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Referral Guidelines For Imaging

Guidelines for Healthcare Professionals who prescribe Imaging Investigations involving Ionising Radiation

Final Report to the European Commission for Grant Agreement SUBV99/134996

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FOREWORD

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Foreword

The European Commission has issued a booklet with referral guidelines for imaging (Radiation Protection 118) for use by health professionals referring patients for medical imaging. The booklet proved to be of great value in ensuring that radiological imaging prescriptions are justified, in application of Articles 3.1 and 6.2 of Council Directive 97/43/EURATOM on "health protection of individuals against the dangers of ionising radiation in relation to medical exposure".

This document was published in 2000; however, there is a need for a regular update of such guidance, in the light of rapid technical developments.

Such an update was prepared in 2003 under contract no. SUBV. 99/134996 (concluded at the time with DG Environment but now under the responsibility of DG Energy and Transport). While many experts in Europe were involved in this project, which should provide assurance on the quality of the updated guidance, circumstances prevented the prompt finalisation of this document's publication.

This is why the document is only now being posted on our website, at a time when a new update is already being prepared. It is available in English only, whereas Radiation Protection 118 was published in booklet form in 11 languages.

Pending the publication of a new update of publication 118 we hope that many users will nevertheless benefit from this intermediate version.

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1 INTRODUCTION

These guidelines have been prepared to help referring practitioners make the best use of a Department of Clinical Radiology. The Guidelines have been designed to assimilate, evaluate, and implement the ever-increasing amount of evidence and opinion on current best practice. The EU Council Directive 1997/43/Euratom declared that member states will promote the establishment and use of diagnostic reference levels for radiological examinations and the guidance thereof. The present guidelines can be used for this purpose.

Continued use of recommendations of this kind can lead to a reduction in the number of referrals and also to a reduction in medical radiation exposure [1-5]. However, the primary objective of the guidelines is to improve clinical practice. Such guidelines work best if they are used as part of clinico-radiological dialogue and the audit process. They are intended for use by all referring practitioners. The development methodology minimises context-specificity: they should be of relevance and value throughout the European Community (EC) and, indeed, internationally.
The editorial process was undertaken by Professor Gillian Needham (Aberdeen), Professor Iain McCall (Stoke-on-Trent), and Dr Mike Dean (Shrewsbury), under the auspices of the European Guideline Development Steering Group (see below), and the processes of literature searching, critical appraisal, synthesis and grading were carried out by European and UK Special Interest Groups (SIGs) and Specialist Societies (see below). Mr Chris Squire (RCR Clinical Audit Officer) developed the evidence-gathering template. Mr Barry Wall from the National Radiological Protection Board (NRPB) advised on dosimetric data and scoring.

2 CLASSIFICATION OF EVIDENCE

Classification of evidence levels has been translated into grades of recommendation based on the system developed by the US Department of Health and Human Services, Agency for Health Care Policy and Research [6-7]. The levels are

[A]

- High quality diagnostic studies in which a new test is independently and blindly compared with a reference standard in an appropriate spectrum of patients
- Systematic review and meta-analyses of such high quality studies
- Diagnostic clinical practice guidelines/clinical decision rules validated in a test set

[B]

- Studies with a blind and independent comparison of the new test and reference standard in a set of non-consecutive patients or confined to a narrow spectrum of subjects
- Studies in which the reference standard was not performed on all subjects

- Systematic reviews of such studies
- Diagnostic clinical practice guidelines/clinical decision rules not validated in a test set

[C]

- Studies in which the reference standard was not objective
- Studies in which the comparison between the new test and the reference standard was not blind or independent
- Studies in which positive and negative test results were verified using different reference standards
- Studies performed in an inappropriate set of patients
- Expert opinion.

3 COLLECTION OF EVIDENCE

The evidence gathering, synthesis and grading processes that are so crucial to best guideline development have been undertaken by over 200 radiologists across the EC. This truly collaborative effort, cascaded-out by European and UK special interest groups (SIGs) and societies, has been supported by guideline development teams in London (based at the RCR) and Aberdeen (based in the Health Services Research Unit, University of Aberdeen). Training in the guideline development process was delivered early on in the project.

While wide consultation across the whole of Europe and the UK (see Appendix) was undertaken in the development of this booklet, and best-evidence methodology applied, undoubtedly there will be some decisions that will not accord with local practice. Evidence has at times been conflicting and this has required compromise and interpretation. We would welcome referenced comments, to allow continued development of these Guidelines.

4 GUIDELINES

A 'gold standard' search strategy for diagnostic-imaging tests has been developed as part of this project, as has work to investigate the feasibility of establishing a comprehensive register of studies. At the time of publication however, we continue to rely on the Guideline Development Steering Group for strategic direction and SIGs for detailed content.

5 WHY ARE GUIDELINES NEEDED?

A useful investigation is one in which the result - positive or negative - will alter clinical management and/or add confidence to the clinician's diagnosis. A

significant number of radiological investigations do not fulfil these aims and may add unnecessarily to patient irradiation [14]. The chief causes of the wasteful use of radiology are:

1 **Repeating investigations which have already been done:** e.g., at another hospital, in an outpatient department, or in an accident and emergency department. **HAS IT BEEN DONE ALREADY?** Every attempt should be made to get previous films. Transfer of digital data through electronic links may assist in this respect in future years.

2 **Investigation when results are unlikely to affect patient management:** because the anticipated 'positive' finding is usually irrelevant, e.g. degenerative spinal disease (as 'normal' as grey hairs from early middle age) or because a positive finding is so unlikely. **DO I NEED IT?**

3 **Investigating too often:** i.e. before the disease could have progressed or resolved or before the results could influence treatment. **DO I NEED IT NOW?**

4 **Doing the wrong investigation.** Imaging techniques are developing rapidly. It is often helpful to discuss an investigation with a specialist in clinical radiology or nuclear medicine before it is requested. **IS THIS THE BEST INVESTIGATION?**

5 **Failing to provide appropriate clinical information and questions that the imaging investigation should answer.** Deficiencies here may lead to the wrong technique being used (e.g. the omission of an essential view). **HAVE I EXPLAINED THE PROBLEM?**

6 **Overinvestigating.** Some clinicians tend to rely on investigations more than others. Some patients take comfort in being investigated. **ARE TOO MANY INVESTIGATIONS BEING PERFORMED?**

6 WHAT ADVICE IS AVAILABLE?

In some clinical situations firm Guidelines have been established. Guidelines are:

> *systematically developed statements to assist practitioner and patient decisions about appropriate health care for specific clinical circumstances... [Field & Lohr, 1992, 15].*

Just as the term implies, a Guideline is not a rigid constraint on clinical practice, but a concept of good practice against which the needs of the individual patient can be considered. So while there have to be good reasons for ignoring them they are not absolute rules. No set of recommendations will command universal support, and you should discuss any problems with your radiologists.

The preparation of Guidelines has become something of a science, with numerous papers emerging within the evolving Guidelines discipline. In particular, experts have provided a detailed methodology as to how guidelines should be developed, produced and appraised [8, 15-21]. Using such a methodology, the development of a single, scientifically robust guideline represents a major piece of academic endeavour. For the 331 clinical

problems in this booklet, such expenditure of time and resources is somewhat impractical. Nevertheless, increasing effort has been made to ensure the methodology for the preparation of guidelines has been followed during the preparation of these recommendations. In particular, there has been expert development of a search strategy, extensive systematic literature review, and critical appraisal by relevant special interest groups. The Royal College of Radiologists holds an archive of references upon which statements within the text are based. Every opportunity has been given to workers in other disciplines and those representing patients to put forward their views. Many societies and groups across Europe have been encouraged to comment on points of fact, local policies, and other related matters. There has been extensive dialogue with other professional groups, including patients' representatives, European professional associations and specialist societies, and all the medical Royal Colleges (see Appendix).

In some clinical situations (e.g., the role of ultrasound in normal pregnancy) there are conflicting data within a large body of excellent scientific reports. Thus no firm recommendations are given and the evidence is graded C. It should be noted that there are very few randomised trials comparing different radiological procedures – they are difficult to perform and ethical approval may be denied.

7 WHAT IMAGES ARE TAKEN?

All imaging departments should have protocols for each common clinical situation. Therefore no definite recommendations are given about this aspect. Suffice it to say that all examinations should be optimised to obtain maximum information with the minimum of radiation. It is important to be aware of this, as the imaging performed may not be what the referring clinician expects.

8 FOR WHOM ARE THE GUIDELINES DESIGNED?

These Guidelines are intended to be used by all 'referrers', including in particular general practitioners. In the hospital setting they are likely to be of most use to newly qualified doctors, and many hospitals give a copy to each newly appointed junior doctor to stimulate good practice.

The range of investigations available to different health professionals must be determined in consultation with local specialists in radiology and nuclear medicine, bearing in mind the available resources. The recommendations are also of value to those interested in audit of a department's referral pattern and workload [13].

9 USING THE GUIDELINES

These guidelines tend to highlight areas of difficulty or controversy. The pages are composed of five columns: the first sets the clinical situation for

requesting an examination; the next lists some possible imaging techniques; the third gives the recommendation (and the grade of available evidence) on whether or not the investigation is appropriate; the fourth provides explanatory comment; and the fifth shows the band of radiation exposure involved.

The recommendations used are:

1. **Indicated.** This shows an investigation most likely to contribute to clinical diagnosis and management. This may differ from the investigation requested by the clinician: e.g., US rather than venography for deep vein thrombosis.

2. **Specialised investigation.** These are frequently complex, time-consuming or resource-intensive investigations which will usually only be performed after discussion with the radiologist or in the context of locally-agreed protocols.

3. **Not indicated initially.** This includes situations where experience shows that the clinical problem usually resolves with time; we therefore suggest deferring the study for three to six weeks (timescale may be shorter for children) and only performing it then if symptoms continue. Shoulder pain is a typical example.

4. **Indicated only in specific circumstances.** These are non-routine studies which will only be carried out if a clinician provides cogent reasons or if the radiologist feels the examination represents an appropriate way of furthering the diagnosis and management of the patient. An example of such a justification would be plain radiography in a patient with backache in whom there were clinical findings to suggest something more than a degenerative disease (e.g., osteoporotic vertebral fracture).

5. **Not indicated.** Examinations in this group are those where the supposed rationale for the investigation is untenable (e.g., skull radiograph for dementia).

10 PREGNANCY AND PROTECTION OF THE FETUS

Irradiation of a foetus should be avoided whenever possible [23-25]. This includes situations where the woman herself does not suspect pregnancy. The prime responsibility for identifying such patients lies with the referring clinician.

Women of reproductive age presenting for an examination in which the primary beam irradiates directly, or by scatter, the pelvic area (essentially, any ionising irradiation between the diaphragm and the knees), or for a procedure involving radioactive isotopes, should be asked whether they are or may be pregnant. If a patient cannot exclude the possibility of pregnancy, she should be asked if her period is overdue.

If there is no possibility of pregnancy the examination can proceed, but if the patient is definitely or possibly pregnant (i.e., menstrual period is overdue) the justification for the proposed examination should be reviewed by the radiologist and the referring clinician, with a decision taken on whether to defer the investigation until after delivery or until the next menstrual period

has occurred. However, a procedure of clinical benefit to the mother may also be of indirect benefit to her unborn child, and a delay in an essential procedure may increase the risk to the foetus as well as to the mother.

If pregnancy cannot be excluded, but the menstrual period is *not* overdue and the procedure gives a relatively low dose to the uterus, the examination may proceed. However, if the examination gives relatively high doses (in most departments, the common examinations in this category will probably be abdominal and pelvic CT, IVUs, fluoroscopy and nuclear medicine studies), there will be discussion in line with locally agreed recommendations.

In all cases, if the radiologist and referring clinician agree that irradiation of the pregnant or possibly pregnant uterus is clinically justified or is not clinically justified, this decision should be recorded. If it is decided that the irradiation is justified, the radiologist must then ensure that exposure is limited to the minimum required to acquire the necessary information.

If it becomes obvious that a foetus has been inadvertently exposed, despite the above measures, the small risk to the foetus of the exposure is unlikely to justify, even at the higher doses, the greater risks of invasive foetal diagnostic procedures (e.g., amniocentesis) or those of a termination of the pregnancy. When such inadvertent exposure has occurred, a radiation physicist should make an individual risk assessment and the results should be discussed with the patient.

The RCR has co-authored (with the National Radiation Protection Board (NRPB) and the College of Radiographers) a guidance booklet on the protection of the foetus during the diagnostic investigation of its mother [25]. (This publication is available from the NRPB website at http://www.nrpb.org.).

11 OPTIMISING RADIATION DOSE

The use of radiological investigations is an accepted part of medical practice justified in terms of clear clinical benefits to the patient, which should far outweigh the small radiation risks. However, even small radiation doses are not entirely without risk. A small fraction of the genetic mutations and malignant diseases occurring in the population can be attributed to natural background radiation. Diagnostic medical exposures, being the major source of man-made radiation exposure of the population, add about one-sixth to the population dose from background radiation.

The 1997 EU directive [2] requires all concerned to reduce unnecessary exposure of patients to radiation. Responsible organisations and individuals using ionising radiation must comply with these regulations. One important way of reducing the radiation dose is to avoid undertaking investigations unnecessarily (especially repeat examinations).

The effective dose for a radiological investigation is the weighted sum of the doses to a number of body tissues, where the weighting factor for each tissue depends upon its relative sensitivity to radiation-induced cancer or severe hereditary effects. It thus provides a single dose estimate related to the total radiation risk, no matter how the radiation dose is distributed around the body.

Table 1 Typical effective doses from diagnostic medical exposure in the 2000s

Diagnostic procedure	Typical effective dose (mSv)	Equivalent no. of chest radiographs	Approximate equivalent period of natural background radiation [1]
Radiographic examinations:			
Limbs and joints (except hip)	<0.01	<0.5	<1.5 days
Chest (single PA film)	0.02	1	3 days
Skull	0.06	3	9 days
Thoracic spine	0.7	35	4 months
Lumbar spine	1.0	50	5 months
Hip	0.4	20	2 months
Pelvis	0.7	35	4 months
Abdomen	0.7	35	4 months
IVU	2.4	120	14 months
Barium swallow	1.5	75	8 months
Barium meal	2.6	130	15 months
Barium follow through	3	150	16 months
Barium enema	7.2	360	3.2 years
CT head	2.0	100	10 months
CT chest	8	400	3.6 years
CT abdomen or pelvis	10	500	4.5 years
Radionuclide studies:			
Lung ventilation (Xe-133)	0.3	15	7 weeks
Lung perfusion (Tc-99m)	1	50	6 months
Kidney (Tc-99m)	1	50	6 months
Thyroid (Tc-99m)	1	50	6 months
Bone (Tc-99m)	4	200	1.8 years
Dynamic cardiac (Tc-99m)	6	300	2.7 years
PET head (F-18 FDG)	5	250	2.3 years

1UK average background radiation = 2.2 mSv per year: regional averages range from 1.5 to 7.5 mSv per year.
With advice from B Wall, National Radiological Protection Board.

Typical effective doses for some common diagnostic radiology procedures range over a factor of about 1000 from the equivalent of a day or two of natural background radiation (e.g. 0.02 mSv for a chest radiograph) to 4.5 years (e.g., for computed tomography of the abdomen). However, there is substantial variation in the background radiation between and within countries. The doses for conventional x-ray examinations are based on results compiled by the NRPB from patient dose measurements made in 380 hospitals throughout the UK from 1990 to 1995. They are mostly lower than those given in earlier editions of this booklet, which were based on data from the early 1980s, indicating a gratifying trend towards improved patient protection. The doses for CT examinations and radionuclide studies are based on national surveys conducted in 2002 by the NRPB and the British Nuclear Medicine Society (BNMS) and are unlikely to have changed significantly since then.

Low-dose examinations of the limbs and chest are among the most common radiological investigations, but relatively infrequent high-dose examinations such as body CT and barium studies make the major contribution to the collective population dose. The doses from some CT examinations are particularly high and show no sign of decreasing. The use of CT is still rising. CT now probably contributes almost half of the collective dose from all radiographic examinations. It is thus particularly important that requests for CT are thoroughly justified and that techniques are adopted which minimise dose while retaining essential diagnostic information. Indeed, some authorities estimate the additional lifetime risk of fatal cancer from an abdominal CT examination in an adult is around 1 in 2000 (compared with the risk from a chest radiograph at 1 in a million) [26]. However, the overall risk of cancer in the general population is nearly 1 in 3, and in comparison to this the excess risk of a CT scan is very small and should be more than offset by the gain from a CT scan.

In these referral Guidelines the doses have been grouped into broad bands to help the referrer understand the order of magnitude of radiation dose of the various investigations.

Table 2 Band Classification of the typical effective doses of ionising radiation from common imaging procedures

Band	Typical effective dose (mSv)	Examples
0	0	US, MRI
I	<1	CXR, XR limb, XR pelvis
II*	1-5	IVU, XR lumbar spine, NM (e.g. skeletal scintigram), CT head & neck
III	5-10	CT chest and abdomen, NM (e.g. cardiac)
IV	>10	Some NM studies (e.g. some PET)

** The average annual background dose in most parts of Europe falls in band II.*

12 COMMUNICATIONS WITH A DEPARTMENT OF CLINICAL RADIOLOGY

Referral for an imaging examination is generally regarded as a request for an opinion from a specialist in radiology or nuclear medicine. The outcome of this request for an opinion should be presented in the form of a report to assist in the management of a clinical problem.

Request forms should be completed accurately and legibly in order to avoid any misinterpretation. Reasons for the request should be clearly stated and sufficient clinical details should be supplied to enable the imaging specialist to understand the particular diagnostic or clinical problems to be resolved by radiological investigation.

In some cases the best investigation for resolving the problem may be an alternative imaging investigation.

If there is doubt as to whether an investigation is required or which investigation is best, an appropriate specialist in radiology or nuclear medicine must be consulted. Indeed, imaging departments are always pleased to discuss investigations with referring doctors. Regular clinico-radiological meetings provide a useful format for such discussion and are considered good practice [27].

While it should be noted that these recommendations have been widely endorsed, it is recognised that a few departments will adapt them according to local circumstances and policies.

13 IMAGING TECHNIQUES

13.1 Computed tomography (CT)

CT is now quite widely available throughout Europe. Furthermore, there have been recent important advances due to the development of spiral and multislice CT, which allows the acquisition of a large amount of data from a single breath hold. Such advances have opened up new diagnostic opportunities, such as the use of multi-slice CT in the diagnosis of coronary artery disease. Nevertheless, different hospitals will have their own policies about accepting CT requests. It is worth remembering that CT imparts a relatively high x-irradiation dose. Thus it is always worth considering alternatives, especially in view of the increasing role of MRI. The UK National Radiological Protection Board has published several general recommendations with regard to CT in Protection of the patient in x-ray computed tomography [26], and they are currently reviewing the advice.

Like all radiological requests, any CT referral which falls outside established guidelines should be discussed with a radiologist. Because of the need to minimise the extent of the examination (and thereby the cost and radiation dose), it is helpful if the clinical notes and previous imaging investigations are available for review by the imaging department at the time of the proposed CT.

A few further points:

- CT remains the optimal investigation for many clinical problems within the chest and abdomen, despite the radiation risks.

- CT is still widely used for intracranial problems, especially cerebrovascular accident and trauma.

- CT remains a simple method of staging many malignant diseases (e.g., lymphoma) and of monitoring the response to therapy.

- CT provides valuable pre-operative information about complex masses and is widely used to investigate post-operative complications.

- CT allows accurate guidance for drainage procedures, biopsies, and anaesthetic nerve blocks.

- CT has an important role in the management of trauma.

- CT images may be degraded by prostheses, fixation devices, etc.

- CT provides better anatomical detail in obese patients than US. In thinner patients and children, US should be used whenever possible.

- CT of the abdomen imparts a radiation dose equivalent to about 500 chest x-rays.

13.2 Interventional radiology (including angiography and minimal access therapy)

This area of radiology is now fully established. Most abscesses in the abdomen are now treated by percutaneous drainage procedures using radiological guidance. Likewise, the majority of liver biopsies is now performed by radiologists (using US guidance). Lymph node biopsies are routine in most US and CT units. While all departments of clinical radiology have been undertaking angiography and associated procedures (e.g., angioplasty) for many years, new techniques are constantly developing.

New technology is rapidly widening the range of interventional radiology yet further. Innovations include:

- Percutaneous vertebroplasty for collapsed vertebral bodies

- Percutaneous insertion of grafts for abdominal aortic aneurysms

- Various techniques to treat inoperable hepatic lesions (e.g., radiofrequency ablation under imaging control)

- Interventional MRI with 'real-time' imaging to allow monitoring of therapeutic manoeuvres

These examples of recent innovations require close collaboration with clinical colleagues. The precise arrangements vary considerably according to local expertise and availability of equipment. There is continuing discussion at national level about the best arrangement for these interventional procedures.

Inevitably, requests for all such procedures call for detailed discussion involving various specialists.

13.3 Magnetic resonance imaging (MRI)

There has been a substantial recent increase in the number of MRI systems across Europe. Accordingly, there are numerous recommendations for the use of MRI. Indeed, with the recent technical advances and increasing experience, the role of MRI continues to expand, and the limiting factor for further expansion is now often financial.

Since MRI does not use ionising radiation, MRI should be preferred in cases where it would provide information of similar value to that provided by CT (and when both are available). However, MRI is in danger of being subjected to inappropriate demands, which may lead to long waiting times. Thus, all requests for MRI should be agreed with a radiologist.

A few further points:

- MRI usually provides more information than CT about intracranial, head and neck, spinal and musculoskeletal disorders because of its high contrast sensitivity and multiplanar imaging capability. This helps clinicians to establish the diagnosis and institute appropriate management with greater confidence. It is increasingly being used in oncology.

- Major recent advances include: breast and cardiac MRI; angiographic and interventional techniques; magnetic resonance cholangiopancreatography (MRCP) and other fluid-sensitive MRI techniques; functional MRI imaging of the brain. However, many of these techniques await full evaluation.

- MRI is not approved during the first trimester of pregnancy. However, it may well prove to be safer than some of the alternative options. All imaging of pregnant women should be discussed with the radiology department.

- There are some definite contraindications to the use of MRI: metallic foreign bodies (FBs) in the orbits, aneurysm clips, pacemakers, cochlear implants, etc. Furthermore, MRI will give reduced image quality close to prostheses. The full list of contraindications is provided in several textbooks and monographs. Any uncertainty about contraindications should be discussed with the imaging department well in advance of the proposed investigation.

