

Chapter IV

Referral Guidelines with the Three Level Band for Image Quality

In recent years, film/screen radiography has been characterised by the search for optimal image quality, independent of the specific clinical problem. The only restricting parameter was the dose value, which could not exceed a maximum value. The advantage of pursuing a strategy of trying to obtain the highest level of image quality is the fact that a range of unexpected, yet complementary diagnostic information can be obtained, over and above the information normally obtained at a lower dose. By implementing digital imaging methods, however, doses can be reduced over a broad range – which sometimes does decrease image quality, but often does not. Dose and quality management realises this new potential using the ALARA principle (As Low As Reasonably Achievable), adapting image quality and dose to fit the clinical situation (“quality as good as necessary, not as good as possible – dose value as low as possible”).

Quality and dose management should start with establishing a clear definition of indications for Digital Projection Radiography. These guidelines should be based on the criteria and methods of evidence-based medicine, taking into account the clinical situation and the risk for to the patient. The aim is to avoid unnecessary, routine exposures as well as to reduce the dose per image. Two documents can be considered a starting point here, namely “Referral Guidelines for Imaging”, published by the European Commission (European Commission – Radiation protection 118 – ISBN 92-828-9452-5). and the Council Directive 97/43/ Euratom on health protection of individuals against dangers of ionizing radiation in relation to medical exposure. The latter publication includes sections on purpose and scope, definitions, justification, optimisation and responsibilities.

One parameter that can be varied over a broader range in digital radiography than in film/screen radiography is the exposure dose value. Past experience and research demonstrate that for flat detectors, the speed class of 800 is sufficient for nearly all indications. The dose value of the speed class 200 is no longer used. For many indications speed class, 1600 is suitable. The storage phosphor technique’s potential for dose reduction is significantly lower.

Part of the DIMOND III project involved developing a three-level concept of image quality (high, medium, low) for quality and dose management. Certain dose values (for example, the speed classes 400, 800, and 1600) have been assigned to certain quality levels, depending on the specific imaging method.

One example resulting out of a comparative study (see chapter VI) is shown in the following diagram:

Image Quality classes

() Speed class

| High | Medium | Low |
|----------------------------|------------------------|------------------------|
| Flat detector (400) | Flat detector (800) | Flat detector (1600) |
| Storage Phosphor (200/400) | Storage Phosphor (400) | Storage Phosphor (800) |
| Film (200) | Film (400) | Film (800) |

There must be intensive discussion on the strategies and methods for optimising and standardising image quality in the future. Although many individual studies (see references) describe interesting results, they are missing a methodical framework.

Examples of quality classes high, medium and low:

Referral Guidelines for Imaging: European Commission – Radiation protection 118 – ISBN 92-828-9452-5

The column “Quality Class” has been added as a result of the DIMOND III project

INVESTIGATION {DOSE}

XR Plain radiography one or more films
 CXR Chest radiograph

| Class | Typical effective Dose (mSv) | Examples |
|-------|------------------------------|--|
| 0 | 0 | US, MRI |
| I | <1 | CXR, limb XR, pelvis XR |
| II | 1–5 | IVU, lumbar spine XR, 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. PET) |

QUALITY CLASS

H *High*
 M *Middle*
 L *Low*

RECOMMENDATION {GRADE}

- (A) Randomised controlled trials (RCTs), metaanalyses, systematic reviews; or
- (B) Robust experimental or observational studies; or
- (C) Other evidence where the advice relies on expert opinion and has the endorsement of respected authorities.

