Effective choices
for diagnostic imaging
in clinical practice

Report of a
WHO Scientific Group

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Geneva, 7-14 November 1988

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EFFECTIVE CHOICES
FOR DIAGNOSTIC IMAGING IN
CLINICAL PRACTICE

Report of a WHO Scientific Group
on Clinical Diagnostic Imaging

A WHO Scientific Group on Clinical Diagnostic Imaging met in Geneva from 7 to 14 November 1988 to consider the most effective use of the many different methods of diagnostic imaging available to medical practitioners. The meeting was opened by Dr Hu Ching-Li, Assistant Director-General, on behalf of the Director-General.

1. INTRODUCTION

There are so many different methods of diagnostic imaging that medical practitioners may need guidance to choose the best way through the maze of options for each clinical problem \((1, 3, 4, 6, 9)\). Advice may be required for more than just the first choice, because the first imaging procedure does not always give the desired answer and, depending on the results, further imaging may have to be undertaken. The alternative is to submit the patient to a barrage of imaging and hope that one type, at least, provides the diagnosis. This is a quite unacceptable way to practise medicine because of the cost and the risk of radiation damage from unnecessary examinations.

The aim of the Scientific Group, therefore, was to provide clear and simple advice on sequences of steps for the imaging of the most common clinical problems, taking into account the wide range of professional skills and facilities available in many parts of the world.

If WHO's goal of health for all by the year 2000 is to be achieved, the money available for health care must be efficiently used in every country. In an ideal world, the cost of medical care would not be a limiting factor affecting the quality or quantity of the health services provided, but unfortunately this situation does not exist in any country. Even the wealthiest nation must be aware that financial support is not unlimited. As the wealth of a country grows, so do the cost and complexity of medical care, often at rates which exceed
other aspects of the economy. Such an imbalance can have an effect throughout the community which no society can ignore.

Cost and complexity in health care are always reflected in the diagnostic imaging services that can be provided. WHO has established the principle that radiological services are of great importance at the first level of patient care, and has provided specifications for X-ray equipment (10, the WHO Basic Radiological System) and general-purpose ultrasound scanners (14). WHO manuals guiding radiographic and darkroom techniques and the interpretation of X-ray films (5, 7, 8) are available in several different languages and are deservedly popular, and a manual on ultrasound interpretation is in preparation. In addition, several WHO unpublished documents are concerned with the efficacy and efficiency of radiological imaging, and with the technical specifications of the equipment to be chosen (2, 10, 11). However, none of these reports has addressed the vital question of which approach is the most effective for the imaging of any specific clinical problem. What order of imaging should be followed to make the diagnosis accurately, quickly and economically? Equally important, is diagnostic imaging needed at all in some cases? It must be emphasized that imaging can never replace clinical history-taking and examination as the first steps in helping each patient.

The choice of the most effective imaging is often difficult and frequently controversial. The sequence to be followed varies with many factors: the equipment available, the skills of the practitioner, the expected quality of the results, the quality of interpretation, and the conclusion which can be drawn. Local circumstances will alter need; for example, the exact diagnosis of the type of cerebral tumour is not an urgent matter if there is no neurosurgeon available. The quality of the local clinical service, and the simple question, “What can be done with this patient after the diagnosis is made?” must also be taken into account. Priorities must therefore be established and the way in which a patient undergoes imaging will have many local variations. Unfortunately, not everyone can have the benefit of all methods of diagnostic imaging; indeed, the majority of the world’s people will never even see an X-ray unit, let alone have a radiographic examination. Ultrasound equipment is similarly scarce. Both types of facility are unevenly distributed and predominate in large cities. Nuclear medicine withers when departments are unable to obtain radionuclides promptly. The use of magnetic resonance imaging (MRI) is expanding at an astonishing
rate in some countries (12), while remaining only a hope for the future in many others. Any recommendations on the use of imaging must allow for all these variants, so that in each case the best choice can be made from what is available. Despite all the difficulties, some attempt needs to be made to establish the best approach to the most common clinical problems.

Although the economic situation, which cannot easily be changed, may be the ultimate factor limiting the choice of diagnostic imaging techniques, the risk of ionizing radiation, which is controllable, must also be a consideration. At the primary care level, radiography is still the most common method of imaging because the majority of patients can benefit from basic radiological diagnosis. This applies equally at secondary and tertiary levels of care, because throughout the world 80% of all diagnostic images are of the chest and skeleton. Ultrasonography, which is less expensive, cannot satisfy either of these needs. Computerized tomography (CT), using ionizing radiation, is not a survey tool suitable for most initial examinations. MRI is a remarkable technology, particularly for imaging the central nervous system and spine, but even its most ardent advocates have yet to recommend it as a first step when the patient has a cough or a suspected limb fracture. Scintigraphy is seldom of initial importance, except in a few cases such as osteomyelitis or suspected stress fracture. The principle that no patient should be exposed to unnecessary (meaning ineffective or clinically useless) radiation is a very good reason why the sequence of imaging must be carefully chosen by a radiologist or medical practitioner who has a clear idea of what should be done first after the clinical examination, and what subsequent imaging may be needed when the first results are available.

The growth of ultrasonography in the last decade has changed the pattern of imaging: in many clinical situations ultrasonography is now the first choice. Few clinicians would disagree that all pregnant women who need imaging should have an ultrasound scan first, and it is seldom that any other method of obstetric imaging will be contemplated throughout pregnancy. Equally, for the liver, pancreas and spleen, ultrasonography should be used first, even where CT and MRI facilities are available. CT should be deferred because it uses ionizing radiation, costs more and does not always give more information. MRI should be delayed because of even higher costs, and because ultrasonography will provide equally reliable guidance in a high proportion of cases. Similarly, ultrasound is considered the
primary imaging modality for most gynaecological problems, the scrotal contents and the prostate. In some countries, ultrasoundography is used as a screening procedure for detection of echinococcal infection, and has demonstrated a significant number of new cases. However, its predictive value is strongly influenced by the prevalence of the disease. The thyroid may be examined using scintigraphy, and for bone scanning there is no substitute for radionuclide techniques. With the present state of knowledge, mammography should be done with X-rays, despite exposure of the patient to radiation, because no other method has the same accuracy, ease of access and availability.

None of the images obtained by these techniques, be they radiographic, ultrasonic or from magnetic resonance, can be interpreted without knowledge of the clinical examination of the patient, and in many cases of the results of laboratory tests also. This information should be thoroughly and carefully assessed, and the laboratory investigations as carefully chosen as the imaging sequence. All steps in assessing the patient are interrelated and very few images, however spectacular, are valid in the absence of all the other information. There will also be circumstances where local skill and experience in one modality may override other considerations, because the images are only as good as the physician who interprets them.

This report, then, is concerned with the many different indications which will guide the physician in the diagnostic imaging of each patient. There are, today, so many different choices and such a wealth of information that it is often too much for any individual to master, and consultation with colleagues has become essential for good care of patients. While this report may provide useful guidance, it will not displace, wherever available, personal discussions between the patient’s physician and the specialist in diagnostic imaging. Such consultations should precede and guide the choice of imaging, rather than being merely a review of images after they are taken. Early consultation will improve the results, and the twin goals of high quality of patient care and cost restriction may be reached. If, at the same time, ionizing radiation is used more sparingly, the process will be further justified.

The Scientific Group was guided by three previous WHO reports, which outline the criteria for diagnostic imaging. The first considers the indications for and the limitations of the most common diagnostic X-ray investigations, and provides recommendations for
limiting their use when unlikely to provide any clinically significant information \(13\). The second considers the use of ultrasonography and CT in developing countries, as well as the specifications for the equipment required, and outlines the major clinical indications for these imaging methods \(14\). The third considers the rational use of diagnostic imaging in paediatrics, and provides recommendations for improving the use of the various imaging techniques which are valid for children up to the age of 14 years \(15\). It includes criteria not only for those who have to decide which imaging technique is best for their patients, but also for those who are performing the examinations, in the hope of limiting the use of diagnostic imaging to cases where it will really benefit the individual.

The Scientific Group was well aware of the wide variety of imaging techniques available, and yet at the same time, the many parts of the world where the choices are very limited. The report attempts to reflect this practical situation and gives as many alternatives as possible. Throughout it has also been made clear when imaging is not really helpful, or when there are significant limitations on the benefits that will result.

The report is arranged on an anatomical basis, and within each anatomical section the clinical indications for imaging are discussed. While anatomy and illness are much the same everywhere, the available equipment is not so uniform. The Group has therefore described the sequences to be followed, envisaging three different levels of imaging equipment, while being aware that there is bound to be overlap and discrepancy. It is hoped that within the useful life of this report most facilities will approach the levels of imaging described. Unfortunately, Level I represents the most likely situation for most of the world and the Scientific Group was unanimous in recommending that this represented the minimum which should be accepted for good patient care.

- **Level I**
  - Standard radiography, as with the WHO Basic Radiological System
  - General-purpose ultrasonography
  - Where possible within the health care facility or available within a reasonable distance:
    - conventional linear tomography
    - fluoroscopy with image intensification.
• **Level II**
  All Level I techniques and:
  Sophisticated radiography
  Sophisticated ultrasonography, including Doppler
  Mammography
  Angiography
  Digital subtraction angiography (DSA) and macro-radiography
  Computerized tomography (CT)
  Radionuclide scintigraphy, including single-photon emission computerized tomography (SPECT)
  Thermography (of limited use).

• **Level III**
  All Level I and Level II techniques and:
  Magnetic resonance imaging (MRI)
  Positron emission tomography (PET)
  Advanced radionuclide scanning; labelling by means of monoclonal antibodies (immunoscintigraphy).

It is assumed that any Level II department will have all the imaging facilities that are available at Level I, and similarly for Level III, which must be fully equipped to perform any type of imaging. This does not imply, however, that the diagnostic tests performed at Level I, for example, necessarily have to be applied at Levels II and III; the choice of imaging procedures will strongly depend on the particular clinical situation.

More important than the equipment is the availability of skills. An error in diagnosis because of inadequate education and experience is as dangerous as being without the equipment, and the success of any interventional procedure (e.g., angiography) is very dependent on the skill and experience of the responsible physician. Qualified radiologists are not available in many parts of the world, and it should never be suggested that an adequate standard can be reached in any type of imaging on the basis of self-learning and reading. In particular, the effective use of an ultrasound scanner, although less expensive than other imaging equipment, is very dependent on the physician. The minimum required training for ultrasonography and CT, which should be completed in a large centre, has been described elsewhere (14). The recommendations made by this Scientific Group are based on the assumption that at least an equivalent level of expertise will be available to interpret the
images obtained in every facility. If a choice of imaging can be made, the decision should always be in favour of that for which there is the most local experience. Thus, many of the Group’s recommendations can only be, at best, broad guidelines to be adapted according to local conditions and disease patterns.

Yet, the principles remain the same, and the message is very clear. An orderly and logical approach to the diagnostic imaging of all patients will result in more accurate diagnosis, less harmful radiation and less expense. All three are goals well worth achieving in any country.

REFERENCES TO SECTION 1


2. CHEST AND CARDIOVASCULAR SYSTEM

2.1 Acute dyspnoea

Acute dyspnoea is a sudden shortness of breath without cardiac failure. Asthma and toxic inhalation should be clinically excluded.

- **Level I**
  
  *Chest radiography.* If the radiograph is normal or a diagnosis can be made (e.g., pneumonia, large pleural effusion), manage the patient clinically. However, pulmonary embolus has not been excluded. If symptoms continue, obtain a second radiograph after 24 hours.

  If the radiograph is abnormal, but the diagnosis is in doubt, proceed as follows.

(a) Suspected pneumothorax: obtain a posteroanterior chest radiograph with the patient in full expiration.

(b) Suspected atelectasis: add a lateral chest radiograph. An anteroposterior lordotic radiograph may be helpful, especially for children.

(c) Suspected inhaled foreign body: review for atelectasis as above. Consider a full expiratory radiograph (posteroanterior), decubitus views and fluoroscopy to detect localized emphysema. Bronchoscopy should be performed if there is clinical suspicion of a foreign body, even if imaging studies are normal.

(d) Suspected cervical airway obstruction: add a lateral view of the nasopharyngeal and upper tracheal airway. If epiglottitis is suspected clinically, care must be taken not to compromise the airway during examination.
• Level II
Proceed as in Level I.

*Pulmonary ventilation-perfusion scintigraphy* should be performed if pulmonary embolus is clinically possible, no matter what the results of chest radiography.

*Pulmonary arteriography* may precede scintigraphy in patients with severe dyspnoea in whom pulmonary embolus is suspected on clinical grounds.

*Computerized tomography* will rarely contribute to the management of acute dyspnoea.

• Level III
Proceed as in Level II.

*Magnetic resonance imaging* is not indicated.

2.2 Chronic dyspnoea

Shortness of breath for over one month without improvement may be due to airways obstruction, pulmonary parenchymal disorders or cardiac disease (see section 2.8 on cardiac failure).

Dyspnoea secondary to obesity, anaemia, and metabolic and neuromuscular disorders should be excluded by clinical examination and appropriate laboratory studies prior to imaging.

Clinical assessment is better than radiography when there is evidence of chronic obstructive pulmonary disease and/or chronic bronchitis.

• Level I
*Chest radiography*. If a diagnosis can be made, manage the patient clinically. No further imaging is necessary, but conventional tomography can be used to demonstrate upper airway stenosis or obstruction.

• Level II
Proceed as in Level I except:

*Computerized tomography* should be used to characterize and evaluate upper airway obstruction. High-resolution and thin-slice CT may help to evaluate chronic interstitial lung disease.
*Gallium scintigraphy* can be used to evaluate inflammatory activity in chronic interstitial disease.

*Pulmonary ventilation-perfusion scintigraphy* can be used to evaluate vascular occlusion.

*Pulmonary angiography* is unnecessary if pulmonary hypertension is suspected.

- **Level III**
  *Magnetic resonance imaging* has not shown specific clinical usefulness in chronic interstitial disease.

### 2.3 Chronic cough

Cardiac failure and environmental causes of chronic cough must be excluded clinically. Chronic bronchitis and chronic obstructive pulmonary disease are best assessed clinically: imaging does not contribute to management of the patient unless there is a significant clinical change and, in such cases, sputum and lung-function studies are more important.

- **Level I**

  *Chest radiography.* Posteroanterior and lateral views are required. Additional views should be obtained as indicated following examination of the initial radiographs.

  (a) If the radiograph is normal or diagnostic, no further imaging is required.

  (b) Suspected mass: see section 2.5 on chest “mass” or “nodule”.

  (c) Suspected bronchiectasis: bronchography should be undertaken only if surgery is contemplated.

  (d) Suspected pleural effusion: add decubitus views as indicated.

  (e) Unilateral elevation of the diaphragm: fluoroscopy should be undertaken to assess movement; if facilities for fluoroscopy are not available, obtain a posteroanterior radiograph with the patient in expiration.

  (f) Suspected inhaled foreign body in children: bronchoscopy is necessary; see section 2.1 on acute dyspnoea (Level I, point (c)).
• **Level II**
  Proceed as in Level I.

  *Computerized tomography* is indicated in the following cases.
  
  (a) The chest radiograph is normal. CT should be used to rule
  out hilar or mediastinal abnormality.
  
  (b) Suspected or evident aneurysmal aorta. Aortography should
  be undertaken if the CT results are indefinite.
  
  (c) Suspected vascular mass in the hilum. Pulmonary
  arteriography should be undertaken if CT facilities are not
  available to evaluate an enlarged pulmonary artery.
  
  (d) Suspected bronchiectasis. CT will confirm the diagnosis, but
  is not necessary if clinical findings and plain radiographs are
  diagnostic.

• **Level III**

  *Magnetic resonance imaging* is not indicated unless there is
  suspicion of aortic dilatation or aneurysm, or other vascular
  lesion.

2.4 **Acute chest pain (non-cardiac)**

Acute non-cardiac chest pain is sudden chest pain in a patient
with no clinical evidence of cardiac disease and without a history of
trauma. Clinical examination must exclude chest wall causes, e.g.,
herpes zoster. Auscultation can exclude pleurisy and pericarditis. A
carefully taken clinical history will differentiate most cases of chest
pain due to oesophageal reflux or hiatus hernia (if in doubt, see Level
1 below).

• **Level I**

  *Chest radiography.* A posteroanterior view is required. Lateral
  and additional views should be taken if indicated following
  examination of the initial radiograph.
  
  (a) If the radiograph is normal, no further imaging is required.
  
  (b) Suspected bone pain: oblique views centred over the area of
  interest are required. If the bone views are negative, but pain
  persists, repeat the examination with localized views two
  weeks later (see Level II below).
  
  (c) Suspected oesophageal lesion: an upper gastrointestinal
  contrast examination is required.
(d) Suspected pneumothorax: obtain a posteroanterior chest radiograph with the patient in full expiration and standing upright. If the diagnosis of pneumothorax is established, follow-up radiography is dictated by clinical change and should not be done routinely.

(e) Suspected pulmonary embolus: see section 2.11 on pulmonary embolism.

- **Level II**
  Proceed as in Level I.
  Skeletal scintigraphy is recommended for bone pain when localized views are normal.
  Computerized tomography can be used to demonstrate reliably a bone lesion and intrathoracic or extrathoracic extension once identified by radiography and/or scintigraphy.

- **Level III**
  Magnetic resonance imaging does not offer any advantage over CT.

### 2.5 Chest “mass” or “nodule” (found radiographically)

The imaging of a mass or nodule seen on a chest radiograph depends on the anatomical site. The images must be correlated with clinical, laboratory and endoscopic examinations, as appropriate.

