GUIDELINES ON DIAGNOSTIC IMAGING

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1. INTRODUCTION

Diagnostic imaging is an important aspect of an Emergency Department patient workup. Given the high cost of imaging and the potential of patient harm (e.g. radiation dose, contrast reactions), it is essential that imaging be used judiciously.

Representatives from the Australasian College for Emergency Medicine (ACEM) and the Royal Australian and New Zealand College of Radiologists (RANZCR) formed a working group that developed the following imaging guidelines, using available evidence and best practice.

It is strongly suggested that all Emergency Departments and Radiology Departments make these guidelines available to clinical staff and encourage their use.

Emergency clinicians and radiologists should also be encouraged to discuss cases to determine the best imaging modality and pathway to use for a given presentation, especially for difficult and unusual presentations.
1.1 Incident Reporting

Incident Reporting systems are a critical component of high risk/high reliability organisations. The Radiology Events Register (RaER) is an incident reporting system for Medical Imaging. The aim of RaER is to develop a means of systematic data collection and analysis of incidents in radiology, in order to obtain reliable data to assist quality improvement and increase patient safety. RaER incidents most frequently involve the Emergency Department (ED) by a substantial margin.

To report an incident, go to the RaER website (http://www.raer.org) and click on ‘Report an Incident’. You can then enter the reporting site anonymously. The data entry is intuitive and on average takes about five minutes per incident.

Quality improvement at the ED-ED Imaging interface will benefit significantly from a shared approach to incident reporting and analysis, as well as the formulation of appropriate strategies that reduce the risk of patient harm.

1.2 Other Resources

The guidelines presented here have been developed for use in the Emergency Medicine setting. A source of these guidelines is Diagnostic Imaging Pathways (http://www.imagingpathways.health.wa.gov.au/) which has been developed in Perth and endorsed by RANZCR. The extensive set of DIP guidelines encompasses use in all settings as well as Emergency Medicine.

1.3 Committee Members

Dr Yusuf Nagree, Emergency Physician (Chair)  
Dr Neil Jones, Radiologist  
Dr Carmel Crock, Emergency Physician  
Dr Richard Mendelson, Radiologist  
Dr Kim Hansen, Emergency Physician  
Dr Dinesh Varma, Radiologist
2. GUIDELINES – USE OF DIAGNOSTIC IMAGING FOR CLINICAL DIAGNOSIS

2.1 Adult acute pyelonephritis (AP)

**ADULT ACUTE PYELONEPHRITIS (AP)**

High risk?

- **Safe** (No evidence of obstruction or complication of AP on US)
  - **No**
    - Expectant medical management
  - **Yes**
    - Improving?
      - **Yes**
        - No imaging required
      - **No**
        - **High risk patients:**
          - Single kidney
          - Transplant kidney
          - Immunocompromise
          - Abnormal renal function
          - Diabetes
          - Congenital urinary tract abnormalities
          - Ultrasound urinary tract
          - No evidence of obstruction or complication of AP on US
            - **No**
              - Contrast CT may be indicated
            - **Yes**
              - Obstruction present
                - Urgent urology consult

**Notes:**
- The majority of cases are diagnosed clinically with appropriate confirmatory evidence from laboratory testing.
- Routine imaging is not recommended in uncomplicated acute pyelonephritis.
- If obstruction is suspected, prompt imaging should be undertaken.
2.2 Non traumatic acute right iliac fossa (RIF) or pelvis pain

**Notes:**
- Males 16-40 and females < 16 may not need imaging, but advise early surgical referral.
- Early surgical review is best practice – imaging should not be used as a substitute for review nor used to delay review.
- Causes of acute RIF pain include appendicitis, mesenteric adenitis, inflammatory bowel disease, right sided diverticulitis, omental torsion/infarction, renal colic.
- Causes of acute RIF pain in women include ectopic pregnancy, pelvic Inflammatory disease (PID), ovarian or ovarian cyst complication, rupture/haemorrhage, and endometriosis.
- CT – sensitivity: 76-100%, specificity: 83-97% for appendicitis. Good for obese patients and for identifying alternate diagnoses. May require intravenous and/or oral contrast. Reasonably high radiation dose.
2.3 Child with hip pain

