, had the request stated all the relevant clinical details and asked if the patient had cholecystitis, the radiologist would usually have performed an ultrasound which is more sensitive and specific than CT for the disease and would not have exposed the patient to ionizing radiation. Inadequate clinical details on the request may therefore lead to inappropriate imaging which results in a delay in diagnosis and treatment.
- **Will the examination change management?** This is particularly pertinent to out of hours requests, as generally imaging investigations should only be performed if they will change the out of hours management of the patient.
- **Risk of the examination.** The clinician must always balance the potential risk of an examination with the potential benefits. Not only does the clinician have a responsibility to act in the best interest of the patient but they also have a legal responsibility when referring a patient for a study that involves ionizing radiation, i.e. X-ray, fluoroscopy, CT and nuclear medicine. Under the Ionizing Radiation (Medical Exposure) Regulations 2000 (IRMER), the referrer has a responsibility to provide sufficient medical information so that the radiologist can decide if the exposure can be justified.¹ Radiation risk is significant and 700 cases of cancer per year in the UK can be attributed to diagnostic radiation.² Radiation exposure is of particular importance if a woman is, or may be, pregnant and the referrer has a responsibility to inform the radiologist if this is the case. Even MRI has small potential risks: pacemakers are contraindicated and some implanted devices may be magnetic, e.g. prosthetic heart valves and aneurysm clips. In such cases it is best to find out the exact type of prosthesis before contacting the MRI department for advice. Metal workers may have small shards of metal within the orbit which can become dislodged during the study. Finally, all interventional procedures carry a small inherent risk which will be discussed in the appropriate chapters.

What to put on the referral form. Typically, referrals to radiology come in the form of paper or electronic requests. While there may be a temptation

to exaggerate a patient's symptoms or signs to accelerate imaging, it may lead to an inappropriate test or even an unnecessary intervention.

Include: full patient name, hospital number, age or DOB, ward, means by which patient can travel to the department (e.g. chair), clinical history and your contact details. If your shift is about to finish then give the contact details of a colleague who will take action once the study has been reported and remember to contact them before leaving the hospital. Also include:

- History of **allergic reactions** to contrast medium.
- **Renal function:** elevated creatinine is associated with an increased risk of contrast medium induced nephropathy (📖 p. 24)
- **Pacemaker/metal prosthesis** for patients having an MRI.
- **Platelets and clotting** if the procedure involves intervention. If appropriate, consent the patient but only if you are suitably trained and qualified to do so.³
- **Pregnancy status** in women of reproductive age.
- **Infection risk**, e.g. MRSA.
- **Oxygen requirement** including flow rate.
- **What not to put on the referral form.** The decision to give intravenous (IV) contrast medium is generally made by the radiologist and there is no need to specify this on the form unless the patient has renal impairment and the clinical team is willing to dialyze the patient should acute renal failure result. It is best to ask a specific question rather than to ask for contrast medium to be given. For example, instead of asking for a CT with contrast medium, the clinician could ask if the hepatic artery is patent; in this case, an arterial study is necessary to answer the question but had the requester simply asked for a contrast-enhanced CT (CECT), a portal abdominal CT may have been performed and the question could have remained unanswered.
- **Contact the radiologist personally.** For any emergency study, it is of paramount importance that the referring doctor contacts the on-call radiologist personally and does not solely rely on an electronic referral system. Furthermore, a conversation with the radiologist may allow the complete clinical details to be discussed, thus ensuring that the patient has the appropriate examination in the appropriate timescale.
- **Who should refer a patient?** There is no simple answer to this question and different hospitals will have different policies. An experienced clinician should usually discuss a complicated case with an experienced radiologist. In general, the seniority of the referrer should be similar to that of the radiologist and in all cases it should be someone who knows the full clinical details.
- **Patient escort.** Once a study has been agreed and a time arranged, remember to inform the ward. Most hospitals will insist that an unwell patient is escorted to the radiology department with a nurse but occasionally they may also require a doctor, e.g. anaesthetist.
- **Reviewing the report.** The referrer bears the responsibility of checking the radiologist's report and acting accordingly. In the case of unexpected or immediately life-threatening findings, the radiologist should also contact the referring clinician directly.⁴