| CLINICAL PROBLEM | INVESTIGATION {DOSE} | QUALITY - DOSE - LEVEL | | | | RECOMMENDATION {GRADE} | COMMENT |
|--|------------------------------------|------------------------|-------|--------|--------|-------------------------------|---|
| | | Trier | Athen | Madrid | Dublin | | |
| A. Head | | | | | | | |
| Orbits Metallic FB (before MRI) | <i>XR orbits (I)</i> | H | H | H | H | Indicated (B) | Especially for those who have worked with metallic materials, power tools, etc. Some centres use CT. (see Trauma Section K for acute injury). |
| Headache: chronic | <i>XR skull, sinus C spine (I)</i> | M | M | M | M | Not indicated routinely (B) | Radiography of little use in the absence of focal signs/symptoms. See A13 below. |
| Pituitary and juxta-sellar problems | <i>SXR (I)</i> | M | H | H | M | Not indicated routinely (C) | Patients who require investigation need MRI or CT |
| Hydrocephalus | <i>XR</i> | L | L | L | L | Indicated (C) | XR can demonstrate whole valve system. |
| Sinus disease | <i>Sinus XR (I)</i> | M | M | M-H | M | Not indicated routinely (B) | Thickened mucosa is a non-specific finding and may occur in asymptomatic patients. |
| Dementia and memory disorders, first onset psychosis | <i>SXR (I)</i> | M | M | L-M | M | Not indicated routinely (B) | Consider investigation if clinical course unusual or in younger patient. |
| Orbits Metallic FB (before MRI) | <i>XR orbits (I)</i> | H | H | H | H | Indicated (B) | Especially for those who have worked with metallic materials, power tools, etc. Some centres use CT. (see Trauma Section K for acute injury). |
| Visual disturbances | <i>SXR (I)</i> | M | M | M | M | Not indicated routinely (C) | Plain XRs rarely contributory. Specialists may require CT or MRI. |
| Epilepsy (adult) | <i>SXR (I)</i> | M | M | M | M | Not indicated routinely (B) | Evaluation requires specialist expertise. Late onset seizures should normally be investigated but imaging may be unnecessary if clearly alcohol-related. |
| B. Neck (for the spine see Sections C [The spine] and K [Trauma]) | | | | | | | |
| <i>Soft tissues</i> | | | | | | | |
| Temporo-mandibular joint dysfunction | <i>XR (I)</i> | M | H | M-H | M | Specialised investigation (B) | Radiographs will demonstrate bony abnormalities, but are normal in great majority, as problems are usually related to articular disk dysfunction. |
| C. The spine | | | | | | | |
| <i>General (for trauma see Section K)</i> | | | | | | | |
| Congenital disorders | <i>XR (I)</i> | L | L | L | L | Specialised investigation (C) | e.g. Full-length standing radiograph for scoliosis. See Section M for back pain (M10). |
| <i>Cervical spine</i> | | | | | | | |
| Possible atlanto-axial subluxation | <i>XR (I)</i> | M | M | M-H | M | Indicated (C) | A single lateral cervical spine XR with the patient in subluxation supervised comfortable flexion should reveal any significant subluxation in patients with rheumatoid arthritis, Down's Syndrome, etc. MRI (flexion/extension) shows effect on cord when XR positive or neurological signs present. |

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| Neck pain, brachialgia, degenerative change | <i>XR (I)</i> | M | M | M | M | Not indicated routinely (B) | Degenerative changes begin in early middle-age and are often unrelated to symptoms which are usually due to disk/ligamentous changes undetectable on plain XR. MRI increasingly being used, especially when brachialgia is present. |
| Thoracic spine | | | | | | | |
| Pain without trauma: degenerative disease | <i>XR (I)</i> | M | M | M | M | Not indicated routinely (B) onwards. | Degenerative changes are invariable from middle-age. Examination 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. |
| Lumbar spine | | | | | | | |
| Chronic back pain with no pointers to infection or neoplasm | <i>XR (II)</i> | M | M | M | M | Not indicated routinely (C) | Degenerative changes are common and non-specific. Main value in younger patients (e.g. younger than 20, spondylolisthesis, ankylosing spondylitis, etc.) or in older patients e.g. >55. |
| Acute back pain: disk herniation; sciatica with no adverse features (see above). | <i>XR (II)</i> | M | M | M | M | Not indicated routinely (C) | Acute back pain is usually due to conditions which cannot be diagnosed on plain XR (osteoporotic collapse an exception). 'Normal' plain XRs may be falsely reassuring. Demonstration of disk herniation requires MRI or CT and should be considered immediately after failed conservative management. |
| D. Musculoskeletal system | | | | | | | |
| Osteomyelitis | <i>XR (I) + NM (II) or MRI (0)</i> | M | H | M | M | Indicated (B) | The 2–3 phase skeletal scintigram is more sensitive than XR. However, findings are not specific and further specialised NM with alternative agents may be needed. Fat-suppressed MRI is becoming regarded as the optimal investigation. |
| Primary bone tumour | <i>XR (I)</i> | H | H | H | H | Indicated (B) | XR may characterise the lesion. |
| Known primary tumour. Skeletal metastases | <i>Skeletal survey (II)</i> | H | H | H | H | Not indicated routinely (C) | |
| Bone pain | <i>XR (I)</i> | M | M | M | M | Indicated (B) | Local view of symptomatic areas only. |
| Myeloma | <i>Skeletal survey (II)</i> | M | M | M | M | Indicated (C) | For staging and identifying lesions which may benefit from radiotherapy. Survey can be very limited for follow-up. |
| Metabolic bone disease | <i>Skeletal survey (II)</i> | H | H | H | H | Not indicated routinely (C) | Biochemical tests usually suffice. If needed, this should be limited (e.g. hands, CXR, pelvis and lateral lumbar spine). Bone densitometry may be needed. (see D9). |
| Osteomalacia | <i>XR (0)</i> | H | H | H | H | Indicated (B) | Localised XR to establish cause of local pain or equivocal lesion on NM. |
| Pain — osteoporotic collapse | <i>XR (II) lateral thoracic and lumbar spine</i> | M | M | M | M | 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. Bone densitometry (dual energy XR absorptiometry (DEXA) or quantitative CT) provides objective measurements of bone mineral content; can also be used for metabolic bone disease (see D7, D8). |
| Arthropathy, presentation | <i>XR (I) affected joint</i> | H | H | H | H | Indicated (C) | May be helpful to determine cause although erosions are a relatively late feature. |