**CHILD WITH HIP PAIN**

- **History and examination**
  - **History of trauma**
    - Suspicion of infection based on FBC, CRP
      - Yes
        - **Suspicion of infection?**
          - No
            - Plain Radiography
              - (AP pelvis and lateral hip views)
            - Imaging normal?
              - Yes
                - **Imaging normal?**
                  - No
                    - **Appropriate treatment based on findings**
                      - Appropriate treatment for cause
                        - Ortho / paeds review
                          - MRI or radio nuclide scanning may be indicated
                      - Abnormal
                        - Orthopaedic review
                          - Normal
                            - Orthopaedic review
                              - Abnormal
                                - **Orthopaedic review**
  - No history of acute trauma

**Notes:**

- **Plain Radiographs**
  - Imaging of choice for older child with no trauma.
  - Slipped capital femoral epiphysis (SCFE) is usually posteromedial and best seen on a frog-leg lateral view.
  - Plain radiography should include both hips.
  - Plain radiography not sensitive in early osteomyelitis.
- **Bone Scans**
  - High sensitivity/specifcity for osteomyelitis (which may be multifocal).
  - Lower sensitivity for septic arthritis and difficult to distinguish septic arthritis & transient synovitis.
  - High ionizing radiation dose.
- **US**
  - Imaging of choice for young children in the absence of trauma.
  - US better for joint effusions.
  - No ionizing radiation.
2.4 Possible cervical spine injury

POSSIBLE CERVICAL SPINE INJURY

Harborview Criteria
(If yes to any, high risk of c-spine injury)
- Presence of significant head injury
- Presence of focal neurological deficit(s)
- Presence of pelvic or multiple extremity fractures
- Combined impact of accident >50km/h
- Death at the scene of the MVA
- Accident involved a fall from a height of 3m or more

NEXUS criteria
(If yes to any, high risk of c-spine injury)
- Posterior midline cervical tenderness
- Evidence of intoxication
- Reduced level of consciousness(GCS ≤ 14)
- Focal neurological deficit
- Painful distracting injuries.

CANADIAN C-SPINE RULE
Any high-risk factor that mandates radiography?
Age ≥ 65 yr or dangerous mechanism or paresthesia in extremities
- Yes
- No

Any low-risk factor that allows safe assessment of range of motion?
Simple rear-end motor vehicle collision or sitting position in the emergency department or ambulatory at any time or delayed (not immediate) onset of neck pain or absence of midline cervical tenderness
- Yes
- No

Imaging Required

Choice between CT or plain film evaluation depends on many factors including:
- risk of a c-spine injury
- age
- the likelihood of obtaining plain film radiography
- CT scanning becomes more cost effective with concomitant head CT scanning

Patients in whom adequate plain film radiography would be difficult to obtain

Abnormal Neurology?

Older patients

Younger Patients

CT scan of other body region indicated (eg. head CT for suspected brain trauma)

CT stat

CT scan of other body region not indicated

CT cervical spine with sagittal and coronal reformatted images

Abnormality seen or inadequate study

Appropriate management depending on findings

Any neurological signs or for preoperative assessment

MRI

Examination of Cervical Spine

Ongoing suspicion of cervical spine injury

Targeted CT cervical spine

Clinical Follow-up

Adequate plain film radiography likely to be obtained

Low risk of c-spine injury

No imaging of C-spine needed

Able to rotate neck actively?
45° left and right

Yes

No

Patients

Abnormality seen

Possible cervical spine injury

Normal

Evaluation of Cervical Spine
2.5 First trimester pregnancy – pain or bleeding

**FIRST TRIMESTER PREGNANCY**

**Pain or Bleeding**

- History, Physical and Speculum Exam
- Ensure that blood group and use of anti-D is considered

**Highly suspicious for ectopic pregnancy?**

- Yes
  - Transabdominal US + Transvaginal (TV) US
- No

**Suspicous for ruptured ectopic pregnancy?**

- Yes
  - Clinical instability
  - Straight to theatre
- No

**FAST available**

- Yes
  - Yes
    - URGENT Obstetrics & Gynaecology discussion
  - No
    - No
      - Suspicous but stable: asap by suitable operator
      - Unstable: go to theatre
      - Low suspicion: within 24 hours
- No