#### 2.5.1 Solitary pulmonary mass or nodule (not in contact with the pleura)

- **Level I**
  Chest radiography. Both posteroanterior and lateral views are required. Further information can be obtained from conventional tomography. If the results are diagnostic, no further imaging is required. If they are equivocal, the diagnosis may depend on sputum examination or biopsy. If the mass or nodule is thought to be benign, follow-up radiographs are needed at appropriate intervals.
Ultrasonography is of no value for a pulmonary lesion. If echinococcosis is suspected, ultrasound scans should be made of the abdomen.

Fluoroscopy seldom adds useful information.

- **Level II**
  
  **Computerized tomography** may provide further information, and is sometimes diagnostic. Even if the results suggest benign disease, depending on the patient’s age and status, it is advisable to obtain further plain radiographs after an appropriate interval; these will indicate whether further CT is necessary.

  **Angiography** is indicated for suspected vascular masses.

  **Scintigraphy** is not indicated.

- **Level III**
  
  **Magnetic resonance imaging** is not superior to CT except to distinguish nodules contiguous to large pulmonary vessels.

2.5.2 Mediastinal or hilar mass

- **Level I**
  
  **Chest radiography.** Posteroanterior and lateral views are required, usually combined with conventional tomography. If the results are diagnostic, no further study is required; if the diagnosis is in doubt, correlate the radiographic evidence with clinical and endoscopic results. A follow-up radiograph may provide further diagnostic information.

  **Ultrasonography** is of use to differentiate a cystic from a solid mediastinal mass, and to demonstrate subcarinal lymphadenopathy particularly in the lower and upper mediastinum.

  **Barium examination** is indicated for diagnosing diverticula, oesophageal hernia, and congenital anomalies of the aortic arch presenting as a widened upper mediastinum.

- **Level II**
  
  **Chest radiography** is required as in Level I. Conventional tomography is not indicated.
Computerized tomography may provide further useful information, particularly to differentiate a non-vascular from a vascular mass.

Angiography, including DSA, is indicated for preoperative evaluations of aortic aneurysm, dissection and other vascular anomalies.

Scintigraphy. A gallium scan is useful for staging malignancy and to confirm inflammation. An ectopic thyroid can be identified scintigraphically.

- **Level III**
  Magnetic resonance imaging can be used to distinguish readily between vascular and non-vascular masses, and to evaluate aortic aneurysm, dissection and congenital vascular anomalies. The pericardium and heart can be visualized.

2.5.3 Pleural mass

- **Level I**
  Chest radiography. Posteroanterior and lateral views are required, in some cases with additional oblique projections, combined with conventional tomography. If the results are diagnostic, no further imaging is needed.

  Ultrasonography is useful only in identifying encapsulated pleural fluid.

- **Level II**
  Proceed as in Level I but replace conventional tomography with CT.

  Computerized tomography is very sensitive in depicting primary pleural masses and metastatic pleural nodules.

  Scintigraphy and angiography are not indicated.

- **Level III**
  Magnetic resonance imaging is not superior to CT in evaluating pleural masses except when close to the diaphragm and pericardium.
2.5.4 Extrapleural mass

- **Level I**
  *Chest radiography.* Posteroanterior, lateral and appropriate oblique views may provide the diagnosis.

  *Conventional tomography* may be helpful, but the final diagnosis is usually made by biopsy.

  *Ultrasonography* may define and characterize the mass, but will seldom establish the diagnosis without guided biopsy.

- **Level II**
  *Computerized tomography* demonstrates rib or other skeletal involvement; it will also demonstrate pleural extension, but will seldom establish the diagnosis.

  No other imaging is likely to be useful.

- **Level III**
  *Magnetic resonance imaging* will provide further information, but will not establish the diagnosis.

2.5.5 Diaphragmatic mass

- **Level I**
  *Chest radiography.* Posteroanterior and lateral radiographs are needed. An additional view with the patient in full expiration (or fluoroscopy) should be used to evaluate the diaphragm.

  *Ultrasonography* can be used, especially in children, to evaluate diaphragmatic masses or mediastinal masses close to the diaphragm.

  *Radiological examination* of the gastrointestinal tract with contrast will be necessary if any type of hiatus hernia is suspected.

- **Level II**
  *Computerized tomography* will accurately delineate and sometimes characterize masses in the diaphragmatic region.

  Otherwise, proceed as in Level I.

- **Level III**
  *Magnetic resonance imaging* will provide more information than CT or ultrasonography.
2.6 Acute cardiac pain (without cardiac failure)

Acute cardiac pain without cardiac failure is acute chest pain of suspected cardiovascular origin in a patient without clinical evidence of congestive heart failure. Clinical and laboratory evaluation including electrocardiography should precede imaging. Referred pain and pain due to oesophageal reflux, hiatus hernia, acute pericarditis and acute pleurisy can all simulate cardiac pain.

- **Level I**
  - Chest radiography
    - (a) Suspected myocardial infarction: plain radiographs provide no useful information.
    - (b) Suspected aortic dissection: repeated chest radiography will be needed to assess any change in mediastinal width. If no change is observed, further chest radiographs will be needed at increasing intervals as necessary.

  *Ultrasonography* provides no useful diagnostic information.

- **Level II**
  - If aortic dissection is suspected after the plain radiograph has been reviewed, proceed to CT or angiography.

  *Coronary arteriography and aortography* are reliable in the diagnosis of coronary artery stenosis or occlusion, and the recognition of aortic dissection, respectively.

  *Intravenous digital subtraction angiography* can demonstrate aortic dissection with moderate reliability.

  *Scintigraphy* is highly reliable in the detection and evaluation of myocardial ischaemia and infarction, even when the results of coronary arteriography are normal.

  *Computerized tomography* can detect aortic dissection, but the aorta may appear normal in some cases in which dissection has occurred.

  *Ultrasonography* requires special expertise and equipment and may then be helpful in some cases.

  *Echocardiography* has little to contribute.
Level III

Magnetic resonance imaging currently provides no further information and can be technically difficult in acutely ill patients.

2.7 Chronic cardiac pain (without cardiac failure)

For a patient suffering from cardiac pain persisting over a period of weeks, without cardiac failure, electrocardiography and laboratory studies are of great diagnostic importance.

Level I

Neither chest radiography nor ultrasonography is likely to provide useful diagnostic information, unless cardiac aneurysm or aortic aneurysm is suspected clinically.

Level II

Scintigraphy (including angiography and myocardial scintigraphy with stress studies) is a very reliable method of assessing cardiac morphology and physiology.

Echocardiography may be used to assess reliably myocardial function and morphology.

Computerized tomography can reliably demonstrate infarction, aneurysm, mural thrombi and abnormalities in cardiac wall motion, and can be used to evaluate chronic aortic dissection.

Coronary angiography is generally used before cardiac surgery or interventional angioplasty.

Level III

Magnetic resonance imaging can be used for accurate assessment of acute and chronic myocardial infarction and sequelae, and for reliable assessment of aortic dissection.

2.8 Cardiac failure

Cardiac failure may involve either or both sides of the heart; both sides are affected in the late stage. There are many different factors and causes; this section does not discuss imaging of specific underlying cardiovascular diseases.
- **Level I**
  *Chest radiography.* Both posteroanterior and lateral views are required for the assessment of cardiac size and shape. The patient must be erect. Supine or semi-erect radiographs are not indicated for the evaluation of the heart except in infants (of less than two years).

  Assessment of the degree of left-side cardiac failure and the prognosis can be made with reasonable accuracy from good-quality plain radiographs. Judgement of right-side failure is less satisfactory.

  When there is cardiac enlargement, *ultrasonography* is the only reliable method of distinguishing pericardial effusion from other types of cardiomegaly.

- **Level II**
  *Echocardiography and Doppler ultrasonography* are reliable in assessing ventricular ejection fractions, the myocardium and underlying cardiac disease.

  *Scintigraphy* can be used to assess cardiac size, contractility and ejection fractions.

- **Level III**
  *Magnetic resonance imaging* can be used to assess cardiac flow and heart muscle status.

  *Positron emission tomography* can be used to assess heart muscle metabolism.

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### 2.9 Peripheral arterial disease (cold hands/feet)

Peripheral arterial disease is becoming more frequent as the proportion of elderly people in the population increases. It is particularly common in smokers and patients with diabetes.

- **Level I**
  No specific imaging modality is available.

- **Level II**
  *Doppler ultrasonography* will demonstrate vascular flow.
Arteriography should be performed if therapeutic intervention is indicated.

Angiographic scintigraphy can be used if facilities for ultrasonography and angiography are not available.

Thermography is an extremely sensitive but nonspecific method for evaluating vascular perfusion.

- **Level III**
  - Magnetic resonance imaging is a non-invasive way of examining peripheral arterial disease.

### 2.10 Deep vein thrombosis

The clinical symptomatology of deep vein thrombosis is often nonconclusive and nonspecific. Diagnosis and treatment must rely both on what the clinician suspects on clinical grounds and on imaging procedures.

Non-imaging methods are complementary: plethysmography and the Doppler-probe in screening for deep vein thrombosis, and radiolabelled fibrinogen to monitor the effects of treatment.

- **Level I**
  - Ultrasonography can visualize thrombi, more easily in the pelvis and thigh than peripherally, but a normal scan does not exclude thrombosis. Ultrasound can often exclude other causes of leg swelling and pain.
  
  Venography is the method of choice for direct visualization of thrombi. It is indicated when ultrasound scans are normal or equivocal. Technical and interpretive errors result in misdiagnosis in about 10% of cases.

- **Level II**
  - Proceed with ultrasonography and venography as in Level I.
  
  *Colour Doppler ultrasonography* is likely to be the method of choice if appropriate facilities are available.

  *Real-time* and *continuous-wave Doppler ultrasonography* add information on flow abnormalities due to thrombosis but, although highly sensitive and specific, are more reliable in proximal thrombus localization.
Radionuclide venography should be limited to patients with sensitivity to intravenous contrast drugs. If the results are normal, deep vein thrombosis is not excluded.

Thermography can demonstrate deep vein thrombosis, but has a significant error rate.

- **Level III**
  Magnetic resonance imaging can provide useful information for pelvic thrombi, and is more reliable than other methods in this region.

Radionuclide imaging using labelled monoclonal antibodies may well become important in the future.

### 2.11 Pulmonary embolism

The onset of pulmonary embolism may be abrupt (acute) or insidious (chronic); most pulmonary emboli originate from deep venous thromboses of iliofemoral and pelvic vessels. Associated signs and symptoms are frequently nonspecific and clinical diagnosis may be difficult.

Definitive diagnosis relies on imaging, which must precede treatment.

- **Level I**
  Chest radiography is necessary to exclude other causes in a symptomatic patient, and for follow-up in patients with proven pulmonary embolism. Although there are radiographic abnormalities in more than 50% of cases, these are usually nonspecific.

See also section 2.10 on deep vein thrombosis.

- **Level II**
  Chest radiography is necessary as in Level I, and for comparison with scintigraphy.

Ventilation-perfusion scintigraphy is the standard procedure in the evaluation of pulmonary embolism. If the results are normal, clinical observation, without further imaging, is justified.
Pulmonary angiography, with or without DSA, is the most specific method for confirming the diagnosis of pulmonary embolism, and is required when scintigraphy is equivocal.

Computerized tomography is not indicated.

Additional diagnostic imaging to demonstrate deep vein thrombosis may be required in the prophylaxis and therapy of pulmonary embolism (see section 2.10).

- **Level III**
  
  Magnetic resonance imaging currently provides no additional useful diagnostic information.

2.12 Hypertension

A significant proportion of the adult population have hypertension. High blood pressure without identifiable cause is known as essential (primary) hypertension, and accounts for 96-99% of the hypertensive population.

2.12.1 Essential hypertension

- **Level I**

  Raised blood pressure is not an indication for a chest radiograph or other imaging in the absence of any other clinical findings or unless there has been no response to treatment. The imaging sequence should then start with chest radiography, postero-anterior and lateral views, and thereafter follow that described for secondary hypertension as appropriate; imaging may also be necessary to assess the effect of hypertension on other organs.

2.12.2 Secondary hypertension

  Imaging is required to establish the cause of secondary hypertension.

(1) Hypertension secondary to aortic disease

- **Level I**

  Chest radiography. Posteroanterior and lateral views, with added contrast in the oesophagus, may demonstrate congenital aortic or vascular anomalies. Normal results do not exclude vascular lesions.

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Ultrasonography is useful only if a 5-MHz transducer is available and suprasternal studies can be made. These will demonstrate 50–80% of cases of aortic coarctation.

- **Level II**
  
  Chest radiography. Plain posteroanterior and lateral views are required, as in Level I.

  Angiography is the best way to demonstrate aortic disease. Digital and other subtraction techniques improve image quality.

  Computerized tomography is more sensitive than radiography in recognizing congenital coarctation.

  Colour Doppler ultrasonography may provide more specific diagnosis in the future.

- **Level III**
  
  Magnetic resonance imaging is the best way to image aortic and other vascular anomalies which may be associated with hypertension. It is less satisfactory in aortic stenosing-obstructive disease (aortitis).

  
  
  
  
(2) Hypertension secondary to renal disease

- **Level I**
  
  Abdominal ultrasonography will demonstrate renal abnormalities. Excretory urography may provide further information, but images obtained by either technique can be normal in the presence of significant renal disease.

  If ultrasound equipment is not available, renal size can be evaluated by abdominal radiography followed by excretory urography. Conventional tomography can provide better definition of the kidneys.

- **Level II**
  
  Proceed with ultrasonography as in Level I.

  Computerized tomography will demonstrate the kidneys more clearly and may be useful in cases where ultrasonography has shown a renal abnormality.

  Scintigraphy is very useful in evaluating renal function.
Aortography, renal arteriography and digital subtraction angiography may be combined with renal vein sampling to provide a further check of renal status and function. This is an important examination in the diagnosis of renal vascular hypertension.

- **Level III**
  Magnetic resonance imaging may provide sufficient information to make interventional studies unnecessary.

(3) **Hypertension secondary to adrenal disease**

Laboratory tests must precede imaging.

- **Level I**
  Ultrasonography of the adrenal glands will reveal the majority of adrenal masses, but cannot characterize them and, even when the results are normal, an adrenal mass is not excluded.

  Radiography and excretory urography are unreliable in the diagnosis of adrenal disease and are not indicated.

- **Level II**
  Computerized tomography is more accurate than ultrasonography, but masses of less than 1 cm in diameter may not be detected.

  Scintigraphy (MIBG; meta-iodobenzylguanidine) is complementary to CT and ultrasonography and may provide functional information concerning phaeochromocytomas and adrenal cortical tumours.

  Selective venography (with angiography in some cases) is indicated only for the detection of cortical adenomas of 1.0–1.5 cm in diameter.

- **Level III**
  Magnetic resonance imaging is no more successful than CT in the diagnosis of adrenal tumours.

**2.13 Breast mass or screening for breast cancer**

The same imaging techniques are used for investigating a palpable mass in the breast as for the regular screening of the breasts of
women over 40 years (mammography). In patients with clinical evidence of mastitis or a breast abscess no imaging is required.

- **Level I**
  
  *Standard radiographic equipment* is not suitable for mammography. The technique requires specially designed X-ray units, specialized films and well-trained staff.

  *Ultrasonography* can distinguish between cystic and solid breast masses, but **cannot exclude cancer**.

- **Level II**
  
  *Mammography* of both breasts is required, even if there is a palpable mass in only one.

  (a) If the mammogram is normal, no further imaging is required. When mammography is being used for screening, the next mammogram should be obtained after the locally recommended interval.

  (b) If the diagnosis is equivocal, a biopsy may be required, or a further mammogram may be needed after three months. *Computerized tomography* has not proved to be reliable in the differential diagnosis of breast lesions. High-frequency *ultrasonography* (7–10 MHz) can help in displaying a mass in hyperdense breasts where mammography is less precise. Ultrasonography can also be used to guide biopsy. However, it cannot exclude cancer.

  (c) If the results of mammography are suggestive of malignancy, standard chest radiography and imaging for hepatic and skeletal metastases may be necessary, but will depend on the clinical extent of disease (see section 3.4 on skeletal metastases).

- **Level III**
  
  *Magnetic resonance imaging* currently has no advantage over mammography.

REFERENCES TO SECTION 2


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3. MUSCULOSKELETAL SYSTEM

3.1 Low back pain (without trauma)

Pain in the lower back is a common complaint in adults. Fortunately, 95% of the attacks resolve spontaneously. The need for and sequence of imaging will depend on the duration of the pain and the presence or absence of neurological symptoms.

3.1.1 Normal results on neurological examination

No imaging is indicated.

3.1.2 Abnormal results on neurological examination or persistent/ recurrent pain

- **Level 1**
  
  *Radiography* of the lumbar and upper sacral spine should include anteroposterior and lateral views. If the lumbosacral junction is not clearly seen in the lateral view, an additional view is needed.
  
  *(a)* If the radiographs are normal or show only degenerative changes, additional imaging is unnecessary, unless there are neurological signs.
  
  *(b)* If there is a need to confirm spondylolisthesis, oblique views should be obtained after the routine views have been examined. Flexion and extension views in the lateral projection can be taken if clinically indicated.

*Conventional tomography* is not required for degenerative disease but may provide further information on suspected infection, neoplasm or developmental abnormalities.
• **Level II**
  Proceed as in Level I, but replace conventional tomography with either scintigraphy or CT as indicated below.

  *Skeletal scintigraphy* is indicated when plain radiographs are normal but pain persists. Scintigraphy is highly sensitive for neoplasm or infection, but is not diagnostically specific and will not detect plasmacytoma, histiocytosis or multiple myeloma. Scintigraphy should precede plain radiography when metastases or other skeletal neoplasms are suspected.