Tips for the emergency radiologist

- **Always be contactable.** Make sure the hospital switchboard has an up to date list of who is on call and that they have your full contact details. As rota changes occur frequently, it may be appropriate at the beginning of an on-call to ring the switchboard and check that they know your preferred method of contact.
- **Polite but firm.** While there may be good reasons for being irritated by a poor-quality referral, being rude to a clinician is not constructive or helpful.
- **Clinical disagreements and acting in the best interests of the patient.** The on-call radiologist must not perform a test that they feel is inappropriate, unnecessary or puts the patient at unwanted risk (e.g. radiation risk as controlled by IRMER). If, after discussion, the referring clinician still feels it is appropriate to perform a test that the on-call radiologist disagrees with, then further advice should be sought. If a junior clinician has requested an examination that is under discussion, it is reasonable for the radiologist to ask to speak with the most senior doctor caring for the patient. Most misunderstandings are resolved at this stage but very occasionally a disagreement will persist, and in such cases a consultant-to-consultant discussion should occur. However, in all circumstances, the *patient's best interest must be paramount* and local guidelines/departmental policy should be adhered to.
- **Accept responsibility for the patient.** Sometimes a clinician may be given differing opinions by several radiologists on a particular case, e.g. regarding which imaging modality to use first. While these differing opinions may all be valid, such a scenario is clearly frustrating to the referrer. It is the authors' opinion that when a patient is referred to a radiologist, they should take responsibility for arranging the required imaging for that patient. This may take many forms, e.g. actually performing the study, speaking with the appropriate radiologist, leaving a message for someone else in the department, or even nothing if the test will be done in a timely fashion during normal working hours. The important point is that the radiologist receiving the request has taken responsibility for ensuring that the correct study will be performed in an appropriate timescale.
- **Patient details.** When accepting a referral, it is important to take all the necessary details described above. A patient escort is particularly important when working alone in the department as it may be difficult to call for help if the patient's condition deteriorates. If the clinician is to end their shift shortly, then it is important to get the contact details of someone who will be caring for the patient when the test has been performed.

- **Contacting the clinician with the results.** Hospital policies differ but generally it is appropriate to contact the clinician with the results of an on-call study. Although it is ultimately the responsibility of a clinician to check a report, when an immediately life-threatening abnormality is detected the radiologist should bring this to the attention of the clinician as rapidly as possible via direct telephone communication.⁴

Further reading

1. Department of Health (2000) *Ionising Radiation (Medical Exposure) Regulations 2000*. HMSO, London, UK.
2. Berrington de Gonzalez A and Darby S (2004) Risk of cancer from diagnostic X-rays. *Lancet* **31**(363): 363–45.
3. Royal College of Radiologists (2005) *Standards for Patient Consent Particular to Radiology*. Royal College of Radiologists, London.
4. Royal College of Radiologists (2006) *Standards for the Reporting and Interpretation of Imaging Investigations*. Royal College of Radiologists, London.

The role of the trainee in emergency radiology

The radiologist provides the continuum between the patient, the referring clinician and the sequence of radiological investigations.

RCR guidelines suggest that trainees should be working on an on-call rota during the third year of training if not before.¹ While on-calls may appear daunting at first, preparation can make them less frightening and more rewarding:

- Ask a more experienced trainee for tips on how to best approach on-calls in your hospital(s). Even simple things such as knowing where the on-call bleep is kept can reduce stress.
- Find out what your local hospital guidelines are, what you are expected to do out of hours and what you are not.
- Before you start your first on-call, make sure you are confident in the basic interpretation of the imaging you are likely to encounter as outlined in this book.

Always remember that the trainee is just that: a *trainee*. You are not expected to know all the answers and indeed even experienced consultants refer to other colleagues for help with a difficult case. Consultant radiologists have been shown to have a clinically significant discrepancy rate in their reporting of head CTs of ~2 % (when compared to neuro-radiologists.²) Furthermore, trainees have been shown to be more likely to overcall abnormalities on trauma radiographs than consultant radiologists.³ *Asking for help should not be considered a sign of failure or weakness and should never be treated as such.* RCR guidelines state that on-calls should be performed with 'appropriate consultant back-up'.¹ Clearly this support varies depending on the trainee's level of experience but it should always be readily available when requested.

