THE PLACE OF CLINICAL RADIOLOGY AND IMAGING IN MEDICAL EDUCATION: OBJECTIVES, CONTENT AND DELIVERY OF TEACHING

Adapted from The Royal College of Radiologists UK

SUMMARY

1) This report has been prompted by developments in clinical medicine and in clinical radiology, including new legislation.

2) Clinical radiology should be taught so that newly qualified doctors have the knowledge, skills and attitudes to practice competently and to learn in postgraduate foundation years. Clinical radiology is now integral to the management of almost all patients.

3) Clinical radiology offers a valuable means of supporting learning across the whole curriculum and should be integrated into general curricular planning.

4) Teaching of clinical radiology should address emerging changes in practice, such as the development of minimally invasive treatment.

5) Clinical radiology teaching should include human morphology, physiology and disease, clinical effects of disease and the role of imaging techniques, together with legislation relating to patient protection and informed consent. Teaching should support the acquisition of skills necessary to clinical practice, including the interpretation of basic imaging studies.

6) The most appropriate teaching delivery for clinical radiology is a core plus options approach, delivered as a continuous thread throughout the medical curriculum.

7) Teaching delivery in clinical radiology should involve a mixture of formats, both within the radiology department and in the clinical environment.

8) Teaching programmes should exploit the advantages of clinical radiology in supporting modern methods of teaching, including problem-based learning, self-directed student learning and computer-assisted learning.

9) Computer-based teaching methods, including Virtual Reality should be available, enhanced by internet access and sharing of educational material by medical schools. In time, certain modules from the RCR/DH Integrated Training Initiate electronic learning database should become available for these purposes.

10) Medical schools should ensure standards in radiology teaching by involving radiologists in course design and delivery, and educational policy and standards. This should extend to all environments in which clinical radiology is taught.

11) Multidisciplinary teaching in clinical radiology is to be encouraged, provided that this is integrated with the rest of the radiology curriculum.

12) Clinical attachments to the radiology department have value in allowing students to deepen their experience of the subject and of the patient experience.

13) A suggested curriculum is provided at the end of this document: Recommended framework for radiology curriculum design.

BACKGROUND

There have heen significant advances in radiology and imaging over the last ten years. Advances include newer generation CT and MRI units which have advanced our knowledge of many disease processes, and have ensured that imaging now plays a pivotal role in the care of patients. Functional imaging in the form of CT/PET (Computed Tomography and Positron Emission Tomography) allows functional imaging to be merged with an anatomic imaging providing a precise localisation of areas of abnormal metabolism. CT/PET is now widely used in the evaluation of cancer, brain and cardiac pathologies. Interventional radiology has continued to grow and is playing an increasingly large part in the minimally invasive treatment of many disease processes. Because of the above new developments, radiology now plays a pivotal role in the diagnosis and indeed treatment of many disease processes throughout the Hospital setting.

The advent of these new techniques has also meant that the imaging strategies of many diseases has shifted as knowledge has been gained. This makes it difficult for non-radiology personnel to stay abreast of the rapidly changing environment of imaging.

Changes in radiology protection has recently been adopted in Ireland. The new law predominantly relates to the protection of the patient from ionizing radiation, and newly qualified doctors now have an onus of legal responsibility.

Undergraduate medical school curricula have changed over the last number of years to an integrated teaching format. Radiology and imaging lends itself very well to this method of teaching.

Clinical radiology and imaging now plays a important role at multidisiciplinary team meetings, where many decisions with regard to patient care, are decided.

Aims of Undergraduate Radiology Teaching

1. Newly qualified doctors should have the necessary knowledge and skills, to treat patients in emergency clinical settings where radiology plays an important diagnostic role.

2. To impart knowledge and understanding of the role of radiology in modern disease diagnosis and management

3. To ensure that newly qualified doctors are aware of new laws governing ionizing radiation, and their role in same.

4. To provide a platform of knowledge and skills for learning in the postgraduate years and indeed, life long learning.

Objectives of this document:

- To enhance awareness of the importance of medical student teaching in clinical radiology.

- To ensure that clinical radiology is appropriately represented and integrated into medical school curricula.

- To raise awareness of the potential of clinical radiology in modern methods of learning and teaching delivery.

WHY SHOULD CLINICAL RADIOLOGY BE TAUGHT?

The aim of medical student education is to ensure that newly qualified doctors have the appropriate knowledge, skills and attitudes to practice effectively and efficiently, and an intellectual base from which to address the postgraduate foundation years.

Clinical radiology is now integral to clinical management and understanding of imaging is fundamental to ensuring appropriate clinical practice.