  *Computerized tomography* is indicated when clinical and neurological signs suggest the following conditions:
  (a) disc degeneration and herniation;
  (b) infection (CT will define not only the bone but also the soft-tissue component, and can guide needle aspiration);
  (c) spinal stenosis;
  (d) neurogenic tumours.

  *Myelography* may be useful when there is poor clinical, radiographic and CT correlation, and is indicated for the evaluation of disc degeneration or herniation if facilities for CT are not available.

• **Level III**
  *Magnetic resonance imaging* should be the initial imaging examination for patients with suspected disc herniation, intraspinal tumour or neural tube malformation. Additional imaging beyond plain radiography is usually not required.

### 3.2 Localized bone pain

Neurogenic, soft-tissue and vascular pain should be excluded clinically.

For the following clinical diagnoses please refer to the section indicated: back pain—section 3.1; osteomyelitis—section 3.3; metastases—section 3.4; joint disease—section 3.6; trauma—section 7.

• **Level I**
  *Radiography*. For all patients with localized bone pain radiographs are needed in two different planes.
(a) If the radiographs are normal, manage the pain clinically and re-examine the patient later. If the pain is severe and continuous, conventional tomography may provide diagnostic information.

(b) If the radiographic diagnosis is a bone tumour, conventional tomography may improve diagnostic reliability, but for the vast majority of bone tumours a histological diagnosis is essential, particularly if malignancy is likely. Pain in a bone tumour may indicate a pathological fracture.

(c) If the radiographs are diagnostic of generalized skeletal disease proceed as in section 3.2.1 below.

_Ultrasound_ can delineate the soft-tissue component in many cases.

- **Level II**
  - **Radiography.** Plain radiographs are required as in Level I.
  
  _Computerized tomography_ should be used instead of conventional tomography and will provide more information, but will seldom permit a definite diagnosis.

  _Skeletal scintigraphy_ can exclude clinically silent skeletal lesions, except in cases of plasmacytoma, histiocytosis and multiple myeloma.

  _Angiography_ will demonstrate the soft-tissue component and vascular tumours. It may increase the accuracy of diagnosis.

- **Level III**
  - _Magnetic resonance imaging_ is the imaging method of choice and permits reliable differential diagnosis. It can detect tumours that would be scintigraphically negative.

3.2.1 Generalized skeletal disease

- **Levels I and II**
  - If _radiographs_ are diagnostic of generalized skeletal disease (e.g., Paget's disease or bone dysplasia) the imaging requirements and sequence will depend on the diagnosis.

  (a) Suspected Paget's disease: lateral skull and pelvic radiographs will often confirm the diagnosis. Skeletal scintigraphy will locate other involved bones and local radiographs will then be needed.
(b) Suspected bone dysplasia: in most cases a radiographic survey will provide adequate further information to confirm the diagnosis.

c) Suspected histiocytosis, plasmacytoma or multiple myeloma: all these are scintigraphically negative; laboratory tests will be needed, with a radiographic bone survey in some cases.

Computerized tomography has little to offer in the diagnosis of generalized bone diseases.

- **Level III**

  Magnetic resonance imaging can distinguish histiocytosis, plasmacytoma and multiple myeloma but has no other indication.

### 3.3 Osteomyelitis

Early diagnosis of acute haematogenous osteomyelitis is essential so that treatment can be initiated before permanent damage to the bone has occurred. The rate of relapse or progression to chronic osteomyelitis is nearly 20%.

The differential diagnosis can be difficult because the clinical and laboratory findings may be similar for a variety of traumatic or inflammatory conditions.

Treatment of osteomyelitis in children must always start even when there is no radiological confirmation of the diagnosis.

- **Level I**

  Radiography. Plain radiographs in two projections are required. Early radiographic bone changes do not usually occur until the end of the second week after the appearance of clinical symptoms. Sensitivity is rather low: 37–51%. If the first examination is normal, follow-up radiography, if indicated, should be deferred for at least two weeks.

  In children with pyogenic osteomyelitis a chest radiograph to exclude septic pulmonary emboli is advisable, particularly if there has been a change in the patient’s temperature.

  Ultrasonography in the first week after clinical symptoms appear may be useful for the detection of subperiosteal fluid collections and soft-tissue abscesses.
Conventional tomography will demonstrate subtle bone changes a few days after symptoms appear in acute osteomyelitis as well as sequestrum formation in chronic osteomyelitis.

- **Level II**
  
  *Radiography.* In spite of their low sensitivity, plain radiographs are recommended to rule out non-inflammatory causes of localized bone pain (e.g., tumour).

  *Skeletal scintigraphy* has been shown to be more sensitive than radiography. However, a single normal bone scan does not exclude osteomyelitis.

  *Labelled white-cell or gallium scintigraphy* will increase the specificity of a positive bone scan.

  *Computerized tomography* permits reliable detection of cortical destruction, periosteal proliferation and soft-tissue extension. In addition, it allows for the correct identification of sequestra in chronic osteomyelitis.

- **Level III**
  
  *Magnetic resonance imaging* is as specific and sensitive as radionuclide scanning for the diagnosis of acute osteomyelitis. It is particularly valuable in the detection of vertebral osteomyelitis.

### 3.4 Skeletal metastases

Metastases can be the first presentation of an unknown primary tumour or the manifestation of a known malignancy. Patients may present with pain, pathological fractures or, on follow-up examination, with no clinically evident symptoms.

- **Level I**
  
  *Radiography* of the site of suspected metastasis is required (two projections).

  Additional information may be obtained from *conventional tomography*:
  
  (a) to confirm a doubtful finding on the plain film; or 
  
  (b) if additional information would change the subsequent management of the patient.
• Level II

Skeletal scintigraphy is the procedure of choice. It has high sensitivity but low specificity. A single area of increased uptake of radionuclide is an indication for plain radiography, to rule out benign causes. Multifocal areas of increased uptake of radionuclide need no radiographic confirmation, except for locations with a high risk of pathological fracture.

(a) If both skeletal scintigraphy and radiography give positive results no further imaging is required.

(b) If skeletal scintigraphy is negative, bony destruction due to histiocytosis, plasmacytoma and multiple myeloma is not excluded.

(c) If, in a single area, scintigraphy is positive but the radiograph is negative, CT may be useful to detect early bone destruction.

(d) If scintigraphy is negative on follow-up examination of a patient and there are no clinical symptoms, no further imaging is required, but the patient should be kept under clinical observation.

(e) If scintigraphy is negative but the patient has clinical symptoms, proceed with plain radiography.

• Level III

Magnetic resonance imaging will detect early skeletal metastases and plasmacytoma foci, as well as bone marrow involvement in systemic disease such as leukaemia.

3.5 Swollen extremities

Clinical differentiation must be made between swelling of developmental, cardiac, venous, lymphatic or inflammatory origin.

3.5.1 Cardiac origin

See section 2.8 on cardiac failure.
3.5.2 Venous origin

See section 2.10 on deep vein thrombosis.

3.5.3 Lymphatic origin

(1) Primary lymphoedema

This is a rare familial disorder, caused by hypoplasia of lymphatic vessels in 90% of cases. Since treatment of primary lymphoedema is almost always conservative, no invasive imaging should be performed. In particular, lymphography using oily contrast media is contraindicated.

(2) Secondary lymphoedema

Obstruction to lymph flow may occur within lymph-nodes or in the lymphatic vessels. Imaging may help to define the cause and permit treatment.

- Level I
  Ultrasonography may define the cause of the obstruction, e.g., a pelvic mass or lymphadenopathy. It is unlikely to provide an exact diagnosis.

If facilities for ultrasonography are not available, radiography of the limb or the abdomen is unlikely to provide helpful information. If a retroperitoneal mass is suspected, an excretory urogram may be helpful.

If there is lymphoedema of an arm, a chest radiograph is needed.

- Level II
  Ultrasonography is required as in Level I. If the results are unsatisfactory, computerized tomography can provide more information on pelvic or retroperitoneal masses, and identify lymphadenopathy more reliably.

Lymphography is indicated in the staging of Hodgkin's disease, and testicular tumours other than seminoma. Lymphography is difficult and not therapeutically helpful in cases of parasitic elephantiasis.

Lymphoscintigraphy may be useful to distinguish between lymphatic and venous oedema.
• **Level III**
  
  *Magnetic resonance imaging* relies on the detection of enlarged lymph-nodes. Results of controlled studies are no better than with CT.

  *Immunoscintigraphy* may be the method of choice in the future to identify lymph-node involvement not shown by other imaging methods.

3.5.4 **Developmental origin**

Swelling of developmental origin includes that caused by lympho-haemangioma and neurofibroma.

• **Level I**
  
  *Radiography*. Plain radiographs can show changes in soft tissues and bone.

  *Ultrasonography* can be used for imaging soft tissues, whether cystic or solid.

• **Level II**
  
  *Computerized tomography* can better define the extent of the lesion and the involvement of muscles and vessels.

  *Scintigraphy, angiography* and *Doppler ultrasonography* can all be used for flow studies if clinically needed.

• **Level III**
  
  *Magnetic resonance imaging* provides the most information and is the imaging method of choice.

3.6 **Joint disease**

There are numerous causes of joint disease. Clinical signs and symptoms may be limited to one joint, or there may be evidence of polyarthropathy or spondyloarthropathy.

3.6.1 **Monoarticular joint disease**

• **Level I**
  
  *Radiography*. Two projections are usually adequate. Additional views may be necessary to identify and locate erosions or loose
bodies within the joint. Views should be obtained in different positions (for example views of the temporomandibular joints with the patient's mouth open or closed).

In patients with suspected suppurative arthritis, infection cannot be excluded by a normal radiographic examination. Prompt aspiration of fluid from the joint is necessary for diagnosis.

Radiographic abnormalities may be distinctive for degenerative and certain inflammatory diseases; however, if the radiographs are normal, joint disease cannot be excluded.

_Ultrasonography_ can be used to identify the nature of soft-tissue swellings around the affected joint and to confirm joint effusions, periarticular cysts and fluid-filled bursae. Ultrasonography is the most sensitive method for detecting dislocation of the hips in newborn infants.

- **Level II**
  
  _Arthrography_ can be used to identify internal derangement, loose bodies and capsular and ligamentous abnormalities. The knee, shoulder, hip and temporomandibular joints are the most often examined.

  _Scintigraphy_ can be used to confirm avascular necrosis, or to detect inflammation.

  _Computerized tomography_ can be used to confirm internal derangement and loose bodies within joints and to demonstrate soft-tissue abnormalities around the joint.

- **Level III**

  _Magnetic resonance imaging_ is more sensitive than either arthrography or CT in demonstrating internal derangement, ligamentous tears, loose bodies and arthritis. It is better than scintigraphy in identifying avascular necrosis.

3.6.2 **Polyarticular joint disease**

Polyarticular disease includes rheumatoid arthritis, chronic gout and other polyarthritic and spondyloarthritic syndromes.
• **Level I**
  
  *Radiography.* It is usual to obtain radiographs of the affected joints at presentation, including two views of peripheral joints. For follow-up examinations of patients with chronic arthropathy only single projections may be needed. If spondyloarthropathy is suspected clinically, lateral views of the cervical and/or thoracolumbar spine plus anteroposterior views of the pelvis to show the sacro-iliac joints are usually adequate.

  Radiologically visible features of polyarthritis or spondyloarthritis may not be present at the onset of symptoms, but the initial films provide baseline records with which subsequent radiographs can be compared.

  Flexion/extension lateral views of the cervical spine are indicated if atlanto-axial dislocation is suspected in patients with rheumatoid arthritis.

  *Ultrasonography* is relevant only if there are soft-tissue abnormalities around individual joints such as juxta-articular cysts or fluid-filled bursae.

• **Level II**
  
  Proceed as in Level I.

  *Scintigraphy* may be used to identify early disease before radiographic abnormalities become apparent in either rheumatoid arthritis or ankylosing spondylitis.

  *Arthrography or computerized tomography* may be used to identify derangements of individual joints prior to surgical treatment.

• **Level III**
  
  *Magnetic resonance imaging* can be used to identify complications in individual joints.

### REFERENCES TO SECTION 3


4. ABDOMEN, PELVIS AND URINARY TRACT

4.1 Abdominal pain (adults)

Pain in the abdomen may be acute or chronic, and its cause is influenced by age and sex. The choice of imaging depends on the results of clinical examination. Abdominal radiography is unlikely to yield useful information if the pain, whether acute or chronic, cannot be clinically characterized.

4.1.1 Acute abdominal pain

Acute uncomplicated gastroenteritis is not an indication for imaging.

Acute abdominal pain is frequently accompanied by gastrointestinal or other symptoms which direct imaging towards a specific organ or diagnosis.
Level I

(a) Suspected acute appendicitis or peritonitis:

*Abdominal radiography* occasionally (less than 10% of patients) provides useful diagnostic information.

*Ultrasonography* may be useful in clinically equivocal cases; however, a normal scan does not exclude appendicitis.

(b) Suspected acute pancreatitis: see section 4.11 on pancreatic disease.

(c) Suspected urinary calculi: see section 4.12 on urinary calculus.

(d) Suspected dissection of the abdominal aorta: see section 4.3.5 on abdominal aortic aneurysm.

(e) Suspected intestinal perforation: see section 4.6 on intestinal perforation.

(f) Suspected biliary pain:

*Ultrasonography* is useful in the diagnosis of acute cholecystitis. It will demonstrate most gallstones in the gallbladder, but is unreliable for stones in the cystic and common ducts.

*Anteroposterior radiographs* are less satisfactory than ultrasound scans; however, if facilities for ultrasonography are not available, a single anteroposterior supine radiograph may be helpful.

*Contrast cholecystography* and *cholangiography* are not indicated.

(g) Suspected peptic ulcer: endoscopy or a radiological examination with contrast is required. A negative study does not exclude an ulcer.

(h) Suspected ovarian lesion: see section 4.3.10 on pelvic mass.

(i) Suspected colonic diverticulitis: endoscopy or a radiological examination with a contrast enema is required.

(j) Suspected trauma: see section 7.5 on blunt abdominal trauma.

(k) Suspected obstruction: see section 4.5 on intestinal obstruction.

(l) Suspected abdominal abscess: see section 4.3 on abdominal mass (adults).
• Level II
  Proceed as in Level I.

  Suspected biliary pain:

  *Excretory hepatobiliary scintigraphy* (which will take about 1½ hours) is accurate.

  *Computerized tomography* can demonstrate duct calculi, but a normal scan does not exclude biliary calculi. CT can provide complementary information in many cases, especially when there is an abscess.

4.1.2 Chronic abdominal pain

Chronic abdominal pain tends to be vague and imprecisely localized and seldom causes a significant change in the patient's status. There are relatively few clinical indications for imaging in the absence of localizing signs and symptoms. (If the pain is localized, indications for imaging are as detailed in section 4.1.1.)

• Level I

  (a) Suspected urinary retention:

  *Ultrasonography* will show the bladder accurately and can be repeated after (attempted) micturition.

  If facilities for ultrasonography are not available, *excretory urography* is reliable.

  If the obstruction is urethral, *contrast retrograde urethrogram* is reliable.

  (b) Suspected inflammatory bowel disease:

  A *radiological examination* of the alimentary tract with contrast is required. Plain *radiographs* of the abdomen are unlikely to provide helpful information.

  *Ultrasonography* can demonstrate thickened loops of bowel, but is nonspecific. It is helpful to exclude abscesses.

  (c) Suspected abdominal lymphadenopathy:

  *Computerized tomography or ultrasonography* can demonstrate the lymph-nodes but the results do not indicate the cause.
4.2 Acute abdominal pain (children)

Acute abdominal pain in infants and children may reflect many different medical and surgical conditions of intra-abdominal and extra-abdominal origin. In the vast majority of patients the pain is of limited duration, and in many the cause of the pain is never identified.

The course of imaging is little different from that in the adult except for certain specific paediatric diseases.

- **Level I**

  *Chest radiography* may be necessary to exclude pulmonary infection including pneumonia in the febrile patient with acute abdominal pain.

  (a) Suspected intussusception:

  *Abdominal radiography* is nonspecific, but may show intestinal obstruction or bowel necrosis/perforation in advanced cases.

  A *radiological examination with a contrast enema* can be used for both diagnosis and treatment and should be performed as an emergency procedure.

  *Ultrasonography* can be used for diagnosis and to guide reduction with a plain water enema where there is specific expertise.

  (b) Malrotation and volvulus:

  *Abdominal radiography* is nonspecific and a normal radiograph does not exclude either diagnosis.

  A *radiological examination with contrast* should be carried out as an emergency procedure in all cases to exclude or confirm the diagnosis, unless the patient is to undergo surgery immediately.

  *Ultrasonography* has also been used, but a normal scan does not exclude either diagnosis.

(c) Ascariasis:

*Ultrasonography*. Worms can be identified within various hollow viscera including the hepatobiliary system.
Abdominal radiography may reveal parasites singly or in a mass within the intestinal tract. A barium-meal study can provide exact diagnosis.

(d) Meckel’s diverticulum: see section 4.7 on gastrointestinal bleeding.

- Levels II and III

Computerized tomography, angiography and magnetic resonance imaging are rarely, if ever, indicated.

4.3 Abdominal mass (adults)

There are many causes of abdominal mass with a variety of clinical features. Some masses are palpable and yet of obscure origin; others are found as expected in a specific organ (e.g., certain metastases).

Imaging is used to identify the site of origin of the mass. Once identified, further imaging may be used to characterize the nature of the mass.

4.3.1 Palpable mass of unknown origin

- Level I

Ultrasoundography will show the organ or site of origin of masses in the majority of patients, but may not be able to locate precisely the origin of large tumours that involve several organs, particularly some pelvic masses. If the origin, extent and features of the mass can be identified, no further imaging is necessary.