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| | <i>XR (I) hands/feet</i> | H | H | H | H | Indicated (C) | In patients with suspected rheumatoid arthritis, XR feet may show erosions even when symptomatic hand(s) appear normal. |
| | <i>XR (II) multiple joint(s)</i> | H | H | H | H | Not indicated routinely (C) | |
| Arthropathy, follow-up | <i>XR (I)</i> | M | M | M | M | Not indicated routinely (C) | XR needed by specialists to assist management decisions. |
| Painful shoulder joint | <i>XR (I)</i> | M | M | M | M | Not indicated routinely (C) | Degenerative changes in the acromio-clavicular joints and rotator cuff are common. Earlier XR if soft tissue calcification is expected. |
| Painful prosthesis | <i>XR (I) + NM (II)</i> | M | M | M-H | M | Indicated (B) | A normal NM study excludes most late complications. Further specialised NM studies can help distinguish loosening from infection. |
| SI joint lesion | <i>XR SI joints (II)</i> | H | H | H | H | Indicated (B) | May help in investigation of sero-negative arthropathy. SI joints usually adequately demonstrated on AP lumbar spine. |
| Hip pain: full movement | <i>XR pelvis (I)</i> | M | M | M | M | Not indicated routinely (C) | XR only if symptoms and signs persist or complex history (e.g. chance of avascular necrosis, see D20) |
| Hip pain: limited movement | <i>XR pelvis (I)</i> | M | M | M | M | Not indicated routinely (C) | Symptoms often transient. XR if hip replacement might be considered or symptoms persist. PET may be helpful, if XR, MRI standard NM all normal. |
| Hip pain: avascular necrosis | <i>XR Pelvis (I)</i> | M | H | M | M | Indicated (B) | Abnormal in established disease. |
| Knee pain: without locking or restriction in movement | <i>XR (I)</i> | M | M | M | M | Not indicated routinely (C) | Symptoms frequently arise from soft tissues and these will not be demonstrated on XR. OA changes common. XRs needed when considering surgery. |
| Knee pain: with locking, restricted movement or effusion (loose body) | <i>XR (I)</i> | M | M | M | M | Indicated (C) | To identify radio-opaque loose bodies. |
| Hallux valgus | <i>XR (I)</i> | L | L | L | L | Specialised investigation (C) | For assessment before surgery. |
| Plantar fasciitis — calcaneal spur | <i>XR (I)</i> | M | M | M-H | M | Not indicated routinely (B) | Plantar spurs are common incidental findings. The cause of the pain is seldom detectable on XR. US, NM and MRI are more sensitive in showing inflammatory change but the majority of patients can be managed without imaging. |

E. Cardiovascular system

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| Central chest pain myocardial infarction | <i>CXR (I)</i> | M | M | M | M | Indicated (B) | CXR must not delay admission to a specialised unit. CXR can assess heart size, pulmonary oedema, etc. and can exclude other causes. Department film preferable. Subsequent imaging involves specialised investigations (NM, coronary angiography, etc.) and depend on local policy. NM offers myocardial perfusion and ventriculography data. Increasing E1 interest in MRI. |
| Chest pain: aortic dissection: acute | <i>CXR (I)</i> | M | M | M | M | Indicated (B) | Mainly to exclude other causes; rarely diagnostic. |
| Pericarditis — pericardial effusion | <i>CXR (I)</i> | M | M | M | M | Indicated (B) | May be normal; effusion volume/effect not determined. |
| Suspected valvular cardiac disease | <i>CXR (I) and cardiac US (O)</i> | M | M | M | M | Indicated (B) | Used for initial assessment and when there is a change in the clinical picture. |