**Suspicious features for ectopic pregnancy:**

- Lateral pelvic pain
- Pain before bleeding

**Risk factors:** previous history, IVF, PID, endometriosis, tubal surgery

**Suspicious features for ruptured ectopic pregnancy:**

- Haemodynamic instability
- Shock

**Timing of ultrasound**

- Suspicious but stable: asap by suitable operator
- Unstable: go to theatre
- Low suspicion: within 24 hours

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**Viable Intra-uterine pregnancy**

- Follow up US as indicated

**Non-viable Intra-uterine pregnancy**

- Refer to Obstetrics and Gynaecology

**Empty gestational sac**

- Gestational sac <25mm and no foetal pole OR foetal pole <7mm and no heartbeat

**Empty gestational sac**

- Gestational sac >25mm or foetal pole >7mm and no heartbeat

**Empty uterus or sac & no foetal pole ± free fluid with adnexal mass**

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**β-hCG < 1500 IU and/or clinically stable?**

- Yes
  - Repeat β-hCG in 48 hrs
  - Repeat US in 1 week
  - Laparoscopy
- No
  - Discuss with Obstetrics. Repeat β-hCG and clinical follow up or Laparoscopy

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**Suspicious features for ectopic pregnancy:**

- Lateral pelvic pain
- Pain before bleeding

**Risk factors:** previous history, IVF, PID, endometriosis, tubal surgery

**Suspicious features for ruptured ectopic pregnancy:**

- Haemodynamic instability
- Shock

**Timing of ultrasound**

- Suspicious but stable: asap by suitable operator
- Unstable: go to theatre
- Low suspicion: within 24 hours

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**β-hCG < 1500 IU and/or clinically stable?**

- Yes
  - Repeat β-hCG in 48 hrs
  - Rise ≥ 66%
  - Rise < 66% or clinical deterioration
- No
  - Repeat US in 1 week
  - Laparoscopy

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**Intra-uterine**

- Be aware of possibility of simultaneous intra-uterine pregnancy and ectopic pregnancy

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**NOTES:**

- Viable Intra-uterine pregnancy
- Non-viable Intra-uterine pregnancy
## 2.6 Adult patient with a headache

**ADULT PATIENT WITH A HEADACHE**

**Meningitis suspected?**
- Yes → **Antibiotics without delay**
- No → **Clinical evidence of raised ICP**

**Clinical evidence of raised ICP**
- No → **CT head**
- Yes → **Lumbar puncture**

**CT head normal?**
- No → **Treat according to results**
- Yes → **Are any of the following suspected?**

**Are any of the following suspected?**
- No → **Significant intracranial pathology unlikely but not excluded**
- Yes → **If ongoing headache - neurology consult**

**Signs of raised ICP**
- Altered mental state
- Papilloedema
- Focal neurology

**Does the patient have any of the following red flag features?**
- Thunderclap headache (See thunderclap headache pathway above)
- New headache in the older population
- New onset headache with history of cancer or immunodeficiency
- Headache with mental state changes
- Headache with focal neurological deficit if not previously documented as a migraine with aura
- Substance abuse with amphetamine or cocaine
- Patient is pregnant or post-partum
- Headache causing wakening from sleep or worsened by Valsalva maneuver
- Progressively worsening headache
- Significant trauma (See head trauma pathway above)
- History of seizures in non-epileptic
- Headache different to usual migraine
- Anti-coagulation (warfarin LMWH, aspirin and clopidogrel)

**Notes:**
- CT – generally initial investigation of choice.
- Carotid or vertebral dissection - Magnetic resonance angiography (MRA) considered investigation of choice.
- Temporal arteritis – limited role of imaging. It is a clinical diagnosis in conjunction with ESR and CRP.
- Trigeminal neuralgia – limited role of imaging. Main use is to detect those with a structural cause (e.g. Demyelinating lesions, mass lesions or ectatic vessel).
- Dural venous sinus thrombosis – variable non specific presentation. Combination of MRI and magnetic resonance venography (MRV) is imaging of choice.
2.7 Adult with a blunt head injury

The Canadian CT Head Rule is a clinical decision rule for adults with a minor head injury, although individual patient factors do need to be taken into account.