Radiography. If facilities for ultrasonography are not available or scans are unsatisfactory, a supine radiograph may specifically identify certain masses (e.g., dermoid cyst, fibromyoma or echinococcal cyst), but in the majority of cases will be nonspecific and will not contribute to the management of the patient. Excretory urography is not indicated except when facilities for ultrasonography are not available and renal or retroperitoneal masses are suspected. If gastrointestinal involvement is suspected clinically, an erect abdominal radiograph should be taken. If skeletal involvement is suspected, appropriate radiographs should be taken, e.g., bony pelvis or lumbar spine. A chest
radiograph is indicated when there is an upper abdominal mass or a suspected malignant neoplasm or the patient has a fever.

For contrast studies, see section 4.3.7 on gastrointestinal mass. Unless there is strong clinical indication, a radiological examination of the gastrointestinal tract with contrast should be undertaken only after other diagnostic imaging has been completed, because residual contrast medium interferes with most other imaging investigations.

- **Level II**
  
  Ultrasonography (as in Level I) is the initial examination of choice. If the diagnosis can be made, no further abdominal imaging is necessary.

  Computerized tomography should not be used unless ultrasonography has been unsuccessful.

  Scintigraphy offers no advantages over CT. If CT equipment is not available, scintigraphy can image abdominal organs but the specificity is low. Gallium scintigraphy can localize an intra-abdominal abscess.

- **Level III**
  
  Magnetic resonance imaging has no advantage over CT or ultrasonography.

4.3.2 Hepatic mass

- **Level I**
  
  Ultrasonography should be the first examination and frequently gives sufficient information on which management decisions can be based. If scans of the liver are entirely normal, the likelihood of mass lesions of over 2 cm in diameter is extremely low; however, if a liver abscess is clinically suspected, the examination should be repeated after 24 hours because ultrasound scans may be normal in the presence of an evolving abscess.

  If malignancy is suspected and hepatomegaly increases, further ultrasound scans are indicated after two weeks or more.

  Chest radiography. If there is a large mass in the liver, posteroanterior and lateral views are indicated to visualize the diaphragm and demonstrate any pleural fluid or chest lesion.
If ultrasound scans are equivocal or not available, an anteroposterior supine radiograph of the abdomen may show hepatic calcification. If a hepatic abscess is possible, an additional erect radiograph may show a fluid-level. Such findings are not common, but can be very important for diagnosis.

- **Level II**
  *Ultrasonography* is required as in Level I, complemented by guided biopsy.

  *Computerized tomography* is effective in identifying liver masses if ultrasound scans are equivocal, but may not be able to discriminate between inflammatory and neoplastic lesions.

  *Scintigraphy* can demonstrate hepatic abscesses, tumours or metastases, but the false-negative rate is high and specificity is low.

  *Angiography* can be used to identify vascular tumours and, when facilities for CT or ultrasonography are not available, hepatic abscesses. It may be necessary before surgery.

- **Level III**
  *Magnetic resonance imaging* has the same potential for the diagnosis of a liver mass as CT.

**4.3.3 Biliary mass**

- **Level I**
  *Ultrasonography* can demonstrate a dilated gallbladder and biliary calculi. The differentiation of an empyema of the gallbladder is not difficult, but malignancy cannot be reliably recognized unless spread of the tumour can be demonstrated. A choledochal cyst is easily recognized.

  *Abdominal radiography* is unlikely to show a dilated gallbladder, although gallstones may be seen.

- **Level II**
  *Ultrasonography* may be useful, as in Level I.

  If ultrasound diagnosis is either unsuccessful or equivocal, *computerized tomography* can provide reliable images of the gallbladder.
• **Level III**
  *Magnetic resonance imaging* is as reliable as CT for demonstrating an enlarged gallbladder.

4.3.4 Retroperitoneal mass

1) **Renal mass**

Renal masses may be of congenital, neoplastic or inflammatory origin.

• **Level I**
  *Ultrasonography* is highly specific in differentiating cystic lesions from solid lesions, but cannot differentiate benign from malignant solid masses. When all sonographic criteria for cystic renal disease are present, cyst puncture and further diagnostic imaging are unnecessary.

  *Plain radiography* may show renal enlargement, but is seldom more specific.

  *Excretory urography*, even with tomography, is less accurate than ultrasonography in separating cystic from solid masses and has a high false-negative rate. Excretory urography is useful for demonstrating hydronephrosis and may show the cause. It can also be used to check contralateral renal function before surgery. Cystography may be necessary.

• **Level II**
  *Ultrasonography* may be useful as in Level I. *Colour Doppler ultrasonography* may contribute to the differentiation of benign from malignant masses.

If ultrasound scans are equivocal or unsatisfactory, *computerized tomography* can provide a clear demonstration of cystic and solid masses, and can be used for staging malignant tumours and checking the function of the opposite kidney. Careful technique and correlation with previous examinations will result in a very low error rate.

*Scintigraphy* can be used to evaluate renal function, pseudotumours, hydronephrosis and renal abscesses.
Angiography is of limited value following ultrasound and CT evaluation for assessing vascular extension in cases of renal malignancy. DSA is an accurate and less invasive alternative to conventional angiography. When facilities for ultrasonography or CT are not available, renal arteriography can provide useful information.

- **Level III**
  
  Magnetic resonance imaging shows vascular extension of malignancy but is less accurate than CT in detecting small tumours.

(2) **Non-renal mass**

Retroperitoneal masses not arising in the kidneys may be adrenal masses, enlarged lymph-nodes due to lymphoma, metastases or retroperitoneal lipomas and sarcomas. A psoas abscess can also present as a retroperitoneal mass.

- **Level I**
  
  Ultrasonography can identify lymph-node enlargement and other non-renal retroperitoneal masses.

  Excretory urography will only demonstrate masses that either displace or obstruct the urinary tract. If the results are normal, a mass is not excluded.

  Abdominal radiographs may be entirely normal in the presence of large adrenal tumours or nodal masses. A minority of adrenal cysts and carcinomas are calcified and can be identified by radiography. Conventional linear tomography may provide more information.

- **Level II**
  
  Proceed as in Level I.

  Computerized tomography should be used when ultrasonography fails to establish a definite diagnosis of adrenal mass or lymph-node enlargement (sensitivity and specificity are significantly greater for the former technique). A normal CT scan excludes primary retroperitoneal tumours of over 1 cm in diameter; most adrenal tumours causing Cushing's syndrome can be identified. CT demonstration of normal lymph-nodes does not exclude
malignancy. Differentiation between inflammatory and malignant lymphadenopathy is not possible.

CT guidance for the biopsy of retroperitoneal masses is preferable to ultrasound guidance.

*Scintigraphy* can locate functional adrenal tumours. The sensitivity of [131I]MIBG for detecting phaeochromocytomas is 78–92%, and its specificity is also high. Whole-body scanning with [131I]MIBG is useful for finding extra-adrenal phaeochromocytomas. [131I]Iodocholestrol can be used to locate small cortical tumours responsible for primary aldosteronism. In Cushing’s syndrome, scintigraphy is usually able to differentiate between adenoma and hyperplasia.

- **Level III**
  
  *Magnetic resonance imaging* has no obvious advantage over CT in the assessment of retroperitoneal masses except for phaeochromocytomas.

### 4.3.5 Abdominal aortic aneurysm

Most aneurysms are arteriosclerotic and 90% of these involve the abdominal aorta below the origins of the renal arteries. The aneurysms of aortitis (aorta-stenosing aortitis) are more common in those aged under 30 years, especially women, and may involve any part of the aorta.

- **Level I**
  
  *Ultrasonography* can demonstrate the aneurysm and permit measurement of its length and diameters. Lesions of over 4 cm in diameter, even in symptomless patients, should be monitored regularly. The extension of the aneurysm downwards cannot always be recognized.

*Abdominal radiography* with anteroposterior and lateral views can demonstrate the arteriosclerotic aneurysm in 60–80% of cases, but assessment of extent and size is not so accurate as with ultrasonography.
• **Level II**
  Proceed as in Level I.

  *Colour Doppler ultrasonography* can be used to demonstrate renal and iliac artery involvement more clearly.

  *Enhanced computerized tomography* is usually able to show the origins of the renal arteries and the presence of an intraluminal clot. CT can demonstrate haemorrhage from the aneurysm better than ultrasonography can.

  *Arteriography* is used less often when facilities for CT and ultrasonography are available, unless surgery is planned. However, DSA, particularly with the intravenous technique, may have a role in assessing renal and iliac artery involvement.

  *Scintigraphy* has no place in the investigation of arteriosclerotic aneurysm.

• **Level III**
  *Magnetic resonance imaging* has advantages over ultrasonography and CT by providing images in the coronal and axial planes. It can reliably demonstrate the renal and iliac vessels and does not require contrast. Ultrasonography is still preferable for monitoring smaller aneurysms in symptomless patients.

4.3.6 **Pancreatic mass**
  See section 4.11 on pancreatic disease.

4.3.7 **Suspected gastrointestinal mass**
  See also section 4.7 on gastrointestinal bleeding and section 4.1 on abdominal pain.

• **Level I**
  *Plain radiography* is not indicated because, even if the results are normal, a tumour is not excluded. A *radiological examination preferably with double contrast*, can reliably demonstrate a tumour in the stomach or duodenum. Endoscopy will be necessary for tissue identification in certain parts of the gastrointestinal tract. A contrast enema is indicated for tumours of the large bowel; double contrast is more sensitive for small mass lesions.
*Abdominal ultrasonography* can be used to identify or exclude hepatic metastases when a tumour of the gastrointestinal tract has been identified.

*Chest radiography* to exclude pulmonary metastases is recommended before surgery.

- **Level II**
  Proceed as in Level I.

  If ultrasound scans are equivocal for hepatic metastases, *computerized tomography* can be used and can also demonstrate enlargement of lymph-nodes due to metastasis.

  *Scintigraphy* can also be used to show hepatic metastases but is much less sensitive.

- **Level III**
  *Magnetic resonance imaging* does not have any advantage over CT or ultrasound imaging.

### 4.3.8 Suspected intra-abdominal abscess

Intra-abdominal sepsis, suspected on clinical grounds, does not often present with a palpable mass except in children, and the location or presence of intra-abdominal sepsis may be clinically uncertain. Patients are usually extremely ill and difficult to examine.

- **Level I**
  *Ultrasonography* will identify the depth and extent of a palpable mass prior to percutaneous or surgical drainage. It will show most abscesses in or around the liver, spleen or kidneys or in the pelvis, which is useful if the diagnosis of an abscess or other inflammatory mass in the abdomen is uncertain. Abscesses located centrally or in the left side of the abdomen may be obscured by overlying bowel and can be more difficult to identify unless the patient can be rotated.

  *Abdominal radiography* with horizontal-beam films may show fluid-levels in abscess cavities not accessible to ultrasound. Contrast medium given orally may be necessary to locate the stomach, which may be displaced by a left subphrenic abscess. Radiography is much less sensitive than ultrasonography.
Chest radiography may show elevation of the diaphragm due to a subphrenic abscess. If an intra-abdominal abscess is still suspected, even if the initial investigation has not contributed to the diagnosis, a further examination is indicated.

- **Level II**
  Ultrasonography is the investigation of choice to confirm and locate an intra-abdominal abscess and, if satisfactory, no further investigation will be necessary prior to percutaneous or surgical drainage.

  If ultrasonography fails to locate an abscess, abdominal computerized tomography can identify fluid collections in the peritoneal cavity or retroperitoneum.

  Neither CT nor ultrasonography can show whether a fluid collection, even if loculated, is infected, so that fine-needle aspiration is needed for microbiological confirmation. When the bowel is distended some abscesses may not be identified.

  Scintigraphy is indicated only in a small proportion of patients in whom ultrasonography and CT have been equivocal. Leukocyte scintigraphy is more effective than gallium scintigraphy in locating pyogenic abscesses, and takes less time to perform. Either may be used to confirm that a fluid collection shown by CT or ultrasonography is infected, in situations where fine-needle aspiration would be difficult.

### 4.3.9 Splenomegaly

- **Level I**
  Ultrasonography can easily and accurately show spleen size, and splenic infarction, and may provide some information about malignant infiltration. Cystic lesions can be recognized. A splenic abscess can be identified.

  An erect abdominal radiograph may show a fluid-level in a splenic abscess.

- **Level II**
  Computerized tomography can recognize splenomegaly, infection and infarction.
• **Level III**
  
  *Magnetic resonance imaging* is less sensitive than CT.

4.3.10 *Pelvic mass*

Pelvic masses may arise from the bowel, urinary tract or pelvic skeleton, but a gynaecological mass is most common. Patients with urinary or colorectal neoplasms are more likely to present with obstructive or bleeding symptoms than with palpable masses arising in the pelvis.

Pregnancy must always be considered as an explanation for a pelvic mass in the female.

• **Level I**
  
  *Ultrasoundography* can identify 90% of pelvic masses; it is less sensitive in identifying their site of origin. Pelvic abscesses or other cystic lesions may be identified, but it is difficult to distinguish between ovarian carcinoma and a simple ovarian cyst. Correlation with clinical findings is very important, as sonographic findings are often nonspecific. Ultrasonography can be used to identify lymphadenopathy and demonstrate tumours arising from the bony pelvis.

If a bony tumour is likely, *skeletal radiography* is indicated before ultrasonography.

If facilities for ultrasonography are not available, a *supine radiograph* may provide some information, but is unlikely to influence treatment. When there are clinical signs of intestinal obstruction, an erect anteroposterior view should be added. If a rectal or colonic mass is suspected, a contrast enema is indicated, preceded by endoscopy.

If the urinary tract is involved, an *excretory urogram* is indicated, with a post-micturition view if possible.

• **Level II**
  
  Proceed as in Level I. *Ultrasoundography* and *radiography* have the same indications.

*Computerized tomography* may differentiate masses when ultrasound scans are either equivocal or unsatisfactory.
Lymphadenopathy can be demonstrated, but malignant involvement cannot be determined.

*Lymphography* gives a better assessment of metastatic spread to pelvic lymph-nodes but does not visualize the internal iliac group. A normal lymphogram does not exclude metastatic spread.

- **Level III**
  *Magnetic resonance imaging* may be more useful in the evaluation of lymph-node metastases, but further experience is needed to estimate its accuracy. In other respects it provides the same information as CT, although it is possibly a little more sensitive in demonstrating tissue invasion from a primary tumour or extra-nodal metastases.

MRI can demonstrate submucosal uterine tumours as small as 0.3 cm in diameter with nearly 100% sensitivity.

### 4.4 Abdominal mass (children)

Abdominal masses in infants and children may be of congenital, neoplastic, inflammatory or traumatic origin. The palpable mass is the presenting clinical complaint in 90% of cases. Symptoms may be limited to the abdomen or be more widespread with associated signs. The objectives of imaging are to identify and localize the mass, to characterize its structure and extent, and to guide diagnostic and therapeutic procedures. The guidelines for imaging in adults also apply to children (see section 4.3).

- **Level I**
  *Ultrasonography* should be used first to localize the mass and identify cystic and solid or mixed lesions. In some cases of developmental anomalies and inflammatory disease, ultrasound scans are diagnostic.

If ultrasound results are equivocal, *thoraco-abdominal radiography* may be used to show calcification in a mass, bone lesions and anomalies, and pulmonary metastasis. Otherwise the plain radiograph is of little diagnostic value.

*Excretory urography* can be used for further localization and morphological characterization in equivocal cases. If facilities for ultrasonography are not available, excretory urography should be
the initial imaging study. *Venacavography* may be combined with excretory urography.

*Voiding cysto-urethrography* can identify the site, cause and sequelae of lower urinary tract obstruction and some pelvic tumours.

*Radiological examination* of the gastrointestinal tract with *contrast* occasionally provides useful diagnostic information.

*Genitography* is indicated only in cases of uterovaginal malformation, and is occasionally needed after ultrasonography.

- **Levels II and III**
  Proceed with *ultrasonography* as in Level I. The presumptive diagnosis will then be established.

  Additional imaging is indicated only if the diagnosis is in doubt or additional information is necessary for treatment. The imaging sequence is determined by the type of mass suspected.

  *Arteriography* and *venacavography* are rarely indicated unless facilities for CT and ultrasonography are not available, but arteriography may be necessary to localize hepatic malignancy prior to surgery.

  *Gallium scintigraphy* is not indicated in children.

  (a) Suspected hydronephrosis:

  *Renal scintigraphy* with dynamic and static imaging is more sensitive than excretory urography in evaluating renal function, especially in the neonate.

  (b) Suspected Wilms' tumour (nephroblastoma):

  *Computerized tomography* can be used to define the tumour and is sensitive for the detection of bilateral disease. Chest CT should be included with abdominal CT to check for metastasis. Extension of the tumour into the vena cava can be evaluated by ultrasonography or CT.

  *Magnetic resonance imaging* is sensitive for showing vascular extension but is usually unnecessary.
(c) Suspected neuroblastoma:

*Computerized tomography* shows tumour calcification better than plain radiography, and accurately defines its extent.

*Scintigraphy*. Skeletal scintigraphy (technetium) is indicated for the evaluation of metastases once the diagnosis is established. $[^{131}I]MIBG$ scintigraphy should be used to detect bone-marrow metastases (sensitivity 90%). MIBG can also be used to identify an occult primary tumour.

*Magnetic resonance imaging* is most useful for staging the mass, and is better than CT for defining local tumours extending to lymph-nodes and blood vessels.

(d) Suspected hepatic haemangioendothelioma:

*Ultrasonography*, while not diagnostically specific, is most useful for clinical follow-up. *Doppler ultrasonography* may be helpful.