Misses, misinterpretations and other errors

Follow-up is an essential element of personal education. Working in a vacuum on-call is not only of poor educational value but can be dangerous. After all, if we do not realize that we are making the same errors then we will continue to make them. As a trainee there are numerous approaches that can be taken to minimize errors:

- Ask the consultant on-call to review your reports. If the answer to the question would change management of the patient out of hours then the consultant should be called immediately. Teleradiology will make reviewing images at home increasingly feasible. However, if the problem is not critical, the images can be reviewed the following morning. It is important to contact the clinicians if any significant changes have been made to a provisional report following this review.
- Find out the definitive diagnosis. This may be determined from later radiological tests, blood tests, from pathological specimens, at the time of surgery or at post-mortem. Contacting the clinician the next day may be enlightening.
- Personal audit. Keeping a record of all the patients you have imaged on-call will allow the trainee to audit their performance.

- Feedback to your colleagues. This is important if you find others have made mistakes and a 'no-blame' culture is essential for a healthy learning environment.
- Attending discrepancy/errors meetings. Learning from the mistakes of others may help you avoid making the same error yourself.
- Attending multidisciplinary team (MDT) meetings. Most interesting cases are reviewed at one or more MDT. These allow the opportunity for a second opinion to be given as well as comparing the radiological results with other non-imaging tests.
- The dangers of 'overcalling'. There is often a common perception that 'overcalling' a suspected abnormality as abnormal is better than 'undercalling' it by suggesting it may be a normal variant. While this may usually be the case, this approach underestimates the financial and human cost of unnecessary and potentially invasive further tests and treatment. Radiology is driven by experience—generally the more you have seen the better you are. *Asking for a second opinion from a more experienced radiologist should never be undervalued.*

Further reading

1. Royal College of Radiologists (2007) *Structured Training Curriculum for Clinical Radiology*. Royal College of Radiologists. <http://www.rcr.ac.uk/docs/radiology/pdf/Curriculum-CR-Jan2007.pdf>
2. Eryl WK, Boyd C, Lucio RW et al. (2003) Evaluation of emergency CT scans of the head: is there a common standard? *AJR* **180**: 1727–30.
3. Williams SM, Connelly DJ, Wadsworth S et al. (2000) Radiological review of accident and emergency radiographs. *Clin Rad* **55**: 861–5.

Writing reports and radiological terminology

Report writing

The art of writing reports is tailoring them to the referring clinician, answering the clinical question and stating important negatives that are implicit from the request. Reports should not be too long—otherwise the clinicians will probably not read them—or too short, e.g. normal abdominal appearances, as the clinician may want to know whether you remembered to look at the bones.

Suggested layout

- **Indication:** A precis of the clinical information, including any clinical questions to be answered.
- **Technique:** A short description of the technique used stating whether contrast was used. If MRI, then the sequences should be recorded. The anatomical region imaged should also be recorded.
- **Findings:** A sentence regarding the technical adequacy of the study and any limitations. A concise description of the important positive and negative findings. Two common styles are numbered points or paragraphs of text.
- **Conclusion:** This should contain the answer to a clinical question that has been posed. Furthermore, the most important findings should be highlighted, including unexpected findings and any suggestions for further imaging/management included.

Radiological terminology

A full description of radiological terminology is beyond the scope of this book but it is important to use the appropriate term when describing the appearance of images from each of the major radiological modalities. The following may be helpful to non-radiologists in understanding the radiological report:

Radiographs Radio-opacity or density: radio-opaque is white or bright and radiolucent is black or dark.

Ultrasound Echogenicity or reflectivity: ↑ echogenicity is white or bright.

CT Density or Hounsfield Units (HU): ↑ density is white or bright with a high HU value.

MRI Signal: ↑ Signal is white or bright.