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| Follow-up of patients with heart disease or hypertension | CXR (I) | M | M | M | M | Not indicated routinely (B) | Only if signs or symptoms have changed, when comparison with the CXR obtained at presentation may be helpful. |
| F. Thoracic system | | | | | | | |
| Non-specific chest pain | CXR (I) | M | M | M | M | Not indicated routinely (C) | Conditions such as Tietze's disease show no abnormality on CXR. Main purpose is reassurance. |
| Chest trauma | CXR (I) | M | M | M-H | M | Not indicated routinely (C) | Showing a rib fracture after minor trauma does not alter management (see Trauma Section K). |
| Pre-employment screening medicals | CXR (I) | M | M | M | M | Not indicated | 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). |
| Pre-operative | CXR (I) | M | M | M | M | Not indicated routinely (B) | Exception before cardio-pulmonary surgery, likely admission to ITU, suspected malignancy or possible TB. Anaesthetists may also request CXRs for smokers, dyspnoeic patients, those with known cardiac disease and the very elderly. Many patients with cardio respiratory disease have recent CXR available; a repeat CXR is then not usually needed. |
| Upper respiratory-tract infection | CXR (I) | M | M | M | M | Not indicated routinely (C) | |
| Chronic obstructive airways disease or asthma; follow-up | CXR (I) | M | M | M | M | Not indicated routinely (B) | Only if signs or symptoms have changed. |
| Pneumonia adults: follow-up | CXR (I) | L | L | M | L | Indicated (A) | To confirm clearing, etc. Pointless to re-examine at less than 10-day intervals as clearing can be slow (especially in the elderly). |
| Pleural effusion | CXR (I) | M | M | M | M | Indicated (B) | Small effusion can be missed, especially on a fronta CXR.I |
| Haemoptysis | CXR (I) | M | H | M | M | Indicated (B) | PA plus lateral view. |
| ITU/HDU patient | CXR (I) | M | M | M | M | 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. |
| G. Gastrointestinal system | | | | | | | |
| Gastrointestinal tract | | | | | | | |
| Oesophageal perforation | CXR (I) | M | M | M | M | Indicated (B) | CXR may be sufficient, unless localisation for surgical repair is planned. |
| Acute GI bleeding: haematemesis | AXR (II) | L | L | L | L | Not indicated routinely (B) | Of no value. |
| Acute abdominal pain-perforation- obstruction | CXR (I) (erect) and AXR (II) | L | M | M | L | Indicated (B) | Decubitus AXR to show free air if CXR supine. Supine AXR usually sufficient to establish diagnosis and point to an anatomical level of obstruction. |
| Inflammatory bowel disease of colon | AXR (II) | L | M | M-H | L | Indicated (B) | Often sufficient for evaluation. |
| General abdominal problems | | | | | | | |

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| Acute abdomen pain; (warranting hospital admission and surgical consideration) | AXR (II) plus erect CXR (I) | L | M | M | L | Indicated (B) | Local policy will determine strategy. Supine AXR (for gas pattern, etc.) is usually sufficient. Erect AXR not indicated routinely. Increasing use of CT as a 'catch- all' investigation here. US widely used as a preliminary survey. |
| Palpable mass | AXR (II) | L | L | M | L | Not indicated routinely (C) | |
| Constipation | AXR (II) | L | L | L | L | Not indicated routinely (C) | Many normal adults show extensive faecal material; although this may be related to prolonged transit time it is impossible to assess significance on AXR alone. But AXR can help certain specialists (e.g. geriatricians) in refractory cases. |
| Biliary disease, (e.g. gallstones) | AXR (II) | M | M | M | M | Not indicated routinely (C) | Plain XRs only show about 10 % of gallstones. |
| Pancreatitis: acute | AXR (II) | M | M | M | M | Not indicated routinely (C) | Unless diagnosis in doubt; then AXR needed to exclude other causes of acute abdomen pain (see G19). Some patients presenting with acute pancreatitis have underlying chronic pancreatitis which may cause calcification evident on AXR. |
| Pancreatitis: chronic | AXR (II) | M | M | M | M | Indicated (B) | To show calcification. |

H. Urological, adrenal and genito-urinary systems

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| Hypertension (without evidence of renal disease) | IVU (II) | M | M | M | M | Not indicated routinely (A) | IVU is insensitive for renal artery stenosis. See H3. |
| Renal colic, loin pain | IVU (II) or US (0) and AXR (II) or CT (III) | M | M | M | M | Indicated (B) | Imaging should be performed as an emergency examination whilst the pain is present, as radiological signs disappear rapidly after passage of a stone. Delayed films (up to 24 hrs) may be needed to show the site of obstruction. A plain AXR on its own is of little value. Both CT and US are increasingly being used, especially in those with contraindications to contrast medium. |
| Renal mass | AXR (II) + IVU (II) | M | M | M | M | Not indicated routinely (C) | CT or MRI preferable for further evaluation. NM may be needed to determine relative function. |
| Prostatism | IVU (II) | M | M | M | M | Not indicated routinely (B) | US can also assess upper tract and bladder volumes before and after voiding, preferably with flow rates. It can also show bladder calculi. |
| Urinary retention | IVU (II) | L | L | L | L | Not indicated routinely (C) | US for diagnostics of upper urinary tract (after catheterisation and relief of bladder distension), particularly if urea levels remain raised. |

I. Obstetrics and gynaecology

NB: Transvaginal (TV) US equipment should be available in all departments performing pelvic US