*Hepatic scintigraphy* with dynamic and static imaging is highly sensitive and specific, and may be the primary imaging examination when a haemangioendothelioma is strongly suspected on clinical grounds.

*Arteriography* is indicated only if medical management is unsuccessful and embolization is necessary.

*Computerized tomography* and *magnetic resonance imaging* are not indicated.

(e) Suspected neonatal adrenal haemorrhage—the diagnosis is usually suggested clinically:

*Ultrasonography* is highly sensitive and specific, and can be used to follow resolution of the haematoma.

*Computerized tomography*, *scintigraphy* and *magnetic resonance imaging* are not indicated.
4.5 Intestinal obstruction

Even in these days of sophisticated technology, the diagnosis of intestinal obstruction is based almost entirely on plain radiography and contrast studies.

- **Level I**
  
  *Abdominal radiography*, including supine and erect anteroposterior views, should be the first imaging procedure. In infants and small children, and in patients unable to stand, a horizontal-beam decubitus or supine lateral view may be used. Radiography is 80% sensitive in identifying obstruction but is relatively nonspecific. If the radiographs are normal, obstruction is not entirely excluded.

  *Chest radiography* is necessary to identify pneumonia, especially in elderly adults and young children.

The subsequent course of imaging will be determined by the presence or absence of obstruction, the apparent level of obstruction, and other findings, e.g., intestinal perforation.

(a) Normal radiographs: no further imaging is needed. A strangulating obstruction is not excluded.

(b) Abnormal radiographs: in some cases the plain radiographic diagnosis of obstruction is sufficient to allow for definitive therapy; in others a radiological examination of the gastrointestinal tract with contrast is necessary.

(c) Colonic or low small-bowel obstruction: a radiological examination with a contrast enema will usually reveal the level of obstruction but is relatively nonspecific. Contrast medium given orally is rarely indicated for the diagnosis of low intestinal obstruction.

(d) Gastric and high small-bowel obstruction: when acute, contrast studies are not indicated. When the obstruction is chronic, contrast medium given orally is reliable in identifying the site of obstruction, but less reliable in identifying the cause.

*Ultrasonography*. If plain radiographs are equivocal, ultrasound scans may be used to delineate distended, fluid-filled loops of bowel with thick walls. Inflammation and gastroenteritis must be excluded in such cases.
(a) Suspected pyloric stenosis: ultrasonography is a sensitive and specific method for the diagnosis. If facilities for ultrasonography are not available, a radiological examination of the upper gastrointestinal tract with contrast can provide useful information; however, if the results are normal, stenosis is not excluded.

(b) Suspected intussusception: ultrasonography may demonstrate the intussusceptum, but if the large bowel is involved, a fluoroscopically controlled contrast enema should follow so that the diagnosis can be confirmed and reduction attempted.

- Levels II and III
  
  Computerized tomography, scintigraphy and magnetic resonance imaging are not indicated, and provide no useful diagnostic information in a patient with acute intestinal obstruction.

4.6 Intestinal perforation

Intestinal perforation may present with pneumoperitoneum and/or peritonitis.

- Level I

  Abdominal radiography. When the patient is able to stand, supine and erect anteroposterior views should be obtained; the supine abdominal radiograph should include the pelvis. In patients unable to stand and in infants and small children, lateral decubitus or supine lateral horizontal-beam films should be substituted for the erect view. The diaphragm should be included in all horizontal-beam views.

  Normal or nonspecific radiographic findings do not exclude perforation, and continued surveillance is suggested, with further abdominal radiography where necessary.

  Ultrasonography may be useful in evaluating patients if no pneumoperitoneum is visible on plain abdominal radiographs; it should precede gastrointestinal contrast studies.

  Radiological examination of the gastrointestinal tract with contrast may be indicated if the results of other imaging studies are equivocal and there is strong clinical evidence for “silent” perforation. The choice of studies of the upper or lower
gastrointestinal tract is influenced by clinical findings. A water-soluble contrast medium is usually used.

- **Levels II and III**
  Imaging beyond Level I is rarely indicated.

### 4.7 Gastrointestinal bleeding

The cause of gastrointestinal bleeding varies with the age of the patient and the site of bleeding, either upper (oesophagus to jejunum) or lower (ileum to rectum). The site is usually suggested clinically (e.g., haematemesis as compared with melaena), and the diagnosis can often be established by endoscopy without recourse to imaging. The severity and acuteness of bleeding will, to a large extent, direct the sequence of imaging. Resuscitation must be maintained during any imaging procedure.

#### 4.7.1 Acute bleeding

In the acute stage, therapy is based on the severity of the bleeding and the diagnosis is usually established by endoscopy.

1. **Severe, massive haemorrhage**
   - **Level I**
     Chest and abdominal radiography, ultrasonography and contrast studies play no significant role in evaluation of the patient, and in fact may compromise the clinical condition and delay necessary therapy.

   - **Level II**
     Abdominal arteriography is indicated in patients with severe, life-threatening haemorrhage to identify the site of bleeding when it cannot be identified endoscopically; it allows for therapeutic embolization. Angiography is not indicated when active bleeding has stopped, or for the evaluation of acutely bleeding oesophageal varices.

     Scintigraphy, using radiolabelled red blood cells or colloid, can also localize intestinal bleeding, and provides guidance for the endoscopist, surgeon or angiographer. Multiple sequential
scintigraphy over a 24-hour period is useful in patients with intermittent haemorrhage.

(2) **Subacute haemorrhage**

- **Level I**

  *Abdominal radiography* provides no useful diagnostic information.

  *Radiological contrast studies* of the upper and lower tract complement endoscopy.

  *Ultrasonography* can be used to evaluate the splenoportal venous system in patients with oesophageal varices.

- **Level II**

  *Scintigraphic angiography* can be used to identify the site of bleeding.

  *Technetium pertechnetate scintigraphy* is the most sensitive imaging method for diagnosing Meckel’s diverticulum, even without bleeding.

  *Arteriography* is indicated if bleeding persists and the results of endoscopy and other imaging studies are normal.

  *Portal venacavography* is indicated prior to the surgical construction of a shunt for bleeding oesophageal varices.

**4.7.2 Chronic bleeding**

Laboratory evidence of occult bleeding must be present before any imaging is undertaken. Endoscopy may or may not precede imaging in such cases.

- **Level I**

  *Radiological examination* of the gastrointestinal tract with a contrast enema may occasionally help in identifying the source of bleeding.

  *Abdominal radiography* and *ultrasonography* provide no useful diagnostic information.
• **Level II**  
   *Scintigraphy* and *angiography* may be useful when evidence of bleeding persists; prompt examination is indicated if active bleeding recurs.

• **Level III**  
   *Magnetic resonance imaging* provides no useful diagnostic information.

### 4.8 Ascites

Ascites is defined as free fluid within the intraperitoneal cavity, including serous fluid, blood, chyle, urine, pus and bile.

In the majority of cases, clinical and laboratory evaluation of patients with ascites is sufficient. However, in some cases, even when the cause of ascites seems clear, it is important to look for another disease that might supervene; for example, a patient with ascites due to liver cirrhosis may have an occult hepatoma.

• **Level I**
  
  *Abdominal ultrasonography.* As little as 100 ml of ascitic fluid can be detected (sensitivity 80–95%). If no ascites is found, no further imaging is needed. If there is ascites, ultrasound should be used to search for a concomitant pleural effusion; chest radiography is required if an effusion is detected.

  If facilities for ultrasonography are not available, *plain abdominal radiography* can be helpful, but in adults can only detect volumes of 800 ml of fluid or more.

• **Level II**  
  
  When ultrasonography does not demonstrate the cause of the ascites, or when there is massive ascites, *computerized tomography* can be used. It is particularly reliable in the recognition of retroperitoneal causes.

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1 Diagnosis based on percutaneous aspiration of ascites fluid is unreliable but can be useful in the rare cases of granulomas caused by starch from surgical gloves.
If portal hypertension is a possible cause, *Doppler ultrasonography* can be used.

- **Level III**
  *Magnetic resonance imaging* currently has no advantage over CT.

### 4.9 Jaundice (adults)

Clinical differentiation must be made between haemolytic, cholestatic and hepatocellular jaundice. No imaging is indicated for hepatocellular jaundice. Abdominal imaging will rarely be necessary in cases of haemolytic jaundice except to demonstrate suspected pigment calculi; skeletal radiography and scintigraphy can be used to demonstrate bone infarction and infection.

#### 4.9.1 Cholestatic jaundice

It is important to distinguish between medical and surgical causes because surgery is not beneficial for patients with hepatitis and carries a high mortality rate, while decompression is essential in obstructive jaundice.

- **Level I**
  *Ultrasonography* of the liver and biliary tract is indicated. Major bile-duct dilatation predicts obstruction with a high degree of reliability. The absence of dilated ducts does not entirely exclude obstruction (specificity 90%).

  Ultrasonography is less reliable in identifying the cause of biliary obstruction, but if the level and cause of obstruction are demonstrated, no further imaging is necessary.

  If ultrasound scans are normal, further scans should be obtained if bilirubin concentrations in serum do not fall.

  *Abdominal radiography* seldom provides any useful diagnostic information and is unreliable in the diagnosis of gallstones.

  *Oral and intravenous biliary contrast studies* are contraindicated in jaundiced patients.
• **Level II**
  
  *Ultrasonography* is indicated, as in Level I.

  *Computerized tomography* will demonstrate pancreatic and hepatic tumours, biliary parasites, and some low common-duct calculi not seen on ultrasound scans.

  *Percutaneous transhepatic cholangiography* guided by ultrasound is highly reliable in demonstrating the cause of obstruction when CT is not available.

  *Endoscopic retrograde cholangiopancreatography* is indicated if the site of obstruction cannot be identified by ultrasonography or CT.

  *Hepatobiliary excretory scintigraphy* may show biliary obstruction but is nonspecific.

• **Level III**

  *Magnetic resonance imaging* has no diagnostic advantage over ultrasonography and CT.

  

4.10 **Jaundice (children)**

Indications for imaging are the same as for adults (see section 4.9).

• **Level I**

  *Ultrasonography*. Cholestatic jaundice in children due to hepatobiliary infestation with ascarides and other parasites is readily diagnosed, as is prolonged neonatal jaundice due to a choledochal cyst.

• **Levels II and III**

  *Hepatobiliary excretory scintigraphy* can be used in the neonate with prolonged jaundice, to differentiate between neonatal hepatitis and biliary atresia.

  

4.11 **Pancreatic disease**

Patients with pancreatic disease present with a wide range of signs and symptoms, including abdominal or back pain, weight loss, jaundice, diabetes and steatorrhoea.
Laboratory findings are specific in the diagnosis of acute pancreatitis.

- **Level I**
  
  *Ultrasonography* is not always satisfactory because of overlying bowel gas. When technically acceptable, ultrasound scans can show pancreatic abnormality.

  Ultrasonography can be used for the definitive diagnosis of:
  
  - (a) pancreatic cysts or pseudocysts (without always being able to differentiate);
  - (b) biliary calculi, which can be associated with pancreatitis;
  - (c) dilated bile ducts.

  It is seldom possible to differentiate between pancreatitis and carcinoma of the pancreas. If ultrasound results are inconclusive, further imaging is necessary.

  *Plain radiography of the abdomen* may show pancreatic calcification in chronic pancreatitis or lithiasis; it cannot, however, differentiate between the two conditions. Calculi may be seen in the biliary system. A small persistent loop of gas-filled small bowel in the upper abdomen overlying the pancreas may indicate pancreatitis. This is a helpful indicator, but is not reliable for diagnosis. A normal radiograph does not exclude pancreatic disease.

  *Radiological examination* of the upper gastrointestinal tract with contrast may demonstrate abnormalities suggestive of an enlarged pancreas, but the findings are very nonspecific.

  *Chest radiography* will show a left-sided pleural effusion in 30% of patients with acute pancreatitis. A normal chest radiograph does not exclude pancreatitis.

- **Level II**
  
  Proceed as in Level I.

  *Ultrasonography* should be the first investigation. Duplex or Doppler ultrasonography can show the patency of the peripancreatic vasculature. Ultrasonography can also guide fine-needle biopsy of the pancreas.

  *Computerized tomography* is indicated if ultrasound results are negative or equivocal, and can further evaluate pancreatic mass
lesions prior to surgery. Pancreatic enlargement can be demonstrated, but it is not possible to differentiate between a carcinoma or an inflammatory mass.

*Scintigraphy* is not helpful.

*Endoscopic retrograde cholangiopancreatography* is used to evaluate the pancreatic duct, particularly if a congenital duct abnormality is suspected in painful chronic pancreatitis, and in some cases of malignancy when other imaging has been inconclusive.

*Percutaneous transhepatic cholangiography* is indicated only if there is evidence of biliary obstruction (see section 4.9 on jaundice).

*Arteriography* is specific for the diagnosis of islet-cell tumours. It is used less frequently for diagnosing other pancreatic diseases if CT facilities are available, but may be helpful prior to surgery. Arteriography cannot distinguish pancreatitis from carcinoma. Where there is an endocrine tumour, arterial and transhepatic portal-vein sampling is of major importance.

- **Level III**
  
  *Magnetic resonance imaging* is less sensitive than CT in the diagnosis of pancreatic disease and does not allow definite distinction between chronic infection and malignancy.

### 4.12 Suspected urinary calculus

Urinary calculi may be found in the kidneys, ureters or bladder. Patients may be asymptomatic, have relatively little pain during passage of the calculi or have severe symptoms related to ureteral obstruction, localized irritation or infection. Haematuria (usually microscopic) is almost always present.

The purpose of imaging is to identify and localize the calculus/calculi, to characterize stone structure and to identify coexistent conditions responsible for stone formation.

- **Level I**
  
  *Abdominal radiography* will establish the diagnosis in many cases. *Conventional tomography* will provide further information. Once identified, many calculi can be followed clinically and with plain
radiography. If urinary obstruction is likely, ultrasonography should be used.

*Excretory urography* should be used after abdominal radiography to localize calculi when necessary, and to evaluate renal function and obstructive uropathy.

*Cysto-urethrogram* may follow excretory urography to evaluate the bladder for diseases of the lower urinary tract that predispose to stone formation (e.g., schistosomiasis).

*Ultrasonography* is a highly sensitive method for renal stone detection; it is more sensitive than plain radiography alone, but slightly less sensitive than the combination of abdominal radiography and conventional tomography. The ability to detect renal stones with ultrasonography depends on size; the smallest calculus that can be recognized is about 5 mm. Ultrasonography is less sensitive for the detection of ureteral calculi.

- **Level II**
  Beyond basic Level I imaging, other advanced procedures are rarely indicated.
  
  *Renal scintigraphy* can be used to assess renal function when there is renal failure associated with coexisting renal disease or obstruction.

- **Level III**
  *Magnetic resonance imaging* is not applicable.

### 4.13 Renal failure

The purpose of imaging is to distinguish acute from chronic renal failure, to identify abnormalities that will influence treatment and outcome, and to guide needle biopsy. In selecting patients for imaging, the highest priority should be given to those suffering from conditions that are potentially reversible.

#### 4.13.1 Acute renal failure

- **Level I**
  
  *Ultrasonography* will show renal size and provide reliable morphological information, particularly in obstructive uropathy.
Excretory urography may be needed if the cause of the obstruction is not demonstrated. Intravenous contrast agents may worsen renal function in some patients, and all patients must be well hydrated before urography.

Abdominal radiography may show renal size if ultrasonography is not successful.

Conventional linear tomography improves radiographic assessment of renal size and shape if ultrasonography is not successful.

- **Level II**
  Ultrasonography is indicated, as in Level I.

  Renal scintigraphy is preferable to excretory urography and will reliably demonstrate renal size and obstructive uropathy. Renal anatomy is poorly shown.

  Computerized tomography may be helpful if ultrasonography is unsuccessful and scintigraphy facilities are unavailable. It may also demonstrate a retroperitoneal tumour or fibrosis producing ureteral obstruction.

- **Level III**
  Magnetic resonance imaging is unlikely to provide more useful information than ultrasonography or CT.

4.13.2 Chronic renal failure

In cases where renal parenchymal disease is established, imaging is indicated only to demonstrate obstructive uropathy.

- **Level I**
  Plain abdominal radiography can demonstrate nephrocalcinosis or papillary necrosis.

  For other patients with chronic renal failure, see section 4.13.1 on acute renal failure.

4.14 Prostatic disease

Prostatic disease in an adult is characterized by increasing difficulty in micturition and/or a large prostate gland on clinical examination.
No imaging method can accurately distinguish between benign and malignant disease: biopsy is needed. The main indications for imaging are assessment of prostate size, urinary obstruction and staging of known carcinoma of the prostate.

- **Level I**
  *Ultrasonography* of the bladder, prostate and kidneys is indicated.

  *Excretory urography* does not contribute to management of the patient except for the staging of known carcinoma.

  No further imaging at this level is clinically helpful.

- **Level II**
  Proceed as in Level I.

  *Intracavitary ultrasonography* may produce further useful information when there is clinical evidence of malignancy; however, the predictive value is low. It can be used for guided biopsy.

  *Computerized tomography* of the abdomen and pelvis is indicated only for the staging of proven malignancy. For nodal metastasis its sensitivity is 85% and its specificity is about 65%.

  *Skeletal scintigraphy* is indicated for the staging of proven malignancy.

  *Lymphangiography* is of limited value other than for the staging of malignancy prior to radical surgery.

- **Level III**
  *Magnetic resonance imaging* is more sensitive than CT for the staging of prostatic carcinoma.

### 4.15 Scrotal mass

A scrotal mass may be cystic or solid, and is discovered by palpation or transillumination.