New legislation places legal responsibility on clinical staff who refer patients for investigations involving radiation exposure. Legal requirements relating to informed consent are also relevant to some referrals to radiology.

Medical images offer powerful tools for supporting learning in human morphology and physiology, and understanding the nature of disease and response to treatment. Specific characteristics of images which make them suitable for enhancing learning in the medical curriculum are:

a. They evoke visual cues and provide a powerful learning stimulus.
b. They are part of a clinical history and evoke memory cues.
c. Digital images are particularly amenable to incorporation into virtual leaning environments.
d. Images are objective and immutable; and therefore appropriate to assessment strategies.

HOW SHOULD CLINICAL RADIOLOGY BE TAUGHT?

Teaching strategy and design

Radiology education should be integrated across the medical curriculum, with the aim of supporting learning in medicine. This requires that clinical radiology should be taught as a continuous thread throughout the medical course.

Medical schools should ensure that the learning outcomes for clinical radiology are clearly expressed in their published curricula, in particular the understanding of human morphology, physiology and disease.

In view of their ability to evoke visual and memory cues, images can be regarded as a means of engaging student interest and stimulating motivation.

The importance of clinical radiology in supporting learning throughout the curriculum requires that when teaching strategies are defined this process is lead by radiologists and clinicians in partnership.

Whenever possible the teaching programme in radiology should be integrated with clinical subjects, to enhance reinforcement of learning and encourage the development of a frame of reference.

It is natural that the emphasis of teaching will change during the medical course. At the beginning basic science elements, particularly morphology, physiology and disease, will predominate. As the programme proceeds the emphasis changes to aspects of clinical management, leading to a final phase in which interpretation of basic investigations should be taught, including referral skills and legal requirements.

Clinical radiology lends itself well to a "core plus options" approach, the core being integrated into the curriculum and the options allowing students to adapt learning approaches to aspects which attract their interest. The options include opportunities as 'Special Study Modules' and elective periods in Radiology.

Curricula should identify clearly the core so that medical students may identify the role of radiology within the curricular framework.

The core curriculum should be limited to material that is essential and justifiable; over-extended curricula are likely to lead to rote learning. The core will consist of preparation for work as a junior hospital doctor or community-based team. This will naturally emphasise acute clinical problems but should also be broad enough to ensure that students are introduced to common clinical problems across the major specialties, based on clinical prevalence. Less common clinical conditions should be included where they have the potential of serious outcome and are preventable by effective clinical management.

Methods of delivery

Teaching provision will necessarily differ between schools. Individual schools should define a delivery framework appropriate to their circumstances .

Teaching delivery for clinical radiology may comprise a mix of different formats presented in different clinical fora. Wherever possible the teaching should be designed to be appropriate to the intended learning outcomes of that part of the clinical curriculum. Definition of delivery methods should be in the hands of those charged with the management of education and should involve both radiologists and clinicians.

The standard teaching format in radiology is likely to be small groups, using medical images as a learning focus. This approach lends itself well to teaching within the radiology department and also within the clinical environment.

Clinical radiology should be learnt in clinical context. Students can better appreciate the clinical role of imaging, and the interaction with clinicians. Suitable fora include clinico-radiological conferences, clinical ward rounds and patient evaluation clinics. Multidisciplinary team meetings are also suitable although discussion is often at a high level and attention should be given to making this interpretable and relevant to students.

It is probable that the overall teaching strategy will need to utilise some formal lectures on essential core elements, most notably at the outset of the course and during revision classes.

Images are particularly suitable for self-directed student learning. Collections of illustrative images, whether commercially developed or constructed within the school, offer students a valuable resource in exploring clinical radiology in detail.

Changes have taken place in clinical radiology which now make it particularly valuable to modern teaching strategies such as problem-based learning (PBL). The increasing digitisation of clinical imaging also makes it advantageous for digitally-based methods such as computer-assisted learning (CAL). These new strategies should be incorporated wherever possible.

Clinical radiology is particularly suitable for PBL. The relationship between clinical history and investigation provides an excellent base for exploration of clinical management problems. Imaging packages containing prepared images and requiring students to explain the nature or significance of their findings have proved popular and stimulate enquiry into morphology and pathology. These packages are most effective in the context of simulated clinical scenarios.

The value of digital imaging

Computer-based teaching packages are easy to create using digitised images. The approach is particularly useful when establishing new teaching programmes. It is recommended that all schools should incorporate computer-based imaging packages in their teaching delivery.

The development of three dimensional imaging and virtual reality programmes has greatly increased the potential of CAL. Three-dimensional images may be used to create physical models of morphology and disease, allowing students to deepen their understanding. There is great scope for developing this approach, most notably in support of self-directed learning and assessment.