**High Risk Head Injury**
- Focal neurological deficit
- Patients on oral anticoagulants or with a bleeding disorder
- Penetrating skull injury
- Obvious depressed skull fracture
- GCS < 13 at any time since injury
- Post-traumatic seizure
- Unstable vital signs with major trauma

**Minor Head Injury**
- Patient with a history of loss of consciousness, amnesia, or disorientation and a GCS of 13 or greater when examined

**Trivial Head Injury**
- No loss of consciousness, no amnesia and no disorientation

**Canadian CT Head Rule**
- High risk (of abnormality requiring neurosurgical intervention)
  - GCS score < 15 at 2h after injury
  - Suspected open or depressed skull fracture
  - Any sign of basal skull fracture (haemotympanum, ‘racoon’ eyes, cerebrospinal fluid otorrhoea/rhinorrhoea, Battle’s sign)
  - Vomiting two or more times
  - Aged 65 or older
- Medium risk (for demonstrating brain injury on CT not requiring neurosurgical intervention)
  - Retrograde amnesia of more than 30 minutes
  - Dangerous mechanism (pedestrian struck by motor vehicle, occupant ejected from motor vehicle, fall from height of more than 3 feet or five stairs)

**Any High Risk Factors**
- Head CT

**Either of the Medium Risk Factors**
- Head CT or close observation depending on resources

**No High or Medium Risk Factors**
- Very low risk for significant intracranial injury
- Head Injury Advice

Notes:
- Canadian CT Head Rules
  - Prospective validation in Canada reported sensitivity of 100%, specificity of 52% for clinically important brain injury. A Dutch study reported sensitivity of 100% for those requiring neurosurgical intervention but sensitivity of 85% for clinically important brain injury.
  - Skull x-rays – rarely used because of the lack of correlation between skull fracture and significant intracranial injury.
  - MRI – superior to CT in identifying diffuse axonal injury but lower sensitivity in detection of acute subarachnoid or parenchymal haemorrhage and skull fracture.

2.8 Suspected adult hip fracture

**SUSPECTED ADULT HIP FRACTURE**

Plain Radiograph (AP Pelvis and lateral hip)

Fracture Seen?

<table>
<thead>
<tr>
<th>Yes</th>
<th>Senior review of X-ray</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>Treat</td>
</tr>
</tbody>
</table>

Fracture seen?

<table>
<thead>
<tr>
<th>Yes</th>
<th>MRI pelvis and hip available?</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>Ongoing suspicion of fracture?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>No</th>
<th>Stop</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>Perform MR</td>
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</tbody>
</table>

Notes:
- MRI has sensitivity & specificity close to 100% for occult fracture. CT widely available but may miss impacted fractures or undisplaced fractures parallel to axial plane (sensitivity = 93%).
- Bone Scan – sensitivity 92%, specificity of 95%. Optimal results if delayed up to 72 hours (early scanning may be associated with false negative results).
2.9 Suspected renal colic

**Notes:**
- CT considered gold standard – sensitivity of 97%, specificity of 98% compared with IVP (69% and 94%). Low radiation dose protocol seems to be as sensitive & specific as regular protocol.
- Limited IVP – not as accurate as CT and not recommended unless CT not available.
- US – low sensitivity (10-50%) but high specificity (90%). In combination with KUB, sensitivity of 79%, specificity of 90%. Stones missed tend to be small (<5mm). Investigation of choice for pregnant women. Not recommended for older patients due to high incidence of non-renal calculi pathology.
- KUB – useful after CT if stone detected in order to determine visibility on KUB to allow stone follow up if clinically indicated.
- Patients presenting with multiple episodes of typical renal colic in whom CT has previously demonstrated calculi may not require CT at each presentation.
2.10 Investigation of a possible subarachnoid haemorrhage

Notes:
- CT – high sensitivity (90%) if performed within 24 hours of haemorrhage but a normal CT does not exclude haemorrhage. Lower sensitivity in small volume bleeds, delayed CT scanning or low haematocrit (<30%).
- Lumbar Puncture – should be delayed at least 6 hours, preferably 12 hours after onset of headache.

3. DATES AND NOTES

Approved by Council: July 2012