13.4 Nuclear medicine (NM)

In some EU countries NM is an independent specialty and the use of unsealed sources of radionuclides for diagnosis and therapy is restricted to NM specialists. In some countries other specialists, usually radiologists, provide NM services. Whatever the local arrangements, an experienced specialist will be available to discuss the appropriate NM techniques for a given clinical situation. The specialist will also be able to advise on which particular NM investigation should be used. Accordingly, referring clinicians should indicate

the precise clinical problem requiring investigation, because this will determine which radionuclide (or alternative) investigation is used.

Despite some misconceptions, the radiation doses imparted by most NM techniques compare favourably with those of many other imaging investigations regarded as 'safe'. As shown in Table 1 the effective dose associated with most routine NM studies is considerably less than that for abdominal CT.

There is particular value in the functional data that can be provided by NM techniques. At a basic level, NM can determine whether a distended renal pelvis shown by US is merely due to a capacious collecting system or is caused by an obstructing lesion. The same investigation can provide data on the percentage of overall renal function provided by each kidney. More complex studies can indicate the ejection fraction of the left ventricle or the distribution of blood flow to the cerebral cortex.

Positron emission tomography (PET) has recently made large strides, and its availability is gradually increasing. Because of the short-lived nature of the key radionuclides (the glucose analogue F-18 fluorodeoxyglucose, FDG, is widely used), PET can only be offered at a reasonable distance from a cyclotron and radionuclide pharmacy. PET can identify small foci of viable tumours, so it offers exceptional opportunities in the staging of various cancers (e.g., bronchus) and in cancer follow-up (e.g., lymphoma), where other imaging techniques may be unable to distinguish between residual fibrotic masses and active disease. PET can also provide unique data about brain metabolism and myocardial viability, and there are several research units studying these aspects. Over the next few years there will be an increasing uptake of PET into clinical practice, and its potential use is flagged for certain clinical problems in the ensuing recommendations.

13.5 Nuclear medicine therapy

Although it is not within the scope of these referral Guidelines, it is worth remembering that NM has an important role in the treatment of both benign and malignant disease. The thyroid gland is still the most important target, but the field is rapidly expanding: other indications include neuroendocrine tumours, painful skeletal metastases, some arthropathies, polycythaemia, and malignant effusions. NM treatment options are being investigated in the leukaemias/lymphomas and some liver tumours.

13.6 Ultrasound (US)

Since the previous edition of these Guidelines, most departments of clinical radiology have experienced a large increase in referrals for US examinations. During this period US equipment and expertise have advanced and the scope of referrals (colour Doppler, power Doppler, transvaginal gynaecological work, etc.) has widened. These trends are to be welcomed because US does not employ ionising radiation. However, there is scant evidence that the increase in US referrals has been accompanied by much reduction in referrals for other radiological investigations and a consequent reduction in total radiation dose to the public. The one notable exception is the IVU, which is required much less often since the advent of US. However, because US in non-invasive, the total number of patients investigated with urological problems has increased.

Departments of clinical radiology have developed different local policies for dealing with the increasing US workload.

The actual acquisition of US images has to be undertaken by an experienced operator; even such an operator may not be able to gain perfect images in every patient. For example, US can be difficult and unsatisfactory in obese patients. Furthermore, the distribution of bowel gas may mask certain features. Nevertheless, the cheap, quick, reliable, and non-invasive nature of US makes it an excellent initial investigation for a wide range of clinical referrals. Accordingly, US has been recommended as the investigation of choice whenever appropriate.

Since US avoids ionising radiation and is relatively inexpensive, it is often recommended where more expensive studies (e.g. CT) cannot be justified or resources are limited. Conversely, it is difficult to refuse a request for US on grounds of invasiveness or expense. There is thus a danger of US departments being overloaded with requests that may be on the margins of appropriateness. Referring clinicians therefore still have a duty to consider carefully whether each request for US is justified and whether the result (e.g., the presence of gallstones) will affect management (see Introduction: Why are guidelines needed?).

14 GLOSSARY

Abbreviation	Definition
ACTH	Adrenocorticotrophic hormone
AVM	Arteriovenous malformation
AXR	Abdominal radiograph
COPD	Chronic obstructive pulmonary disease
CSF	Cerebrospinal fluid
CT	Computed tomography
CTA	Computed tomographic angiography
CTM	Computed tomographic myelography
CXR	Chest radiograph
DEXA	Dual energy x-ray absorptiometry
DMSA	Dimercaptosuccinic acid
DSA	Digital subtraction angiography
EDTA	Ethylenediaminetetraacetiacid
ERCP	Endoscopic retrograde cholangiopancreatography
ERNVG	Equilibrium radionuclide ventriculography
FB	Foreign body
FDG	F-18-fluorodeoxyglucose
FDG-PET	Positron emission tomography using F-18 fluorodeoxyglucose

FNAC	Fine-needle aspiration cytology
GA	General anaesthesia
GFR	Glomerular filtration rate
GI	Gastrointestinal
HDU	High dependency unit
HIDA	Hydroxy iminodiacetic acid
HRCT	High resolution computed tomography
HRT	Hormone replacement therapy
ITU	Intensive treatment unit
IUCD	Intrauterine contraceptive device
IV	Intravenous
IVC	Inferior vena cava
IVU	Intravenous urogram
LP	Lumbar puncture
LV	Left ventricle
MAG3	Mercaptylacetyltriglycerine
MCUG	Micturating cystourethrogram
MEN	Multiple endocrine neoplasia
MIBG	Metaiodobenzylguanidine
MRA	Magnetic resonance angiography
MRCP	Magnetic resonance cholangiopancreatography
MRI	Magnetic resonance imaging
MS	Multiple sclerosis
MUGA	Multiple-gated acquisition (radionuclide angiography)
NAI	Non-accidental injury
NM	Nuclear medicine
NRPB	National Radiological Protection Board
OIH	Ortho-iodohippurate
OPG	Orthopantomographic
PET	Positron emission tomography
PSA	Prostate-specific antigen
PTA	Percutaneous transluminal angioplasty
PUJ	Pelvic-ureteric junction
PV loss	Vaginal bleeding
rCBF	Regional cerebral blood flow
RV	Right ventricle
SAH	Subarachnoid haemorrhage

SOL	Space occupying lesions
SPECT	Single photon emission computed tomography
SVC	Superior vena cava
SXR	Skull radiograph
T N M staging	A system of clinicopathological evaluation of tumours based on the extent of tumour involvement at the primary site (T), lymph node (N) and metastasis (M)
TIA	Transient ischaemic attack
TIPS	Transjugular intrahepatic portosystemic shunt
TOE	Transoesophageal echocardiography
Triple assessment	Clinical examination/imaging/needle biopsy performed in the clinical suspicion of breast cancer
TRUS	Transrectal ultrasonography
US	Ultrasonography
UTI	Urinary tract infection
V:Q	Ventilation-perfusion scintigraphy
VSD	Ventriculoseptal defect
WBC	White blood cell
XR	Radiograph

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A. Head (including ENT problems)

CLINICAL/DIAGNOSTIC PROBLEM	INVESTIGATION	RECOMMENDATION [GRADE]	COMMENT	DOSE
Congenital disorders ***(For children see section M)*** **A01**	MRI	Indicated [B]	Definitive exam for all malformations. CT may be needed to define bone and skull base anomalies. Sedation or GA may be required for infants and young children. ***(For congenital disorders in children see M01 and M02)***	0
Acute stroke ***(See also N01, N02)*** **A02**	CT	Indicated [diagnosis B, treatment A]	A policy of CT for most strokes as soon as reasonably possible is to be encouraged, but at least within 48 hours, as this will ensure accurate diagnosis of the cause, site, and appropriate primary treatment and secondary prevention.	II
	MRI	Specialised investigation [B]	MRI should be considered in young patients with stroke, in patients presenting late where it is essential to know whether they have previously had a haemorrhage, and in suspected posterior fossa stroke in patients in whom it is important to demonstrate the site of the stroke lesion.	0
	US carotids	Indicated only in specific circumstances [B]	Should only be performed in: (1) those with full recovery in whom carotid endarterectomy is contemplated for secondary prevention; (2) suspected dissection; or (3) young patients, whether disabling or non-disabling ischaemic stroke.	0
Transient ischaemic attack (TIA) ***(See also B05)*** **A03**	CT	Indicated [B]	May be normal. Can detect established infarction and haemorrhage and exclude disease processes that can mimic stroke syndromes, such as glioma, extracerebral haemorrhage, and cerebritis.	II
	US carotids	Indicated [B]	To assess suitability for carotid endarterectomy or angioplasty. Angiography, MRA, and CTA are alternatives to show the vessels. MRI and NM can be used to show function.	0
Demyelinating and other white matter disease **A04**	MRI	Indicated [A]	MRI is viewed as the most sensitive and specific investigation for establishing a diagnosis of multiple sclerosis. The diagnosis is made by demonstrating dissemination of clinical events and lesions in space and time.	0
Space occupying lesion (SOL) **A05**	MRI	Indicated [B]	MRI is more sensitive for early tumours, in resolving exact position (useful for surgery), and for posterior fossa lesions. MRI may miss calcification.	0
	CT	Indicated [B]	CT is often sufficient in supratentorial lesions.	II

CLINICAL/DIAGNOSTIC PROBLEM	INVESTIGATION	RECOMMENDATION [GRADE]	COMMENT	DOSE
Headache: acute, severe; subarachnoid haemorrhage (SAH)	CT	Indicated [B]	The clinical history is critical. A clinician should be able to diagnose patients who have classical migraine or cluster headaches without CT. SAH headache comes on typically in seconds, rarely in minutes, and almost never over more than 5 minutes. CT will provide evidence of haemorrhage in up to 98% of patients with SAH if performed on a modern scanner within the first 48 hours of ictus. An LP should still be performed on all patients (delayed 12 hours after ictus for xanthochromia) with suspected SAH but with negative CT. CT is indicated in patients with acute-onset headache with focal neurological signs, nausea or vomiting, or GCS (Glasgow Coma Score) below 14. An LP is the diagnostic test of choice for meningitis unless there are focal signs or a significantly depressed level of consciousness.	II
A06	MRI/NM	Specialised investigation [C]	MRI is better than CT for inflammatory causes. SPECT may be the most sensitive investigation for encephalitis and can provide evidence of circulatory derangement in migraine.	0/II
Headache: chronic ***(See also A13 below)*** ***(For children see section M)*** **A07**	CT/MRI	Indicated only in specific circumstances [C]	In the absence of focal features imaging is not usually useful. The following features significantly increase the odds of finding a major abnormality on CT or MRI: • Recent onset and rapidly increasing frequency and severity of headache • Headache causing to wake from sleep • Associated dizziness, lack of coordination, tingling or numbness ***(For headache in children see M08)***	II/0
	SXR, XR sinus, XR cervical spine	Indicated only in specific circumstances [B]	XR is of little use in the absence of focal signs/symptoms.	I/I/I
Pituitary and juxtasellar problems	MRI	Specialised investigation [B]	Urgent referral when vision is deteriorating.	0
A08	SXR	Not indicated [C]	Patients who require investigation need MRI or CT.	I
Posterior fossa signs **A09**	MRI	Indicated [A]	MRI is the investigation of choice. CT is often degraded by beam hardening artefacts.	0
Hydrocephalus, shunt function	CT	Indicated [B]	CT is adequate for most cases; MRI is sometimes necessary and may be more appropriate in children. US is first choice for infants. ***(For hydrocephalus in children see M06)***	II
(For children see section M) **A10**	XR	Indicated [C]	If there is evidence of hydrocephalus on CT, XR can demonstrate the whole valve system.	I

CLINICAL/DIAGNOSTIC PROBLEM	INVESTIGATION	RECOMMENDATION [GRADE]	COMMENT	DOSE
Middle or inner ear symptoms (including vertigo) **A11**	CT	Specialised investigation [B]	Evaluation of these symptoms requires ENT, neurological, or neurosurgical expertise.	II
Sensorineural hearing loss ***(For children see section M)*** **A12**	MRI	Specialised investigation [B]	MRI is much better than CT, especially for acoustic neuromas. ***(For hearing loss in children see M05)***	0
Sinus disease ***(For children see section M)*** **A13**	XR sinus	Indicated only in specific circumstances [B]	Acute sinusitis can be diagnosed and treated clinically. If it persists past 10 days on appropriate treatment, XR sinus may be required. Signs on XR sinus are often non-specific and encountered in asymptomatic individuals. ***(For sinus disease in children see M09)***	I
	CT sinus	Specialised investigation [B]	CT is useful to demonstrate the presence and distribution of disease and sinonasal anatomy. Low-dose technique is desirable. CT is indicated for failure of maximal medical treatment, development of complications (such as orbital cellulitis), or if malignancy is suspected.	II
Dementia and memory disorders, first-onset psychosis **A14**	CT	Indicated only in specific circumstances [A]	Yield is low, even in younger patients; neurological signs and rapid progression increase it. Over the age of 65, CT can be reserved for patients with an onset within the last year or an atypical presentation, rapid unexplained deterioration, unexplained focal neurological signs or symptoms, a recent head injury (preceding the onset of dementia), or urinary incontinence and/or gait ataxia early in illness.	II
	MRI NM	Not indicated [B]	More sophisticated examinations (MRI, SPECT) have no proven clinical value, although they may be used in research.	0 II
	SXR	Not indicated [A]	SXR should only ever be used to show clinically relevant abnormalities of the skull bones.	I
Orbital lesions **A15**	CT	Specialised investigation [A]	CT remains the investigation of choice. MRI may be of value if CT is unhelpful or gives insufficient detail. Consider US for intraocular lesions.	II
	XR	Not indicated [A]	Suspected orbital lesions require specialist referral.	I
Orbital lesions: trauma **A16**	CT	Specialised investigation [A]	CT is indicated when orbital trauma may be combined with major facial fracture. If a less severe blowout fracture is suspected, CT is carried out only if the patient is a candidate for surgery.	II

CLINICAL/DIAGNOSTIC PROBLEM	INVESTIGATION	RECOMMENDATION [GRADE]	COMMENT	DOSE
Orbital lesions: suspected foreign body	CT	Specialised investigation [A]	Indicated when XR fails to show a strongly suspected foreign body which may not be metallic, when multiple foreign bodies are present, or when it is not certain whether a foreign body already demonstrated is intraocular.	II
	XR orbits	Indicated [A]	A single 'soft' lateral XR is the only projection required to exclude a metallic foreign body; eye-moving images are only for confirmation of the intraocular position of a foreign body once demonstrated. Prior to an MRI study a posteroanterior XR is adequate to exclude a significant metallic foreign body. If a foreign body is confirmed CT may be required by some specialists.	I
A17	US	Indicated [B]	US may be indicated for radiolucent foreign bodies or where XR is difficult.	0
Acute visual loss: visual disturbances	SXR	Not indicated [A]	Specialists can diagnose many cases without resorting to imaging.	I
	MRI/CT	Specialised investigation [A]	MRI is preferable for suspected lesions of the optic chiasm. CT is preferable for orbital lesions.	0/II
A18	Cerebral angiography	Specialised investigation [A]	Specialist referral is indicated.	III
Epilepsy (adult)	MRI	Specialised investigation [B]	Structural imaging is the technique of choice. Higher soft-tissue resolution and multiplanar capability give greater sensitivity and specificity for the identification of small cortical lesions. Particularly valuable in the evaluation of partial epilepsy, e.g. temporal lobe epilepsy. ***(For epilepsy in children see M04)***	0
	CT	Specialised investigation [B]	Following trauma. CT may complement MRI in the characterisation of lesions, e.g. calcification.	II
(For children see section M) **A19**	NM	Specialised investigation [B]	Ictal SPECT or interictal PET is useful in the planning of epilepsy surgery when MRI is negative or its results conflict with EEG or neurophysiological evidence. Regional cerebral blood flow (rCBF) agents are also of value.	II

B. Neck (for spine see sections C & K)

Soft tissues

CLINICAL/DIAGNOSTIC PROBLEM	INVESTIGATION	RECOMMENDATION [GRADE]	COMMENT	DOSE
Thyroid nodules	US	Indicated only in specific circumstances [B]	US is excellent for differentiating between thyroid and extrathyroid masses, for guiding aspiration or biopsy (particularly in difficult-to-palpate or small thyroid nodules), and for the detection of associated lymphadenopathy in thyroid malignancy. While US can be specific for malignancy, it has poor sensitivity. In generalised thyroid enlargement or multinodular goitre US readily shows retrosternal extension; real-time studies show effect of neck extension, etc. CT/MRI is needed to demonstrate full retrosternal extent and tracheal compromise. NM has no role in the initial evaluation of thyroid nodules.	0
B01	US-guided FNAC/FNAC	Indicated [B]	Thyroid nodules are extremely common; the majority are benign. Conventional fine-needle aspiration (FNAC) (without imaging) is the most cost-effective initial investigation.	0/0
Thyrotoxicosis **B02**	NM	Indicated [B]	NM can differentiate between Graves' disease, toxic nodular goitre, and subacute thyroiditis. Provides functional information about nodules. Also useful in thyroiditis.	II
Ectopic thyroid tissue (e.g. lingual thyroid) **B03**	NM	Indicated [C]	NM excellent for small ectopic rests of thyroid tissue.	II
Hyperparathyroidism **B04**	US/NM/CT/MRI	Specialised investigation [C]	Seek advice. Diagnosis made on clinical/biochemical grounds. Imaging can assist in pre-operative localisation but may not be needed by experienced surgeons. Much depends on local policy and available technology and expertise. US, NM, CT, and MRI are all accurate in the un-operated neck. MRI is probably evolving as the best investigation for ectopic and residual tumours. Super-selective venography for sampling after previous imaging may be useful.	0/II/II/0
Asymptomatic carotid bruit **B05**	US carotids	Indicated only in specific circumstances [B]	US not usually valuable as evidence suggests that surgery is not recommended for asymptomatic carotid stenosis.	0
Swallowed or inhaled foreign body *(See also K27–K29)* *(For children see section M)* **B06**	Lateral XR soft tissues of neck	Indicated only in specific circumstances [B]	The majority of foreign bodies are not seen on XR. The clinical history and findings are more accurate indicators of the presence of a foreign body. Direct examination of the oropharynx, laryngoscopy, and endoscopy are the investigations of choice. *(For swallowed or inhaled foreign body in children see M26 and M31)*	I

CLINICAL/DIAGNOSTIC PROBLEM	INVESTIGATION	RECOMMENDATION [GRADE]	COMMENT	DOSE
Neck mass of unknown origin **B07**	US	Indicated [C]	First-line investigation for characterisation of neck mass. May be combined with FNAC.	0
	CT/MRI	Indicated only in specific circumstances [C]	CT/MRI may be indicated if the full extent of the lesion is not determined by US, for identifying other lesions, and for staging.	II/0
Salivary obstruction **B08**	US/Sialogram	Indicated [C]	For intermittent, food-related swelling. MR sialography may be preferred in some centres.	0/II
	XR	Indicated only in specific circumstances [C]	Where there is calculus in the floor of the mouth, XR may be all that is required.	I
Salivary mass **B09**	US	Indicated [B]	US is the initial investigation of choice for a suspected salivary mass; it can be combined with FNAC, if necessary. It is extremely sensitive and has high specificity.	0
	MRI/CT	Specialised investigation [B]	Whenever deep lobe involvement or extension into deep spaces is suspected, MRI or CT should be carried out.	0/II
Dry mouth: connective tissue disease **B10**	US/ Sialogram/ NM	Specialised investigation [C]	Not commonly required. Sialogram may be diagnostic, but NM provides better functional assessment. MR sialography is also used here.	0/II/ II
Temporomandibular joint dysfunction **B11**	MRI	Specialised investigation [B]	XRs do not often add information as the majority of temporomandibular joint problems are due to soft tissue dysfunction (usually subluxation of the intra-articular disk) rather than bony changes, which appear late and are often absent in the acute phase.	0

CLINICAL/DIAGNOSTIC PROBLEM	INVESTIGATION	RECOMMENDATION [GRADE]	COMMENT	DOSE
C. Spine (for trauma see section K)				
General				
Congenital disorders	MRI	Indicated [B]	MRI defines all spinal malformations and excludes associated thecal abnormality. CT may be needed to delineate bone detail. Sedation or GA may be required for infants and young children. ***(For congenital disorders in children see M01, M02)***	0
(For children see section M) **C01**	XR	Specialised investigation [C]	E.g. full-length standing XR for scoliosis. ***(For congenital disorders in children see M01, M02)***	I
Myelopathy: tumours, inflammation, infection, infarction, etc.	MRI	Indicated [B]	MRI is the initial investigation of choice for all spinal cord lesions, to evaluate cord compression and to give an indication of post-operative prognosis.	0
	CT/CTM	Specialised investigation [B]	CT may be needed if better bony detail is required. CT myelography (CTM) only if MRI is unavailable or impossible.	II/II
C02	NM	Specialised investigation [B]	NM is still widely used to screen for metastases and to identify focal skeletal lesions (such as osteoid osteoma).	II
Cervical spine				
Possible atlanto-axial subluxation	XR	Indicated [B]	A single lateral cervical spine XR with the patient in supervised comfortable flexion should reveal any significant subluxation in patients with rheumatoid arthritis, Down's syndrome, etc.	I
C03	MRI	Specialised investigation [B]	MRI in flexion/extension shows effect on cord when XR is positive or neurological signs are present.	0
Neck pain, brachialgia, degenerative change	XR	Indicated only in specific circumstances [B]	Neck pain generally improves or resolves with conservative treatment. Degenerative changes begin in early middle age and are often unrelated to symptoms.	I
C04	MRI	Specialised investigation [B]	Consider MRI and specialist referral when pain affects lifestyle or when there are neurological signs. CT myelography may occasionally be required to provide further delineation or when MRI is unavailable or impossible.	0
Thoracic spine				
Pain without trauma: degenerative disease	XR	Indicated only in specific circumstances [C]	Degenerative changes are invariably present from middle age onwards. Imaging is rarely useful in the absence of neurological signs or pointers to metastases or infection. Consider more urgent referral in elderly patients with sudden pain to show osteoporotic collapse or other forms of bone destruction. Consider NM for possible metastatic lesions.	I
C05	MRI	Specialised investigation [C]	MRI may be indicated if local pain persists or is difficult to manage, or if there are long tract signs.	0

