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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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CONTENTS

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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