BACKGROUND

Medical imaging investigations are unlike most other diagnostic tests, in that the patient must always be present, prepared, informed and (usually) cooperative in order for a test to be performed effectively. For every imaging test there is a small chance of significant harm to the patient, ranging from minimal radiation exposure to death.

Each imaging test should be tailored for the specific clinical question at hand; unless this is done in a skilled and expert manner, with all appropriate background clinical information available, it is likely that a suboptimal investigation and report will be provided.

It should be noted that although most imaging investigation are conducted by radiologists and nuclear physicians, medical imaging is widely performed by many different disciplines in clinical medicine, and is not confined x-ray, ultrasound, MRI and nuclear imaging but also includes endoscopy and other forms of direct visualisation.

An imaging test should not be regarded as an order. These are not blood tests to be read by a machine, and always involve a human opinion. The influence of prior clinical information and underlying expertise is critical to an appropriate opinion in the medical imaging report. The best imaging interpretation is generally obtained in the context of multidisciplinary consultation and discussion. The commonest sources of error in medical imaging reports usually arise either from an inappropriate request, or insufficient/inaccurate clinical information.

The complex nature of preparation, appropriate imaging protocol and skilled interpretation in the light of relevant clinical & other medical information means this should always be regarded as a consultation with an expert clinical service.

Today, image-guided interventions, or interventional radiology, are widely used to diagnose and treat many common clinical conditions such as nonspecific masses, obstructed duct systems, intracavitary fluid collections, obstructed or stenosed vessels, aneurysms and even unresectable cancers in specific tissues. The complex nature of these procedures requires even more consultation, discussion and appropriate background information, and the very real risks of harm to patients mean that formal signed consent, relevant pre-testing and appropriate preparation must be performed, in the same manner as for minor or even major surgery.

The rational requesting of imaging investigations and the interpretation of imaging results requires:

- thorough clinical assessment & history
- revision, recall and understanding of the relevant anatomy
- appropriate consultation with medical imaging staff
- recall of the range of imaging investigations appropriate for specific clinical situations
- understanding the preparation, patient safety issues and physical requirements required to perform imaging investigations safely and appropriately in patients
- understanding the role of the imaging investigation in the patient’s clinical pathway
- ability to explain how the results of an imaging test could lead to altered patient outcomes
On graduation students should be able to:

A. GLOBAL OBJECTIVES OF THE IMAGING CURRICULUM

1. Understand the role of medical imaging in clinical investigation
2. Explain the importance of consultation and appropriate and cost-effective usage of imaging
3. Explain and discuss the key issues in patient safety associated with imaging
4. Describe the various forums for clinical consultation and discussion of medical imaging
5. Explain how imaging investigations are conducted, including patient preparation, explanation and safety
6. Describe the key principles of various imaging modalities
7. Explain how prior probability influences the likelihood of a test returning a positive or negative result
8. Explain which imaging tests should be used in specific clinical situations (listed in the Topic sections below)
9. Recall the normal anatomy of each area imaged and apply this knowledge to the interpretation of results
10. Describe key findings and relevant anatomy in the imaging for the key clinical conditions listed in each Topic section
11. Show an appropriate approach to basic interpretation of imaging findings in the key clinical conditions listed in each Topic section

B. PATIENT SAFETY TOPICS

1. Enumerate typical normal background radiation levels in Australia
2. Enumerate typical radiation exposures for air travel
3. Enumerate the typical absorbed patient dose for the following common tests:
   (a) chest X-ray
   (b) CT Scan of the abdomen
   (c) mammogram
   (d) bone scan
   (e) PET-CT Scan
4. Explain the application of the inverse square law for radiation exposure to staff
5. Describe the value and use of lead shielding for patients and staff
6. Discuss the risks of radiation exposure for:
   (a) 6 year old child undergoing a CT of the abdomen
   (b) a pregnant woman (first trimester) from an abdominal X-ray
   (c) a 60 year old man undergoing PET-CT Scan for cancer evaluation
   (d) a person standing near a bone scan patient 4 hours after injection
7. Describe the risks of performing MRI in patients with:
   (a) a steel orthopaedic bone implant
   (b) a steel cerebral aneurysm clip
   (c) a cardiac pacemaker
   (d) a metallic foreign body in the eye
8. Describe the risks of inappropriate or inaccurate communication between referring and medical imaging staff, both before and after the imaging test for:
   (a) critically ill patients
   (b) emergency department outpatients
   (c) elective inpatients
   (d) clinic outpatients
C. IMAGING AGENT SAFETY TOPICS

