This document is part of a set of ten education modules which are aimed at improving the appropriateness of referrals for medical imaging by educating health professionals about the place of imaging in patient care.
# CLINICAL DECISION RULES

As featured in the Educational Modules for Appropriate Imaging Referrals project

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SUSPECTED PULMONARY EMBOLISM
Does this patient with suspected pulmonary embolism need imaging?

Is Pulmonary Embolism Likely (risk > 10%) or Unlikely (risk < 10%)?
Which rule should be applied?

- Is the patient < 50 years?
  - Yes
  - No

  Are you experienced in the use of the Simplified Wells Score?
  - Yes
  - No

Simplified Wells Score

Unlikely (risk < 10%)

Pulmonary Embolism Rule-out Criteria (PERC)
- Age <50 years
- Pulse <100 beats per minute
- $\text{SaO}_2 > 95\%$ on room air
- No haemoptysis
- No exogenous oestrogen use
- No prior venous thromboembolism
- No surgery or trauma requiring hospitalization within the past 4 weeks
- No unilateral leg swelling

Likely (risk > 10%)

Imaging for PE – which test?

- Patient age <55
  - No
  - Yes

- Female
  - No
  - Yes

- No significant suspicion of pathology other than PE
  - No
  - Yes

- Clear chest radiograph
  - No
  - Yes

- Patient cooperative
  - No
  - Yes

- Haemodynamically stable
  - No
  - Yes

VQ scan recommended as first investigation

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Quality and Safety Program

Poster – Overview of PE

Education modules for appropriate imaging referrals – CDR Summaries
The Charlotte Rule

Algorithm:

**Pulmonary Embolism Rule-out Criteria (PERC)**
- Age < 50 years
- Pulse < 100 beats per minute
- \( \text{SaO}_2 > 95\% \) on room air
- No haemoptysis
- No exogenous oestrogen use
- No prior venous thromboembolism
- No surgery or trauma requiring hospitalisation within the past 4 weeks
- No unilateral leg swelling

---

**Applying the Charlotte Rule for PE**

1. **HR / systolic BP > 1 OR Patient age > 50**
   - **YES to EITHER**
   - **NO to BOTH**

2. **Haemoptysis OR**
   - Unexplained hypoxaemia (\( \text{SaO}_2 < 95\% \) breathing air) **OR**
   - Unilateral leg swelling **OR**
   - Surgery requiring general anaesthesia in the preceding 4 weeks

3. **Quantitative Whole Blood D dimer assay**
   - **-ve**
   - **+ve**
   - **NO to ANY**
   - **YES to ANY**

4. **Imaging to exclude PE recommended**

---

*Reported by the patient or observed
**Non-smoker, no clinical evidence or history of asthma, COPD or other cause of hypoxaemia except PE
***Reported by the patient or observed except in the ED
Inclusion Criteria:

- Patients (age limitation not specified) admitted to the emergency department, in whom pulmonary embolism (PE) is suspected.

Exclusions Criteria:

- No clear exclusion criteria described.

Summary Statement:

This decision tool is for patients presenting to the emergency department in whom a board-certified emergency physician has enough suspicion for PE, to order a pulmonary vascular imaging study (either a contrast-enhanced CT scan of the chest or a ventilation-perfusion lung scan [V/Q scan]).

The rule has been extensively validated and safely rules out PE in patients classified as “Safe” or “Low probability” in the presence of a negative result using a sensitive whole blood D dimer assay (sensitivity of at least 90%). Its disadvantage in practice is that use of the Charlotte Rule may result in more patients over age 50 being triaged to imaging rather than D dimer due to the way the rule works than would be the case if the Wells score were used. This may lead to more imaging in this particular age group than if the Simplified Wells Score was used but the Charlotte Rule has the advantage of potentially more reproducible rule criteria and does not require the user to make a subjective judgement about whether PE is more likely than another diagnosis.

Patients who are classified as “unlikely” for PE with the Charlotte Rule, who also have a negative result on a sensitive whole blood D dimer assay, have a probability of PE of 2% or less and thus require no further investigation, such as imaging, to exclude PE.

In addition, the PERC rule may be used with patients identified as “unlikely” to determine those who should have a D dimer test and those who require no further testing for PE.