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|---------------------------------------|--------------------|---|---|---|---|-----------------------------|--|
| Lost IUCD | AXR (II) | M | M | ? | M | Not indicated routinely (C) | Unless IUCD is not seen in uterus on US. |
| Suspected cephalopelvic disproportion | XR (II) Pelvimetry | L | L | L | L | Not indicated routinely (B) | The need for pelvimetry is increasingly being questioned. Local policy should be determined in agreement with obstetricians. Furthermore MRI or CT should be used wherever possible. MRI is best as it avoids x-irradiation. CT generally offers a lower dose than standard XR pelvimetry. |

| K. Trauma | | | | | | | |
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| Head: general | | | | | | | |
| Head: low risk of intracranial injury | | | | | | | |
| | | | | | | | |
| <ul style="list-style-type: none"> Fully orientated No amnesia No neurological defects No serious scalp laceration No haematoma | SXR (I) | M | M | M | M | Not indicated routinely (C) | These patients are usually sent home with head injury instructions into the care of a responsible adult. They may be admitted to hospital if no such adult is available. |
| Head: medium-risk of intracranial injury | | | | | | | |
| <ul style="list-style-type: none"> Loss of consciousness or amnesia Violent mechanisms of injury Scalp bruise, swelling or laceration down to bone or > 5 cm Neurological symptoms or signs (including headache, vomiting twice or more, return visit) Inadequate history or examination (epilepsy/alcohol/child/etc .) Child below 5 yrs: suspected NAI, tense fontanelle, fall of more than 60 cm or on to hard surface | CT (II) or | M | M | M | M | Indicated (B) | CT is increasingly being used first and ONLY to exclude cranial injury. If no fracture is seen, patients will usually be sent home with head injury instructions into the care of a responsible adult. If no responsible adult is available or if a fracture is present, the patient will usually be admitted. See Section M (M13) for non-accidental injury in children. MRI of the brain is the preferred investigation for intracranial injuries in NAI, but SXR may still be needed to exclude fractures missed on CT. |
| Head: very high risk of intracranial injury | | | | | | | |
| Nasal trauma | SXR (I) XR facial bones (I), XR nasal bones (I) | H | H | H | H | Not indicated routinely (B) | Unless requested by a specialist. Poor correlation between radiological findings and presence of external deformity. Management of the bruised nose will depend on local policy: usually follow-up at an ENT or maxillo-facial clinic will determine the need for XR. |
| Orbital trauma: blunt injury | XR facial bones (I) | H | H | H | H | Indicated (B) | Especially in those where 'blow-out' injury possible MRI or low dose CT may eventually be required by specialists, especially when XRs or clinical signs equivocal. |
| Orbital trauma: penetrating injury | XR orbits (I) | M | M | H | M | Indicated (C) | When: (1) Radio-opaque intra-ocular FB is a possibility (see A16). (2) Investigation requested by ophthalmologist. (3) Suspicion of damage to orbital walls. |
| Middle third facial injury | XR facial bones (I) | M | M | M | M | Indicated (B) | But patient cooperation essential. Advisable to delay XR in uncooperative patients. In children, XR often unhelpful. |
| Mandibular trauma | XR Mandible (I) or orthopantomogram (OPG) (I) | M | M | M | M | Indicated (C) | For non-traumatic TMJ problems see B11. |
| Cervical spine | | | | | | | |
| Conscious patient with head and/or face injury only | XR C spine (I) | M | M | M | M | Not indicated routinely (B) | In those who meet all of the following criteria: (1) Fully conscious (2) Not intoxicated (3) No abnormal neurological findings. (4) No neck pain or tenderness. |
| Unconscious head injury (see K3/4) | XR C spine (I) | H | H | H | H | Indicated (B) | Must be of good quality to allow accurate evaluation. But radiography may be very difficult in severely traumatised patient and must avoid manipulation (see K11 also K12). |