1. Describe the differences in principle and use for the following imaging agents and the typical pathway for their elimination from the body:
   (a) Air
   (b) Barium
   (c) Iodine-based radiographic agents
   (d) Gadolinium-based MRI agents
   (e) Technetium-99m-DTPA
   (f) Fluorodeoxyglucose

2. Explain the basic principles and reasons for use of specific imaging agents for:
   (a) Fluoroscopic bowel procedures
   (b) CT scan of the abdomen
   (c) MRI of the brain
   (d) Intravenous pyelogram
   (e) Bone scan
   (f) FDG PET Scan

3. Discuss the risk factors for, and the complications of the administration of intravenous imaging agents in the following clinical scenarios
   (a) Extravasation during bolus injection
   (b) Allergic reactions
   (c) Diabetic ketoacidosis
   (d) Contrast induced nephropathy
   (e) Nephrogenic systemic fibrosis

D. CHEST IMAGING TOPICS – THORACIC CAGE, MEDIASTINUM, PULMONARY VESSELS, LUNGS

1. Describe and recognise the differences between the PA, AP and erect and supine frontal views on a normal chest X-ray
2. Describe and recognise the radiographic appearance of the heart, mediastinum and lungs on the frontal and lateral views on a normal chest X-ray
3. Differentiate between a well performed good quality frontal x-ray of the chest and one of suboptimal quality.
4. Describe the common clinical indications for X-Ray, CT, ultrasound, MRI, and lung V/Q scan of the chest as imaging modalities
5. Explain how High Resolution CT (HRCT) and CT Pulmonary Angiography (CTPA) differ from standard CT
6. Identify on Chest X-Ray the following core clinical conditions
   (a) lung collapse
   (b) pneumonia
   (c) pulmonary oedema
   (d) pneumothorax
   (e) pneumomediastinum
   (f) pleural effusion
   (g) rib fracture
   (h) free gas under the diaphragm
   (i) a widened mediastinum (list the differential diagnosis)
7. Identify on chest X-ray the following normally and abnormally positioned lines and tubes:
   (a) endotracheal tube
   (b) nasogastric tube
   (c) central venous catheters
   (d) intercostal tubes
8. Choose the appropriate imaging investigations and/or interventions for the following conditions and explain the rationale for your choice:
   (a) suspected lung cancer
   (b) suspected pulmonary embolism
   (c) suspected pneumothorax
   (d) suspected foreign body aspiration
   (e) suspected pneumonia
   (f) solitary pulmonary nodule found on CXR
   (g) suspected pleural effusion

E. VASCULAR IMAGING TOPICS
1. Describe the different types of diagnostic information available from vascular imaging using ultrasound, CT and catheter angiography.
2. Interpret reports from Doppler ultrasound of great arteries of neck for:
   (a) normal arteries
   (b) arterial occlusion
   (c) varying degrees of stenosis
3. Describe the chest X-ray features that indicate possible aortic dissection or rupture in clinical presentations related to:
   (a) trauma
   (b) non-trauma
4. Explain the clinical significance of the PIOPED (Prospective Investigation of Pulmonary Embolism Diagnosis) criteria of lung ventilation-perfusion reports
5. Identify features of abdominal aortic aneurysm on CT
6. Interpret reports of venous Doppler studies in the lower limb veins

F. BREAST IMAGING TOPICS (INCLUDES THE BREAST AND LYMPHATIC DRAINAGE)
1. Describe the common clinical indications for mammography and for breast ultrasound
2. Describe how a mammogram is performed
3. Describe how a breast ultrasound is performed
4. Outline the key diagnostic information provided by each of these imaging modalities
5. State the target group for and outline recommended participation in the breast cancer screening program in Australia
6. Describe the advantages and limitations of mammography in breast cancer screening
7. Describe the advantages and limitations of breast ultrasound in breast cancer screening
8. Choose the appropriate imaging investigation and/or intervention for the following clinical presentations and explain the rationale for your choice:
   (a) a young woman <30 years with a new breast lump
   (b) a woman ≥40 years with a new breast lump
   (c) a 30 year old lactating woman with breast pain and inflammation
G. MUSCULOSKELETAL IMAGING TOPICS (APPENDICULAR AND AXIAL SKELETON)