CLINICAL/DIAGNOSTIC PROBLEM	INVESTIGATION	RECOMMENDATION [GRADE]	COMMENT	DOSE
Lumbar spine				
Chronic back pain with no pointers to infection or neoplasm **C06**	XR	Indicated only in specific circumstances [C]	Degenerative changes are common and non-specific. Main value of XR is in younger patients (e.g. < 20 years) with spondylolisthesis, ankylosing spondylitis, etc., or in older patients (e.g. > 55 years). In cases where management is difficult, negative findings may be helpful.	II
	MRI	Specialised investigation [C]	When symptoms persist or are severe or where management is difficult, MRI is considered the first-choice investigation. Imaging findings need to be interpreted with caution because many imaging 'abnormalities' occur with high frequency in asymptomatic individuals and therefore have an uncertain relationship with back pain. The significance of imaging findings depends upon correlation with clinical signs. Negative findings may be helpful.	0
Back pain with possible serious features such as: • Onset at < 20 or > 55 years • Sphincter or gait disturbance • Saddle anaesthesia • Severe or progressive motor loss • Widespread neurological deficit • Previous carcinoma • Systemic unwellness • HIV • Weight loss • Intravenous drug abuse • Steroids • Structural deformity • Non-mechanical pain ***(For children see section M)*** **C07**	MRI	Indicated [B]	Together with urgent specialist referral, MRI is usually the best investigation. Imaging should not delay specialist referral. ***(For back pain in children see M11)***	0
	NM	Indicated [B]	NM is also widely used for possible bone destruction due to metastases, where infection is suspected, or in some cases of chronic pain. *'Normal' plain XR may be falsely reassuring.*	II
Acute back pain: disk herniation; sciatica with no adverse features ***(For children see section M)*** **C08**	XR	Indicated only in specific circumstances [C]	Acute back pain is usually due to conditions that cannot be diagnosed on XR (osteoporotic collapse is an exception). *'Normal' plain XR may be falsely reassuring.* ***(For acute back pain in children see M11)***	II
	MRI/CT	Specialised investigation [B]	Demonstration of disk herniation requires MRI or CT and should be considered after failed conservative management. MRI is generally preferred (wider field of view visualising the conus, post-operative changes, etc.). Clinico-radiological correlation is important as a significant number of disk herniations are asymptomatic. ***(For acute back pain in children see M11)***	0/III

D. Musculoskeletal system

CLINICAL/DIAGNOSTIC PROBLEM	INVESTIGATION	RECOMMENDATION [GRADE]	COMMENT	DOSE
Osteomyelitis	XR	Indicated [C]	Initial investigation.	I
	MRI	Specialised investigation [C]	MRI accurately demonstrates infection, especially in the spine.	0
	CT	Specialised investigation [C]	CT is valuable for demonstration of sequestra.	II
	US	Indicated [C]	US may be valuable in acute osteomyelitis to demonstrate subperiosteal abscess, but there is a high false negative rate.	0
D01	NM	Specialised investigation [C]	The two- or three-phase skeletal scintigram is more sensitive than XR in detecting suspected focal osteomyelitis. If osteomyelitis is suspected but there are no localising signs or symptoms, a skeletal scintigram is useful. Findings on a skeletal scintigram are not specific and further specialist NM imaging with alternative agents may be required. White cells: the use of Tc-99m-HMPAO or In-111-labelled white cells may be useful in confirming infection in bone or joint. False negative results may be encountered in the spine.	II-III
Primary bone tumour	XR	Indicated [B]	XR should be carried out where there is bone pain that is not resolving.	I
	MRI	Specialised investigation [B]	If the XR appearances are suggestive of primary bone tumour, referral to a specialist centre should not be delayed. MRI is the investigation of choice for local staging.	0
	NM	Indicated [B]	If the XR appearances are suggestive of primary bone tumour, the acquisition of skeletal scintigraphy should not delay referral to a specialist centre. The scintigram may overestimate local tumour extent. The role of FDG-PET remains to be clarified.	II
	CT	Specialised investigation [B]	CT may improve diagnostic information in some tumours, such as osteoid osteoma, and demonstrate intratumoral calcification and ossification. CT-guided biopsy of primary bone tumours should be carried out in specialised bone tumour centres where histological expertise and knowledge of surgical approach is available.	II
(See also L44, L45) **D02**	US	Specialised investigation [B]	US-guided biopsy of certain superficial primary bone tumours should be carried out in specialised bone tumour centres where histological expertise and knowledge of surgical approach is available.	0

CLINICAL/DIAGNOSTIC PROBLEM	INVESTIGATION	RECOMMENDATION [GRADE]	COMMENT	DOSE
Known primary tumour, skeletal metastases	MRI	Indicated [B]	More sensitive and specific than NM, MRI is the primary investigation of choice, particularly in the axial skeleton. May underestimate some peripheral lesions.	0
	NM	Indicated [B]	A sensitive test, but correlative imaging is required to increase specificity. NM is useful for assessing the presence and extent of skeletal metastases in patients with known primary cancers. The skeletal scintigram is insensitive in assessing the extent of myeloma. It may also be used to assess response to treatment, although the flare phenomenon may suggest disease progression if performed too soon after systemic therapy. It is usually only appropriate to repeat a skeletal scintigram within 6 months if there are new symptoms.	II
D03	XR skeletal survey	Not indicated [B]	XRs are indicated only for specific focal symptomatic areas or for correlation with a NM examination.	II
Soft tissue mass tumour	MRI	Indicated [B]	Provides best local staging and can provide a tissue diagnosis in a proportion of patients.	0
D04	US	Indicated [C]	US can answer specific questions (e.g. cystic/solid) and can monitor progress of benign masses such as haematomas.	0
Bone pain	XR	Indicated [C]	Local view of the symptomatic area.	I
	MRI	Indicated [C]	MRI is appropriate if pain persists with normal XR or apparently normal NM. If pain is diffuse, MRI is not always practicable (depends on the technical capabilities of the MRI unit). MRI may also provide further information when XR and/or NM findings are abnormal.	0
	NM	Indicated [C]	If pain persists with normal XR or equivocal and abnormal XR in specific circumstances (e.g. suspected osteoid osteoma, osteomyelitis, or metastases).	II
D05	CT	Specialised investigation [C]	To define bony anatomy in areas of abnormality on XR/MRI/NM, especially if bone biopsy is indicated.	II
Myeloma	MRI	Specialised investigation [B]	Sensitive, limited to spine, pelvis, and proximal femora. Particularly useful in non-secretory myeloma or in the presence of diffuse osteopenia. Can be used for tumour mass assessment and follow-up.	0
	XR skeletal survey	Indicated [C]	For staging and identifying lesions which may benefit from radiotherapy. Survey can be limited to specific areas for follow-up.	I-II
D06	NM	Not indicated [B]	Skeletal scintigraphy is often negative and underestimates disease extent; consider bone marrow studies.	II

CLINICAL/DIAGNOSTIC PROBLEM	INVESTIGATION	RECOMMENDATION [GRADE]	COMMENT	DOSE
Metabolic bone disease	NM	Indicated [C]	Skeletal scintigraphy may be useful in differentiating causes of hypercalcaemia, e.g. metastases and hyperparathyroidism, and of raised alkaline phosphatase, e.g. Paget's disease and metastases.	II
	XR	Indicated [C]	May be helpful in differentiating new from old vertebral fractures or identifying a different cause of pain unrelated to osteoporosis. Correlation with NM will be required.	II
D07	DEXA	Indicated [A]	Measurement of bone density. DEXA or quantitative CT provides objective measurements of bone mineral content.	II
Osteomalacia	XR	Indicated [B]	Localised XR to establish cause of local pain or equivocal lesion identified on NM.	I
(See also D09) **D08**	NM	Specialised investigation [C]	Can show increased activity and some local complications, such as pseudo-fractures.	II
Pain: osteoporotic collapse ***(See also D08)*** **D09**	Lateral XR thoracic and lumbar spine	Indicated [B]	Lateral views will demonstrate compression fractures. NM or MRI more useful in distinguishing between recent and old fractures and can help exclude pathological fractures.	I-II
Arthropathy: presentation	XR affected joint	Indicated [C]	May be helpful to determine cause, although erosions are a relatively late feature.	I
	XR hands/feet	Indicated [C]	In patients with suspected rheumatoid arthritis, XR feet may show erosions even when symptomatic hand(s) appear normal.	I
	XR multiple joints	Indicated only in specific circumstances [C]	Symptomatic joints only.	II
D10	US/NM/MRI	Specialised investigation [C]	All can show acute synovitis. NM can show distribution. MRI can show articular cartilage and early erosions.	0/II/0
Arthropathy: follow-up **D11**	XR	Indicated only in specific circumstances [C]	May be needed by specialist to assist management decisions.	I
Painful shoulder **D12**	XR	Not indicated initially [C]	Degenerative changes in the acromioclavicular joints and rotator cuff are common.	I

CLINICAL/DIAGNOSTIC PROBLEM	INVESTIGATION	RECOMMENDATION [GRADE]	COMMENT	DOSE
Shoulder impingement syndrome	XR	Indicated only in specific circumstances [B]	Pre-operative investigation.	I
	MRI	Specialised investigation [B]	Has value in the demonstration both of bursal inflammatory change and the aetiology of associated abnormalities. Dynamic MRI or MRI in the abducted position may be of diagnostic value in subacromial impingement syndrome.	0
D13	US	Specialised investigation [B]	Clinical diagnosis can be aided by US findings.	0
Shoulder instability **D14**	CT/MRI	Specialised investigation [B]	Glenoid labrum and synovial cavity are well delineated by both techniques. Some gradient echo MRI techniques can show labrum well without arthrography. Arthrography (with or without CT), US, and MRI may all be used in the diagnosis.	II/0
Rotator cuff tear **D15**	Arthrography/ US/MRI	Specialised investigation [C]	MRI has the advantage of providing a global assessment of structures around the shoulder and when combined with arthrography has the highest accuracy.	I/0/0
Sacroiliac joint lesion	XR sacroiliac joints	Indicated [B]	US valuable for demonstrating complete tears. May help in investigation of sero-negative arthropathy. Sacroiliac joints are usually adequately demonstrated on AP XR lumbar spine or pelvis.	I
D16	MRI/CT/NM	Specialised investigation [C]	MRI or CT or perhaps NM when XR is equivocal; MRI can detect earlier than XR. Dynamic contrast enhancement may be useful. MRI is particularly useful in children and adolescents.	0/II/ II
Hip pain: full or limited movement	XR pelvis	Indicated only in specific circumstances [C]	XR and MRI only if symptoms and signs persist or there is a complex history.	I
	MRI	Indicated only in specific circumstances [C]	MRI is useful to demonstrate inflammation and MR arthrography for evaluation of acetabular labral tears or loose bodies. Intra-articular local anaesthetic injections have still to be evaluated properly.	0
(For children see section M) **D17**	NM	Not indicated initially [B]	May be helpful if XR is normal. ***This recommendation does not apply to children. (For hip pain in children see M18, M21)***	II
Hip pain: avascular necrosis	XR pelvis	Indicated [B]	Abnormal in established disease.	I
	MRI	Indicated [B]	MRI is the most sensitive in the detection of early avascular necrosis and will demonstrate its extent.	0
D18	NM/CT	Specialised investigation [B]	The use of pinhole collimator or SPECT is important.	II/II
				I

CLINICAL/DIAGNOSTIC PROBLEM	INVESTIGATION	RECOMMENDATION [GRADE]	COMMENT	DOSE
Knee pain without locking or restriction of movement **D19**	XR	Indicated only in specific circumstances [C]	Symptoms frequently arise from soft tissues and these will not be demonstrated on XR. Osteoarthritis changes are common. XR is needed when considering surgery. To identify radio-opaque loose bodies.	I
Knee pain with locking **D20**	XR	Indicated [C]		0
Knee pain **D21**	MRI	Specialised investigation [B]	MRI is only appropriate where there is a specific clinical management decision, e.g. arthroscopy being considered. MRI may also be required in defining the extent of rheumatological disorders, e.g. rheumatoid arthritis. Even in patients with definite clinical abnormalities warranting intervention, some surgeons find pre-operative MRI helpful in identifying unsuspected lesions.	I
Painful prosthesis **D22**	XR	Indicated [B]	XR is useful to detect established loosening.	II-III
	NM	Indicated [B]	Two- to three-phase skeletal scintigraphy is useful for diagnosing and differentiating infection and loosening. A normal NM study excludes most late complications. Further specialised NM studies can help distinguish loosening from infection. It may be difficult to differentiate post-surgical changes from pathology in the early stages. If infection is suspected, further, more specific imaging may be required. Combined leukocyte and marrow imaging is currently the technique of choice for peri-prosthetic infection.	II
	Arthrography (aspiration/ biopsy)	Specialised investigation [B]	Aspiration in conjunction with arthrography is useful when findings are equivocal, when there is a high clinical suspicion of infection, or when a cause of pain is not established.	0
	US	Specialised investigation [C]	Accurate for detection of peri-prosthetic abscess or superficial infection.	I
Hallux valgus **D23**	XR	Indicated only in specific circumstances [C]	Useful for assessment before surgery.	II/0/ 0
Heel pain: plantar fasciitis or calcaneal spur **D24**	NM/US/MRI	Indicated only in specific circumstances [B]	Calcaneal spurs are common incidental findings. The cause of pain is rarely detectable on XR. Other imaging, NM, US, and MRI, are more sensitive in showing inflammatory change and should be used selectively. The majority of patients should be managed on the basis of clinical findings without imaging.	

E. Cardiovascular system

CLINICAL/DIAGNOSTIC PROBLEM	INVESTIGATION	RECOMMENDATION [GRADE]	COMMENT	DOSE
Acute central chest pain: myocardial infarction **E01**	CXR	Indicated [B]	CXR must not delay admission to a specialised unit. CXR can assess heart size, pulmonary oedema, tumour, etc., and can exclude other causes. Departmental radiograph preferable.	I
Chronic ischaemic heart disease and assessment after myocardial infarction	CXR	Indicated only in specific circumstances [B]	May be helpful only if signs or symptoms have changed, when comparison with the CXR obtained at presentation.	I
	NM (myocardial perfusion imaging)	Indicated [B]	Appropriate method of determining prognosis/ diagnosis, ischaemic burden, and specific ischaemic zone. Either pharmaceutical or exercise stress can be used in conjunction with isotopes. Tl-201 imparts a higher radiation burden but may be a better prognostic/viability agent. Tc-99m has a higher energy and allows concomitant assessment of LV contraction to be made via gated imaging. Particular uses are: • Prognostic assessment • Diagnosis in atypical or asymptomatic individuals • Assessing patients for revascularisation strategies • Risk stratification prior to non-cardiac surgery	II
	Angiography	Indicated [B]	Only technique currently available for detailed assessment of coronary artery anatomy. Essential prerequisite for interventional strategies and sometimes to establish diagnosis.	III
	MRI	Specialised investigation [B]	The role of MRI perfusion is still to be evaluated.	0
	NM (radionuclide angiography: MUGA or ERNVG)	Specialised investigation [B]	Can assess both LV and RV function after myocardial infarction. Echocardiography is the preferred technique for assessment of LV contraction, etc.	III
	US echo-cardiography **E02**	Indicated [A]	Allows assessment of residual LV contraction, valves, and complications such as myocardial rupture. Can easily be used sequentially, particularly if haemodynamic clinical deterioration is noted.	0

CLINICAL/DIAGNOSTIC PROBLEM	INVESTIGATION	RECOMMENDATION [GRADE]	COMMENT	DOSE
Chest pain: aortic dissection	CXR	Indicated [B]	Mainly to exclude other causes; rarely diagnostic.	I
	US trans-oesophageal echo-cardiography (TOE)	Indicated [B]	TOE is a useful and accurate bedside technique, but not as good as CT for aortic arch.	0
	CT	Indicated [B]	CT with IV contrast is the most reliable and practical technique.	III
E03	MRI	Specialised investigation [B]	MRI is accurate and assesses any change in longitudinal extent, but practical difficulties can limit imaging potential. Useful for sequential follow-up.	0
Pulmonary embolism	CXR	Indicated [B]	CXR should be the preliminary investigation to demonstrate consolidation and pleural effusion, but a normal CXR does not exclude a pulmonary embolus.	I
	NM (ventilation/ perfusion scintigraphy)	Indicated [B]	Ventilation/perfusion (V:Q) scintigraphy can be diagnostic if used selectively in patients without COPD or consolidation on CXR, or less often if used non-selectively. A normal perfusion scintigram excludes clinically significant pulmonary emboli.	II
(See also N03, E13) **E04**	Spiral CT	Indicated [B]	Spiral CT is the investigation of choice, is as accurate as pulmonary angiography in the detection of pulmonary emboli, and reliably excludes clinically important pulmonary embolism. It is the investigation of choice for patients with COPD or an abnormal CXR, and may be used following a non-diagnostic V:Q scintigram.	III
Pericarditis, pericardial effusion	US echo-cardiography	Indicated [B]	Useful for assessment of concomitant pathology (e.g. effusion). Can make assessment of size of pericardial effusion, suitability for drainage, development of tamponade, etc. Best for sequential follow-up.	0
E05	CXR (including left lateral)	Indicated [B]	May reveal concomitant pathology (e.g. tumour) or calcification in pericardium.	I
Suspected valvular cardiac disease	CXR	Indicated [B]	Used for initial assessment and when there is a change in the clinical picture.	I
	US echo-cardiography	Indicated [B]	Best method of sequential follow-up. TOE may be needed for prosthetic valves.	0
E06	MRI	Indicated [B]	Can be useful but is generally impracticable. Contraindicated for many prosthetic valves. Useful in the context of congenital heart disease.	0
Clinical deterioration following myocardial infarction	US echo-cardiography	Indicated [B]	US may show remediable complications (ventriculoseptal defect, papillary rupture, aneurysm, etc.).	0
E07	CXR	Indicated [B]		I

CLINICAL/DIAGNOSTIC PROBLEM	INVESTIGATION	RECOMMENDATION [GRADE]	COMMENT	DOSE
Hypertension	CXR	Indicated [B]	Assesses cardiac size and possible associated pathology such as coarctation or rib erosion from collaterals.	I
	US echo-cardiography	Indicated [B]	Most practical method of assessing LV hypertrophy.	0
E08	MRI	Specialised investigation [B]	Most accurate method of assessing LV hypertrophy.	0
Suspected cardiomyopathy, myocarditis	CXR	Indicated [B]	Globular cardiac silhouette suggestive of dilated cardiomyopathy.	I
	US echo-cardiography	Indicated [A]	Allows clear assessment of dilated, hypertrophic, and constrictive/restrictive cardiomyopathy and associated cardiac abnormalities. Not so useful for arrhythmogenic RV dysplasia. TOE can distinguish constrictive from restrictive cardiomyopathy.	0
E09	NM (radionuclide angiography)	Specialised investigation [B]	Rest radionuclide angiography is indicated in the determination of initial and serial LV and RV performance in patients with myocarditis or dilated, hypertrophic and restrictive cardiomyopathy and in patients receiving chemotherapy with doxorubicin. Myocardial perfusion imaging may help to differentiate ischaemic and dilated cardiomyopathy and to assess myocardial ischaemia in hypertrophic cardiomyopathy.	III
Congenital heart disease	US echo-cardiography/ US trans-oesophageal echo-cardiography (TOE)	Indicated [B]	Provides diagnostic and functional data. Facilitates follow-up. Specialist area. TOE can provide additional useful information to transthoracic echocardiography.	0/0
E10	MRI	Indicated [B]	Best assessment/follow-up tool. Contraindicated for many prosthetic valves.	0
Unstable angina	NM	Specialised investigation [B]	Tc-99m or Tl-201 scintigraphy in diagnosis, prognosis, and assessment of therapy in patients with unstable angina is indicated in the: • Identification of ischaemia in the distribution of the culprit lesion or in remote areas • Measurement of baseline LV function • Identification of the extent and the severity of disease in patients with ongoing ischaemia or myocardial hibernation	III
E11	Coronary angiography	Specialised investigation [B]	Only tool currently available for assessment of coronary artery anatomy. Essential prerequisite for interventional strategies and sometimes to establish diagnosis.	III

CLINICAL/DIAGNOSTIC PROBLEM	INVESTIGATION	RECOMMENDATION [GRADE]	COMMENT	DOSE
Abdominal aortic aneurysm	US	Indicated [A]	Useful in diagnosis, determination of maximal diameter, and follow-up. CT preferable for suspected leak but should not delay urgent surgery.	0
(See also N05) **E12**	CT/MRI	Indicated [A]	CT (especially spiral) and MRI for relationship to renal and iliac vessels. There is increasing demand for detailed anatomical information because of increasing consideration of percutaneous stenting.	III/0
Deep vein thrombosis	US	Indicated [A]	More sensitive with colour flow Doppler. Most clinically significant thrombi are detected. There is increasing experience with US for calf vein thrombi. May show other lesions.	0
E13	Venography	Indicated only in specific circumstances [B]	Extensive variation according to US expertise and local therapeutic strategy.	II
Ischaemic leg	Angiography	Specialised investigation [A]	Local policy needs to be determined in agreement with vascular surgeons, especially with regard to therapeutic interventions. US used in some centres as first investigation.	III
(See also N06–N09) **E14**	CTA/MRA	Specialised investigation [C]	CTA and MRA are increasingly used for diagnosis.	III/0
Ischaemic upper limb **E15**	Angiography	Specialised investigation [B]	Local policy needs to be determined in agreement with vascular surgeons, especially with regard to therapeutic intervention.	III

F. Thoracic system

CLINICAL/DIAGNOSTIC PROBLEM	INVESTIGATION	RECOMMENDATION [GRADE]	COMMENT	DOSE
Non-specific chest pain **F01**	CXR	Not indicated initially [C]	Conditions such as Tietze's disease show no abnormality on CXR. Main purpose is reassurance.	I
Minor chest trauma *(See also K30)* **F02**	CXR	Indicated only in specific circumstances [C]	Showing a rib fracture does not alter management.	I
Pre-employment or screening medicals **F03**	CXR	Indicated only in specific circumstances [B]	Not justified except in a few high-risk categories (e.g. at-risk immigrants with no recent CXR). Some have to be done for occupational (e.g. divers) or emigration purposes (UK category 2).	I
Routine pre-operative CXR **F04**	CXR	Not indicated [A]	Routine pre-operative CXR is not indicated in patients aged < 60 years undergoing non-cardiothoracic surgery. The yield of abnormalities increases in patients > 60 years. However, if patients without known cardio-respiratory disease are excluded, the yield is still low.	I
Upper respiratory tract infection **F05**	CXR	Not indicated [C]	There is no documented evidence of the effect of CXR on the management or outcome of upper respiratory tract infection.	I
Acute exacerbation of asthma **F06**	CXR	Indicated only in specific circumstances [B]	Patients presenting with asthma but without localising signs in the chest, pyrexia, or leucocytosis do not require CXR, except when the asthma is life-threatening or fails to respond to treatment adequately.	I
Acute exacerbation of COPD **F07**	CXR	Indicated only in specific circumstances [B]	Patients presenting with COPD but without localising signs in the chest, pyrexia, or leucocytosis do not require CXR, except when the condition is life-threatening or fails to respond to treatment adequately.	I
Pneumonia *(For children see section M)* **F08**	CXR	Indicated [C]	The majority of patients with community-acquired pneumonia will show radiological resolution at four weeks, but this may be prolonged in the elderly, smokers, and those with chronic airway disease. Further CXR after resolution in asymptomatic patients is not indicated. *(For pneumonia in children see M23)*	I
Pneumonia: follow-up *(For children see section M)* **F09**	CXR	Indicated only in specific circumstances [B]	CXR need not be repeated before hospital discharge in those who have made a satisfactory clinical recovery from community-acquired pneumonia. CXR should be arranged after about six weeks for all patients who have persistent symptoms or physical signs or who are at higher risk of underlying malignancy (especially smokers and patients > 50 years), whether or not they are admitted to hospital. *(For pneumonia in children see M23)*	I