Computer-based teaching packages make possible distance and e-learning in imaging, including video conferencing, web casts and teleradiology links. The approach may achieve its greatest impact in this form. It is recommended that schools should exploit the possibilities of shared learning resources by electronic links or internet-based packages, to widen the study opportunities and offer high level multimedia facilities to their medical students.

Who should teach?

Radiologists should be involved at all stages, from basic science to clinical practice. The learning experience of the role of clinical radiology is likely to be enriched by positive involvement by radiologists.

Regional general hospital attachments provide valuable extension of clinical experience and teaching for medical students and it is desirable that radiology departments in these hospitals are involved in teaching.

Integration of radiology teaching into the clinical curriculum offers collaborative opportunities between radiologists and clinicians motivated to teach on imaging in their own clinical practice.

The radiographic staff of a department of radiology offer an important teaching resource and should be involved in medical student courses. This offers a means of promoting interprofessional relationships.

It may be locally desirable that some teaching is undertaken by imaging scientists. It is valuable to extend multidisciplinary collaboration in teaching but directors of studies should ensure that this is achieved on the basis of defined learning outcomes and agreed policies on delivery.

The importance of student attachments to the radiology department

Student involvement in the radiology department is valuable for experiential learning and can demonstrate how the clinician uses imaging as a clinical tool, and of the patient experience when undergoing investigation. Such attachments could be a standard component of all teaching programmes in clinical radiology, either as core or student-selected component.

It is probable that attachment to radiology departments may be an option during post-graduate Foundation Years. Attachments before graduation may be seen as preparing the ground for future learning approaches.

Attachments of a few days' intensive exposure or a core module should be available to all students. Longer periods such as Special Study Modules offer attractive course options, exposing students in depth to practical procedures such as ultrasound and interventional techniques.

Many medical schools now require students to complete clinical research projects during their course. Projects based on clinical radiology should be encouraged.

Some schools with appropriate facilities may be able to offer radiology-based research programmes or intercalated degrees.

Radiology in assessment

Formative assessment provides feedback, stimulates learning and may determine students' learning styles. Clinical radiology should be incorporated into schools' assessment programmes.

Images provide a valuable resource for assessment strategies, including OSCEs, because they are immutable, can be graded and may be used for repeated exercises in which the development of skills can be evaluated. Radiology assessment in the form of 2-4 OSCEs should form part of the final medical examination. The radiology examination should also incorporate at least 5-10% of the final medical examination marks

Radiological involvement in assessment programmes offers an opportunity for integration of radiology teaching with the rest of the curriculum. Defining assessment programmes should be a joint responsibility of radiological and clinical teachers. This should preferably be done at the same time that learning outcomes are specified for the course.

Management and organisation of teaching

The design and delivery of teaching in clinical radiology should be integrated into the medical curriculum and details should be widely distributed to students and directors of other courses.

Where teaching occurs outside the main teaching hospital the clinical radiology teaching there should be coordinated with the rest of the programme.

Medical schools may find it convenient to designate individual radiologists to be responsible for the coordination of medical student teaching.

Where the medical school possesses an academic department of radiology education will normally be among that department's responsibilities.

Teaching and the preparation of teaching represents a significant time commitment and teaching responsibilities should be quantified and recognised in job plans and contracts of employment.

Radiologists involved with educational programmes should have the opportunity to be informed on developments in educational theory and practice by attending educational training courses, by involvement with departments of Education, or by undertaking teaching diploma or degree courses.

Suggested Core Syllabus - Section A

A1: Interpretation of basic radiological studies

The learning outcomes are characterised by an ability to detect abnormalities on chest, abdominal and skeletal radiographs and relate the findings to clinical management. Students should also display a systematic approach to comprehensive interpretation of radiographs.

On completion of the programme the student should demonstrate knowledge and recognition of the subjects listed below.

A1.1 Thoracic Imaging

Cardiac enlargement
Cardiac failure and pulmonary oedema
Pleural effusion
Pulmonary collapse and consolidation
Misplaced endoluminal tubes
Pneumothorax, including tension
Pneumomediastinum and subcutaneous emphysema
Hyperinflation of lungs
Free gas beneath the diaphragm
Detection of pulmonary and mediastinal masses
Signs of acute vascular problems, including aortic dissection and trauma

A1.2 Abdominal imaging

Small and large bowel obstruction
Toxic megacolon
Signs of intestinal perforation
Aortic aneurysm
Urinary calculi
Gallstones
Endoluminal foreign bodies

A1.3 Skeletal imaging

Common fractures in the limbs
Fracture of femoral neck
Fractures of the wrist and scaphoid

Fractures of the shoulder, including dislocation
Pelvic fractures
Signs of osteoarthritis/rheumatoid arthritis
Sclerotic and lytic metastases
Skull fracture
Cervical spine fracture and dislocation
Fractures in children

Skills will include the ability to relate the mode of injury to the type and site of fracture, classification of simple, comminuted and compound fractures and an understanding of the value of different radiographic projections (especially AP and lateral).