- **Level I**
  *Ultrasonography* will localize the mass precisely and differentiate solid from cystic masses, but is not specifically diagnostic.
When an epididymal mass is suspected, especially in children, the kidneys should be examined by ultrasonography and excretory urography performed to check for associated abnormality, which will be found in 40% of cases. If schistosomiasis is a possible cause of an epididymal mass, the ureters and bladder can be checked by ultrasonography (or excretory urography).

If malignancy is suspected, ultrasonography can be used to assess lymph-node involvement but it is not very sensitive and is nonspecific.

- **Level II**
  Ultrasonography is indicated, as in Level I.

  *Computerized tomography* is more sensitive in the demonstration of lymphadenopathy (60%), but its specificity is low. Even if lymph-nodes appear normal on ultrasound scans or by CT, malignancy is not excluded.

  *Lymphangiography* can demonstrate metastatic spread to apparently normal lymph-nodes, but there is a 20% false-positive and a 20% false-negative rate.

  *Angiography* is helpful for the embolization of varicocele.

- **Level III**
  Magnetic resonance imaging is rather more sensitive than CT in demonstrating lymphadenopathy but specificity remains low.

**REFERENCES TO SECTION 4**


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5. OBSTETRICS AND GYNAECOLOGY

Diagnostic ultrasound has been used in obstetrics for over a quarter of a century. It provides a direct, easy and (so far as is currently known) safe way of imaging the fetus, for both serial observation and measurement. It is the first choice for imaging pregnant women even where other imaging methods are available.

In a number of industrialized countries of the world, for example, France, the Federal Republic of Germany, Italy, Japan, the Netherlands, and the United Kingdom, there is widespread use of ultrasound for routine screening in pregnancy. There is substantial evidence in the literature that ultrasonography has advantages for the diagnosis of certain complications of pregnancy. However, at present, no data unequivocally suggest benefit from its routine use in prenatal and intrapartum care. This does not imply that it is not beneficial. Rather, in some cases the appropriate study has not been performed and in others the sample sizes have been inadequate, so that statistically acceptable results have not been achieved. Thus opinions differ concerning the routine use of ultrasonography in pregnancy, and the final answer will only be given after further very careful study.

There is no doubt that the value of the clinical information obtained from an ultrasound scan is very dependent on the skill of the operator. Ultrasound diagnosis demands ability both to interpret images and to master the scan technique and the gain control and dynamic focus settings of the equipment, and adjust each according to the position of the fetus, the size of the mother, the amount of amniotic fluid and many other variables. The quality of ultrasound equipment has improved considerably in the last decade, and it is now much easier to use. The diagnostic accuracy has also been improving, largely owing to training courses in ultrasonography. However, there is still enormous scope for further improvement in training and certification. In 1984, a WHO Scientific Group made specific recommendations for required training and experience at different levels and stated that “the purchase of ultrasound equipment without making provision for training of an operator is contrary to good health care practice and is unlikely to be cost-effective”. The present Scientific Group strongly endorsed that statement.
5.1 Obstetrics

5.1.1 Discrepancy in dates

Discrepancy in gestational age is commonly caused by wrong clinical or maternal estimation or by multiple pregnancy, and less frequently by hydramnios or oligohydramnios, tumours associated with pregnancy and intrauterine growth retardation.

- **Level I**
  *Ultrasoundography* should include measurements of gestational sac volume, crown–rump length, biparietal diameter and femoral length. The measurements are highly accurate for establishing gestational age in the first and second trimester; of these, crown–rump length is the most accurate in the first trimester. Measurement of biparietal diameter is very reliable from 10 to 26 weeks of gestation. The measurement of femur length is useful when there is an abnormality of the skull.

If facilities for ultrasonography are not available, a fetus can usually be detected radiographically after 20 weeks' gestation, but this is not a reliable way of assessing age and is not recommended. In the last trimester, radiography can more accurately indicate gestational age, but never with the exactness of ultrasonography.

Ultrasonography can reliably demonstrate multiple pregnancy; this should be done at 16–18 weeks' gestation. If facilities for ultrasonography are not available, radiographs can demonstrate multiple pregnancy from 20 weeks onwards, but are not recommended until the last trimester, to minimize radiation risk.

- **Levels II and III**
  Proceed as in Level I. No further imaging is indicated.

5.1.2 Pain in pregnancy

Pain during any phase of gestation may or may not be associated with the pregnancy. In early pregnancy, ectopic gestation is the commonest cause; other causes are rare. (For abdominal pain not related to pregnancy, see section 4.1.)
• **Level I**
*Ultrasonography* can reveal ectopic gestation with 75% accuracy. The demonstration of a live embryo or fetus outside the uterus is definitive.

Spontaneous abortion is more likely to present as bleeding than as pain (see 5.1.3 on bleeding in pregnancy).

• **Level II**
Proceed as in Level I, but the ultrasound results are more specific if interpreted together with a sensitive radioimmunoassay of the beta subunit of human chorionic gonadotrophin in the patient’s blood serum or urine. The combination of a positive serum pregnancy test and the absence of an intrauterine gestational sac on pelvic ultrasound scans accurately predicts ectopic pregnancy in more than 90% of cases. A significant improvement in accuracy can be obtained by using a high-frequency transvaginal ultrasonic probe.

• **Level III**
Proceed as in Level II.

5.1.3 **Bleeding in pregnancy**

Bleeding may occur at any stage during pregnancy. The most common causes in the first half of pregnancy are spontaneous abortion, ectopic pregnancy and, rarely, trophoblastic tumours. In the second half of pregnancy, placenta praevia is the main cause of bleeding.

• **Level I**
*Ultrasonography* should be used as the initial imaging examination and will quickly and reliably locate the pregnancy and permit assessment of fetal viability and identification of causes of bleeding such as pregnancy-associated tumours. (For ectopic pregnancy, see section 5.1.2 on pain in pregnancy).

Although the placenta can be easily located by ultrasonography, the type of placenta praevia (central, partial, low-lying), if present, may not always be differentiated correctly. The placenta has different locations at different gestational ages, and repeated ultrasound examinations and careful clinical correlation are needed for each individual for correct diagnosis. The significance
of the location of the placenta on ultrasound scans at any stage needs good clinical judgement.

Ultrasonography is less reliable for diagnosing abruptio placentae.

If facilities for ultrasonography are not available, clinical assessment is more reliable than radiography, which is not indicated as an imaging alternative.

- **Levels II and III**
  The placenta can be located by computerized tomography, angiography, scintigraphy and magnetic resonance imaging, but none of these techniques are recommended.

### 5.1.4 Abnormal fetal size and growth

Clinical assessment of intrauterine growth retardation and macrosomia is very unreliable.

- **Level I**
  Ultrasonography is highly accurate in excluding an abnormal fetal growth rate but, if the biparietal diameter only is measured, it is much less reliable. However, fetal growth impairment can be predicted with considerable accuracy by measuring the fetal abdominal circumference and the head circumference to obtain a head:body ratio.

- **Level II**
  Proceed as in Level I.

  Doppler ultrasonography can be used to measure blood velocity and make a dynamic assessment of fetal activity.

  Ultrasound-guided sampling of fetal blood from the umbilical cord is being used as a direct test of prenatal hypoxia.

- **Level III**
  Proceed as in Levels I and II.

### 5.1.5 Prenatal diagnosis of fetal abnormalities

Approximately 2–4% of liveborn humans suffer from gross structural abnormalities. In obstetrics, the problem of birth defects is second only to the problem of prematurity.
• **Level I**
  
  *Ultrasonography* should be used for detailed anatomical examination of the fetus in older mothers, when there is a strong family history of congenital abnormality or a maternal condition which increases the risk of malformation (such as diabetes or polyhydramnios), or when alpha-fetoprotein levels in maternal serum are raised.

  If facilities for ultrasonography are not available, radiography may be used, but the examination should not be performed before 20 weeks' gestation. Only gross defects will be demonstrated at that stage. More information can be obtained by radiography in the last trimester.

• **Levels II and III**
  
  *Ultrasonography* can guide prenatal diagnostic invasive procedures, such as chorion biopsy, amniocentesis and "cordocentesis" (sampling of fetal blood), and prenatal surgical procedures such as the placement of a vesico-amniotic shunt.

  No other imaging is recommended.

### 5.2 Gynaecology

#### 5.2.1 Pelvic inflammatory disease

Pelvic inflammatory disease is most common in women between the ages of 15 and 40 years. Its diagnosis is based on the results of clinical and laboratory tests. Clinical examination of these patients can be difficult because of pain, and is not easy in prepubertal and obese patients.

• **Level I**

  *Ultrasonography* is highly sensitive but not specific. It is, however, very helpful in evaluating the extent of disease and optimizing the treatment.

  *Plain abdominal radiography* does not contribute to the diagnosis.

  *Hysterosalpingography* is contraindicated in patients with acute pelvic inflammatory disease, but can help in diagnosis and management when the condition becomes chronic. When
tuberculosis is suspected ultrasonography is reliable but nonspecific.

- **Level II**
  Proceed as in Level I.

  *Interventional ultrasonography* can be used for diagnostic and therapeutic procedures, preferably transvaginally.

  *Computerized tomography* can be used to obtain further information, particularly when ultrasound results are not satisfactory.

- **Level III**
  *Magnetic resonance imaging* is no better than CT but should be used when CT is contraindicated because of pregnancy.

5.2.2 Missing intrauterine contraceptive device

The intrauterine device is a popular method of contraception and localization of a missing device is a common request.

- **Level I**
  *Ultrasonography* will localize an intrauterine device in the uterus with great accuracy, but it is not so reliable when the device is outside the uterus. Ultrasonography can also be used to detect complications, but the scan may appear normal even when there is perforation of the uterus or the device is deeply embedded in uterine tissue.

  If ultrasound scans show that the uterus is empty, a *plain radiograph* of the whole abdomen, including the pelvis, is indicated. If the device can be seen on the radiograph and more exact localization is needed, *hysterosalpingography* may be required.

  If facilities for ultrasonography are not available, plain radiography will demonstrate the majority of intrauterine devices.

- **Levels II and III**
  Proceed as in Level I.

  *Computerized tomography* and *magnetic resonance imaging* are not indicated.
REFERENCES TO SECTION 5


6. CENTRAL NERVOUS SYSTEM, HEAD AND NECK

See also section 7.1 on head trauma.

6.1 Acute headache

An acute headache is headache that persists for two or three days and does not respond to routine medication.

The need for and sequence of imaging will depend on the results of clinical examination and the presence or absence of localizing symptoms. Imaging is not always required, and sound clinical judgement is necessary in every case.
6.1.1 Normal results on clinical examination but sufficient discomfort to need medical advice

- **Level I**
  *Skull radiography* provides no useful diagnostic information.

- **Level II**
  *Computerized tomography* will exclude most mass lesions or haemorrhage (sensitivity 90%) but is not specific in all cases (70%).
  
  *Brain scintigraphy* will help to exclude a mass or haemorrhage if CT facilities are not available; however, its sensitivity is only about 60% and its specificity is less than 30%.

- **Level III**
  *Magnetic resonance imaging* is highly sensitive in detecting intracranial abnormalities except for acute haemorrhage. If the results of MRI used for the initial examination are negative and headache persists, a CT scan is indicated.

6.1.2 Abnormal results on clinical examination

(1) Paranasal sinusitis

- **Level I**
  *Paranasal sinus radiography*. Horizontal-beam projections are required, particularly the lateral view. The occipitomental projection is very sensitive and specific (80%) and should be used for the initial study in children and adults. Occipitofrontal and lateral projections may then be taken if necessary. Oblique views are usually unnecessary unless the routine radiographs are equivocal.

  Radiography of the sinuses below the age of three years is unhelpful and inaccurate: overall misinterpretation of sinus radiographs may occur in 30% of paediatric examinations. Clinical examination is often more accurate; imaging is necessary only when surgery is to follow.

  Normal radiographs do not exclude frontal sinus infection; clinical judgement is essential. When there is persistent opacity of a paranasal sinus, the possibility of underlying malignancy must be considered.
Conventional tomography should be used when spread of infection beyond a sinus is suspected, and to help differentiate between infection and tumour.

- **Level II**
  
  Computerized tomography is preferable to routine radiography in adults: it is more reliable and more easily interpreted, and will immediately show a tumour or the spread of infection. In children, however, conventional radiography is preferred as the first examination, but CT is required when more extensive infection or malignancy is suspected.

- **Level III**
  
  Magnetic resonance imaging is no more sensitive than CT and is much more expensive.

(2) **Migraine headache**

No useful information is obtained from imaging. If there is any doubt about the correctness of the clinical diagnosis, see section 6.9 on suspected intracranial mass, and section 6.10 on intracranial haemorrhage (without trauma).

(3) **Acute infection of the middle ear or mastoiditis**

No imaging is indicated: radiography, conventional tomography and CT provide no useful diagnostic information in the acute phase. When the patient has symptoms relating to the central nervous system, see the section on meningitis below.

(4) **Meningitis**

- **Level I**
  
  Skull and paranasal sinus radiography provides no useful diagnostic information.

- **Levels II and III**
  
  Computerized tomography and/or magnetic resonance imaging are indicated in chronic or recurrent disease, to assess progression and complications, and particularly to exclude a localized abscess.

If there is blood in the cerebrospinal fluid, see section 6.10 on intracranial haemorrhage (without trauma).
(5) Glaucoma

Imaging is not indicated unless an intraocular tumour is suspected. Such tumours can be demonstrated very accurately by MRI, CT and sophisticated ultrasound techniques.

(6) Temporal arteritis

Imaging is not indicated.

(7) Abnormal results on clinical examination of the central nervous system

See section 6.9 on suspected intracranial mass and/or section 6.10 on intracranial haemorrhage (without trauma).

- Level II
  Single-photon emission computerized tomography is useful only when the headache is clinically of vascular origin.

- Level III
  Magnetic resonance imaging is preferable to SPECT.

6.2 Chronic headache

A chronic headache is a headache that is either continuous or intermittent over a period of three months, is without accurate clinical localization, does not progress and is not accompanied by fever.

6.2.1 Normal results on clinical examination

Imaging is not indicated.

6.2.2 Abnormal results on clinical examination

The need for and sequence of imaging are determined by the results of clinical examination and localizing signs.
(1) Paranasal sinusitis

See section 6.1.2 part (1).

• Level III
  Magnetic resonance imaging is a sensitive method for evaluating neoplasms of the paranasal sinuses.

(2) Chronic infection of the middle ear or mastoiditis

• Level I
  Radiography can be very helpful (accuracy 70%, specificity 70%). Angled mastoid views of both sides and a Towne’s view are required. In children, initial radiography may be limited to submentovertex and fronto-occipital (Towne’s) views. However, if the radiographs are normal, infection is not entirely excluded and clinical judgement must be used. Radiography of the mastoids is not indicated in infants and small children.

  Conventional tomography of the mastoids seldom adds unequivocal evidence and the procedure entails a high radiation dose. The patient’s eyes should be protected if tomography is performed.

• Level II
  Computerized tomography is highly reliable in detecting chronic mastoid infection and should be the initial imaging examination when available, particularly in children.

6.3 Orbital pain or disease (without trauma)

Bilateral proptosis does not require imaging. Unilateral proptosis, sudden paresis or pain may be due to infection or to a tumour.

• Level I
  Sinus radiography (occipitomental, occipitofrontal and lateral views) can demonstrate bone destruction and/or an opaque maxillary sinus, but will seldom differentiate between infection and malignancy.

  Conventional tomography can add further information but seldom provides a specific diagnosis.
- **Level II**
  *Computerized tomography* is the imaging method of choice and may be helpful in diagnosis.

  *Ultrasonography* is useful in the diagnosis of intraocular tumours.

- **Level III**
  *Magnetic resonance imaging* is a very sensitive and specific method for evaluating the orbits.

### 6.4 Stroke

Stroke is a sudden loss of consciousness or other clinical indication of cerebrovascular accident, and occurs primarily in elderly patients.

If the results of cerebral imaging are normal, the possibility of extracerebral vascular disease must be considered (see section 6.5 on syncope).

- **Level I**
  *Skull radiography* is not helpful in any age group.

  *Ultrasonography* is indicated only in the neonate with suspected intracranial haemorrhage.

- **Level II**
  The major use of *computerized tomography* is to exclude haemorrhage. If CT facilities are not available, *cerebral arteriography* is the only alternative.

- **Level III**
  *Magnetic resonance imaging* provides equivalent information to CT.

### 6.5 Syncope

Syncope is a sudden, clinically unexplained loss of consciousness of short duration.
6.5.1 No headache and normal results on clinical examination of the central nervous system

- **Level I**
  
  *Skull radiography* is not indicated.

- **Level II**
  
  *Doppler ultrasonography* of the carotid arteries in the neck is recommended if syncopeal episodes are recurrent or there is clinical suspicion of transient ischaemic attacks.

  *Carotid arteriography* is indicated if ultrasound scans of the carotid arteries are negative. Arteriography must precede surgery if ultrasound results are positive.

  *Angiographic scintigraphy* is an alternative to arteriography but provides less morphological detail than contrast studies.

- **Level III**
  
  *Magnetic resonance imaging* of the carotid arteries may be performed as part of imaging of the central nervous system.

6.5.2 Abnormal results on clinical examination of the central nervous system

See section 6.9 on suspected intracranial mass.

6.6 Coma

Coma is prolonged unconsciousness without history of preceding trauma.

Clinical and laboratory examination can exclude diabetes, malaria, poisoning, drugs and metabolic, infectious or endocrine causes. Imaging is indicated only if no clear cause has been established clinically.

- **Level I**
  
  *Skull radiography* is not indicated.