CLINICAL/DIAGNOSTIC PROBLEM	INVESTIGATION	RECOMMENDATION [GRADE]	COMMENT	DOSE
Pleural effusion suspected **F10**	CXR	Indicated [C]	CXR may detect small quantities of pleural fluid.	I
	US	Indicated [B]	US may be used to confirm the presence of pleural fluid, characterise it, detect pleural metastases, and guide thoracentesis.	0
	CT	Indicated only in specific circumstances [B]	CT with IV contrast may help in the detection and characterisation of pleural fluid.	III
Haemoptysis **F11**	CXR	Indicated [B]	All patients presenting with haemoptysis should have a CXR. If this is normal and the haemoptysis was significant and occurred out of the context of a concurrent chest infection, referral for further investigation should be considered.	I
	CT	Not indicated initially [B]	CT should be used in conjunction with bronchoscopy to investigate the majority of patients with haemoptysis. CT may detect malignancies not identified on CXR or bronchoscopy, but is insensitive in detecting mucosal and submucosal disease.	III
ITU/HDU patient **F12**	CXR	Indicated [B]	A CXR is most helpful when there has been a change in symptoms or insertion or removal of a device. The value of the routine daily CXR is being increasingly questioned. CT is a useful adjunct to CXR for problem-solving in critically ill patients.	I
Occult lung disease **F13**	CT	Specialised investigation [B]	There is evidence to indicate that high resolution CT (HRCT) may be histospecific; valuable information about disease reversibility and prognosis may be gleaned from HRCT.	III

G. Gastrointestinal system

Gastrointestinal tract

CLINICAL/DIAGNOSTIC PROBLEM	INVESTIGATION	RECOMMENDATION [GRADE]	COMMENT	DOSE
Difficulty in swallowing: high dysphagia (lesion may be high or low) **G01**	Video-fluoroscopy and Ba swallow	Indicated [B]	Video recording of swallow is essential. Webs and pouches are well demonstrated. Motility disorders, which must be looked for in prone or supine position, may be seen despite normal endoscopy. Subtle strictures, not seen at endoscopy, best demonstrated by marshmallow or other bolus study. Multi-disciplinary approach with speech therapist and ENT surgeon is optimal.	II
Difficulty in swallowing: low dysphagia (lesion will be low) **G02**	Ba swallow	Indicated only in specific circumstances [B]	Endoscopy is required (biopsy of strictures essential). Ba swallow used to demonstrate motility disorder or subtle stricture, if endoscopy normal.	II
	NM	Specialised investigation [B]	Radionuclide oesophageal transit study is indicated as an alternative non-invasive assessment of oesophageal motility.	II
Heart burn/chest pain: hiatus hernia or reflux **G03**	Ba swallow/ meal	Indicated only in specific circumstances [B]	Reflux is common and investigation is only indicated where lifestyle changes and empirical therapy fail. While pH monitoring is the gold standard for reflux, endoscopy alone will reliably show early changes of reflux oesophagitis and allows detection and biopsy of metaplasia. Ba studies aimed at assessing oesophageal motility prior to anti-reflux surgery do not reliably predict post-operative dysphagia.	II
Oesophageal perforation	CXR	Indicated [B]	Will be abnormal in 80% of cases, but pneumo-mediastinum is present in only 60%.	I
	Contrast swallow	Indicated [B]	Non-ionic iodinated contrast is the only safe agent. It is sensitive, but if no leak is seen then proceed to immediate CT.	II
G04	CT	Indicated [A]	CT is sensitive both for the presence of perforation and for the detection of mediastinal and pleural complications.	III
Acute GI bleeding: haematemesis/ melaena	Endoscopy	Indicated [A]	Endoscopy provides diagnosis in the majority of cases of upper GI bleeding and can be used to deliver haemostatic therapy.	0
	AXR	Not indicated [B]	Of no value.	I
	Abdominal US	Indicated only in specific circumstances [B]	Only useful to look for signs of chronic liver disease.	0
	Ba studies	Not indicated [C]	Precludes angiography.	II
	NM	Specialised investigation [B]	After endoscopy. Red cell labelling can detect bleeding rates as low as 0.1 ml/minute; more sensitive than angiography. Red cell study is most useful in intermittent bleeding.	II
(See also N10, N11, N13, N14) **G05**	Angiography	Specialised investigation [B]	In uncontrollable bleeding. Angiography can accurately direct surgery and transcatheter embolisation may be used as the primary treatment.	III

CLINICAL/DIAGNOSTIC PROBLEM	INVESTIGATION	RECOMMENDATION [GRADE]	COMMENT	DOSE
Dyspepsia in the younger patient (e.g. < 45 years) **G06**	Ba studies	Indicated only in specific circumstances [B]	Most patients < 45 years can be treated without investigations and will undergo a trial of therapy (anti-ulcer or reflux). If symptoms recur or persist, the *Helicobacter pylori* status should be assessed serologically or by using the C-14 urea breath test. If positive or patient has alarm symptoms (weight loss, anorexia, iron deficiency anaemia, severe pain or non-steroid anti-inflammatory drug use), endoscopy is the investigation of choice.	II
Dyspepsia in the older patient (e.g. > 45 years) **G07**	Ba studies	Indicated only in specific circumstances [B]	Endoscopy is the investigation of choice. The main concern is the early detection of cancer. If endoscopy is negative and symptoms persist, then Ba meal should be considered.	II
Ulcer: follow-up	Ba studies	Not indicated [B]	Scarring precludes accurate assessment. Endoscopy is preferred to confirm complete healing and to obtain biopsies where necessary.	II
G08	NM	Indicated only in specific circumstances [B]	Most centres use C-14 urea breath test to assess effect of treatment for *Helicobacter pylori*.	I-II
Previous upper GI surgery (recent) to check for anastomotic leaks **G09**	Contrast swallow/meal	Indicated [B]	If water-soluble contrast swallow does not demonstrate a leak in the anastomotic site and there is a clinical concern, then immediate CT should be performed as it is more sensitive. Ba should not be used as the contrast agent.	II
Previous upper GI surgery (not recent): dyspeptic symptoms **G10**	Ba studies	Indicated only in specific circumstances [B]	Gastric remnant best assessed by endoscopy (gastritis, ulceration, dysplasia, recurrent tumour, etc.)	II
Previous upper GI surgery (not recent): dysmotility/ obstructive symptoms **G11**	Ba studies	Indicated [B]	Shows surgical anatomy and may demonstrate dilated afferent loop, narrowed anastomoses, internal hernias, closed loops, etc.	II
	NM	Specialised investigation [B]	Good method for assessment of gastric emptying, dumping, and stasis.	II
Intestinal blood loss: chronic or recurrent	Ba studies	Not indicated initially [B]	The initial investigation is endoscopy of the upper GI tract and colon. Small bowel follow-through is not sufficiently sensitive for lesions likely to cause chronic bleeding and should not be used.	II
	Ba small bowel enema	Indicated [B]	More sensitive than Ba follow-through for small discrete lesions. However, early results of 'capsule' endoscopy in chronic bleeding suggest that this will be the investigation of choice when small bowel strictures have been excluded.	II
(See also N14) *Continued* **G12**	NM	Indicated [B]	When all other investigations are negative, labelled red cell and/or Meckel's study may be useful in detecting and localising the site of chronic and/or recurrent bleeding.	II

CLINICAL/DIAGNOSTIC PROBLEM	INVESTIGATION	RECOMMENDATION [GRADE]	COMMENT	DOSE
Intestinal blood loss: chronic or recurrent *Continued* *(See also N14)* **G12**	CT	Indicated [B]	IV contrast-enhanced CT is a useful technique to look for lesions that may be bleeding (e.g. tumours). CTA may demonstrate bowel angiodysplasia.	III
	Angiography	Specialised investigation [B]	Angiography is sensitive for angiodysplasia (with early filling vein) and to demonstrate tumour neovascularity.	III
Acute abdominal pain: perforation/ obstruction *(For children see section M)* **G13**	AXR and CXR erect	Indicated [B]	Supine AXR may be sufficient to establish diagnosis of obstruction and point to an anatomical level. Consider erect AXR if supine AXR normal and strong clinical suspicion of obstruction. Lateral decubitus AXR indicated to show free gas if CXR has to be supine.	I + I
	US	Indicated [C]	Widely used as a survey following AXR. It is sensitive for free fluid in perforation.	0
	CT	Indicated [B]	For small sealed perforations and for establishing site and cause of obstruction. *This recommendation does not apply to children.* ***(For acute abdominal pain in children see M37)***	III
Small bowel obstruction: acute **G14**	Contrast studies	Indicated only in specific circumstances [B]	Frequently unhelpful.	II
	CT	Indicated [B]	When AXR suggests small bowel obstruction, CT confirms diagnosis, indicates level, and may show cause. When AXR equivocal but small bowel obstruction suspected clinically, volume challenge (i.e. CT with water or methylcellulose ingestion) may be required for complete assessment.	III
Small bowel obstruction: chronic or recurrent *(See also G13, G14)* **G15**	Ba small bowel enema	Indicated [B]	Will reveal presence and level of obstruction in most cases and may suggest a cause.	II
	CT	Indicated [B]	Performed with or without volume challenge. CT will be diagnostic as for small bowel enema, but may be a better guide to management in complex cases, e.g. in patients with a previous malignancy or following complicated abdominal surgery.	III
Suspected small bowel disease (Crohn's disease) **G16**	Ba small bowel meal	Indicated [B]	A useful survey examination for the diagnosis of small bowel disease, including Crohn's disease.	II
	Ba small bowel enema	Indicated [B]	This is the investigation of choice to establish extent of disease prior to surgery, in cases where fistula is suspected, and to diagnose the cause of obstructive symptoms in patients with known Crohn's disease.	II
	US/CT/MRI	Specialised investigation [B]	Use of these techniques is evolving, e.g. in assessment of disease activity, and they are particularly useful to assess extramural complications.	0/ III/0
	NM	Specialised investigation [B]	Labelled white cell scintigraphy reveals activity and extent of disease and is complementary to Ba studies.	III

CLINICAL/DIAGNOSTIC PROBLEM	INVESTIGATION	RECOMMENDATION [GRADE]	COMMENT	DOSE
Change of bowel habit to diarrhoea and rectal bleeding in the absence of perianal symptoms: colorectal neoplasia **G17**	Ba enema	Indicated [B]	Colonoscopy is often the first-line investigation. Ba enema is an alternative to colonoscopy and is widely used as the first-line investigation of change of bowel habit in the absence of rectal bleeding. Ba enema is insufficient with rectal bleeding, but flexible sigmoidoscopy followed by immediate Ba enema is a good alternative to colonoscopy. Defer Ba enema for seven days after full thickness biopsy via a rigid sigmoidoscope. No delay is needed for superficial biopsies taken via flexible sigmoidoscopy.	III
	CT	Specialised investigation [B]	CT has an established and developing role in the demonstration and exclusion of colorectal neoplasia. Its use can range from a minimally invasive approach with no oral contrast and no bowel preparation to full CT colonography. The minimally invasive approach is preferable to Ba enema in frail elderly patients. Accuracy is increased by oral contrast over 24 hours with no purgation. Alternatively, a water enema is helpful. CT colonography with full bowel preparation and air enema is more accurate than Ba enema and closely approaches the accuracy of colonoscopy. It is already the technique of choice for the proximal colon when colonoscopy has been incomplete.	III
Large bowel obstruction: acute **G18**	AXR	Indicated [B]	May suggest diagnosis and indicate likely level.	I–II
	Contrast enema	Indicated [B]	Water-soluble or air-contrast enema can confirm diagnosis and level of obstruction and may indicate likely cause. In some cases interpretation is difficult and if no abnormality is seen it is important to understand that although this may indicate pseudo-obstruction, a significant obstructing lesion may have been missed.	III
	CT	Specialised investigation [B]	The value of CT, particularly in sick and very frail patients, is becoming established. It is likely that it will prove a more accurate and less uncomfortable alternative to water soluble enema.	III
Inflammatory bowel disease of the colon: acute exacerbation **G19**	AXR	Indicated [B]	Often sufficient to determine disease severity and extent.	I–II
	Ba enema	Indicated [B]	Unprepared 'instant' enema complements AXR and confirms extent of disease. It is contraindicated in toxic megacolon.	III
	NM	Indicated [B]	Labelled white cell study will reveal activity and extent of disease.	III
	MRI	Specialised investigation [B]	MRI is extremely valuable in guiding surgical management of patients with anorectal sepsis.	0
Inflammatory bowel disease of colon: long-term follow-up **G20**	Ba enema	Indicated only in specific circumstances [B]	Ba enema has a limited role after complex surgery and in the evaluation of fistulae. Colonoscopy is the most reliable investigation to identify complications including dysplasia, stricture, and carcinoma.	III

General abdominal problems

CLINICAL/DIAGNOSTIC PROBLEM	INVESTIGATION	RECOMMENDATION [GRADE]	COMMENT	DOSE
Acute abdominal pain warranting hospital admission for consideration of surgery ***(See also G13, G14, G15, G30, G32)*** **G21**	AXR and CXR erect/ US	Indicated [B]	Local policy will determine strategy. Supine AXR (for gas pattern, etc.) is usually sufficient; erect AXR is indicated only in specific circumstances. Erect CXR is used for exclusion of perforation. US is widely used as a preliminary survey.	I-II/ 0
	CT	Indicated [B]	CT is increasingly used.	III
Palpable mass	AXR	Indicated only in specific circumstances [C]	Rarely of value.	I-II
	US	Indicated [B]	Often solves the problem.	0
G22	CT	Indicated [B]	Where US is inconclusive and to provide more complete assessment of disease extent prior to definitive treatment.	III
Malabsorption	Ba small bowel meal	Indicated only in specific circumstances [B]	Imaging is not required for the diagnosis of coeliac disease but may be indicated for other causes of small bowel malabsorption or when biopsy is normal/ equivocal.	II
G23	NM	Specialised investigation [B]	Numerous NM investigations are available, which should establish presence of malabsorption. Some of these are non-radiological (e.g. breath test).	II
Constipation	AXR	Indicated only in specific circumstances [B]	May be useful in geriatric and psychiatric specialties to show extent of faecal impaction. ***(For constipation in children see M38)***	II
	Intestinal transit studies	Specialised investigation [B]	A simple investigation using radio-opaque shapes can confirm normal intestinal transit.	I-II
	NM	Specialised investigation [B]	In-111 colonic transit study enables a more detailed study of colonic delay than radio-labelled pellets. Important before colectomy is undertaken.	III
(For children see section M) **G24**	Evacuation proctography	Specialised investigation [B]	In some patients constipation is secondary to a disorder of evacuation, which can be demonstrated and characterised by this investigation.	II
Abdominal sepsis; pyrexia of unknown origin	US	Indicated [C]	Seek early radiological advice. US is often used first and may be definitive, particularly when there are localising signs; it is especially good for subphrenic/ subhepatic spaces and pelvis.	0
	CT	Indicated [C]	CT is probably best test overall. Infection and tumour are usually identified or excluded. It also allows biopsy of nodes or tumour and drainage of collections (especially recent post-operative when US is difficult).	III
(See also N16, N17) **G25**	NM	Indicated [C]	NM is particularly good when there are no localising features. Labelled white blood cell (WBC) study is good for chronic post-operative sepsis; Ga will accumulate at sites of tumour (e.g. lymphoma) and infection.	III

Liver, gallbladder and pancreas

CLINICAL/DIAGNOSTIC PROBLEM	INVESTIGATION	RECOMMENDATION [GRADE]	COMMENT	DOSE
Hepatic metastases *(See also N33–N35)* **G26**	US	Indicated [B]	Will often be the initial investigation. US is reliable for lesions >2 cm in diameter, but for smaller lesions the sensitivity is reduced. Developments in therapy for hepatic metastases, particularly in colorectal cancer, dictate the use of more sensitive tests. US, however, will often be used as the first-line exclusion of hepatic metastases.	0
	CT	Indicated [B]	CT is significantly more sensitive than US for detection of liver metastases, particularly smaller lesions. It is essential for accurate staging of patients with metastases being considered for liver resection.	III
	MRI	Specialised investigation [B]	With liver-specific contrast agents MRI is even more sensitive than CT in detecting metastases, but it is also useful in accurate characterisation of small lesions. It is widely used in the pre-operative assessment of candidates for liver resection.	0
Solitary hepatic lesion on US, haemangioma, metastases, other *(See also L15)* **G27**	CT/ MRI	Specialised investigation [B]	Both techniques reliably show characteristic features of haemangioma and many other solitary hepatic lesions.	III/0
Known cirrhosis, complications **G28**	US	Indicated [B]	Very sensitive for ascites. US may show varices, particularly in the splenic hilum in portal hypertension. It is the initial screening test for hepatoma.	0
	CT	Specialised investigation [B]	Particularly when US is equivocal in the presence of raised alpha feto-protein and in the staging of hepatoma.	III
	MRI	Specialised investigation [B]	With liver-specific contrast agents MRI is at least as sensitive as CT for hepatoma.	0
Jaundice *(See also N18–N20)* *Continued* **G29**	US	Indicated [B]	US reliably differentiates between obstructive and non-obstructive jaundice, but bile duct dilatation may be subtle in early obstruction. When US indicates obstructive jaundice, subsequent investigation will depend on the level of obstruction, presence or absence of stones in the gall bladder and ducts, as well as the clinical situation. Early discussion with radiologist is required.	0
	ERCP	Specialised investigation [B]	If US shows duct stones, proceed to ERCP for confirmation and therapy. ERCP remains the gold standard for intrahepatic duct changes in sclerosing cholangitis.	II
	CT	Specialised investigation [B]	Frequently the next investigation for US-proven obstructive jaundice, particularly if US level of obstruction is below the hilum. For pancreatic cancer CT reliably predicts unresectability. In malignant hilar-level obstruction, CT may provide staging information critical to the planning of surgery or palliative therapy.	III

CLINICAL/DIAGNOSTIC PROBLEM	INVESTIGATION	RECOMMENDATION [GRADE]	COMMENT	DOSE
Jaundice *Continued* *(See also N18–N20)* **G29**	MRI, including MRCP	Specialised investigation [B]	In hilar-level obstruction, MRCP (magnetic resonance cholangiopancreatography) is now the investigation of choice following US. MRCP reliably and non-invasively depicts the pattern and extent of duct involvement, thus facilitating planning of curative surgery or interventional treatment. In malignant hilar-level obstruction, MRI may provide staging information critical to the planning of surgery or palliative treatment. If US shows gallstones, but no definite duct stones, then MRCP is indicated prior to ERCP.	0
	Endoscopic US	Specialised investigation [B]	Is the most accurate method for detection of small duct stones and small papillary or peri-ampullary tumours. It allows biopsy of pancreas without risk of tumour seeding.	0
Biliary disease (e.g. gallstones, post-cholecystectomy pain) *(See also N20)* **G30**	AXR	Not indicated [C]	Only shows about 10% of gallstones.	I-II
	US	Indicated [B]	Is the investigation of choice for the demonstration or exclusion of gallstones and acute cholecystitis. It is the initial investigation of biliary pain but cannot reliably exclude common duct stones. Cholecystography is virtually never used.	0
	CT	Specialised investigation [B]	Has a limited role in cholelithiasis but is useful in the evaluation of gallbladder wall and gallbladder masses.	III
	MRCP	Specialised investigation [B]	Indicated in stone disease where the symptoms, signs, and/or liver function tests suggest the possibility of duct calculi not confirmed by US, and in the investigation of post-cholecystectomy pain.	0
	NM	Specialised investigation [B]	Biliary scintigraphy shows cystic duct obstruction in acute cholecystitis.	II
Post-operative biliary leak **G31**	US	Indicated [B]	First investigation of suspected leak. US will show the size and anatomical position of collections	0
	ERCP	Indicated [B]	Definitive investigation to detect and demonstrate the site of the leakage and for treatment by stent placement.	II
	NM	Specialised investigation [B]	HIDA scan will show activity at site of leak.	II
Pancreatitis: acute *(See also G21)* **G32**	AXR	Indicated [C]	Presents as non-specific acute abdominal pain. AXR is needed to exclude other causes.	I-II
	US	Indicated [B]	Must be performed early to identify patients with gallstones, indicating a diagnosis of gallstone pancreatitis, in which case early ERCP may be considered.	0
	CT	Indicated [B]	CT with IV contrast enhancement is used early in severe cases to assess extent of necrosis, which is helpful in prognosis. In follow-up, it is used to detect and monitor complications, and for this purpose it is superior to US. US is used to monitor more chronic pseudocysts, to avoid high radiation dose of CT.	III

CLINICAL/DIAGNOSTIC PROBLEM	INVESTIGATION	RECOMMENDATION [GRADE]	COMMENT	DOSE
Pancreatitis: chronic **G33**	AXR	Indicated [B]	To show calcification (calcified duct stones) but is of limited value in exclusion.	I
	US/CT	Indicated [B]	US may be definitive, particularly in thin patients. CT is highly sensitive for pancreatic calcification but poorly sensitive for early parenchymal changes.	0/III
	ERCP/MRCP	Specialised investigation [B]	ERCP shows duct morphology. MRCP (particularly with secretin) shows moderate and severe ductal changes and may indicate exocrine function. MRCP does not reliably show minor side branch changes in mild chronic pancreatitis.	II/0
Pancreatic tumour **G34**	US	Indicated [B]	US is good at detecting the primary lesion in thin patients, particularly for lesions in the head and body, but is insufficient where precise staging is required.	0
	CT	Indicated [B]	CT is of value in diagnosis, when US is inconclusive, and in staging, where IV contrast-enhanced spiral CT reliably predicts unresectability.	III
	Endoscopic US	Specialised investigation [B]	May provide detailed staging information in candidates for surgical resection after CT and allows image-guided biopsy of pancreatic masses.	0
	ERCP	Specialised investigation [B]	Demonstrates anatomy of strictures and facilitates tissue diagnosis and intervention, e.g. stent placement in selected cases.	II
Insulinoma **G35**	Endoscopic US	Specialised investigation [B]	Accurate localisation of the tumours is essential if surgery is to be curative. Invasive preoperative vascular techniques (i.e. arterial stimulation with venous sampling) combined with intra-operative US and operative palpation represent the gold standard for localisation and surgical planning. Endoscopic US appears promising and may offer a less invasive alternative to angiography in the future. US, CT, MRI and NM are non-invasive but often fail to demonstrate insulinoma(s) responsible for clinical hyperinsulinaemia. These studies are probably of greatest value in the diagnosis of metastatic disease.	0