1. Drawing on your knowledge of X-ray principles, explain the rationale for:
   (a) obtaining two perpendicular views for each bone/region
   (b) including the joint above and below a limb injury
   (c) taking special projections (e.g., scaphoid, radial neck)

2. Describe the different types of diagnostic information provided by X-Ray, CT, Ultrasound, MRI, Bone Scan, Gallium Scan

3. Describe the common clinical indications for each type of test

4. Explain the advantages and disadvantages of each test for trauma, infection and neoplasm

5. Identify the following core clinical conditions on X-Ray:
   (a) primary signs of fracture (cortical break, abnormal linear lucency or white line, altered bone shape)
   (b) secondary signs of fracture (angulation, displacement, soft tissue swelling, joint effusion)
   (c) lipohemarthrosis of the knee and elbow joints
   (d) normal alignment and contours of the cervical spine

6. Recognise on X-ray the following important injuries that commonly present to emergency departments
   (a) cervical spine fracture or dislocation
   (b) scaphoid fracture
   (c) distal radius fracture (Colles, Smith)
   (d) radial neck fracture
   (e) distal humerus/elbow fracture
   (f) humeral neck fracture
   (g) shoulder dislocation
   (h) neck of femur fracture
   (i) tibial condylar fracture

7. Choose the appropriate imaging investigation and/or intervention for the following conditions and explain the rationale for your choice:
   (a) suspected Infection (Spine, Joint)
   (b) complex Skeletal Trauma
   (c) radiographically Occult Fracture
   (d) joint Pain (Suspected Arthritis)
   (e) bone Pain (Suspected Bone Neoplasm)
   (f) back Pain

H. GASTROINTESTINAL RADIOLOGY TOPICS

1. Describe the key diagnostic information provided by the following abdominal imaging modalities:
   (a) Abdominal X-ray,
   (b) CT
   (c) U/S

2. Develop a systematic approach to identifying the following features on an abdominal X-ray:
   (a) normal bowel gas pattern (small vs. large bowel)
   (b) abnormal calcifications
   (c) normal organs / soft tissue structures

3. Identify and correctly describe the abdominal X-ray findings for the following core clinical conditions:
   (a) free intraperitoneal gas
   (b) small bowel obstruction
   (c) large bowel obstruction
   (d) ileus

4. Identify and correctly describe the Abdominal CT findings for:
   (a) free intraperitoneal gas
   (b) free intraperitoneal fluid
   (c) abdominal Aortic Aneurysm
5. Choose the appropriate initial imaging investigation (e.g. AXR, U/S, CT) for the following clinical presentations and explain the rationale for your choice:
   (a) right iliac fossa pain (20y.o male / female and 60y.o. male/ female)
   (b) right upper quadrant pain
   (c) left iliac fossa pain (20y.o. female vs. 60y.o. female)
   (d) colicky pain in
      i. right upper quadrant
      ii. central abdominal
   (e) melaena / haematochezia
   (f) jaundice

I. UROGENITAL IMAGING TOPICS

1. Describe the different diagnostic information provided by the following urogenital imaging modalities:
   (a) CT
   (b) plain X-ray
   (c) ultrasound
   (d) nuclear medicine – DMSA Renal Scan, DTPA, MAG3 Renal Scan)

2. List and appropriately sequence imaging investigations for the following clinical conditions:
   (a) haematuria
   (b) acute and chronic renal failure
   (c) renal colic
   (d) acute scrotal pain
   (e) pregnancy related pelvic pain
   (f) suspected ectopic pregnancy

3. Identify:
   (a) radio-dense calculi on Abdominal X-ray
   (b) calculi on CT

J. NEUROIMAGING TOPICS

1. Describe the different diagnostic information provided by the following neuroimaging modalities:
   (a) CT
   (b) MRI
   (c) angiography
   (d) nuclear medicine (PET and Cerebral Perfusion)

2. Identify the diagnostic CT features of the following core clinical conditions:
   (a) subarachnoid haemorrhage
   (b) subdural, intracerebral and extradural haemorrhage
   (c) haemorrhagic and non-haemorrhagic stroke
   (d) signs of raised intracranial pressure
   (e) hydrocephalus
   (f) space occupying mass

3. Identify the key imaging features on brain MRI sequences of:
   (a) T1 weighting
   (b) T2 weighting
   (c) fluid attenuation inversion recovery (FLAIR)
   (d) diffusion imaging (DWI)