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| Neck injury: with pain | <i>XR C spine (I)</i> | H | H | H | H | Indicated (B) | Cervical spine XRs can be very difficult to evaluate. Radiography also difficult 1. Must show C7/T1. 2. Should show odontoid peg (not always possible at time of initial study) 3. May need special views, CT or MRI especially when XR equivocal or complex lesions. |
| Neck injury: with neurological deficit | <i>XR (I)</i> | H | H | H | H | Indicated (B) | For orthopaedic assessment. |
| Neck injury: with pain but XR initially normal; suspected ligamentous injury | <i>XR C spine; flexion and extension (I)</i> | M | M | M | M | Specialised investigation (B) | Views taken in flexion and extension (consider fluoroscopy) as achieved by the patient with no assistance and under medical supervision. MRI may be helpful here. |
| Thoracic and lumbar spine | | | | | | | |
| Trauma: no pain, no neurological deficit | <i>XR (II)</i> | M | M | M | M | Not indicated routinely (B) | Physical examination is reliable in this region. If the patient is awake, alert and asymptomatic, the probability of injury is low. |
| Trauma: with pain, no neurological deficit or patient not able to be evaluated | <i>XR painful area (II)</i> | M | M | M | M | Indicated (B) | A low threshold to XR when there is pain/tenderness, after a significant fall, if a high impact RTA or other spinal fracture present or it is not possible to clinically evaluate the patient. Increasing use of CT and MRI here. |
| Trauma: with neurological deficit - pain | <i>XR (II)</i> | M | M | M-H | M | Indicated (B) | |
| Pelvis and sacrum | | | | | | | |
| Fall with inability to bear weight | <i>XR pelvis (I) plus lateral XR hip (I)</i> | M | M | M | M | 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 normal or equivocal. |
| Urethral bleeding and pelvic injury | <i>Retrograde urethrogram (II)</i> | M | M | M | M | Indicated (C) | To show urethral integrity, leak, rupture. Consider cystogram if urethra normal and suspicion of bladder leak. |
| Trauma to coccyx or coccydynia | <i>XR coccyx (I)</i> | M | M | M | M | Not indicated routinely (C) | Normal appearances often misleading and findings do not alter management. |
| Upper limb | | | | | | | |
| Shoulder injury | <i>XR shoulder (I)</i> | M | M | M | M | Indicated (B) | Some dislocations present subtle findings. As a minimum, orthogonal views are required. US, MRI and CT arthrography all have a role in soft tissue injury. |
| Elbow injury | <i>XR elbow (I)</i> | M | M | M | M | Indicated (B) | Indicated in cases of effusion with no obvious fracture' (see also Section M). Increasing use of CT and MRI here. |
| Wrist injury | <i>XR wrist (I) NM (II) or MRI (O)</i> | M | M | M | M | Indicated (B) Specialised investigation (B) | Scaphoid fractures can be invisible at presentation. Most centres repeat XR at 10–14 days if there are strong clinical signs and initial XR negative. Some departments use CT, NM or MRI to exclude fracture earlier than this. Increasing use of MRI as the only examination. |
| Lower limb | | | | | | | |
| Knee injury (fall/blunt trauma) | <i>XR knee (I)</i> | M | M | M | M | Not indicated routinely (B) | Especially where physical signs of injury are minimal. Inability to bear weight or pronounced bony tenderness, particularly at patella and head of fibula, merit radiography. CT/MRI may be needed where further information is required (see D23). |

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| Ankle injury | <i>XR ankle (I)</i> | M | M | M | M | Not indicated routinely (B) | Features which justify XR include age (elderly patients), malleolar tenderness, marked soft tissue swelling and inability to bear weight. |
| Foot injury | <i>XR foot (I)</i> | M | M | M | M | Not indicated routinely (B) | Not indicated unless there is true bony tenderness. Even then the demonstration of a fracture rarely influences management. Only rarely are XRs of foot and ankle indicated together; both will not be done together without good reason. Clinical abnormalities are usually confined to either foot or ankle. |
| Stress fracture | <i>XR (I)</i> | M | M | M | M | Indicated (B) | Although often unrewarding. |
| | <i>NM (II) or MRI (O)</i> | M | M | M | M | Indicated (B) | Provides a means of early detection as well as visual account of the biomechanical properties of the bone. Some centres use US here. |
| Foreign Body (FB) | | | | | | | |
| Soft tissue injury: FB (metal, glass, painted wood) | <i>XR (I)</i> | H | H | H | H | Indicated (B) | All glass is radio-opaque; some paint is radio-opaque. Radiography and interpretation may be difficult; remove blood-stained dressings first. Consider US, especially in areas where radiography difficult. |
| Soft tissue injury: FB (plastic, wood) | <i>XR (I)</i> | M | M | M-H | M | Not indicated routinely (B) | Plastic is not radio-opaque, wood is rarely radio-opaque. |
| Swallowed FB suspected in pharyngeal or upper oesophageal region | <i>XR soft tissues of neck (I)</i> | M | M | M | M | Indicated (C) | After direct examination of oropharynx (where most FBs lodge), and if FB likely to be opaque. Differentiation from calcified cartilage can be difficult. Most fish bones invisible on XR. Maintain a low threshold for laryngoscopy or endoscopy, especially if pain persists after 24 hours (see K33). NB: for possible inhaled FB in children see Section M (M23). |
| Swallowed FB: smooth and small (e.g. coin) | <i>CXR (I)</i> | M | M | M | M | Indicated (B) | The minority of swallowed FBs will be radio-opaque. In children a single, slightly over-exposed, frontal CXR including neck should suffice. In adults, a lateral CXR may be needed in addition if frontal CXR negative. Majority of FBs that impact, do so at crico pharyngeus. If the FB has not passed (say within 6 days), AXR may be useful for localisation. |
| Sharp or potentially poisonous swallowed FB: (e.g. battery) | <i>AXR (II)</i> | M | M | M | M | Indicated (B) | Most swallowed foreign bodies that pass the oesophagus eventually pass through the remainder of the gastrointestinal tract without complication. But location of batteries is important as leakage can be dangerous. |
| Swallowed FB: large object (e.g. dentures) | <i>CXR (I)</i> | M | M | M | M | Indicated (B) | Dentures vary in radio-opacity; most plastic dentures are radiolucent. AXR may be needed if CXR negative, as may barium swallow or endoscopy. Lat CXR may be helpful. |
| Chest | | | | | | | |
| Chest trauma: minor | <i>CXR (I)</i> | M | M | M | M | Not indicated routinely (B) | The demonstration of a rib fracture does not alter management. |
| Chest trauma: moderate | <i>CXR (I)</i> | M | M | M | M | Indicated (B) | Frontal CXR for pneumothorax, fluid or lung contusion. A normal CXR does not exclude aortic injury and arteriography/CT/MRI should be considered. |
| Stab injury | <i>CXR (I)</i> | M | M | M | M | Indicated (C) | PA and/or other views to show pneumothorax, lung damage or fluid. US useful for pleural and pericardial fluid. |