A2. Understanding the role of imaging in clinical investigation

The learning outcome involves understanding the role of the various imaging techniques in the management of patients, including their strengths, limitations and risks. Knowledge of the preparation required for individual procedures is also needed. So too are the principles of referral based on clinical history and examination findings.

Students will display understanding of the concept of structured diagnostic regimens and of the disadvantages of unjustifiable over-investigation. This will include the relationship of clinical radiology techniques to other investigations (for example endoscopy). Students will understand that appropriate referral for radiological investigation is justified by a supposition of change in clinical management.

Students will demonstrate a basic knowledge of the clinical possibilities of image-guided procedures and minimally invasive treatment.

Learning should concentrate on the imaging techniques of:

- Ultrasound
- Computed tomography
- Magnetic resonance imaging
- Contrast examinations of viscera
- Radionuclide Imaging
- Angiography

On completion of the course students will be able to demonstrate their knowledge of imaging investigation of the following conditions.

A2.1 Chest and cardiovascular disease

Asthma
Aneurysms and vascular dissection
Pulmonary emboli
Pulmonary neoplasms
Haemoptysis

A2.2 Gastrointestinal disease

Abdominal pain
Abdominal masses
Abdominal trauma
Inflammatory bowel disease
Jaundice
Hepatic neoplasms
Biliary disease

A2.3 Renal and urological disease

Renal failure and urinary obstruction
Haematuria
Urological neoplasms
Renal and urinary infection

A2.4 Endocrine and breast disease

Thyroid dysfunction and thyroid masses
Breast Masses

A2.5 Oncological and marrow disease

Principles of oncological staging by imaging and knowledge of common staging classifications
Investigation of haematological disease including anaemia and leukaemia
Basic knowledge of potential complications of oncological treatment and means of detection

A2.6 Musculoskeletal disease

Bone and soft tissue infection
Bone and soft tissue trauma
Bone and soft tissue tumours
Diagnosis of undisplaced or stress fractures
Investigation of spinal injury
Investigation of low back pain
Metabolic bone disease
Arthridites

A2.7 Neurological Disease

Head injury
Intracranial haemorrhage and infarction
Spinal cord compression and radiculopathy
Intracranial space occupying lesions

A2.8 Disease of the ear nose and throat

Deafness
Disease of paranasal sinuses
Cervicofacial cancer
Salivary disease
Oropharyngeal lesions

A2.9 Disease in childhood

The principles of imaging in children, including protection of the patient and confidentiality.
Disease of the chest and gastrointestinal tract in childhood, and certain paediatric neoplasms.

A2.10 Obstetric and gynaecological disease

Investigation of suspected pregnancy, including ectopic gestation.
Post menopausal bleeding
Gynaecological neoplasms

A3 Legislation

On completion students will be able to demonstrate knowledge of:

A3.1 Protection of the patient

The hazards of radiation and the concepts of cumulative dose and differential radiosensitivity of tissues.
The value of alternative investigations without radiation
Awareness of which investigations deliver a large absorbed radiation dose
Current regulations, and principles of justification and optimisation [2]
Recognition of increased risk in pregnancy and children and of measures to avoid inadvertent irradiation in early pregnancy

A3.2 Informed consent

Understanding of the principle of informed consent and its relation to invasive investigations in clinical imaging.

A4. Attitudinal objectives

Students will demonstrate an understanding of what the patient will experience when undergoing investigation in the radiology department. This will assist communication with the patient before any investigation, allowing provision of any appropriate psychological preparation as well as advice about and preparation for sedation or anaesthesia (local or general).

Suggested Syllabus Options - Section B

The options which each School finds it possible to offer will depend upon local circumstances and the list attached is intended to be a general guide to the possibilities within the specialty, rather than a prescribed list of recommended subjects.

Correlated imaging regimens in investigation of clinical syndromes.

Role of clinical radiology in emergency investigation or trauma, including;

- Acute cardiovascular disease
- Acute cerebral disease
- Acute abdominal disease

Role of clinical radiology in public health measures.

Role of clinical radiology in studying normal and disordered functions.

Newly emerging applications of clinical radiology.

Interventional techniques and minimally invasive treatment in the management of disease of

- The vascular system
- The gastrointestinal system
- The urological system

Imaging-guided biopsy, drainage and pain relief manoeuvres.

Complications of interventional radiology.

Exploration of informed consent issues.