H. Urological, adrenal, and genitourinary systems

CLINICAL/DIAGNOSTIC PROBLEM	INVESTIGATION	RECOMMENDATION [GRADE]	COMMENT	DOSE
Haematuria, macro- or microscopic **H01**	IVU	Indicated [B]	There is wide variation in local policy. Imaging strategies should be agreed with local nephrologists and urologists. Neither IVU nor US and AXR is ideal for detecting upper urinary tract causes of bleeding: in most patients both IVU and US should be used, either together or in sequence.	II
	US and AXR/ CT	Indicated [B]	In young patients with microscopic haematuria only US and AXR may be used to evaluate the upper tracts: this strategy misses some upper tract pathology, including some calculi. Bladder US detects many bladder tumours but is not sufficiently sensitive to obviate cystoscopy. There has been recent interest in using CT to evaluate the upper tracts in haematuria but there are insufficient data to make a recommendation.	0 + I/ II
Hypertension without evidence of renal disease *(See also H03)* **H02**	IVU	Not indicated [B]	IVU is not indicated for the evaluation of hypertension with no evidence of renal disease.	II
Hypertension: in the young adult or in patients unresponsive to medication	Angiography (DSA/CTA/ MRA)	Specialised investigation [C]	To show stenosis if surgery or angioplasty is considered as a possible treatment.	III/ III/0
	MRA	Specialised investigation [B]	Imaging is only appropriate if renovascular hypertension is clinically suspected, since the prevalence of renal artery stenosis in essential hypertensives is very low. MRA is the best non-invasive method to visualise the renal arteries directly.	0
	CTA	Specialised investigation [B]	CTA is as sensitive as MRA but more invasive (iodinated contrast medium, irradiation) and should only be used if MRA is not available.	III
	NM	Specialised investigation [B]	Captopril renography is best to check for functionally significant renal artery stenosis.	II
(See also N21, N22) **H03**	US	Specialised investigation [B]	Doppler US can be sensitive and specific but needs special expertise.	0

CLINICAL/DIAGNOSTIC PROBLEM	INVESTIGATION	RECOMMENDATION [GRADE]	COMMENT	DOSE
Renal failure *(See also N23)* **H04**	Renal US and AXR	Indicated [B]	US is indicated as the first investigation in renal failure to measure kidney size and parenchymal thickness and to check for pelvicalyceal dilatation indicating possible obstruction. AXR is necessary to show calculi not detectable by US.	0 + I
	CT	Not indicated initially [B]	CT (unenhanced or enhanced, depending on renal function) helps if US is non-diagnostic or does not show the cause of obstruction.	III
	IVU	Not indicated [B]		II
	MRI	Specialised investigation [C]	MRI is a possible alternative to CT and avoids potentially nephrotoxic contrast medium. On rare occasions, obstruction occurs without dilatation seen with any imaging method.	0
Measurement of renal function: • Effective renal plasma flow (ERPF)	NM	Specialised investigation [B]	GFR is preferred by many authorities to assess global renal function: Hippurate OIH labelled with either I-123, I-125 or I-131 is used, but Tc-99m MAG3 may be used as a substitute.	II
• Glomerular filtration rate (GFR)	NM	Specialised investigation [A]	Single-sample Cr-51 EDTA at 3 hours if well calibrated and GFR >30 ml/min. Accurate preparation of standards and injection without loss are crucial: 51Cr EDTA clearance, four-sample method.	II
• Relative function	NM	Specialised investigation [A]	Tc-99m MAG3 is recommended for the measurement of relative renal function.	II
• Renal transit **H05**	NM	Specialised investigation [B]	Renal Tc-99m MAG3 should be used with an established method of deconvolution analysis for parenchymal transit time index for obstructive nephropathy and mean parenchymal transit time for renovascular disorder.	II
Suspected ureteric colic	CT	Indicated [B]	Unenhanced CT is the method of choice in suspected ureteric colic.	III
	IVU	Indicated [B]	IVU is a satisfactory alternative to CT.	II
(See also N25) **H06**	US/AXR	Indicated only in specific circumstances [B]	US and AXR may be used where radiation/contrast medium are contraindicated, e.g. in cases of pregnancy and contrast allergy. To maximise US sensitivity, patients should be well hydrated. US is less accurate than CT or IVU.	0 + I
Renal calculi in absence of acute colic	AXR/CT	Indicated [B]	AXR or CT provide the best baseline assessment in patients with renal stone disease. In routine practice AXR is adequate to detect the majority of renal calculi, which contain calcium. For detailed detection of renal calculi, CT is more sensitive.	I/III
(See also N25) **H07**	US	Indicated only in specific circum-stances[B]	US is less sensitive than either AXR or CT for detecting renal calculi but can detect urate calculi.	0

CLINICAL/DIAGNOSTIC PROBLEM	INVESTIGATION	RECOMMENDATION [GRADE]	COMMENT	DOSE
Renal mass **H08**	US	Indicated [B]	US is sensitive at detecting renal masses > 2 cm and accurately characterises masses as cystic or solid. US helps to characterise some masses indeterminate at CT.	0
	IVU	Not indicated [B]	IVU is less sensitive than US for the detection of renal masses. IVU does not characterise renal masses accurately.	II
	CT	Indicated [B]	CT is sensitive at detecting renal masses of 1.0–1.5 cm or greater and accurately characterises masses.	III
	MRI	Specialised investigation [B]	MRI (including contrast-enhanced imaging) is as sensitive as contrast-enhanced CT for detecting and characterising renal masses. MRI should be used if masses are not adequately characterised by CT and US or if iodinated contrast medium is contra-indicated because of diminished renal function or allergy.	0
Urinary tract obstruction **H09**	IVU	Indicated only in specific circumstances [B]	May be used to define anatomy prior to surgery or other intervention.	II
	US	Indicated [B]	Useful to assess the upper tracts.	0
	NM	Indicated [A]	Tc-99m-MAG3 with frusemide diuresis is used. Output (outflow) efficiency study provides reliable quantification of frusemide response independent of renal function. Parenchymal transit time index measurements aid assessment of obstructive nephropathy.	II
Urinary tract infection in adults ***(For children see section M)*** **H10**	US and AXR	Indicated only in specific circumstances [B]	The majority of adults with urinary tract infection do not require imaging. Imaging is indicated (1) if infection does not settle rapidly with antibiotics and (2) after infection has settled in men with one proven UTI or women with a proven recurrence of UTI.	0 + I
	CT	Specialised investigation [B]	US and AXR offer a good first investigation. Contrast-enhanced CT may be necessary in severe infection not responsive to treatment, since CT detects renal sepsis and changes of pyelonephritis more sensitively than US.	III
	IVU	Indicated only in specific circumstances [B]	IVU may be helpful in the non-acute phase in patients who are suspected of having underlying renal disease (e.g. calculus, papillary necrosis, reflux nephropathy). ***(For urinary tract infection in children see M43)***	II
Renal transplant evaluation **H11**	NM	Indicated [B]	Tc-99m-MAG3 studies are more sensitive than US for acute rejection after transplantation. Such changes in renal function usually predate clinical and chemical indices. This study is helpful for detection of renal artery stenosis and obstructive uropathy.	II

CLINICAL/DIAGNOSTIC PROBLEM	INVESTIGATION	RECOMMENDATION [GRADE]	COMMENT	DOSE
Urinary retention **H12**	IVU	Not indicated [B]	Has low yield.	II
	US	Indicated only in specific circumstances [B]	Renal US is indicated to check for upper tract dilatation (after catheterisation to relieve bladder distension), especially if renal function is impaired.	0
Prostatism *(See also L28)* **H13**	IVU	Not indicated [B]	US is indicated to check for dilatation of the upper urinary tract.	II
	US	Indicated [B]	Bladder US (with measurement of post-void residual volume and urine flow rate) is indicated in prostatism. Renal US is only necessary if there is a post-void residue, haematuria, raised serum creatinine, or infection.	0
Scrotal mass or pain **H14**	US	Indicated [B]	US is indicated for scrotal swelling and when presumed inflammatory scrotal pain does not respond to treatment. Allows differentiation of testicular from extratesticular lesions.	0
Testicular torsion **H15**	US	Indicated [B]	Frequently a clinical diagnosis. Urgent management is essential and imaging should not delay intervention when appropriate. Colour Doppler US has a high sensitivity in suspected testicular torsion. Intermittent torsion remains a significant diagnostic problem.	0
Adrenal medullary tumour **H16**	US/CT/MRI	Specialised investigation [B]	Whilst US may identify lesions of this type, CT and MRI provide the best anatomical delineation. Imaging is rarely indicated in the absence of biochemical evidence of such tumours.	0/III /0
	NM	Specialised investigation [B]	MIBG locates functioning tumours and is particularly useful for ectopic sites and metastases.	II
Adrenal cortical lesions; Cushing's syndrome **H17**	CT/MRI, NM, and/or adrenal venous sampling	Specialised investigation [B]	Local advice on the most appropriate examination should be sought. CT/MRI may be able to identify an adrenal cause for Cushing's syndrome. However, nodular adrenal hyperplasia can occur in a significant proportion of patients with ACTH-dependent and ACTH-independent Cushing's syndrome. In such a situation CT may be unable to distinguish adrenal adenoma and nodular hyperplasia, and further investigation with scintigraphy and/or adrenal venous sampling may be required.	III/0, II/III
Adrenal cortical lesions; primary hyperaldosteronism (Conn's syndrome) **H18**	CT/MRI, NM and/or adrenal venous sampling	Specialised investigation [B]	Local advice on the most appropriate examination should be sought. Both CT and MRI can distinguish between a unilateral adrenal adenoma and bilateral adrenal hyperplasia. NM may be useful in distinguishing between adrenal hyperplasia and an adenoma. However, adrenal venous sampling may be required where other imaging techniques are inconclusive.	III/0, II/III

CLINICAL/DIAGNOSTIC PROBLEM	INVESTIGATION	RECOMMENDATION [GRADE]	COMMENT	DOSE
1. Obstetrics and gynaecology				
NB: Transvaginal US equipment should be available in all departments performing pelvic US				
Screening in pregnancy **I01**	US	Indicated [B]	Screening in early pregnancy (9–13 weeks) accurately dates a pregnancy by measuring the total crown-rump length. This reduces the intervention rate for infants born at or after full term. US accurately assesses fetal number and chorionicity and improves outcome for multiple pregnancies. Screening for structural abnormality at 18–20 weeks has not been shown to alter perinatal mortality except where selective termination of pregnancy is applied in the presence of gross fetal abnormality. US has a proven value in assessing placenta praevia and intrauterine growth restriction. In the specialist care of high-risk pregnancies, Doppler US is essential for the safe practice of intervention and therapeutic procedures such as amniocentesis, fetal blood sampling, and transfusions during pregnancy.	0
Suspected pregnancy **I02**	US	Indicated only in specific circumstances [C]	There is no indication that diagnosing pregnancy by US, other than for dating, is appropriate. If early pregnancy is symptomatic, e.g. pain or vaginal bleeding, US is indicated. Pregnancy testing is the most appropriate test.	0
Suspected ectopic pregnancy **I03**	US	Indicated [B]	After a positive pregnancy test. Transvaginal US is most accurate. Colour Doppler increases sensitivity.	0
Possible non-viable pregnancy **I04**	US	Indicated [C]	Pregnancy test is required. Repeat US after a week may be needed (especially when gestational sac < 20 mm or crown-rump length < 6 mm). Where doubt exists about the viability of a pregnancy, delay in evacuation of the uterus is essential.	0
Uterus: body				
Post-menopausal bleeding: to exclude significant endometrial pathology **I05**	US	Indicated [B]	Transvaginal US is indicated to exclude significant endometrial pathology in post-menopausal bleeding. Endometrial thickening > 5 mm requires biopsy for specific diagnosis.	0
Suspected pelvic mass ***(See also L39-L40)*** **I06**	US	Indicated [C]	Combination of transabdominal and transvaginal US is often required. US should confirm the presence of a lesion and determine the likely organ of origin. Transvaginal scanning should be used to define the anatomy further. MRI is the best second-line investigation, although CT is still widely used.	0

CLINICAL/DIAGNOSTIC PROBLEM	INVESTIGATION	RECOMMENDATION [GRADE]	COMMENT	DOSE
Pelvic pain, including suspected pelvic inflammatory disease and suspected endometriosis	US	Indicated [C]	Especially when clinical examination is difficult or impossible. US has a poor predictive power when diagnosing pelvic inflammatory disease.	0
I07	MRI	Specialised investigation [B]	Can be useful to localise the larger foci of endometriosis.	0
Lost IUCD	US	Indicated [C]	To confirm or refute the presence of the IUCD in uterus.	0
I08	AXR	Indicated only in specific circumstances [C]	Indicated only when IUCD is not seen in uterus on US.	I-II
Recurrent miscarriages	US	Indicated [C]	Will show the major uterine congenital and acquired problems and is useful to identify polycystic ovaries.	0
I09	MRI	Specialised investigation [C]	Supplements US for uterine anatomy.	0
Infertility	US	Indicated [C]	For follicle tracking during treatment. For assessment of tubal patency, US is not yet widely practised. Some centres use MRI and/or laparoscopy and/or hysterosalpingography.	0
I10				
Suspected cephalopelvic disproportion	XR pelvimetry	Not indicated [B]	The need for pelvimetry is increasingly being questioned. Local policy should be determined in agreement with obstetricians. MRI or CT should be used wherever possible.	II
I11	MRI/CT	Specialised investigation [C]	MRI is best as it avoids x-irradiation. CT generally offers a lower dose than standard XR pelvimetry.	0/I

J. Breast disease

Asymptomatic patients

CLINICAL/DIAGNOSTIC PROBLEM	INVESTIGATION	RECOMMENDATION [GRADE]	COMMENT	DOSE
Screening women < 40 years old **J01**	Mammography	Not indicated [B]	There is no evidence to support screening of women < 40 years old who are not at increased risk of breast cancer.	I
Screening women 40–49 years old	Mammography	Indicated only in specific circumstances [A]	Women seeking screening at this age should be made aware of the risks and benefits.	I
J02	US	Indicated only in specific circumstances [B]	Useful adjunct to mammography in women with dense breasts and those with implants.	0
Screening women 50–64 years old	Mammography	Indicated [A]	Women aged 50–64 are invited for screening at 3-yearly intervals in the UK under the auspices of the NHS Breast Screening Programme.	I
J03	US	Indicated only in specific circumstances [B]	Useful adjunct to mammography in women with dense breasts and those with implants.	0
Screening women > 65 years old	Mammography	Indicated [A]	Currently self-referral to the NHS Breast Screening Programme is required, but screening by invitation is being extended up to age 70 by 2005.	I
J04	US	Indicated only in specific circumstances [B]	Useful adjunct to mammography in women with dense breasts and those with implants.	0
Family history of breast cancer	Mammography	Specialised investigation [B]	Evidence of benefit is emerging for women at significantly increased risk in their 40s and appears to outweigh the harm of screening. Screening should only be undertaken after genetic risk assessments and appropriate counselling as to the risks and benefits. Consensus is that screening of women < 50 years old with a family history should only be undertaken when the lifetime risk of breast cancer is greater than twice the average. Further guidelines for mammographic and other forms of screening in these women remain under review.	I
J05	US	Indicated only in specific circumstances [B]	Useful adjunct to mammography in women with dense breasts and those with implants.	0

CLINICAL/DIAGNOSTIC PROBLEM	INVESTIGATION	RECOMMENDATION [GRADE]	COMMENT	DOSE
Women < 50 years old having or being considered for HRT **J06**	Mammography	Indicated only in specific circumstances [C]	HRT has been shown to increase density and benign changes within the breast. There is a subsequent fall in sensitivity and specificity and an increased recall rate from screening. There is no evidence for routine mammography prior to starting HRT.	I
	US	Indicated only in specific circumstances [B]	Useful adjunct to mammography in women with dense breasts and those with implants.	0
Breast screening in women aged 50 and over who have had augmentation mammoplasty **J07**	Mammography	Indicated [C]	Sensitivity for cancer detection is lower than in the non-augmented.	I
	US	Indicated only in specific circumstances [B]	Useful adjunct to mammography in women with dense breasts and those with implants.	0
Symptomatic patients				
Clinical suspicion of carcinoma **J08**	Mammography	Indicated [B]	Referral to a breast clinic should precede any radiological investigation. Mammography and US should be used in the context of triple assessment (i.e. mammography, US, and needle tests).	I
	US	Indicated [B]	Mammography is appropriate for women > 35 years old. For women 35 years old, US is the imaging investigation of first choice. Performed in the context of triple assessment at a specialist breast clinic.	0
	NM	Indicated only in specific circumstances [A]	Scintimammography is to be performed only if additional information is required after triple assessment, e.g. if there is a disagreement between imaging and pathology.	III
	MRI	Indicated only in specific circumstances [B]	To be performed only if additional information is required after triple assessment, e.g. if there is a disagreement between imaging and pathology.	0
Augmentation mammoplasty (clinical suspicion of carcinoma) ***(See also J08)*** **J09**	Mammography	Indicated [B]	Mammography is indicated when there is clinical suspicion of carcinoma in women with implants.	I
Generalised lumpiness, pain or tenderness, long standing nipple retraction **J10**	Mammography	Not indicated initially [C]	May be worthwhile in women > 40 years old with persisting non-suspicious breast symptoms.	I
	US	Indicated only in specific circumstances [C]	In the absence of other signs suggestive of malignancy, breast US is unlikely to influence management.	0

CLINICAL/DIAGNOSTIC PROBLEM	INVESTIGATION	RECOMMENDATION [GRADE]	COMMENT	DOSE
Cyclical mastalgia	Mammography	Not indicated [B]	Should not be performed in women with breast pain in the absence of clinical signs.	I
J11	US	Not indicated [B]		0
Assessment of integrity of silicon breast implants	US and MRI	Specialised investigation [B]	US is quick and simple and a normal US study is highly predictive of an intact implant. Symptomatic women with implants > 10 years old and positive US have a 94% probability of rupture. MRI can reasonably be used for confirmatory testing in other subsets.	0 + 0
J12				
Suspected Paget's disease of the nipple	Mammography	Indicated [C]	Mammography will show an abnormality in 50% of women. It is helpful to determine the possibility of image-guided biopsy. When invasive disease is confirmed it will influence the surgical management of the axilla.	I
J13				
Breast inflammation	Mammography	Specialised investigation [C]	Helps to diagnose or exclude malignancy when there is clinical doubt.	I
J14	US	Indicated [C]	Also useful in drainage and follow-up.	0
Breast cancer follow-up (surveillance)	Mammography/ US/MRI/NM	Indicated [A]	Mammography, US, and MRI may all be used for follow-up of the conserved breast. In suspected locoregional recurrence the principles of triple assessment apply. Occasionally, scintimammography may have a role.	I/0/ 0/III
J15				

K. Trauma

Head: General

Head injury:

- The primary aim of clinical and radiological assessment is to identify those patients with clinically important brain injury and, most crucially, those with an intracranial haematoma requiring urgent neurosurgical management.
- There are an estimated 700,000 hospital attendances per annum for head injury in England and Wales. The large majority of these are classified as mild with a low risk of intracranial haematoma. Recent UK practice has relied heavily on the use of skull radiography to triage patients with mild head injury, but sensitivity for detection of intracranial haematoma may be as low as 38%. CT has both sensitivity and specificity close to 100% but carries a high radiation burden and major resource implications if used indiscriminately.
- A number of attempts have been made to derive clinical decision rules that can identify patients who are not at risk of a neurosurgical haematoma or other clinically important brain injury and do not require cranial imaging. The Canadian Head CT Rule was derived from a cohort of more than 3,000 patients using a methodologically sound multivariate analysis of several risk factors. Coagulopathy, focal neurological deficit, post-traumatic seizure, and clinically suspected open or depressed skull fracture were considered a priori indications. Five further clinical risk factors identified 100% of patients who required neurosurgical intervention, with a further two factors identifying 98.4% with clinically important brain injury.
- At the time of publication of these Guidelines the validation study of this rule has not yet been completed and it therefore constitutes Level 2 evidence. These Guidelines adopt the Canadian Head CT Rule as the basis for selection of patients for CT scanning, but may be subject to change as new evidence emerges.
- If CT is normal or the patient does not qualify for a CT scan and no other clinical risk factors or social factors are present, the risk of complications requiring hospital care is low enough to warrant discharge to the care of a responsible adult with head injury instructions.
- These recommendations are likely to increase the use of CT in head trauma in most UK centres. There are implications for population radiation dose and cost, although routine CT followed by patient discharge if CT is negative may be cost-effective. CT scanning protocols should be optimised to minimise dose, especially in children.
- Current Royal College of Surgeons Guidelines state that 24-hour availability of CT is required in all centres receiving head-injured patients. In circumstances where, for whatever reason, CT is not promptly available, skull radiographs may still have a role. Other local circumstances may require modification of these guidelines.
- MRI, SPECT, and transcranial Doppler US are specialised investigations in head injury whose role is still under evaluation.

Associated injuries:

- Assessment of the cervical spine including imaging if indicated (see sections K7-11) is essential in all head-injured patients. The opportunity to perform CT of the cervical spine while the patient is having a head scan should be carefully considered, especially if the patient is unconscious. Multi-slice CT scanners enable the whole cervical spine to be scanned at high resolution and multiplanar reformats to be generated with relative ease. Sensitivity to fractures is superior to plain radiographs.
- Occipital condylar fractures are uncommon, but serious injuries are associated with high-energy blunt trauma to the head and/or upper cervical spine. They are difficult to diagnose clinically although they should be suspected in any patient showing signs of lower cranial nerve palsy after injury. Demonstration on plain radiographs is extremely difficult and radiological diagnosis requires good quality CT. This region should be routinely reviewed on 'bone windows' in head-injured patients, with additional high resolution imaging if necessary.

Children:

- The Canadian Rule was derived from a cohort that did not include children. Children have a lower risk of intracranial haematoma than adults, and it is considered safe to apply the rule to this age group. If non-accidental injury is suspected, a skull radiograph as part of a skeletal survey is required. In children 0–2 years old, CT of the head is mandatory. In addition, MRI of the brain may be required later to further document timing of the injury.

  (For non-accidental injury in children see M15)

Trivial head injury:

- Patients with head injury who are fully orientated, have no history of loss of consciousness or amnesia nor any other clinical risk factors have a negligible risk of a clinically important brain injury and do not require imaging.