  *Cranial ultrasonography* is applicable only in infants. If the scan is normal, however, intracranial disease is not excluded.
• **Level II**  
*Computerized tomography* will provide high sensitivity and moderate specificity in the exclusion of intracranial masses or haemorrhage, and is the initial imaging study of choice.

*Cerebral arteriography* may be indicated if CT facilities are not available. It will provide sensitive and specific diagnosis of vascular lesions, but is less specific for exclusion of mass lesions.  
*Cerebral scintigraphy* is indicated only if CT and angiography facilities are not available.

• **Level III**  
*Magnetic resonance imaging* is sensitive for the diagnosis of intracranial masses but is less sensitive than CT for acute intracranial haemorrhage (see section 6.9 on suspected intracranial mass and section 6.10 on intracranial haemorrhage (without trauma)). Comatose patients require close clinical monitoring during MRI, which can be technically difficult.

6.7 Seizure

6.7.1 Adults

The possibility of late-onset epilepsy should be checked by electroencephalography. Whenever the response to anticonvulsant therapy is unsatisfactory, CT or MRI is indicated. Otherwise, see section 6.9 on suspected intracranial mass.

6.7.2 Children

(1) *Febrile seizure*

No imaging is necessary.

(2) *Afebrile seizure*

Electroencephalography should be used to check for the possibility of epilepsy. Whenever the response to anticonvulsant therapy is unsatisfactory, CT or MRI is indicated.
• **Level I**
  *Skull radiography* provides no useful diagnostic information.

• **Level II**
  *Computerized tomography* is not usually indicated in the absence of neurological signs or significant findings on electroencephalograms. CT is sensitive but not very specific, particularly when there are no other abnormalities of the central nervous system.  
  *Single-photon emission computerized tomography* will detect 80% of mass lesions, but is nonspecific. If the radionuclide scan is normal, a mass is not excluded.

• **Level III**
  *Magnetic resonance imaging* is highly sensitive and specific for excluding intracranial lesions other than acute haemorrhage. It may provide evidence of focal cerebral abnormalities not seen on CT scans.

### 6.8 Hearing loss, deafness, dizziness and vertigo

Complete or partial hearing impairment may be due to conductive defects (external–middle ear) or to sensory-neural defects (inner ear–cerebral cortex). Vertigo may be subjective or objective, and should be differentiated from dizziness. Vertigo and dizziness are not infrequently associated with hearing loss.

Imaging is not normally indicated for an elderly person who, in the usual way, is slowly losing hearing acuity.

• **Level I**
  *Skull radiography* should include the submentovertex and fronto-occipital (Towne's) views to show the auditory meatus and auditory structures of the temporal bone. Additional, specific views of the temporal bone may be needed.

  *Conventional linear tomography* will provide better information and increase diagnostic reliability. However, normal radiographs do not exclude abnormality.

• **Level II**
  *Computerized tomography* will show the auditory structures very accurately.
For suspected acoustic neuroma, *myelography with computerized tomography* will be even more reliable; myelography without CT is much less satisfactory.

None of these procedures can entirely exclude a tumour.

- **Level III**
  
  *Magnetic resonance imaging* is highly sensitive and specific for acoustic neuroma, and can exclude a cerebral abscess or spread of infection from the middle ear or mastoid.

### 6.9 Suspected intracranial mass

Intracranial masses are frequently associated with persistent and progressive headache, signs of raised intracranial pressure, abnormal results on clinical examination of the central nervous system and visual defects.

#### 6.9.1 Babies, infants and small children

Infants and young children may require heavy sedation or anaesthesia when CT or MRI is to be used. Anaesthesia poses special problems, particularly for MRI, and skilled help is required.

- **Level I**
  
  *Ultrasonography* is an accurate but nonspecific way of demonstrating increased ventricular size or an intracranial mass.

  *Skull radiography* provides no useful diagnostic information.

- **Level II**
  
  *Computerized tomography* is the method of choice.

- **Level III**
  
  *Magnetic resonance imaging* is highly sensitive and specific.

#### 6.9.2 Older children and adults

- **Level I**
  
  *Skull radiography*. A posteroanterior view should be obtained if possible; otherwise, anteroposterior, lateral and fronto-occipital (Towne's) views may occasionally provide useful but nonspecific information.
Normal radiographs do not exclude an intracranial mass.

*Conventional tomography* does not add further information, unless a pituitary tumour is suspected.

- **Level II**
  *Computerized tomography* has a high level of sensitivity (90%) but lower specificity (about 60%). The posterior fossa is the region in which masses are most likely to be missed.

  *Cerebral arteriography* has a sensitivity of about 60% and a specificity of about 30% in the overall diagnosis of intracranial mass; however, it is much more accurate and specific for vascular lesions. Magnification and subtraction techniques are helpful. Small cerebral aneurysms may not be demonstrated.

  Cerebral arteriography must precede surgery or interventricular angiography if a vascular lesion is suspected.

  *Ventriculography* should be performed in children only when CT facilities are not available, and should precede arteriography in such cases.

  Neither arteriography nor ventriculography can exclude an intracranial mass.

- **Level III**
  *Magnetic resonance imaging* is 90% sensitive and about 60% specific in the diagnosis of intracranial mass. It is less sensitive than CT in the detection of meningioma.

  *Single-photon emission computerized tomography* or *positron emission tomography* can be used if MRI facilities are not available.

**6.10 Intracranial haemorrhage (without trauma)**

Clinical findings include headache, loss of consciousness, abnormal results on examination of the central nervous system and visual defects, often in young or middle-aged patients. See also section 6.4 on stroke.
• **Level I**
  Skull radiography provides no useful diagnostic information.

• **Level II**
  *Computerized tomography* is sensitive (90%) and specific (80%) and is the initial imaging examination of choice. A small cerebral aneurysm may not be recognized.

  *Cerebral arteriography* may be used initially when CT facilities are not available, and should precede any intervention when the CT examination suggests a vascular lesion.

• **Level III**
  *Magnetic resonance imaging* is sensitive (90%) and specific (80%) except in the recognition of acute haemorrhage. If the results are negative, CT (if not already used) is indicated when there are strong clinical signs of intracranial haemorrhage. If the results are abnormal and surgery is likely, MRI may be followed by cerebral arteriography.

6.11 Paraplegia (without trauma)

Non-traumatic paraplegia is an acute or a progressive loss of lower limb function accompanied by spinal neurological abnormalities in a patient without evidence of cerebral abnormality and no history of trauma.

Diagnostic imaging should follow clinical localization of the level at which the spinal cord is affected. The primary purpose of imaging is to differentiate conditions requiring surgical intervention from those that can be managed medically.

• **Level I**
  *Spinal radiography*. Anteroposterior and lateral views of the appropriate level are required; oblique views may be added if the initial radiographs are abnormal. If infection is suspected, add anteroposterior and lateral views of the whole spine, since infections, especially tuberculosis, may be multifocal.

  *Conventional tomography* will provide further information when an abnormality has been detected.
• **Level II**
  Proceed as in Level I.

  *Skeletal scintigraphy* should be the first procedure if metastases are suspected, and will provide accurate localization of a spinal lesion. Since scintigraphy is very nonspecific, localized spinal radiographs of the appropriate level of the spine should then be obtained.

  *Computerized tomography* is 90% sensitive in detecting vertebral abnormalities, and 80% specific. When surgery is expected, CT with contrast myelography is indicated.

  *Conventional myelography* is very helpful if CT facilities are not available. Infection such as tuberculosis or schistosomiasis is not a contraindication. Even when CT results are negative, myelography is indicated prior to surgery.

• **Level III**
  *Magnetic resonance imaging* is highly sensitive and specific for detecting extra-osseous spinal and intervertebral disc disease. If the MRI scan is normal, no further imaging is required. If the MRI scan is abnormal, conventional radiographs may be needed before surgery, although some surgeons may prefer a CT scan.

### 6.12 Loss of voice

A patient suffering loss of voice should initially be examined clinically and by endoscopy. Imaging is indicated, as detailed below, if laryngeal carcinoma or vocal-chord paralysis is suspected. If loss of voice is suspected to be of central nervous system origin, see section 6.4 on stroke.

• **Level I**
  *Conventional tomography* of the larynx is indicated.

  *Chest radiography*. Posteroanterior and lateral views are required.

• **Level II**
  Proceed as in Level I, replacing conventional tomography with *computerized tomography*. CT of the chest is indicated if the radiographs are equivocal.
6.13 Neck mass

Evaluation of a neck mass must start with a differentiation between thyroidal and non-thyroidal origin. For laryngeal masses, see section 6.12 on loss of voice.

6.13.1 Thyroid mass

A thyroid mass can be accompanied by normal, increased or decreased function of the thyroid gland.

- **Level I**
  
  *Ultrasonography* can identify nodules and differentiate multinodular or diffuse goitres and cystic lesions; alone, however, it cannot provide a definite diagnosis.

  *Plain chest radiography* is used to show calcification and to define intrathoracic extension of goitres and tracheal deviation and/or compression.

- **Level II**
  
  *Ultrasonography* is the first approach for juvenile and diffuse goitres. It can also be used in the diagnosis of other goitres or if local or regional metastases are suspected. Ultrasonography can also serve as a guide for fine-needle biopsy.

  *Scintigraphy* is the only specific diagnostic imaging modality for assessing function, and is indispensable for planning treatment and for the recognition of ectopic thyroid sites.

  *Computerized tomography* is useful only in following the development of a regional metastatic carcinoma of the thyroid.
6.13.2 Parathyroid mass

- **Level I**
  No imaging is indicated.

- **Level II**
  Enlarged parathyroid glands can be identified by high-resolution ultrasonography, computerized tomography and subtraction scintigraphy. Ectopic parathyroid adenomas are the domain of scintigraphy.

  Angiography can demonstrate parathyroid tumours but the procedure is difficult and unreliable.

- **Level III**
  Magnetic resonance imaging gives anatomical information similar to that obtained by ultrasonography and CT, and will gain importance in parathyroid imaging.

6.13.3 Non-thyroid mass

The origins of non-thyroid masses comprise:

(a) congenital lesions (thyroglossal-duct cysts, bronchial cysts, cystic hygromas, ectopic thyroid);
(b) inflammatory masses;
(c) neoplastic processes;
(d) vascular lesions;
(e) salivary-gland lesions.

- **Level I**
  Ultrasonography is most useful in evaluating the size and site of a lesion, defining the relationship to the large vessels and differentiating between solid and cystic lesions, and between solitary and multilocular lesions. The ultrasound pattern, however, is not pathognomonic.

  Plain radiography of the neck can demonstrate bone involvement, soft-tissue calcifications and displacement of the trachea.

  Sialography is indicated if disease of the salivary glands is suspected.

  Oesophagography (contrast swallow) is indicated if an oesophageal abnormality is suspected.
Chest radiography is necessary if the patient has vocal-chord paralysis (see section 6.12 on loss of voice).

- **Level II**
  
  Ultrasonography is indicated as in Level I. It can serve as a guide for fine-needle biopsy.

  Computerized tomography gives additional information on a tumour's relationship to adjacent structures, including malignant infiltration.

  Scintigraphy (thyroid) can be used to differentiate an isolated thyroglossal-duct cyst from an ectopic thyroid.

  Carotid arteriography will demonstrate vascular malformations and vascular neoplasms (e.g., tumours of the carotid body).

- **Level III**
  
  Magnetic resonance imaging, because of its superior soft-tissue definition, provides the best available illustration of the extent of malignant disease.

REFERENCES TO SECTION 6


7. TRAUMA

7.1 Head trauma

7.1.1 Non-penetrating head injury with no loss of consciousness and normal results on clinical examination of the central nervous system

- **Level I**
  Skull radiography is not indicated. Clinical observation should continue as necessary.

- **Levels II and III**
  No imaging is indicated.

7.1.2 Non-penetrating head injury with loss of consciousness and/or abnormal results on clinical examination of the central nervous system

- **Level I**
  Skull radiography is indicated only when there is a clinical suspicion of a depressed fracture; in the absence of such a fracture, 98% of skull radiographs do not influence patient management or outcome. The discovery of a linear skull fracture is of very limited clinical significance, but a depressed fracture may require surgical elevation and should be radiographically demonstrated.

  Cervical spine radiography is indicated if the patient is unconscious or there is clinical evidence of cervical spine injury.

- **Level II**
  Computerized tomography should be the first examination when facilities are available, and is highly sensitive and specific.

  Cerebral arteriography will be necessary to exclude intracranial haematoma if CT facilities are not available.

- **Level III**
  Magnetic resonance imaging is not indicated in cases of acute cerebral trauma, and is less sensitive than CT in detecting haemorrhage in the central nervous system in the immediate post-traumatic period (up to three days).
7.1.3 Penetrating head injury

Whatever the cause of the penetrating injury, imaging is necessary for investigating the possibility of a depressed skull fracture or the presence of foreign objects.

- **Level I**
  *Skull radiography.* Posteroanterior or anteroposterior and lateral views can demonstrate depressed fractures and fragments. Tangential views may be added if necessary.

- **Level II**
  *Computerized tomography* is a reliable method of assessing cranial and intracranial injury, and of localizing a radio-opaque foreign body.

  *Cerebral arteriography* may be necessary (with or without preceding CT) to demonstrate vascular damage and haematoma.

- **Level III**
  *Magnetic resonance imaging* is not indicated and, if a metallic foreign body is present, can be injurious.

7.2 Facial trauma

Images of the face require careful analysis, because of the complex nature of the facial bones.

- **Level I**
  *Radiography* of the face, with additional views for the orbits, is sufficient for the detection of gross trauma. A single plain film (lateral) is adequate for diagnosing a fracture of the nasal bone.

  If the injuries are associated with soft-tissue oedema, lacerations and haemorrhage into the sinuses, *conventional tomography* gives better visualization of the fractures.

- **Level II**
  *Plain radiographs* should be obtained first. *Panoramic radiography* is an alternative imaging method.

  *Computerized tomography* is the method of choice, especially if facilities for reconstructive surgery are available, when detailed
preoperative assessment is needed of complicated and displaced fractures.

- **Level III**
  Magnetic resonance imaging will effectively delineate changes in the soft tissues, and is particularly useful if a blow-out fracture of the orbit is suspected.

### 7.3 Spinal trauma

The majority of spinal injuries occur in people under 40 years of age.

Spinal cord injuries occur in 10–14% of patients with spinal fractures and dislocations, and in 85% of cases occur immediately. When there is malalignment of the posterior vertebral elements, the incidence of neurological deficits is approximately 60%.

The risk of spinal fracture increases directly with the severity of the trauma and, when the radiographic findings are equivocal, additional imaging is often desirable if there has been serious injury.

#### 7.3.1 Cervical trauma

Radiographic examination is not indicated when the patient is alert, sober, cooperative and without neck pain or tenderness, even when there are significant other injuries. In other cases, radiography is indicated as detailed below.

- **Level I**
  **Radiography.** The procedure depends on the condition of the patient.
  
  (a) Patient able to stand or sit. Anteroposterior, lateral and open-mouth views are required, with the patient in the erect position. When the clinical or radiographic findings are equivocal, add both oblique projections. The seventh cervical vertebra must be demonstrated, if necessary by conventional tomography.
  
  (b) Patient unable to stand. Supine, horizontal-beam lateral, and 10° cranial anteroposterior views are required. An open-mouth projection should be obtained if possible, but this is not necessary in children under 5 years. If oblique views are
needed, the X-ray tube must be angled, not the patient. The seventh cervical vertebra must be demonstrated; for this purpose, both the patient’s arms will usually need to be pulled downwards, under medical supervision.

Conventional tomography should be performed, preferably in the lateral position, if further information is desired.

- **Level II**
  Proceed as in Level I, except for conventional tomography.

  Computerized tomography. Positive radiographic findings are an indication for CT when a change in the patient’s management may be expected. CT can also be used to show the seventh cervical vertebra or any other equivocal area.

  If clinically indicated, CT of the cervical spine may be performed at the same time as cranial CT in the patient with head injury.

  Myelography may be indicated if CT facilities are not available and surgery is contemplated.

- **Level III**
  Magnetic resonance imaging is indicated in patients who have suffered acute trauma and have a neurological deficit that will be managed surgically. The clinical condition of some patients may not permit MRI.

7.3.2 Thoracic and lumbar trauma

- **Level I**
  Radiography. Anteroposterior and lateral projections are required with the patient in a supine position. In severely injured or clinically unstable patients, a horizontal-beam lateral view must be taken prior to movement of the patient for additional views.

  Conventional tomography, preferably in the lateral projection, should be undertaken if radiographic findings are equivocal, or a fracture is suspected on clinical grounds.

- **Level II**
  Computerized tomography of the thoracic and/or lumbar spine should be undertaken, when clinically indicated, in patients for
whom radiographic and/or conventional tomographic findings are positive.

*Myelography* may be indicated in patients with neurological deficits.

*Skeletal scintigraphy* may reveal occult spine trauma in patients with persistent pain after 48 hours.

- **Level III**
  
  *Magnetic resonance imaging* is the procedure of choice in patients with persistent neurological deficits, even when skeletal radiography and CT findings are normal.

### 7.4 Blunt chest trauma

Trauma to the chest plays a major role in one-third of all deaths related to traffic accidents. The choice of imaging procedures is determined by the patient’s clinical condition.

#### 7.4.1 Patient able to stand

- **Level I**
  
  *Erect radiograph of the chest.* If this is normal no further imaging is required. A chest radiograph does not always demonstrate rib injuries. Oblique views of the injured ribs should be taken if the results are likely to affect the management of the patient.

  Fractures of the first to third ribs may be associated with vascular and upper airway injury, and require clinical supervision and follow-up chest radiography if there is any change in the patient’s condition.