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| Sternal fracture | <i>XR lateral</i> | M | M | M | M | Indicated (C) | Indicated (C) In addition to CXR. Think of thoracic spinal and sternum (I) aortic injuries too. |
| Abdomen (including Supine kidney). Blunt or stab injury | <i>AXR (II) + erect CXR (I)</i> | M | M | M | M | Indicated (B) | US valuable for detecting haematoma and possible injury to some organs, e.g. spleen, liver. CT may be needed (see K40–K42). |
| Major trauma | | | | | | | |
| Major trauma — general screen on unconscious or confused patient | <i>C-spine XR (I), CXR (I), pelvis XR (I),</i> | M | M | M | M | Indicated (B) | Stabilise patient's condition as a priority. Perform only the minimum XRs necessary at initial assessment. C-spine XR can wait as long as spine and cord suitably protected, but CT C-spine may be combined with CT head. Pelvic fractures often associated with major blood loss. See Head Injury K1–K4. |
| Major trauma — abdomen/pelvis | <i>CXR (I), Pelvis XR (I)</i> | M | M | M | M | Indicated (B) | Pneumothorax must be excluded. Pelvic fractures which increase pelvic volume often associated with major blood loss. |
| Major trauma – chest | <i>CXR (I)</i> | M | M | M | M | Indicated (B) | Allows immediate management (e.g. pneumothorax). |
| | <i>CT Chest (III)</i> | M | M | M | M | Indicated (B) | Especially useful to exclude mediastinal haemorrhage. Low threshold for proceeding to arteriography. |
| L. Cancer | | | | | | | |
| Lung | | | | | | | |
| Diagnosis | <i>CXR PA and Lat (I)</i> | M | M | M | M | Indicated (B) | But can be normal, particularly with central tumours. |
| Bladder | | | | | | | |
| Staging | <i>IVU (II)</i> | M | M | M | M | Indicated (B) | To assess kidneys and ureters for further urothelial tumours. |
| Musculoskeletal tumours | | | | | | | |
| Diagnosis | <i>XR (I) +</i> | M | M | M | M | Indicated (B) | Imaging and histology complementary. Best before biopsy: See Musculoskeletal Section D. NM needed to ensure that lesion is solitary. |
| M. Paediatrics | | | | | | | |
| Minimise x-irradiation in children, especially those with long term problems (for head injury in children see Trauma Section K) | | | | | | | |
| CNS | | | | | | | |
| Abnormal head appearance — hydrocephalus — odd sutures | <i>SXR (I)</i> | M | M | M | M | Specialised investigation (C) | US indicated where anterior fontanelle is open. Where sutures are closed/closing. MRI indicated for older children. (CT may be appropriate if MRI not available). |
| Epilepsy | <i>SXR (I)</i> | M | M | M | M | Not indicated routinely (B) | Poor yield. |
| Hydrocephalus —shunt malfunction (see A10) | <i>XR (I)</i> | M | M | M | M | Indicated (B) | XR should include whole valve system. |
| Headaches | <i>SXR (I)</i> | M | M | M | M | Not indicated routinely (B) | If persistent or associated with clinical signs refer for specialised investigations. |
| Sinusitis see also A13 Sinus | <i>XR (I)</i> | M | M | M | M | Not indicated routinely (B) | Not indicated before 5 years as the sinuses are poorly developed; mucosal thickening can be a normal finding in children. A single under-tilted OM view may be more appropriate than the standard OM view depending on the child's age. |