CLINICAL/DIAGNOSTIC PROBLEM	INVESTIGATION	RECOMMENDATION [GRADE]	COMMENT	DOSE
Head injury: **Any** of the following clinical features indicates that there is a risk of a clinically significant brain injury requiring neuro-surgical intervention: • GCS < 13 at any point since the injury • GCS 13 or 14 with failure to regain GCS 15 within 2 hours of injury • Suspected open or depressed skull fracture • Any sign of basal skull fracture (haemo-tympanum, 'racoon eyes', CSF otorrhoea, Battle's sign) • More than one episode of vomiting • Age > 64 years • Post-traumatic seizure • Coagulopathy, including anti-coagulant therapy • Focal neurological deficit The following two features in the absence of any of the above indicates a risk of a clinically significant brain injury that does not require neuro-surgical intervention: • Retrograde amnesia of greater than 30 minutes • Dangerous mechanism of injury: pedestrian struck by motor vehicle, occupant ejected from a motor vehicle, fall from a height > 3 feet or 5 stairs **K01**	SXR	Not indicated [B]	When CT is not available SXR could be justified for triage. ***An important exception is in the case of suspected non-accidental injury in children, where SXR is routinely indicated as part of a skeletal survey. In children 0-2 years old, CT of the head is mandatory. (For non-accidental injury in children see M15)***	I
	CT	Indicated [B]	CT should be performed within 1 hour except in patients with **only** retrograde amnesia of > 30 minutes and/or dangerous mechanism of injury as risk factors. These patients are not at risk of a haematoma requiring neurosurgical intervention and CT may be delayed for up to 8 hours. Deterioration in GCS by 1 point, particularly if on the motor score, may warrant an urgent CT. If a patient with a normal initial CT fails to regain GCS 15 within 24 hours, a further CT or MRI may be appropriate.	II

CLINICAL/DIAGNOSTIC PROBLEM	INVESTIGATION	RECOMMENDATION [GRADE]	COMMENT	DOSE
Face and orbits				
Nasal trauma **K02**	SXR/ XR facial bones/ XR nasal bones	Not indicated [B]	XRs are unreliable in diagnosing nasal fractures and, even when positive, they do not usually influence patient management. They may be requested at ENT/maxillofacial follow-up depending on local policy.	I/I/I
Blunt orbital trauma **K03**	XR facial bones	Indicated [B]	Especially where a blowout injury is suspected. MRI or direct coronal CT may be required by specialists where there is persistent diplopia or XRs and clinical signs are equivocal.	I
Orbital trauma: penetrating injury	XR orbits	Indicated [B]	Indicated for suspected radio-opaque (metallic) intra-orbital foreign body.	I
	CT	Specialised investigation [B]	Indicated for suspected poorly opaque (small or non-metallic) intraorbital foreign body.	II
	US	Specialised investigation [B]	Indicated for anterior intraocular foreign bodies.	0
(See also A16, A17) **K04**	MRI	Specialised investigation [B]	Hazardous with metal intraorbital foreign bodies. Specialised investigation is needed in cases when there is a strong clinical suspicion but failure of localisation or identification of the foreign body on other imaging.	0
Middle third facial injury	CT	Specialised investigation [B]	Patient cooperation is essential to obtain views of diagnostic quality. Consider delay if patient is uncooperative.	II
K05	XR facial bones	Indicated [B]	Discuss with maxillofacial surgeon, who may request low dose CT at an early stage in management of complex injuries.	I
Mandibular trauma **K06**	XR mandible or OPG	Indicated [A]	Panoramic XR is not appropriate in uncooperative or multiply injured patients.	I
Cervical spine				
Conscious patient with head and/or facial injury only **K07**	XR cervical spine	Indicated only in specific circumstances [A]	XR will not be necessary, provided that all five of the following criteria are met: • No midline cervical tenderness • No focal neurological deficit • Normal alertness • No intoxication • No painful, distracting injury.	I
Unconscious patient with head injury **K08**	XR cervical spine, CT	Indicated [B]	Good quality XRs should demonstrate the whole of the cervical spine down to T1/2. If the cervico-thoracic junction is not clearly seen or there are any possible areas of fracture then CT is required. Where available, spiral CT may be used as an alternative to XR, and is essential if the cervico-thoracic junction is not clearly seen on XR. Both techniques may be difficult in the severely traumatised patient, and manipulation must be avoided.	I, II

CLINICAL/DIAGNOSTIC PROBLEM	INVESTIGATION	RECOMMENDATION [GRADE]	COMMENT	DOSE
Neck injury with pain **K09**	XR cervical spine	Indicated [B]	Discuss with department of clinical radiology.	I
	CT/MRI	Specialised investigation [B]	May be valuable when XR is equivocal or lesion complex.	II/0
Neck injury with neurological deficit **K10**	XR cervical spine	Indicated [B]	For orthopaedic assessment. XR must be of good quality to allow accurate interpretation.	I
	MRI	Indicated [B]	MRI is the best and safest method of demonstrating intrinsic cord damage, cord compression, ligamentous injuries, and vertebral fractures at multiple levels. Some constraints with life support systems.	0
	CT	Specialised investigation [B]	CT myelography may be considered if MRI is not practicable.	II
Neck injury with pain but XR initially normal; suspected ligamentous injury **K11**	XR cervical spine	Specialised investigation [B]	Views taken in flexion and extension (consider fluoroscopy) as achieved by the patient with no assistance and under medical supervision.	I
	MRI	Specialised investigation [C]	MRI demonstrates ligamentous injuries.	0
Thoracic and lumbar spine				
Trauma without pain or neurological deficit **K12**	XR	Not indicated [A]	Physical examination is reliable in this region. When the patient is alert and asymptomatic without neurological signs, the probability of a radiological finding that would alter management is low.	I
Trauma with pain, no neurological deficit, or patient not able to be evaluated **K13**	XR	Indicated [B]	Threshold to XR is low when there is pain/tenderness, a significant fall, a high-impact road traffic accident, and presence of other spinal fracture, or when it is not possible to clinically evaluate the patient. If XR suggests instability or posterior element fractures, CT or MRI is essential.	I
Trauma: with neurological deficit with or without pain **K14**	XR	Indicated [B]	Initial investigation, but CT/MRI is essential.	I
	CT	Indicated [B]	Detailed analysis of bone injury is achieved with CT with or without reconstructions.	II
	MRI	Indicated [B]	Whole-spine MRI is indicated when there are multilevel or ligamentous injuries and cauda equina injuries.	0
Pelvis and sacrum				
Fall with inability to weight-bear **K15**	XR pelvis and Lateral XR hip	Indicated [C]	Physical examination may be unreliable. Check for femoral neck fractures, which may not show on initial XR, even with good lateral views. In selected cases, NM or MRI or CT can be useful when XR is normal or equivocal.	I + I

CLINICAL/DIAGNOSTIC PROBLEM	INVESTIGATION	RECOMMENDATION [GRADE]	COMMENT	DOSE
Urethral bleeding and pelvic injury **K16**	Retrograde urethrogram	Indicated [C]	To show urethral integrity, leak, or rupture. Cystography or delayed post-contrast CT should be considered if urethra is normal and haematuria is present to assess for other urinary tract injuries. There is increasing first use of MRI in the non-acute situation.	II
Trauma to coccyx or coccydynia **K17**	XR	Indicated only in specific circumstances [C]	Normal appearance is often misleading and findings do not alter management.	I
Upper limb				
Shoulder injury **K18**	XR	Indicated [B]	Some dislocations present subtle findings. As a minimum, orthogonal views are required. US, MRI, and CT may play a role in complex cases or soft tissue injury. Consider assessment of rotator cuff in over-50s who mobilise poorly following a first dislocation.	I
Elbow trauma **K19**	XR	Indicated [B]	To show effusion. Routine follow-up XRs are not indicated in cases of effusion with no obvious fracture. MRI is a specialist investigation.	I
Wrist injury: suspected scaphoid fracture	XR	Indicated [B]	Four-view series is needed where scaphoid fracture suspected.	I
K20	MRI/NM/CT	Indicated [B]	If clinical doubt persists, MRI/NM/CT studies are reliable. MRI is preferable as it is more specific. Increasingly, MRI is being used as the only examination.	0/ II/II
Lower limb				
Knee trauma: fall/blunt trauma **K21**	XR	Indicated only in specific circumstances [B]	When blunt trauma or a fall is the mechanism of injury. XR is warranted when age < 12 or > 50 years or patient cannot walk four weight-bearing steps. CT/ MRI may be needed where further information is required.	I
Acute ankle injury **K22**	XR	Indicated only in specific circumstances [B]	Features which justify XR include: inability to weight-bear immediately and in the emergency room, point tenderness over the medial malleolus, and/or the posterior edge and distal tip of the lateral malleolus.	I
Foot injury **K23**	XR	Indicated only in specific circumstances [A] – Mid-foot [B] – Fore-foot	Indicated only if there is true bony tenderness or on-going inability to weight-bear. Demonstration of a fore-foot injury rarely influences management. Only rarely are XRs of foot and ankle indicated together; both will not be done without good reason. If XRs are not taken, advise return in one week if symptoms are not improved. For complex mid-foot injuries, CT is required.	I

CLINICAL/DIAGNOSTIC PROBLEM	INVESTIGATION	RECOMMENDATION [GRADE]	COMMENT	DOSE
Stress fracture	XR	Indicated [B]	Although often unrewarding.	I
K24	NM/MRI/CT	Indicated [B]	Provides a means of early detection as well as a visual account of the biomechanical properties of the bone. Some centres use US here.	II/0/ II
Imaging of a foreign body				
Soft tissue injury: foreign body, e.g. metal, glass, painted wood	XR	Indicated [B]	All glass is radio-opaque. Remove blood-stained or soiled dressings first where possible.	I
K25	US	Indicated [B]	US may be indicated for radiolucent foreign body or where XR is difficult.	0
Soft tissue injury: foreign body, e.g. plastic, wood	XR	Indicated only in specific circumstances [B]	Plastic is not radio-opaque: wood is rarely radio-opaque.	I
K26	US	Indicated only in specific circumstances [B]	Soft tissue US may show non-opaque foreign body.	0
Swallowed foreign body suspected in pharyngeal or upper oesophageal region.	XR	Indicated only in specific circumstances [C]	After direct examination of oropharynx (where most foreign bodies lodge), and if foreign body is likely to be opaque. Differentiation from calcified cartilage can be difficult. Most fish bones are invisible on XR.	I
(See also K28 and K29) ***(For children see section M)*** **K27**	AXR	Indicated only in specific circumstances [B]	Maintain a low threshold for laryngoscopy or endoscopy, especially if pain persists after 24 hrs. (NB For possible inhaled or swallowed foreign body in children see M26, M31)	II
Swallowed foreign body: smooth and small, e.g. coin	CXR	Indicated [B]	The minority of swallowed foreign bodies will be radio-opaque. In children a single, slightly over-exposed, frontal CXR to include neck should suffice. In adults, a lateral CXR may be needed in addition if frontal CXR is negative.	I
K28	AXR	Indicated only in specific circumstances [B]	The majority of foreign bodies that impact do so at the cricopharyngeus muscle. If the foreign body has not passed within 6 days, AXR may be useful for localisation.	I
Sharp or potentially poisonous swallowed foreign body, e.g. battery	AXR	Indicated [B]	Most swallowed foreign bodies that pass the oesophagus eventually pass through the remainder of the gastrointestinal tract without complication. However, the location of a battery is important, as leakage can be dangerous.	I
(For children see section M) **K29**	CXR	Indicated only in specific circumstances [B]	Indicated only if AXR is negative. ***(For children see M31)***	I

CLINICAL/DIAGNOSTIC PROBLEM	INVESTIGATION	RECOMMENDATION [GRADE]	COMMENT	DOSE
Chest				
Chest trauma: minor **K30**	CXR	Indicated only in specific circumstances [B]	The demonstration of a rib fracture does not alter management.	I
Chest trauma: moderate **K31**	CXR	Indicated [B]	Frontal CXR for pneumothorax, fluid, or lung contusion.	I
	CT	Specialised investigation [C]	May be required.	III
Stab injury **K32**	CXR	Indicated [C]	PA and/or other views to show pneumothorax, lung damage, or fluid. US is useful for pleural and pericardial fluid.	I
Sternal fracture **K33**	Lateral XR sternum	Indicated [C]	In addition to CXR, lateral XR of the sternum is required. Think of thoracic spinal and aortic injuries too.	I
Abdomen (including kidney)				
Blunt or stab injury **K34**	AXR supine and CXR erect/US	Indicated [B]	Supine AXR and erect CXR are indicated. US valuable for detecting haematoma and possible injuries to some organs, e.g. spleen and liver.	I/I/0
	CT	Specialised investigation [C]	CT may be needed.	III
Renal trauma	IVU	Indicated only in specific circumstances [B]	Adults with blunt renal trauma, microscopic haematuria, and no shock or major associated intra-abdominal injuries can safely be spared imaging.	II
	US	Indicated only in specific circumstances [B]	US can be useful in the initial assessment of patients with suspected renal injury, but a negative US does not exclude renal injury.	0
(See also N27) **K35**	CT	Indicated [B]	CT is the imaging technique of choice in patients with major injury ± hypotension, ± macroscopic haematuria. Delayed (excretory phase) CT must be included to assess the collecting system.	III
Major trauma				
Major trauma: general screen in the unconscious or confused patient ***(See also K1, K37, K38 and N27)*** **K36**	XR cervical spine/CXR/ XR pelvis/CT head	Indicated [B]	Patient's condition must be stabilised as a priority. Only the minimum XRs necessary for initial assessment will be performed. XR cervical spine can wait as long as spine and cord are suitably protected. Pelvic fractures are often associated with major blood loss.	I/I/ I/III

CLINICAL/DIAGNOSTIC PROBLEM	INVESTIGATION	RECOMMENDATION [GRADE]	COMMENT	DOSE
Major trauma: abdomen/pelvis *(See also N27)* **K37**	CXR, XR pelvis	Indicated [B]	Pneumothorax must be excluded. Pelvic fractures which increase pelvic volume are often associated with major blood loss.	I+I
	US/CT	Indicated [B]	Sensitive and specific, but time-consuming and may delay surgery. CT should precede peritoneal lavage. US widely used in the emergency room to show free fluid plus solid organ injury. US has replaced lavage in most circumstances, but has a low sensitivity for splenic injury. If doubt remains, CT should follow US.	0/III
Major trauma: chest **K38**	CXR	Indicated [B]	Allows immediate management (e.g. pneumothorax).	I
	CT chest	Indicated [B]	Especially useful to exclude mediastinal haemorrhage and aortic injury. Low threshold for proceeding to arteriography.	III

L. Cancer

Many of the clinical problems related to the diagnosis of cancer have already been partly covered within the individual system sections. Brief notes are provided here about the use of imaging in the diagnosis, staging, and follow-up in some of the common primary malignancies. Paediatric malignancies are not included as their management is always at specialist level. ***(For breast cancer see also section J)***

A CXR is necessary at presentation for most malignant lesions to identify possible pulmonary metastases.

CXR is also part of many follow-up protocols (e.g. testicular lesions). Follow-up investigations to monitor progress (e.g. post-chemotherapy) are often required. Some are driven by trial protocols rather than clinical need and thus should be appropriately funded. Concern about radiation dose in diagnostic imaging is generally less relevant in this section.

CLINICAL/DIAGNOSTIC PROBLEM	INVESTIGATION	RECOMMENDATION [GRADE]	COMMENT	DOSE
Mouth and pharynx				
Diagnosis **L01**	MRI/CT	Indicated [B]	Diagnosis is commonly by clinical examination, supported by MRI or CT when there is high suspicion of occult disease.	0/II
Staging	MRI/CT	Indicated [B]	Imaging is not commonly needed for diagnosis. Staging should include cervical node groups; colour Doppler US may improve N staging. Chest may be examined by XR or (preferably) CT, but clinical effectiveness of M staging is unproven.	0/II
L02	PET	Specialised investigation [C]	To identify recurrent disease in previously treated patients.	IV
Parotid				
Diagnosis	US	Indicated [B]	Useful for superficial lobe tumours. If FNAC (fine-needle aspiration cytology) is required, US can be used for guidance. If US is unable to visualise the entire tumour, then MRI is the investigation of choice for extent.	0
	MRI/CT	Specialised investigation [B]	MRI is preferred for the assessment of parotid masses. Limitations in ability to identify calcification make CT better for inflammatory disease. MRI cannot reliably differentiate benign from malignant lesions and does not obviate the need for a tissue diagnosis in indeterminate cases. However, MRI is better than CT for soft tissue resolution. Dental amalgam may also be a problem on CT. CT should be used if MRI is impracticable and for suspected inflammatory disease.	0/II
L03	PET	Not indicated [B]	PET is poor at differentiating benign from malignant lesions.	IV

CLINICAL/DIAGNOSTIC PROBLEM	INVESTIGATION	RECOMMENDATION [GRADE]	COMMENT	DOSE
Staging	MRI/CT	Indicated [B]	MRI should be used in preference to CT for the staging of parotid masses because of its superior soft tissue resolution, multiplanar capability, and ability to define both the extent of disease and any intracranial involvement.	0/II
L04	PET	Specialised investigation [C]	May have a role in staging tumours as it will identify metastases in normal-sized lymph nodes.	IV
Larynx				
Diagnosis	CT/MRI	Indicated only in specific circumstances [B]	Clinical endoscopy and biopsy for diagnosis.	II/0
L05				
Staging	CT/MRI	Indicated [B]	Where available, MRI is preferable to CT for T staging. Either can be used for N staging.	II/0
L06	US	Specialised investigation [B]	Can be used for T and N staging and follow-up in centres with appropriate expertise.	0
Thyroid				
Diagnosis	NM	Indicated [B]	For detection of residual/recurrent differentiated thyroid cancer after thyroidectomy.	II
L07	US	Indicated [B]	Used in combination with or to guide FNAC.	0
Staging	CT/MRI	Indicated [B]	To assess large primary tumours, detect distant metastases, and for medullary thyroid carcinoma in MEN syndromes.	II/0
	NM	Indicated [B]	For the detection of residual/recurrent disease after thyroidectomy.	IV
L08	US	Indicated [B]	Where appropriate expertise is available.	0
Lung				
Diagnosis	CXR	Indicated [A]	Lung cancer can have several different clinical presentations and, if it is suspected, CXR is indicated. A proportion of cancers will be radiographically occult despite the presence of malignant cells in the sputum.	I
(See also N29–N31) **L09**	CT	Indicated [B]	CT has not yet been proven to be of benefit as a screening tool for lung cancer. CT will increase sensitivity of detection of early tumours.	III

CLINICAL/DIAGNOSTIC PROBLEM	INVESTIGATION	RECOMMENDATION [GRADE]	COMMENT	DOSE
Staging	CT	Indicated [A]	When correlated with histological findings, CT has an overall accuracy of up to 80% in the detection of mediastinal lymphadenopathy. Mediastinal lymph node biopsy will be required in some cases to confirm the CT findings prior to thoracotomy. PET is more accurate (see below).	III
	MRI	Indicated only in specific circumstances [C]	In the majority of patients with lung cancer MRI does not offer any benefits over CT. However, it is of value in patients with superior pulmonary sulcus (Pancoast's) tumours. MRI may also be of value in demonstrating the vascular anatomy of the mediastinum in those patients allergic to iodinated contrast media. Studies have shown MRI to be better than CT at differentiating tumour from distal atelectasis.	0
L10	PET	Indicated [B]	FDG-PET is significantly more accurate than CT or MRI in the staging of patients with non-small-cell lung cancer and has a high negative predictive value for nodal metastases.	IV
Oesophagus				
Diagnosis **L11**	Ba swallow	Indicated [B]	Before endoscopy in dysphagia, Ba studies are sensitive for the diagnosis of oesophageal cancer.	II
Staging	CT	Indicated [B]	Many patients present with advanced disease that is inoperable. CT can be used as the initial investigation to exclude these patients. Endoscopic US is needed for more accurate TNM staging, particularly if this will alter the surgical approach.	III
	Endoscopic US	Indicated [B]	Requires expertise. If available, it can be initial investigation. Often used if CT suggests patient is operable, to plan most appropriate surgery.	0
L12	PET	Specialised investigation [B]	PET is of use in the pre-surgical assessment of patients with oesophageal cancer in order to detect metastases.	IV
Stomach				
Diagnosis **L13**	Endoscopy/ Ba meal	Indicated [B]	Endoscopy and double contrast Ba meal are equally sensitive in the diagnosis of advanced gastric cancer. Endoscopy allows biopsy for histology.	0/II
Staging **L14**	CT	Indicated [B]	CT is currently the best staging investigation if active treatment is planned. Endoscopic US is useful for local staging. Laparoscopy is most sensitive for small peritoneal deposits.	III

CLINICAL/DIAGNOSTIC PROBLEM	INVESTIGATION	RECOMMENDATION [GRADE]	COMMENT	DOSE
Liver: primary lesion				
Diagnosis	US	Indicated [B]	The majority of lesions will be identified by US.	0
(See also N33, N34, N35) **L15**	MRI/CT	Specialised investigation [B]	Indicated if biochemical markers are elevated and US is negative or the liver is very cirrhotic. Enhanced MRI and arterial-phase CT are most accurate in delineating tumour extent.	0/III
Staging **L16**	MRI/CT	Indicated [B]	MRI is probably the optimal investigation for assessing the involved segments and lobes. CT arterial portography and intra-operative US are useful where available.	0/III
Liver: secondary lesion				
Diagnosis	US	Indicated [B]	US will reliably detect metastases > 2 cm and can guide biopsy.	0
	CT/MRI	Indicated [B]	Indicated when US findings are negative and clinical suspicion is high. MRI is better for characterising lesions. CT arterial portography is sensitive but not specific, but many now use triple-phase spiral CT techniques following IV enhancement. CT and MRI often form part of other staging and follow-up protocols.	III/0
L17	PET	Specialised investigation [C]	Indicated when other imaging is equivocal, to exclude other metastatic disease prior to surgery.	IV
Pancreas				
Diagnosis	US/CT	Indicated [B]	Much depends on local expertise and the patient's body habitus. US is usually successful in thin patients; CT is better in the more obese patient. Biopsy can be performed using US or CT. Endoscopic US is the most sensitive.	0/III
L18	MRI/MRCP/ ERCP	Specialised investigation [C]	MRI for clarification of problems. MRCP or ERCP may also be needed. Interest in PET is increasing.	0/0/ II
Staging	MRI/CT	Indicated [B]	Especially if radical surgery is contemplated. There is wide local variation: some centres use angiography; others, spiral CT.	0/III
	PET	Specialised investigation [B]	Of use in cases where there is a significant possibility of distant spread.	IV
L19	Endoscopic US	Specialised investigation [B]	Should be reserved for those patients in a tertiary referral centre whose disease is deemed resectable on the basis of CT/MRI.	0