  Lower rib fractures may be associated with liver, kidney and spleen trauma. *Ultrasonography* can be used to check for abdominal trauma.

- **Levels II and III**
  
  Proceed as in Level I. No further imaging is indicated. If the patient’s condition deteriorates, follow the sequence for severe abdominal trauma (see section 7.5).
7.4.2 Patient not able to stand (severely injured)

- **Level I**
  
  A supine chest radiograph is required but will not exclude a small pneumothorax or effusion. Mediastinal width is difficult to assess, and if upper ribs are fractured, haemorrhage may not be recognized. If there is any doubt, obtain a further chest radiograph after one hour, or sooner if the patient's condition deteriorates.

  Cardiac size is difficult to assess, but a suspected haemopericardium may be diagnosed with ultrasonography.

- **Level II**
  
  *Chest radiography* is indicated as in Level I.

  *(a)* Suspected vascular injury (upper rib fracture): immediate arch aortography is indicated. If facilities for angiography are not available, computerized tomography can be used to provide the required information.

  *(b)* Suspected ruptured diaphragm: a *radiological examination* of the upper gastrointestinal tract with contrast is indicated.

  *(c)* Suspected ruptured bronchus: endoscopy is indicated.

  *(d)* Suspected organ damage (liver, kidney, spleen) from fractured ribs: ultrasonography or computerized tomography is indicated.

  *(e)* Suspected cardiac injury should be managed clinically.

- **Level III**

  *Magnetic resonance imaging* is not indicated.

7.5 **Blunt abdominal trauma**

Abdominal trauma is responsible for 10% of deaths in victims of trauma.

Patients with blunt abdominal trauma will often present with extensive skeletal injuries, which must not sway the attention of the clinician from the more life-threatening abdominal injuries.

Selection of the imaging methods depends upon the clinical condition of the patient and the severity of trauma.
7.5.1 Patient in an unstable condition

There may be no time for any imaging investigations. Lavage, although not very accurate for diagnosis, may be an alternative.

7.5.2 Patient in a stable condition with significant trauma

- **Level I**
  
  *Ultrasonography* is indicated; lavage should not be performed.
  
  Intraperitoneal fluid can be detected on ultrasound scans, and the liver, spleen and kidneys are usually seen even in severely injured patients. Ultrasonography cannot rule out small injuries. Further scans should be obtained as clinically indicated.
  
  *Abdominal and chest radiographs* should be taken in the supine anteroposterior projection. Depending upon the clinical findings, an additional horizontal-beam radiograph, supine or lateral decubitus, may be taken.
  
  Plain radiography and ultrasonography are complementary and, when possible, should be used for all patients.

- **Level II**
  
  *Computerized tomography*. The patient should be referred directly for CT if ultrasound scans are unsatisfactory. CT is superior to peritoneal lavage and is reliable in the demonstration of retroperitoneal haemorrhage, identification of the injured organ, and estimation of the amount of free blood.
  
  If peritoneal lavage has been performed CT should not be undertaken as the findings may be misleading.
  
  If facilities for computerized tomography or ultrasonography are not available, proceed with radiography as in Level I. *Radionuclide studies* or *arteriography* may, in such cases, be used to detect organ lacerations as well as bleeding sites.

- **Level III**
  
  At present there is no indication for the use of *magnetic resonance imaging*, which is technically difficult in patients with abdominal trauma.
7.5.3 Patient in a stable condition with minor injury

- **Level I**
  
  *Radiography.* Chest and erect and supine abdominal radiographs should be taken. An *ultrasound examination* should follow, if clinically indicated, to exclude possible liver and spleen lacerations and subcapsular haematoma.

  If the results of imaging are positive, proceed to appropriate treatment; if they are equivocal, obtain further ultrasound scans according to the patient’s clinical condition. If the results are negative, no further imaging is required.

- **Level II**

  Proceed as in Level I.

  If the diagnosis is in doubt, *computerized tomography* may be indicated instead of repeated ultrasonography.

7.6 Blunt renal trauma

While immediate surgical intervention remains the accepted treatment in patients with severe renal trauma, non-operative management is increasingly being employed for most types of blunt injury.

In severe trauma it is important to establish the presence of kidney function. A single view of the abdomen can be taken in the operating room 10 minutes after intravenous injection of urographic contrast medium.

Renal trauma may be isolated or, as in many cases, associated with trauma to other abdominal organs (see section 7.5 on blunt abdominal trauma). Persisting pain and haematuria may indicate involvement of the lower urinary tract (see section 7.7 on pelvic and hip trauma).

- **Level I**

  A supine *abdominal radiograph* should be taken followed by limited *excretory urography*. Normal findings will usually exclude significant renal injury. *Ultrasonography* should be undertaken when renal injury is still clinically suspected.

  If urographic findings are abnormal, ultrasonography should be used to rule out a subcapsular, perirenal or intrarenal
haematoma. An ultrasound examination will also serve as a baseline study if non-surgical treatment is advised.

- **Level II**
  Proceed as in Level I. Then proceed directly to computerized tomography.

  If facilities for CT and ultrasonography are not available a renal radionuclide perfusion study can be performed to detect parenchymal injury.

  Renal arteriography is not usually necessary if CT facilities are available.

- **Level III**
  Magnetic resonance imaging. At present there is not sufficient experience with MRI studies in acute renal trauma.

### 7.7 Pelvic and hip trauma

Pelvic fractures are a cause of substantial morbidity and permanent disability, and are a leading cause of death following blunt trauma. Associated fractures of the extremities are common, and injury to abdominal and pelvic viscera may occur.

- **Level I**
  Immediate life-saving treatment should precede any diagnostic imaging examination for patients with multiple injuries, particularly those with severe abdominal and pelvic trauma.

  **Radiography**
  
  (a) Patient in an unstable condition. A supine anteroposterior view of the pelvis is required. *Cysto-urethrography* should be undertaken when a ruptured urethra is suspected clinically.

  (b) Patient in a stable condition. A supine anteroposterior view of the pelvis and a lateral view of the femoral neck are required. In patients with acetabular fractures, *conventional tomography* and oblique views may provide additional information.

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• **Level II**
  Proceed as in Level I.

  *Computerized tomography* shows acetabular fractures and intra-articular bone fragments, if present. Soft-tissue injuries are clearly delineated.

  *Angiography* (and embolization) may be of benefit in patients with surgically intractable bleeding.

  *Scintigraphy* may detect occult fractures.

• **Level III**
  *Magnetic resonance imaging* is not indicated.

### 7.8 Trauma to the extremities

Traumatized patients with any of the following signs and symptoms should undergo a radiographic examination:

(a) gross signs of fracture, e.g., deformity, crepitus and instability;
(b) bruising or severe swelling;
(c) point tenderness on palpation;
(d) moderate to severe pain when weight-bearing;
(e) any abnormality in a knee joint;
(f) injury of tendon, vessel or nerve.

Radiography may also be indicated when there is loss of sensation, or a palpable mass.

Clinical judgement must be used when the patient is unconscious. Imaging may also be indicated if there is the possibility of non-accidental injuries in children (e.g., child abuse), or evidence of osteopenia or pathological fractures in adults.

• **Level I**

  *Radiography of the extremities.* If the patient is in an unstable condition, two projections are desirable. Radiography should only be carried out if it can be undertaken at the same time as any essential clinical treatment. If the patient is in a stable condition, at least two projections are essential.

  Additional projections may be required when radiographic findings do not agree with clinical signs. If no fractures are shown,
ligamentous injuries can be demonstrated with stress views when clinically indicated.

*Delayed radiographs* should be taken if a fracture is not initially identified but is still clinically suspected after eight days because of continued pain or disability. A shorter interval is seldom worthwhile.

*Comparison views* of the uninjured extremity in children should be obtained only after radiographs of the injured limb have been examined and if the findings are equivocal.

*Ultrasonography* may be useful to detect major soft-tissue damage or tendon injury; radiographically occult fractures can be detected in children and elderly people.

- **Level II**
  Proceed as in Level I.

  *Angiography* is indicated in any patient with suspected major vascular trauma.

  *Computerized tomography* may be required if the patient is in a stable condition but has complicated fractures in specific anatomical locations, e.g., knee, shoulder or ankle. If CT facilities are not available, conventional tomography can be used.

  *Bone scintigraphy* is particularly useful in demonstrating stress fractures, occult fractures due to child abuse and fractures in osteopenic bones. It does not replace but complements radiography.

- **Level III**
  *Magnetic resonance imaging* is not indicated in cases of acute limb injury.

REFERENCES TO SECTION 7


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8. SUMMARY AND CONCLUSIONS

While this report was being prepared, two things became increasingly clear to those involved: firstly, that the proper use of the diagnostic equipment now available is very important and, secondly, that with such a wide field with so many variables, it is an almost impossible task to make specific recommendations.

The comprehensive working papers produced by the members of the Scientific Group before the meeting were based on their own individual experience and a large number of professional publications, only the most significant of which have been referenced. Unfortunately most of the existing publications refer to imaging in departments which are of Level II or Level III, whereas Level I represents the most likely situation for most of the world.

The Group acknowledged that none of the recommendations on imaging procedures will always be appropriate; changes will occur as knowledge grows and equipment improves, so that the report may be only a starting point to stimulate discussions and ideas. If proper care within economic bounds is to be given to all patients, their physicians must reach their own conclusions, based on reports,
practice and conversations with their colleagues—particularly with imaging specialists. Hospitals must lay down their own protocols for imaging, guided by local circumstances, which should be reviewed at regular intervals and changed as experience grows. This will be of considerable educational benefit to junior staff as well as to their mentors. There should be a regularly scheduled review in every field of medicine.

Techniques and ideas grow all the time and every effort should be made to stop using outdated methods in favour of the new, provided that the new is really more efficient in terms of patient care. Only too often during diagnostic imaging, an extra projection or another imaging procedure is added with little consideration of whether it will be of significant benefit to the patient. In addition, not all existing equipment can provide the required diagnostic information. For example, a WHO Scientific Group on the Indications for and Limitations of Major X-Ray Diagnostic Investigations (2) concluded that, at a first chest examination, only a posteroanterior view is needed. However, this will be sufficient only when a genuine high-kV radiographic technique is used; the output of some quite complex X-ray equipment does not always reach the level set on the controls. On the other hand, some outwardly simple (but in fact sophisticated) X-ray generators such as those specified in the WHO Basic Radiological System (1) can provide excellent chest radiographs, making the lateral view redundant as part of a routine examination, and permitting a 50% saving in the number of films used, which represents a considerable economy. Quality in every way, including technique and interpretation, is essential, both in primary care facilities and in large hospital centres. High technology is not necessary for every examination, and for imaging, quantity does not always equate with quality. To use many complex procedures when a more simple one would give as good an answer is not the best way to practise medicine.

Some of the Scientific Group’s recommendations for imaging will appear obvious and straightforward to some, controversial to others. There are some clinical situations for which no rules can be made and only principles can be stated, to be used as judgement dictates. The Scientific Group was aware that not everyone will agree with all that has been suggested. The report needs to be discussed and criticized by those who must make choices for imaging, and the unit of Radiation Medicine, World Health Organization, Geneva, Switzerland, will be happy to receive comments. The more
physicians and students who discuss this report, the more valuable it will be.

The economics of medicine cannot be ignored; the benefits of the proper use of imaging cannot be neglected. It is the hope of this Scientific Group that its report will show that these two principles are, in practice, not incompatible.

REFERENCES TO SECTION 8


Annex

EXPLANATIONS OF TERMS

Explanations are provided below not only of terms used in this report but of others that may be relevant to research concerning effective choices in diagnostic imaging. The explanations are intended for use in this context and are not necessarily valid for other purposes.

Accuracy

Accuracy in diagnostic imaging is the ratio of correct outcomes (positive and negative) to all outcomes.

Effectiveness

Effectiveness is used to express the likelihood of benefit to individuals or a population from a technology under average conditions of use.

Efficacy

Efficacy is the ability of a diagnostic test, applied under optimum conditions, to influence the physician’s decision regarding the patient’s diagnosis and management (treatment, after-care), and therefore to influence the health outcome at the individual and population levels. In diagnostic imaging, efficacy refers to the intrinsic value of the imaging procedure.

Efficiency

Efficiency relates to the skill with which resources are used to achieve a given end. The efficiency of a diagnostic imaging procedure is high when the highest number of true positive and/or true negative results are obtained for the lowest investment in terms of money, resources and time.

1 Effectiveness will always be lower than efficacy because effectiveness depends on the skills of the imaging practitioner and the infrastructure under average rather than optimum conditions.

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False negative

A negative diagnosis that is incorrect because the patient does have the disease for which the imaging procedure has been used.

False positive

A positive diagnosis that is incorrect because the patient does not have the disease for which the imaging procedure has been used.

Incidence of a disease

The number of new cases of a disease that occur in a specified population during a defined period of time. It is usually expressed as a rate, for example the number of new cases per year per 100,000 persons.

Negative predictive value

The proportion of negative results that are true negatives when a test is applied to a population containing both healthy and diseased subjects. It depends upon the prevalence of the disease and both the sensitivity and the specificity of the test that is used. It is the proportion of patients reported as free of disease who actually are free of that disease.

\[
\text{Negative predictive value} = \frac{\text{specificity}(1 - \text{prevalence})}{\text{specificity}(1 - \text{prevalence}) + \text{prevalence}(1 - \text{sensitivity})}
\]

which simplifies to:

\[
\text{Negative predictive value} = \frac{\text{no. of true negatives}}{\text{no. of true negatives} + \text{no. of false negatives}}
\]

Positive predictive value

The proportion of positive results that are true positives when a test is applied to a population containing both healthy and diseased subjects. It depends upon the prevalence of the disease and both the
sensitivity and the specificity of the test. It is the proportion of patients reported as having a disease who actually do have the disease.

Positive predictive value =

\[
\frac{\text{sensitivity} \times \text{prevalence}}{(\text{sensitivity} \times \text{prevalence}) + (1 - \text{specificity}) (1 - \text{prevalence})}
\]

which simplifies to:

Positive predictive value =

\[
\frac{\text{no. of true positives}}{\text{no. of true positives} + \text{no. of false positives}}
\]

**Predictive value**

Predictive value is a measure of how useful the imaging technique will be in actual clinical practice. There is a positive predictive value and a negative predictive value.

**Prevalence of a disease**

The *total* number of cases (old and new) of a disease in a given population at a specified point in time. It is usually expressed as a rate, for example the number of cases of the disease per 100 000 persons.

**Reliability**

A reliable imaging procedure is one that, even in the absence of statistical information concerning its sensitivity and specificity, is considered to be accurate and whose use is thought to be justified.

**Sensitivity**

The sensitivity of an imaging procedure is its ability to detect a disease in a patient who does have the disease. Sensitivity decreases with the number of false-negative results obtained.

Sensitivity =

\[
\frac{\text{no. of true positives}}{\text{no. of true positives} + \text{no. of false negatives}} \times 100
\]
Specificity

The specificity of an imaging procedure is its ability to discern that a patient who is truly free of a disease does not have that disease. Specificity decreases with the number of false-positive results obtained.

\[
\text{Specificity} = \frac{\text{no. of true negatives}}{\text{no. of true negatives} + \text{no. of false positives}} \times 100
\]

True negative

A negative diagnosis that is correct because the patient does not have the disease for which the imaging procedure was applied.

True positive

A positive diagnosis that is correct because the patient does have the disease for which the imaging procedure was applied.

REFERENCES


Recent reports:

781 (1989) New approaches to improve road safety
Report of a WHO Study Group (62 pages) ........................................ 8.—

782 (1989) Monitoring and evaluation of oral health
Report of a WHO Expert Committee (69 pages) .................................... 9.—

783 (1989) Management of human resources for health
Report of a WHO Expert Committee (61 pages) .................................... 8.—

784 (1989) The use of synthetic antigens for diagnosis of infectious diseases
Report of a WHO Scientific Group (73 pages) .................................... 9.—

785 (1989) Health surveillance and management procedures for food-handling personnel
Report of a WHO Consultation (47 pages) .......................................... 6.—

786 (1989) WHO Expert Committee on Biological Standardization
Thirty-ninth report (184 pages) ....................................................... 22.—

787 (1989) WHO Expert Committee on Drug Dependence
Twenty-sixth report (32 pages) ....................................................... 4.—

788 (1989) Evaluation of certain veterinary drug residues in food
Thirty-fourth report of the Joint FAO/WHO Expert Committee on Food Additives (66 pages) .................................................. 9.—

789 (1990) Evaluation of certain food additives and contaminants
Thirty-fifth report of the Joint FAO/WHO Expert Committee on Food Additives (48 pages) .................................................. 6.—

790 (1990) WHO Expert Committee on Specifications for Pharmaceutical Preparations
Thirty-first report (79 pages) ....................................................... 9.—

791 (1990) Pesticide application equipment for vector control
Twelfth report of the WHO Expert Committee on Vector Biology and Control (58 pages) .................................................. 8.—

792 (1990) Prevention in childhood and youth of adult cardiovascular diseases: time for action
Report of a WHO Expert Committee (105 pages) ................................ 12.—

793 (1990) Control of the leishmaniasis
Report of a WHO Expert Committee (158 pages) ................................ 18.—

794 (1990) Educational imperatives for oral health personnel: change or decay?
Report of a WHO Expert Committee (43 pages) ................................ 6.—

795 (1990) Effective choices for diagnostic imaging in clinical practice
Report of a Scientific Group (131 pages) .......................................... 16.—

796 (1990) The use of essential drugs
Fourth report of the WHO Expert Committee (57 pages) .................. 8.—

* Prices in developing countries are 70% of those listed here.