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| Neck and spine — For trauma see Section K | | | | | | | |
| Torticollis without trauma | <i>XR (I)</i> | L | L | L | L | Not indicated | Deformity is usually due to spasm with no significant bone changes. If persistent, further imaging (e.g. CT) may be indicated following consultation. |
| Back or neck pain | <i>XR (I)</i> | L | L | L | L | Indicated (B) | Back pain is uncommon in children without an apparent cause. Follow-up is needed if infection is suspected. |
| Spina bifida occulta | <i>XR (I)</i> | L | L | L | L | Not indicated routinely (B) | A common variation and not in itself significant (even in enuresis). However, neurological signs would require investigation. |
| Hairy patch, sacral dimple | <i>XR (I)</i> | L | L | L | L | Not indicated routinely (B) | May be helpful in older children. |
| Musculoskeletal | | | | | | | |
| Non accidental injury — child abuse (for head injury see Section K) | <i>XR (I) of affected parts</i> | M | M | M | M | Indicated (B) | Local policies will apply; close clinical/radiological liaison essential. Skeletal survey for those under two injury see Section K) years after clinical consultation. May occasionally be required in the older child. CT/MRI of brain may be needed, even in the absence of cranial apparent injury. |
| Limb injury: opposite side for comparison | <i>XR (I)</i> | M | M | L-M | M | Not indicated routinely (B) | Seek radiological advice. |
| Short stature, growth failure | <i>XR (I) for bone age</i> | M | M | M | M | Indicated at appropriate intervals (B) | 2–18 yrs: left (or non-dominant) hand/wrist only. Premature infants and neonates: knee (specialised investigation). May need to be supplemented with a skeletal survey and MRI for hypothalamus and pituitary fossa (specialised investigations). |
| Limp | <i>XR pelvis (I)</i> | M | M | M | M | Indicated (C) | Gonad protection is used routinely unless shields will obscure area of clinical suspicion. If slipped epiphyses is likely, lateral XRs of both hips are needed. |
| Focal bone pain | <i>XR (I)</i> | M | M | M | M | Indicated (B) | XR may be normal initially. US can be helpful particularly in osteomyelitis. |
| Osgood–Schlatter’s disease | <i>XR knee (I)</i> | M | M | M | M | Not indicated routinely (C) | Although bony radiological changes are visible in Osgood–Schlatter’s disease these overlap with normal appearances. Associated soft tissue swelling should be assessed clinically rather than radiographically. |
| Cardiothoracic | | | | | | | |
| Acute chest infection | <i>CXR (I)</i> | M | M | M | M | Not indicated routinely (B) | Initial and follow-up films are indicated in the presence of persisting clinical signs or symptoms or in the severely ill child. Consider the need for CXR in fever of unknown origin. Children may have pneumonia without clinical signs. |
| Recurrent productive cough | <i>CXR (I)</i> | M | M | M | M | Not indicated routinely (C) | Children with recurrent chest infection tend to have normal CXRs (apart from bronchial wall thickening). Routine follow-up CXR not indicated unless collapse present on initial CXR. Suspected cystic fibrosis requires specialist referral. |
| Inhaled FB (suspected) (see Section K) | <i>CXR (I)</i> | M | M | M | M | Indicated (B) | History of inhalation often not clear. Bronchoscopy is indicated, even in the presence of a normal CXR. NM/CT may be helpful to show subtle air trapping. Wide variation in local policy about expiratory films, fluoroscopy, CT and NM (ventilation scintigraphy). |

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| Wheeze | CXR (I) | M | M | M | M | Not indicated routinely (B) | Children with asthma usually have normal CXR apart from bronchial wall thickening. Sudden unexplained wheeze CXR indicated, may be due to inhaled FB (above). |
| Acute stridor | XR neck (I) | M | M | M | M | Not indicated routinely (B) | Epiglottitis is a clinical diagnosis, but consider FB (above). |
| Heart murmur | CXR (I) | M | M | M | M | Not indicated routinely (C) | Specialist referral may be needed; cardiac US often may be indicated. |

Gastrointestinal — see also Section G for more general abdominal problems

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| Intussusception | AXR (II) | M | M | M | M | Indicated (C) | Local policies require close paediatric, radiological and surgical liaison. Where expertise is available, both US and contrast enema (air or barium) can confirm diagnosis and guide reduction. |
| Swallowed FBs (see Section K) | AXR (II) | M | M | M | M | Not indicated routinely (C) | Except for sharp or potentially poisonous FBs, e.g. batteries. See Section K. If there is doubt whether the FB has passed, an AXR after 6 days may be indicated. |
| Minor trauma to abdomen | AXR (II) | M | M | M | M | Not indicated routinely (C) | US may be used as initial investigation but CT is more specific, particularly in visceral trauma. XRs may show bone injury in severe trauma. The principles for the investigation of major trauma in children similar to those in adults (see Major Trauma, K40–K42). |
| Constipation | AXR (II) | M | M | M | M | Not indicated routinely (C) | Many normal children show extensive faecal material; impossible to assess significance of radiological signs. But AXR can help specialists in refractory cases. |

Uroradiology

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| Continuous wetting | IVU (II) | L | L | L | L | Indicated | Both examinations may be needed to evaluate duplex system with ectopic ureter. |
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GLOSSARY

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| TABLE | <i>Classification of the typical effective doses of ionising radiation from common imaging procedures</i> | | | | | | |
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| Class | Typical effective Dose (mSv) | Examples | | | | | |
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| 0 | 0 | US, MRI | | | | | |
| I | <1 | CXR, limb XR, pelvis XR | | | | | |
| II* | 1–5 | IVU, lumbar spine XR, 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. PET) | | | | | |

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

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| Quality Dose Level | | | | | | | |
| L | Low | | | | | | |
| M | Middle | | | | | | |
| H | high | | | | | | |