CLINICAL/DIAGNOSTIC PROBLEM	INVESTIGATION	RECOMMENDATION [GRADE]	COMMENT	DOSE
Colon and rectum				
Diagnosis	Ba enema/ colonoscopy	Indicated [B]	Much depends on local availability and expertise.	III/0
L20	CT	Specialised investigation [C]	Increasing interest in CT, particularly in the elderly and infirm.	III
Staging	CXR, US	Indicated [B]	For pulmonary and liver metastases. Endoluminal US is useful for local rectal spread.	I, 0
L21	CT, MRI	Indicated [B]	Local pre-operative staging to assess rectal lesions before pre-operative radiotherapy. Many centres now treat liver secondaries aggressively, which may necessitate MRI and/or detailed CT. MRI and CT are often complementary; both can assess other abdominal spread. Interest in PET is increasing.	III, 0
Follow-up	US	Indicated [B]	For liver metastases. Preliminary evidence now supports routine imaging follow-up in asymptomatic patients.	0
	CT/MRI	Indicated [B]	For liver metastases and local recurrence.	III/0
L22	PET	Specialised investigation [A]	PET is the best imaging technique for the evaluation of suspected local recurrence in patients with colorectal cancer and is of use in the assessment of patients prior to hepatic resection for metastases.	IV
Kidney				
Diagnosis	CXR	Indicated [C]	To look for pulmonary metastases.	I
	US	Indicated [B]	US is a sensitive detector of renal masses > 2 cm and accurately characterises masses as cystic or solid. US helps to characterise some masses indeterminate at CT.	0
	IVU	Not indicated [B]	Less sensitive than US for the detection of renal masses. However, this is the method of choice for detecting transitional cell carcinoma of the pelvicalyceal system or ureters.	II
	CT	Indicated [B]	A sensitive detector of renal masses 1.0–1.5 cm and accurately characterises masses.	III
L23	MRI	Specialised investigation [B]	Contrast-enhanced MRI is as sensitive as contrast-enhanced CT for detecting and characterising renal masses. MRI should be used if masses are not adequately characterised by CT and US or if iodinated contrast medium is contraindicated because of diminished renal function or allergy to iodinated contrast agents.	0

CLINICAL/DIAGNOSTIC PROBLEM	INVESTIGATION	RECOMMENDATION [GRADE]	COMMENT	DOSE
Staging	CT/MRI	Indicated [B]	MRI is better at detecting advanced stages, e.g. renal vein involvement. CT and MRI are equivalent at staging T1 disease.	III/0
L24	PET	Not indicated [C]	Current evidence with PET demonstrates no advantages for staging or detection of renal carcinoma.	IV
Recurrence **L25**	CT	Indicated [B]	For symptoms suggesting relapse around nephrectomy bed. Routine follow-up is not recommended.	III
Bladder				
Diagnosis	IVU	Indicated only in specific circumstances [B]	Cystoscopy is the investigation of choice to diagnose bladder tumours.	II
L26	US	Indicated only in specific circumstances [B]	Not sufficiently accurate to assess small (< 5 mm) bladder tumours, but enables assessment of upper tract.	0
Staging	IVU	Indicated [B]	To assess kidneys and ureters for further urothelial tumours.	II
	CXR	Indicated [C]	To look for pulmonary metastases.	I
	MRI	Indicated [B]	Sensitive and specific and useful in invasive transitional cell carcinoma. CT is less specific than MRI, but of use if MRI is not practicable.	0
L27	PET	Specialised investigation [C]	Role yet to be clarified.	IV
Prostate				
Diagnosis	US	Indicated [B]	Some variation according to local availability and expertise. TRUS (transrectal ultrasonography) is widely used together with guided biopsies.	0
L28				
Staging	MRI	Specialised investigation [B]	Some variation exists in the range of investigative and therapeutic policies. MRI with appropriate coils is sensitive for assessment before possible radical prostatectomy. Staging is continued into the abdomen when pelvic disease is found. CT is of no value for local staging.	0
L29	NM	Indicated [B]	To assess skeletal metastases, when PSA (prostate-specific antigen) is significantly elevated.	II
Testicle				
Diagnosis	US	Indicated [B]	In suspected testicular malignancy and when presumed inflammatory disease does not respond to treatment	0
L30				

CLINICAL/DIAGNOSTIC PROBLEM	INVESTIGATION	RECOMMENDATION [GRADE]	COMMENT	DOSE
Staging **L31**	CT chest, abdomen, and pelvis	Indicated [B]	CT is the mainstay of staging, and at initial diagnosis should include the chest, abdomen and pelvis. Pelvis can be omitted if all risk factors, including abdominal nodal disease, have been excluded. For non-seminomatous germ cell tumours, thoracic CT is more sensitive in the detection of pulmonary metastases than CXR.	III-IV
Follow-up **L32**	CT	Indicated [B]	If risk factors for pelvic nodal disease have been excluded, pelvic CT may be omitted. The appearance of residual masses may assist in decisions on whether to undertake surgery. MRI has no clear advantage over CT, apart from reducing radiation burden. CT of previously involved areas can demonstrate morphological evidence of enlargement of masses.	III-IV
	PET	Specialised investigation [B]	When a marker rises following treatment, F-18 FDG-PET may be helpful in identifying the site of relapse.	IV
Ovary				
Diagnosis **L33**	US	Indicated [B]	Most ovarian lesions are initially identified on clinical examination or US. Transabdominal US supplemented by transvaginal US and colour Doppler are used in their evaluation.	0
	MRI abdomen and pelvis	Specialised investigation [B]	MRI is useful for problem solving, as it is more accurate than US in determining the presence of malignancy. Surgery is still required in some cases to distinguish benign from malignant disease.	0
Staging **L34**	CT abdomen and pelvis	Specialised investigation [B]	Many specialists request imaging in addition to staging by laparotomy.	III
	MRI abdomen and pelvis	Specialised investigation [B]	MRI is useful when enhanced CT is contraindicated, the patient is pregnant, or for problem solving.	0
	PET	Specialised investigation [C]	Indicated in difficult management situations to assess distant and local spread.	IV
Follow-up **L35**	CT abdomen and pelvis	Specialised investigation [B]	CT/MRI defines extent, but normal findings do not exclude recurrence. CT is used to assess treatment response.	III
	MRI abdomen and pelvis	Specialised investigation [B]	MRI is useful for surgical planning and problem solving.	0
	NM	Specialised investigation [C]	Clinical examination and the serum Ca-125 radioimmunoassay are used to detect recurrent disease.	II

CLINICAL/DIAGNOSTIC PROBLEM	INVESTIGATION	RECOMMENDATION [GRADE]	COMMENT	DOSE
Uterus: cervix				
Diagnosis **L36**	MRI	Indicated only in specific circumstances [B]	Usually a clinical diagnosis. MRI may assist in complex cases.	0
Staging **L37**	MRI	Indicated [B]	MRI provides better demonstration of tumour and local extent than CT, and is also better for pelvic nodes. Para-aortic nodes and ureters must also be examined. Some centres now use TRUS for local invasion.	0
	PET	Indicated only in specific circumstances [C]	PET is useful in difficult situations to define the extent of disease with accompanying image registration.	IV
Relapse **L38**	MRI abdomen and pelvis	Specialised investigation [B]	MRI provides better information in the pelvis than CT. Biopsy (e.g. of nodal mass) is easier with CT.	0
Uterus: body				
Diagnosis **L39**	US/MRI	Indicated [B]	MRI can give valuable information about benign and malignant lesions.	0/0
Staging **L40**	MRI	Indicated [B]	MRI is the optimum technique for staging endometrial carcinoma.	0
	CT	Not indicated [B]	CT is of limited value for local staging and is therefore unlikely to affect management.	III
Lymphoma				
Diagnosis **L41**	CT	Indicated [B]	Diagnosis will usually be made by excision biopsy of a lymph node, but CT demonstration of extensive nodal enlargement may strongly suggest the diagnosis of lymphoma. For disease confined to the torso it will also allow the selection of a site for image-guided biopsy.	III-IV
	NM	Specialised investigation [B]	Ga-67 can show foci of occult disease (e.g. mediastinum). PET is used in some centres.	II
Staging **L42**	CT	Indicated [B]	Depending on the site of disease, the head and neck may also need to be examined.	III-IV
	MRI	Indicated only in specific circumstances [B]	While MRI is not indicated routinely as an initial staging test, it shows nodal sites as well as CT and can image marrow burden of disease, which has prognostic implications.	0
	PET	Specialised investigation [B]	FDG-PET is as accurate as CT.	IV

CLINICAL/DIAGNOSTIC PROBLEM	INVESTIGATION	RECOMMENDATION [GRADE]	COMMENT	DOSE
Follow-up	CT	Indicated [B]	CT of areas affected at staging for Hodgkin's disease. If there is clinical suspicion of relapse or progression, it is appropriate to examine chest, abdomen and pelvis, especially for non-Hodgkin's lymphoma.	III-IV
	MRI	Not indicated initially [B]	MRI may help assess the nature of a residual mass detected at CT.	0
	NM/PET	Specialised investigation [B]	Studies directly comparing Ga-67 and FDG-PET are limited. It is clear that FDG-PET is more sensitive and specific than Ga-67, especially for small masses and below the diaphragm. With Ga-67 a pre-treatment image must be obtained.	III/IV
L43	CXR	Indicated [B]	For initial assessment of response in overt thoracic disease the CXR is entirely appropriate.	I
Musculoskeletal tumours				
Diagnosis ***(See also section D)***	XR and MRI	Indicated [B]	Imaging and histology are complementary. Best before biopsy.	I + 0
L44	NM	Indicated [B]	To ensure that a lesion is solitary.	III
Staging	MRI and CT chest	Specialised investigation [C]	MRI is best for local spread and extent. CT is used to detect lung metastases.	0 + III
(See also section D) **L45**	PET	Specialised investigation [C]	PET is best imaging technique for detecting metastases from an unknown primary tumour.	IV

CLINICAL/DIAGNOSTIC PROBLEM	INVESTIGATION	RECOMMENDATION [GRADE]	COMMENT	DOSE
Metastases from unknown primary tumour				
Diagnosis of primary lesion. 'Carcinoma, unknown primary' is a diagnosis of exclusion and not a diagnosis in its own right. Histology review is key to identifying likely sites of primary tumours and treatable tumours, e.g. lymphomas, germ cell tumours, and head and neck primary tumours. The site of initially identified metastases determines the likely origin, e.g. disease in upper cervical lymph nodes is likely to come from head and neck primaries, disease in axillary lymph nodes from breast carcinoma, and cancer cells in ascites from ovarian carcinoma in women. ***(For breast disease see section J)*** **L46**	CXR	Indicated [B]	CXR can help to identify the source of the occult primary.	I
	CT chest, abdomen, and pelvis	Specialised investigation [B]	CT is the most sensitive investigation in determining the primary site. This may allow effective treatment, e.g. for lung cancer, and palliation. It also allows entry into clinical trials and has unquantified psychological benefits to patient and doctor.	IV
	Mammography	Indicated only in specific circumstances [C]	Breast cancer survival is better from occult breast cancer metastases. Even in the presence of metastases, it is worthwhile to diagnose and treat cancer of the breast.	I
	MRI breast	Specialised investigation [B]	MRI may demonstrate a primary breast carcinoma with axillary lymph node metastases despite a normal mammogram and US.	0
	PET head and neck, supra-diaphragmatic, or whole body	Specialised investigation [C]	After full work-up, including CT or MRI.	IV

M. Paediatrics

(For head injury in children see section K)

Central nervous system

CLINICAL/DIAGNOSTIC PROBLEM	INVESTIGATION	RECOMMENDATION [GRADE]	COMMENT	DOSE
Congenital disorders: head **M01**	MRI	Indicated [B]	Definitive exam for all malformations, avoiding x-irradiation. CT may be needed to define bone and skull base anomalies. Sedation or GA may be required for infants and young children, and in some cases therefore CT may be preferred.	0
Congenital disorders: spine **M02**	MRI	Indicated [B]	Definitive exam for all malformations, avoiding x-irradiation. CT may be needed to delineate bone detail. Sedation or GA may be required for infants and young children.	0
Abnormal head appearance: hydrocephalus **M03**	US	Indicated [B]	US indicated where anterior fontanelle is open. Where sutures are closed/closing, MRI is indicated (older children). CT may be appropriate if MRI is not available.	0
	SXR	Specialised investigation [C]	SXR and low-dose CT with 3-D reconstructions are indicated in craniostenosis.	I
Epilepsy *(See also A19)* **M04**	MRI	Specialised investigation [A]	Specialist clinical assessment and EEG investigation should usually be undertaken before MRI, unless there are signs of raised intracranial pressure or an acute neurological deficit. There is no routine indication for CT.	0
	PET/NM/ SPECT/rCBF	Specialised investigation [B]	Useful in pre-surgical evaluation.	II-IV
	SXR	Not indicated [B]	Poor yield.	I
Deafness in children **M05**	MRI and/ or CT	Specialised investigation [C]	Both MRI and CT may be necessary in children with congenital and post-infective deafness.	0/II
Hydrocephalus ?shunt malfunction	XR	Indicated [B]	XR should include whole valve system.	I
(See also A10) **M06**	US/MRI	Indicated [B]	US if practicable; MRI in older children (or CT if MRI unavailable). Neurosurgeons may still want cross-sectional imaging even if US is performed. New programmable valves cause problems in MRI. US of abdomen is indicated if CSF (cerebrospinal fluid) collection is likely.	0/0
Developmental delay ?cerebral palsy **M07**	MRI	Specialised investigation [C]	Remains a controversial area with regard to whom to screen and why. Further studies are needed to improve the accuracy of predicting patient outcome, particularly using newer MRI techniques of diffusion, spectroscopy, and functional imaging.	0

CLINICAL/DIAGNOSTIC PROBLEM	INVESTIGATION	RECOMMENDATION [GRADE]	COMMENT	DOSE
Headache	SXR	Not indicated [C]	If headache is persistent or associated with clinical signs, refer patient for specialised investigations.	I
(See also A06, A07, A13) **M08**	MRI/CT	Specialised investigation [B]	In children MRI is preferable if available because of absence of x-irradiation. *(See A06 for possible meningitis and encephalitis, and see also A07 and A13)*	0/II
Sinusitis *(See also A13)* **M09**	XR sinus	Indicated only in specific circumstances [B]	Not indicated at < 5 years old as the sinuses are poorly developed; mucosal thickening can be a normal finding in children.	I
Neck and spine				
Torticollis without trauma **M10**	XR	Indicated only in specific circumstances [B]	Muscular causes are most common, but when history and examination are atypical, XRs are advised.	I
	CT	Indicated only in specific circumstances [B]	Persistent torticollis for one week justifies further imaging following consultation.	II
	US	Indicated [B]	In congenital torticollis, US of neck muscles is a useful diagnostic tool in confirming sternocleidomastoid tumour in infants. If US is negative, XR and cross-sectional imaging are indicated.	0
Back pain *(See also C07-C08)* **M11**	MRI/CT	Indicated [B]	Persistent back pain in children may have an underlying cause and justifies investigation. Choice of imaging following consultation. Back pain with scoliosis or neurological signs merits MRI/CT.	0/II
Spina bifida occulta **M12**	US/MRI	Not indicated [C]	A common variation and not in itself significant. Investigation is only indicated if neurological signs are present.	0/0
Hairy patch, sacral dimple **M13**	US/MRI	Indicated only in specific circumstances [B]	Isolated sacral dimples and pits may be safely ignored (< 5 mm from midline; < 25 mm from anus). US of the neonatal lumbar spine and canal is the initial investigation of choice if there are other stigmata of spinal dysraphism or associated congenital abnormalities, e.g. cloacal exstrophy anorectal malformation spectrum (CEARMS). MRI is indicated if neurological signs are present, or there is a discharging lesion.	0/0
Neonatal hypothyroidism **M14**	NM	Specialised investigation [B]	Tc-99m or I-123 thyroid scintigraphy is the most accurate diagnostic test to detect thyroid dysgenesis or one of the inborn errors of T4 synthesis in patients with congenital hypothyroidism.	II

CLINICAL/DIAGNOSTIC PROBLEM	INVESTIGATION	RECOMMENDATION [GRADE]	COMMENT	DOSE
Musculoskeletal				
Non-accidental injury/ child abuse	Skeletal survey	Indicated (age 0–2 years) [A]	Age 0–2 years, CT of the head is mandatory. Age 3–5 years, XR clinically suspicious area. Age > 3 years skeletal survey is not generally indicated, as children >3 years can usually describe where pain is located. Examinations should be performed by radiographers trained in paediatric radiographic techniques.	II
(For head injury see section K) **M15**	NM	Indicated [B]	Bone scintigraphy is indicated in children > 2 years if the skeletal survey is equivocal. Abnormal bone findings must always be correlated with clinical history, physical examination, and pertinent XRs.	II
Limb injury: opposite side for comparison **M16**	Comparison XRs of the joint on the contralateral side	Not indicated [B]	Seek radiological advice.	I
Short stature, growth failure **M17**	XR for bone age	Indicated [A]	Child aged 1 year and over: left (or non-dominant) hand/wrist only. XR may need supplementing with further specialised investigations. Skeletal scintigraphy if dysplasia is suspected. MRI of hypothalamus-pituitary fossa if central hormone failure is a possibility.	I
Irritable hip	US	Indicated [B]	US will confirm presence of an effusion but will not discriminate sepsis from transient synovitis.	0
(See also M19, M21) **M18**	XR	Not indicated initially [C]	XR, which may include a frog lateral view, is required if slipped upper femoral epiphysis or Perthes' disease is suspected or if symptoms persist. If symptoms persist, then follow-up should be as for the limping child	I
Limping	US	Indicated [B]	US will confirm the presence of an effusion but will not discriminate sepsis from transient synovitis.	0
	XR	Not indicated initially [B]	Children with a limp need proper clinical assessment. If pain persists, or localising signs are present, XR is indicated.	I
	MRI	Specialised investigation [C]	Should be used after discussion with radiologist.	0
	NM	Not indicated initially [B]	XR and US should be performed before NM. NM is useful for localisation when XR and US are normal. The age of the child is an important factor in limiting the diagnostic possibilities.	II
M19				

CLINICAL/DIAGNOSTIC PROBLEM	INVESTIGATION	RECOMMENDATION [GRADE]	COMMENT	DOSE
Focal bone pain **M20**	XR	Indicated [B]	XR should be the first-line investigation, though MRI and NM are more sensitive than XR in detecting occult infection or fracture.	I
	NM	Specialised investigation [B]	XR should be obtained initially. Skeletal scintigraphy is useful if pain is not well localised. A negative multiphasic study does not exclude active arthritis.	II
	MRI	Specialised investigation [C]	Particularly useful if the child can localise the site of the pain.	0
	US	Specialised investigation [C]	US can detect occult infection.	0
Clicking hip: dislocation **M21**	US	Indicated [A]	US is indicated where there is clinical doubt about developmental dysplasia of the hip but not for routine screening. XR may be necessary in the older child.	0
Osgood-Schlatter disease **M22**	XR	Indicated only in specific circumstances [C]	Although bony radiological changes are visible in Osgood-Schlatter disease, these overlap with normal appearances. Associated soft tissue swelling should be assessed clinically rather than radiographically.	I
Cardiothoracic				
Acute chest infection **M23**	CXR	Indicated only in specific circumstances [A]	CXR indicated if symptoms persist despite treatment or in severely ill children. If CXR is performed and demonstrates simple pneumonia, routine follow-up CXR is not required.	I
Recurrent productive cough **M24**	CXR	Indicated only in specific circumstances [C]	In general, children with recurrent productive cough have CXRs which are normal or show peribronchial thickening. Routine follow-up CXR is not indicated unless atelectasis is seen on initial CXR. Suspected cystic fibrosis or immune deficiency require specialist referral.	I
Cystic fibrosis **M25**	NM	Indicated only in specific circumstances [B]	Perfusion lung scintigraphy is useful in selected cases, especially if surgery is contemplated.	II
Inhaled foreign body (suspected) ***(See also section K27, K28 and B06)*** **M26**	CXR	Indicated [B]	CXR is indicated, though often normal. If there is clinical suspicion of an inhaled foreign body, bronchoscopy is mandatory. While air trapping is the most common sign seen in patients with inhaled foreign bodies, it is seen infrequently and the routine use of expiratory XRs is not warranted. Fluoroscopy is often a better and easier alternative to expiratory XR.	I
Wheeze ***(See also M26)*** **M27**	CXR	Indicated only in specific circumstances [B]	In most children with wheeze, the CXR is either normal or shows features of uncomplicated asthma or bronchiolitis, such as hyperinflation or peribronchial cuffing. In selected cases, such as those with fever or localised crackles, the CXR may be useful in guiding patient management.	I

CLINICAL/DIAGNOSTIC PROBLEM	INVESTIGATION	RECOMMENDATION [GRADE]	COMMENT	DOSE
Acute stridor **M28**	Lateral XR soft tissue neck	Indicated only in specific circumstances [B]	Epiglottitis and croup are clinical diagnoses. Lateral neck XRs may be of value in children with a stable airway in whom an obstructing foreign body or retropharyngeal abscess is possible.	I
Heart murmur **M29**	CXR/US	Indicated only in specific circumstances [C]	Specialist referral is needed; cardiac US may be indicated.	I/0
Gastrointestinal				
Intussusception **M30**	US-guided or fluoroscopy-guided hydrostatic/ pneumatic reduction	Indicated [A]	US has high sensitivity in diagnosing intussusception but is operator-dependent. It is useful in assessing blood flow and identifying lead points and small bowel intussusceptions. Pneumatic reduction has a higher success rate than traditional hydrostatic reduction. However, there is a slightly higher risk of perforation (approximately 1%). Absolute contraindications are perforation, shock, and peritonitis.	0/II
Swallowed foreign body	AXR	Indicated only in specific circumstances [C]	Only for sharp or potentially poisonous foreign body, e.g. battery.	I
(See also B06, K27-K29) **M31**	CXR, including neck	Indicated [B]	If there is doubt whether the foreign body has passed, an AXR after six days may be indicated.	I
Blunt abdominal trauma **M32**	AXR	Indicated only in specific circumstances [B]	Clinical assessment of the patient should be used to determine which patients require further evaluation by imaging. AXR is of limited use after minor trauma unless there are positive physical signs suggestive of intra-abdominal pathology or injury to the spine or bony pelvis.	I
	US	Indicated only in specific circumstances [B]	US may be used to search for the presence of free fluid following blunt abdominal trauma, but a negative examination does not exclude the presence of intra-abdominal injury.	0
	CT	Specialised investigation [B]	CT with IV contrast remains the primary imaging investigation of choice to detect the presence and extent of intra-abdominal injuries following blunt abdominal trauma, and will guide the level or intensity of hospital and post-discharge management of the patient. US may be useful in the follow-up of known organ injuries, to reduce the total radiation burden to the patient.	III
Projectile vomiting in infants **M33**	US	Indicated [A]	US can confirm the presence of hypertrophic pyloric stenosis, especially where clinical findings are equivocal.	0