Reference:

### Wells Score

**Algorithm:**

<table>
<thead>
<tr>
<th>Predictor</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clinical signs and symptoms of DVT (minimum of leg swelling and pain with palpation of deep veins)</td>
<td>+3</td>
</tr>
<tr>
<td>An alternative diagnosis is less likely than PE</td>
<td>+3</td>
</tr>
<tr>
<td>Heart rate greater than 100</td>
<td>+1.5</td>
</tr>
<tr>
<td>Immobilisation at least 3 days or surgery in previous 4 weeks</td>
<td>+1.5</td>
</tr>
<tr>
<td>Previous DVT/PE</td>
<td>+1.5</td>
</tr>
<tr>
<td>Haemoptysis</td>
<td>+1</td>
</tr>
<tr>
<td>Malignancy</td>
<td>+1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>/12.5</td>
</tr>
</tbody>
</table>

**Risk of PE**

<table>
<thead>
<tr>
<th>Associated Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low (3% risk of PE)</td>
</tr>
<tr>
<td>Moderate (28%)</td>
</tr>
<tr>
<td>High (78%)</td>
</tr>
</tbody>
</table>

**Risk of PE**

<table>
<thead>
<tr>
<th>Associated Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unlikely (5.1-7.8% rate of PE)</td>
</tr>
<tr>
<td>Likely (~40%)</td>
</tr>
</tbody>
</table>
Inclusion Criteria:
(Unless ALL are satisfied, the Wells Score cannot be applied to assess the pre-test probability of PE)

- Inpatients or outpatients with clinical suspicion for PE
- Symptoms for < 30 days

Exclusion Criteria:
(If ANY these are satisfied, the Wells Score cannot be applied to assess the pre-test probability of PE)

- Suspected upper extremity DVT as source of PE
- No symptoms of PE for more than 3 days before presentation
- Use of anticoagulation for more than 72hrs
- Expected survival <3 months
- Contraindication to contrast media
- Pregnancy

Summary Statement:
Based on the primary derivation study, a Wells Score of ≤4 and a negative whole blood D dimer assay result is associated with a sufficiently low probability of PE that anticoagulation is not required and an alternative diagnosis should be sought.

In addition, the PERC rule may be used with patients with a score of ≤4 to determine who should have a D dimer and who require no further testing for PE.

Reference:
Simplified Wells Score

Algorithm:

**Applying the Simplified Wells Score for PE**

**Inclusion Criteria:**
- Inpatients and outpatients with clinically suspected PE
- Adult (>18yrs)

**Exclusion Criteria:**
- Received low-molecular weight heparin for >24hrs
- Pregnant
- Known hypersensitivity for iodinated contrast media or renal failure
- Life expectancy <3 months

**Simplified Wells Score**
- Clinical signs and symptoms of DVT (minimum of leg swelling and pain elicited upon palpation of deep veins) 1
- No alternative diagnosis more likely than PE 1
- Heart rate >100 1
- Immobilization at least 3 days, or surgery in previous 4 weeks 1
- Previous DVT or PE 1
- Haemoptysis 1
- Malignancy (on treatment, treated in last 6 months or palliative) 1

**Pulmonary Embolism Rule-out Criteria (PERC)**
- Age <50 years
- Pulse <100 beats per minute
- SaO₂ >95% on room air
- No haemoptysis
- No exogenous oestrogen use
- No prior venous thromboembolism
- No surgery or trauma requiring hospitalisation within the past 4 weeks
- No unilateral leg swelling

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Inclusion Criteria:
- Inpatients and outpatients with clinically suspected PE
- Adult (>18yrs)

Exclusion Criteria:
- Received low-molecular weight heparin for >24hrs
- Pregnant
- Known hypersensitivity for iodinated contrast media or renal failure
- Life expectancy <3 months

Summary Statement:
This is a large study based on the Wells Score. It creates a simplified version of the Wells rule that is easier to follow and should be easier to apply in clinical situations. It is also a larger external validation of the Wells Score. It may be applied in adult inpatient and outpatients with confidence. The study found that using the Simplified Wells Score, a patient with a score of ≤1 and a negative D dimer has an extremely low probability of PE and an alternative diagnosis should be sought.

In addition, the PERC rule may be used with patients with a score of ≤1 to determine who should have a D dimer and who require no further testing for PE.