CLINICAL/DIAGNOSTIC PROBLEM	INVESTIGATION	RECOMMENDATION [GRADE]	COMMENT	DOSE
Recurrent vomiting	Contrast meal ± follow-through	Indicated only in specific circumstances [C]	Recurrent vomiting in children can be caused by a wide variety of conditions, many of which cannot be diagnosed radiologically. An upper GI contrast study is not indicated for the diagnosis of simple gastro-oesophageal reflux. Where significant gastro-oesophageal reflux has been shown on pH studies, an upper GI contrast study may be indicated to exclude a significant structural abnormality such as hiatus hernia or malrotation. If there are other associated clinical symptoms/signs, e.g. bile-stained vomit, the case for contrast studies is much stronger.	II
M34	NM	Specialised investigation [B]	Gastric emptying may be measured with Tc-99m – labelled solid or fluid meal. This may be combined with scintigraphic evaluation and gastro-oesophageal reflux.	II
Persistent neonatal jaundice	US	Specialised investigation [B]	Early (< 10 weeks) and prompt investigation is essential. The absence of dilatation in the intrahepatic bile duct does not exclude obstructive cholangiopathy.	0
M35	NM	Specialised investigation [B]	Hepatobiliary scintigraphy with Tc-99m – labelled IDA derivatives. This cannot confirm biliary atresia if there is no bowel activity.	II
GI bleeding (per rectum)	AXR	Indicated only in specific circumstances [C]	Imaging strategy depends on the age of the patient and severity of bleeding, diagnostic possibilities, and clinical presentation. AXR is required if necrotising enterocolitis is suspected.	I
	US	Specialised investigation [C]	US for diagnosis of intussusception and demonstration of duplication cysts. Upper or lower GI endoscopy is often the most useful next investigation. Consider a small bowel enema if the suspected pathology is inaccessible to endoscopy.	0
M36	NM	Specialised investigation [C]	NM is used for detecting active bleeding sites including Meckel's diverticulum. Angiography is used for investigation of rapid haemorrhage or chronic haemorrhage not found by other means.	II
Acute abdominal pain	US	Specialised investigation [C]	Acute abdominal pain can be due to a diverse range of causes. US can be helpful in further assessment but needs to be guided by clinical findings.	0
M37	AXR	Indicated only in specific circumstances [C]	Rarely of value and best performed under specialist guidance. Generally AXR is not undertaken prior to US.	II
Constipation	AXR	Indicated only in specific circumstances [C]	There is a wide variation in the amount of faecal residue shown on the AXR and good correlation with constipation has not been proven. Additionally there is inter-observer variation in interpretation. AXR can help specialists in the management of intractable constipation.	II
Continued **M38**				

CLINICAL/DIAGNOSTIC PROBLEM	INVESTIGATION	RECOMMENDATION [GRADE]	COMMENT	DOSE
Constipation *Continued* **M38**	Contrast enema	Indicated only in specific circumstances [B]	Non-radiological investigations, i.e. rectal manometry and biopsy are preferred. Contrast enema may have a role if these are not available and referral is difficult.	II
Palpable abdominal/ pelvic mass **M39**	US	Indicated [C]	Indicated in the evaluation of all suspected abdominal masses. If the presence of a mass is confirmed, the patient should be referred to a specialist centre.	0
Genitourinary				
Continuous wetting	US	Indicated [B]	In toilet-trained girls with a history of continuous dribbling/wetting, an ectopic infrasphincteric ureter must be excluded. US of the whole renal tract including the bladder and pelvis is recommended in addition to video-urodynamics. Imaging of the urinary tract in children with solely night-time enuresis is of limited value.	0
	XR lumbosacral spine	Indicated [B]	Indicated in children with abnormal neurology or skeletal examination, in addition to those with bladder wall thickening/trabeculation demonstrated on US or neuropathic vesicourethral dysfunction on video-urodynamics.	II
	NM	Indicated only in specific circumstances [B]	DMSA imaging is useful in the detection and location of the dysplastic kidney and upper moiety of a duplex system.	II
	IVU	Indicated only in specific circumstances [B]	To confirm the ectopic infrasphincteric ureters in girls with a known duplex system on US and/or DMSA imaging.	II
	CT/MRI	Specialised investigation [B]	CT/MRI may be of value to locate the dysplastic kidney or dysplastic occult moiety when US and DMSA imaging have failed. MRI urography, if available, is an alternative to IVU. **M40**	III/0
Impalpable testis	US	Indicated [B]	To locate testis within the inguinal canal.	0
	MRI/ laparoscopy	Specialised investigation [C]	MRI may be of value after US to locate intra-abdominal testis, but laparoscopy is generally preferred. **M41**	0
Fetal renal pelvic dilatation	US	Indicated [B]	Ideally US should be performed post-partum at 72 hours and again at 4 to 6 weeks. Other imaging investigations including MCUG (micturating cystouretography) and diuretic renography should be performed as per local protocol.	0
	NM	Specialised investigation [B]	In cases of persistent postnatal pelvic dilatation, MAG-3 diuretic renography is essential to estimate renal uptake function (differential function) as well as drainage. **M42**	II

CLINICAL/DIAGNOSTIC PROBLEM	INVESTIGATION	RECOMMENDATION [GRADE]	COMMENT	DOSE
Proven urinary tract infection	US	Specialised investigation [C]	There is wide variation in local policy. Much depends on local technology and expertise. Most patients should remain on prophylactic antibiotics pending the results of investigations. The age of the patient also influences decisions. There is much current emphasis on minimising radiation dose; hence AXR is not indicated routinely (calculi are rare). Expert US is the key investigation in all imaging strategies at this age.	0
	NM	Specialised investigation [A]	There is an increasing trend to examine the acutely ill child secondary to urinary tract infection with a DMSA study in the acute setting. In the out-patient setting, to exclude a scar a DMSA study should be done 3 to 6 months after a proven urinary tract infection. NM will establish function and exclude obstruction.	II
	XR cystography	Specialised investigation [A]	Direct XR cystography is still needed in the young (e.g. < 2 years old) male patient where delineation of the anatomy (e.g. urethral valves) is critical.	II
M43	NM	Specialised investigation [B]	NM can also be used for direct or indirect cystography.	II

N. Interventional radiology

CLINICAL/DIAGNOSTIC PROBLEM	INVESTIGATION	RECOMMENDATION [GRADE]	COMMENT	DOSE
Asymptomatic carotid disease ***(See also B05)*** **N01**	Endovascular (angioplasty and stents) management	Indicated only in specific circumstances [C]	Critical appraisal of the literature reveals a need for further studies.	III
Symptomatic carotid disease **N02**	Percutaneous balloon angioplasty and stent placement	Indicated only in specific circumstances [B]	The recommended treatment for the majority of patients remains endarterectomy. Potential indications for endovascular treatment include unsuitability for endarterectomy, status post radiotherapy, surgical restenosis, high lesions, or circumstances where treatment is closely audited or part of structured research in an experienced unit.	III
Pulmonary embolus **N03**	Insertion of IVC filter	Indicated only in specific circumstances [B]	In the presence of known lower limb and/or pelvic venous thrombosis the insertion of an IVC (inferior vena cava) filter is only indicated if there are proven pulmonary emboli despite adequate anticoagulation, or when anticoagulation is contraindicated.	II
Pulmonary arteriovenous malformation (AVM)	Pulmonary angiography and embolisation	Specialised investigation [B]	A prerequisite to other diagnostic intervention at the time of treatment by embolisation.	III
	CT	Specialised investigation [B]	May be useful in the diagnosis of pulmonary AVMs. Non-contrast helical study is usually all that is needed. Some centres recommend this study prior to treatment by embolisation in order to measure feeding vessels and assess anatomy.	III
	CXR	Indicated [B]	CXR is indicated when this diagnosis is suspected and to assess response to treatment. Follow-up assessment is initially performed six-monthly or yearly after embolisation and then five-yearly if no growth. CXR is also indicated as a screening tool in relatives of patients with pulmonary AVMs associated with hereditary haemorrhagic telangiectasia.	I
	MRI brain	Specialised investigation [C]	To look for evidence of previous paradoxical cerebral embolisation in patients with pulmonary AVM diagnoses. MRI is also used to look for evidence of cerebral AVMs in patients with associated hereditary haemorrhagic telangiectasia.	0
	MRI thorax	Specialised investigation [C]	As an alternative to thoracic CT, to confirm diagnosis of pulmonary AVMs. MRI thorax may be useful for diagnosis, but is not necessary in the majority of patients.	0

Continued **N04**

CLINICAL/DIAGNOSTIC PROBLEM	INVESTIGATION	RECOMMENDATION [GRADE]	COMMENT	DOSE
Pulmonary arteriovenous malformation (AVM) *Continued*	NM	Specialised investigation [B]	Perfusion scintigraphy is performed with Tc-labelled macroaggregates for measurement of right to left shunt. It is useful for diagnosis and follow-up assessment after treatment.	II
N04	US	Specialised investigation [C]	Research tool only at present. Doppler US of carotids or cardiac chambers is performed after IV injection of agitated saline or US contrast agent to determine presence of right to left shunt. It is useful for diagnosis.	0
Abdominal aortic aneurysms **N05**	Insertion of stent-grafts	Specialised intervention [B]	Endovascular repair of abdominal aortic aneurysms is a procedure that should only be performed in specialist units.	III
Leg ischaemia (claudication, rest pain with or without tissue loss) with iliac stenotic disease **N06**	Primary angioplasty plus selective stenting	Indicated [A]	The decision to place a stent following angioplasty depends on a number of factors, one of which is a residual pressure gradient across the treated area. The exact pressure gradient after PTA (percutaneous transluminal angioplasty) that mandates stent placement is unknown. In general, a mean pressure gradient of 10 mm Hg is considered appropriate.	III
Leg ischaemia (claudication, rest pain with or without tissue loss) with iliac occlusive disease **N07**	Iliac stent placement	Indicated [B]	The policy of primary stenting for iliac occlusive disease is accepted.	III
Leg ischaemia (claudication, rest pain with or without tissue loss) with femoral occlusive disease **N08**	Superficial femoral/ popliteal artery angioplasty	Indicated [B]	PTA of the superficial femoral and popliteal arteries is effective for restoring patency in the short term, but repeat angioplasty can be performed to avoid the need for surgical bypass. Primary clinical success rates are inferior to those of surgical bypass grafts.	III
Leg ischaemia (claudication, rest pain with or without tissue loss) with tibioperoneal occlusive disease. **N09**	Tibioperoneal trunk angioplasty	Indicated [B]	When there is a suitable lesion in the tibioperoneal trunk, angioplasty should be the first-line treatment in patients with critical ischaemia and claudication.	III
Severe acute GI bleeding from unknown source requiring continuous substitution **N10**	Endoscopy/ DSA with or without embolisation	Specialised intervention [C]	Stabilising the patient is a priority. Endoscopy is the first-line intervention. If endoscopy is negative or unsuccessful, DSA and embolisation follow immediately. However, the patient must be actively bleeding as contrast extravasation is the only diagnostic sign to locate a source. Unsuccessful embolisation indicates surgery.	0/III

CLINICAL/DIAGNOSTIC PROBLEM	INVESTIGATION	RECOMMENDATION [GRADE]	COMMENT	DOSE
Variceal haemorrhage **N11**	TIPS	Indicated only in specific circumstances [A]	Endoscopic therapy should be the first-line treatment for bleeding varices, with TIPS (transjugular intrahepatic portosystemic shunt) reserved for treatment failures. Surgical portosystemic shunting is more durable and may be preferred in medically fit patients.	III
Ascites due to portal hypertension **N12**	TIPS	Indicated only in specific circumstances [B]	TIPS is of limited efficacy and is associated with substantial mortality, particularly in Child's grade C liver disease and/or renal impairment.	III
Acute massive lower GI haemorrhage **N13**	DSA and/or embolisation	Indicated [B]	DSA and embolisation is safe and effective when GI bleeding is life-threatening.	III
Chronic or recurrent upper GI haemorrhage *(See also G05)* **N14**	DSA and/or embolisation	Specialised intervention [C]	Only undertaken after appropriate imaging. Recurrent blood loss can be investigated with DSA and/or NM (red cell) study.	III
Chronic mesenteric ischaemia **N15**	Superior mesenteric artery PTA/ superior mesenteric artery stenting	Indicated [B]	In carefully selected patients mesenteric artery PTA can be performed relatively safely with good technical and clinical results. Superior mesenteric artery stenting can improve the result of angioplasty and may become the therapy of choice in ostial superior mesenteric artery stenosis.	III/III
Subphrenic abscess **N16**	US-/CT-guided percutaneous drainage of subphrenic abscess	Indicated [C]	US is the best technique for draining subphrenic abscesses as it allows an angled approach and real-time imaging. CT may also be helpful in that it may provide a more detailed road map including accurate localisation of the pleural space.	0/III
Pelvic abscess **N17**	CT-/US-guided catheter drainage	Indicated [B]	Percutaneous-transperineal, -transsciatic, -transrectal, and -transvaginal routes are all effective in the treatment of pelvic abscess. The presence of an enteric fistula is a risk factor for failure.	III/0
High biliary obstruction (intrahepatic ducts or upper half of extrahepatic bile duct) **N18**	Percutaneous transhepatic cholangio-graphy	Indicated [B]	Choice of endoscopic or transhepatic route for cholangiography may depend on local expertise. Percutaneous drainage is not recommended as a long-term option due to catheter problems such as peri-drain leak, drain displacement, and cholangitis. For surgical reconstruction percutaneous transhepatic cholangiography may be more valuable than endoscopic retrograde cholangiography since it defines the anatomy of the proximal biliary tree.	III
Low biliary obstruction (lower half of extrahepatic bile duct or pancreatic duct) **N19**	Percutaneous transhepatic cholangio-graphy	Indicated [B]	Preference for transhepatic or endoscopic retrograde cholangiography may depend on local expertise.	III

CLINICAL/DIAGNOSTIC PROBLEM	INVESTIGATION	RECOMMENDATION [GRADE]	COMMENT	DOSE
Actual or suspected acute calculous or acalculous cholecystitis **N20**	Percutaneous transhepatic or transperitoneal chole-cystostomy	Indicated [B]	Percutaneous transhepatic or transperitoneal cholecystotomy is appropriate in the diagnosis and management of actual or suspected acute calculous or acalculous cholecystitis in high-risk patients.	III
Hypertension due to fibromuscular dysplasia **N21**	Renal PTA with or without stent	Indicated [B]	Renal PTA in a specialist centre is indicated.	III
Hypertension due to atherosclerotic renal artery stenosis **N22**	Renal PTA with or without stent	Indicated only in specific circumstances [A]	Hypertension due to atherosclerotic renal artery stenosis should be treated by medical therapy. Renal PTA/stenting may be beneficial in selected patients with uncontrollable hypertension.	III
Renal failure due to atherosclerotic renal artery stenosis **N23**	Renal PTA with or without stent	Indicated only in specific circumstances [B]	Indications for renal PTA/stenting are not established. These procedures should only be performed after careful patient selection in specialist centres.	III
Flash pulmonary oedema due to atherosclerotic renal artery stenosis **N24**	Renal PTA with or without stent	Indicated [B]	Renal PTA/stenting should be considered in patients with recurrent pulmonary oedema with tight bilateral renal artery stenosis or stenosis in a single kidney.	III
Renal calculi **N25**	Percutaneous nephro-lithotomy	Indicated [C]	Percutaneous nephrolithotomy is generally accepted as the first-line treatment for renal stone 3 cm or more in maximum diameter, as well as with certain anatomical abnormalities such as calyceal diverticula and rotated/ectopic kidneys, and in morbidly obese patients, when other treatment modalities have failed.	III
Varicocele **N26**	Embolisation of varicocele	Indicated [A]	Embolisation is effective in the management of varicocele, either for subfertility or for symptoms, and is associated with fewer complications than surgery.	III
Abdominal trauma with acute GI bleeding with or without retroperitoneal or intraperitoneal haemorrhage *(See also K34-K37)* **N27**	DSA/ embolisation	Specialised intervention [C]	Intervention when the patient is stable. The patient must be actively bleeding as contrast extravasation is essential for the source of haemorrhage to be located by DSA. Embolisation or surgery may follow as appropriate.	III
Embolisation for uncontrolled haemorrhage after pelvic fracture **N28**	Pelvic embolisation	Indicated [A]	Patients with pelvic fracture who remain haemodynamically unstable after initial resuscitation should undergo diagnostic pelvic angiography with embolisation if a source of arterial bleeding is identified.	III

NB Dosages will vary with fluoroscopy time, and this depends on the degree of complexity of each case

CLINICAL/DIAGNOSTIC PROBLEM	INVESTIGATION	RECOMMENDATION [GRADE]	COMMENT	DOSE
Pulmonary mass: diagnosis **N29**	Fluoroscopic lung biopsy	Specialised intervention [B]	Fluoroscopic lung biopsy in appropriately selected cases and performed by experienced operators has a low complication rate and high diagnostic yield for pulmonary malignancy.	III
	CT-guided lung biopsy	Specialised intervention [B]	CT-guided lung biopsy is an accurate means of obtaining a diagnosis of malignancy or benign disease (if a cutting needle is used) in patients with large or small pulmonary nodules.	III
	US-guided lung biopsy	Specialised intervention [B]	For appropriately selected patients with pulmonary lesions abutting the chest wall, US-guided biopsy is a safe and accurate method of obtaining a tissue diagnosis.	0
Mediastinal mass (non-vascular) **N30**	CT-guided biopsy	Specialised intervention [B]	CT guidance can be used to aid biopsy of anterior, middle, and posterior mediastinal masses.	III
	US-guided biopsy	Specialised intervention [B]	The majority of anterior mediastinal masses can be safely and accurately biopsied using US guidance. Alternative biopsy routes to the parasternal approach such as a supraclavicular approach may be helpful.	0
Vena caval obstruction **N31**	SVC/IVC stent placement	Specialised intervention [B]	Patients with malignant SVC/IVC obstruction are often frail and have a short life expectancy. Their symptoms are distressing and are usually incompletely relieved by radiotherapy. SVC/IVC stenting is a simple palliative procedure performed under local anaesthesia. Following stenting, most patients will remain asymptomatic. Symptomatic recurrence occurs in about 10% of patients and is usually amenable to repeat treatment. Early referral is preferable as extensive venous thrombosis complicates treatment. Stenting should be the first-line treatment of malignant SVC/IVC obstruction caused by cancers that do not respond quickly to chemotherapy or radiotherapy. Alternatives to stenting (angioplasty and surgery) should be considered in patients with benign strictures and those with a long life expectancy.	III
Percutaneous gastrostomy required for enteral nutrition **N32**	Percutaneous gastrostomy	Specialised intervention [B]	There is little to choose between percutaneous and endoscopic placement of gastrostomy catheters. The technique of choice may be dependent on the local expertise available.	III
Focal liver lesion(s) requiring biopsy **N33**	CT-/US-guided biopsy	Indicated [B]	The guideline assumes normal coagulation indices. Image guidance is dependent on local expertise.	III/0
Unresectable liver tumours **N34**	Radiofrequency ablation	Specialised intervention [B]	Radiofrequency ablation should be used in patients with a small number of accessible liver tumours unsuitable for hepatic resection.	III

CLINICAL/DIAGNOSTIC PROBLEM	INVESTIGATION	RECOMMENDATION [GRADE]	COMMENT	DOSE
Primary hepatoma and liver metastases N35	Radiofrequency ablation/ hepatic chemo-embolisation	Indicated [B]	Radiofrequency ablation is indicated for primary hepatoma and liver metastases. For the vast majority of liver metastases it is more effective than chemoembolisation. Hepatic chemoembolisation has a significant antitumoral effect but this is offset by liver decompensation secondary to embolisation of non-tumour-bearing liver. Selective chemoembolisation should minimise the side-effects of this treatment. Chemoembolisation has also been used for palliation in neuroendocrine tumours and metastatic sarcoma.	III/III

Appendix

List of bodies involved in the consultation exercise:

Royal Colleges, etc.

European Association of Radiology
European Congress of Radiology
Faculty of Accident and Emergency Medicine
Faculty of Dental Surgery, RCS
Faculty of Clinical Oncology, RCR
Faculty of Occupational Medicine
Faculty of Public Health Medicine
Royal College of Anaesthetists
Royal College of General Practitioners
Royal College of Paediatrics and Child Health
Royal College of Physicians of London
Royal College of Physicians and Surgeons of Glasgow
Royal College of Physicians of Edinburgh
Royal College of Physicians of Ireland
Royal College of Psychiatrists
Royal College of Obstetricians and Gynaecologists
Royal College of Ophthalmologists
Royal College of Pathologists
Royal College of Surgeons of Edinburgh
Royal College of Surgeons of England
Royal College of Surgeons of Ireland
Royal Society of Medicine
The Society and College of Radiographers

Other organisations

British Institute of Radiology
British United Provident Association
European Commission
Medical Defence Union
Medical Protection Society
National Radiological Protection Board
Radiological Protection Institute of Ireland
Union of European Medical Specialists
Professional associations in radiology in each European state

Specialty groups

Association of Chest Radiologists
British Society of Thoracic Radiologists
British Society of Nuclear Medicine
British Society of Gastroenterology
British Society of Interventional Radiology
British Society of Neuroradiologists
British Medical Ultrasound Society
British Society of Paediatric Radiologists
British Society of Skeletal Radiologists
Cardiovascular & Interventional Radiological Society of Europe
Dental Radiology Group
European Association of Nuclear Medicine
European Society of Breast Imaging
European Society of Cardiac Radiology
European Society of Gastrointestinal & Abdominal Radiology
European Society of Head & Neck Radiology
European Society of Thoracic Imaging
European Society of Neuroradiology
European Society of Musculoskeletal Radiology
European Society of Paediatric Radiology
European Society of Urogenital Radiology
Magnetic Resonance Radiologists Association UK
RCR Cardiac Radiology Group
RCR Breast Group
RCR Clinical Directors' Group
RCR Interventional Radiology Sub-Committee
RCR Nuclear Medicine Sub-Committee
RCR Paediatric Group
RCR/RCOG Intercollegiate Standing Committee on Obstetric Ultrasound
RCR/RCP Intercollegiate Standing Committee on Nuclear Medicine
SIG in GI and Abdominal Radiology (SIGGAR)
UK Children's Cancer Study Group
UK Neurointervention Group