Reference:
Pulmonary Embolism Rule Out Criteria (PERC)

Algorithm:

Pulmonary Embolism Rule-out Criteria (PERC)
- Age <50 years
- Pulse <100 beats per minute
- SaO₂ >95% on room air
- No haemoptysis
- No exogenous oestrogen use
- No prior venous thromboembolism
- No surgery or trauma requiring hospitalisation within the past 4 weeks
- No unilateral leg swelling

Patients at low or very-low risk of PE (the population for whom the rule is intended), who meet the rule criteria (i.e. answer YES to the 8 clinical variables), are deemed PERC negative.

The authors found that PERC negative patients have a probability of PE <1.8%, and hence, are safe to have PE excluded without further diagnostic testing, since the post-test probability of PE after a negative VQ scan is greater than 1.8%
Inclusions:

• Patients presenting to the ED with clinical suspicion of PE (board-certified emergency physician felt a formal evaluation for pulmonary embolism was necessary).

Exclusions:

• No clear exclusion criteria described

Summary Statement:

The Pulmonary Embolism Rule-out Criteria (PERC) score has undergone extensive validation and can be used for adult patients presenting to the emergency department with a sole or primary complaint of shortness of breath and low clinical suspicion of PE. When all 8 predictors that comprise the rule are positive, further diagnostic testing for PE is not required since the post-test probability of PE is below the test threshold of 1.8%. In PERC(-) patients, the rule has a sensitivity of 96% (90-99%), specificity of 27% (25-30%), false negative rate of 1.4% (0.5-3.0%) and a LR- of 0.015. In a very low risk PERC(-) population, the rule performs better still; with sensitivity 100% (96-97.5%), specificity of 15% (11-18%) and LR- of 0.067. It has not been validated, and therefore should not be used in patients with high or intermediate probability of PE.

The PERC rule has been externally validated in a number of studies, including a systematic review and meta-analysis. The systematic review and meta-analysis by Singh et al in 2012, concluded that their pooled analysis strongly corroborates the safety of using PERC to avoid D dimer testing, reflected in the results of existing literature suggesting consistently high sensitivity and low but acceptable specificity of the PERC rule. However, an impact analysis by Kline et al (2002) suggests that while just over one fifth of surveyed clinicians are electing to use the rule in eligible patients in clinical practice, only 5% of these document the rule without missing any components. This underlines the importance of referring to an electronic or hard copy when you use a CDR to remind you of the elements and the inclusion/exclusion criteria.

Reference:

SUSPECTED LOWER LIMB DEEP VEIN THROMBOSIS
Wells Score for DVT

Algorithm:

Applying the Wells Score for DVT

Inclusion Criteria:
- Ambulatory adult patients (>18 yrs) with suspected DVT

Exclusion Criteria:
- Suspected PE
- Life expectancy <3 months
- Current anticoagulant therapy (INR >2.0 or treatment doses of LMWH) for more than 48 hrs
- Symptoms had resolved for more than 72 hrs prior to presentation

WELLS SCORE
Active cancer (patient receiving treatment for cancer within the previous 6 months or currently receiving palliative treatment) +1
Paralysis, paresis, or recent plaster immobilization of the lower extremities +1
Recently bedridden for 3 days or more, or major surgery within the previous 12 weeks requiring general or regional anaesthesia +1
Localized tenderness along the distribution of the deep venous system +1
 Entire leg swollen +1
Calf swelling at least 3 cm larger than that on the asymptomatic side (measured 10 cm below tibial tuberosity) +1
Pitting oedema confined to the symptomatic leg +1
Collateral superficial veins (non-varicose) +1
Previously documented deep-vein thrombosis +1
Alternative diagnosis at least as likely as deep-vein thrombosis -2

≥2 “DVT likely”

<2 “DVT unlikely”

Ultrasound

No further investigation to exclude DVT
Quantitative Whole Blood D dimer assay

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Inclusion Criteria:
- Ambulatory adult patients (>18yrs)
- With suspected DVT

Exclusion Criteria:
- Suspected PE
- Life expectancy <3 months
- Current anticoagulant therapy (INR>2.0 or treatment doses of LMWH) for more than 48 hrs
- Symptoms have resolved for more than 72 hrs prior to presentation.

Summary statement:
This study established that in ambulatory outpatients with suspected lower limb DVT and a well score of less than 2, it is safe to exclude DVT by performing a d dimer assay which, if negative, obviates the need for imaging to exclude DVT. The lower limit of the negative predictive value of the combination of a score <2 and negative d dimer was found to be 96.7%, making it very comparable with the negative predictive value of a normal ventilation perfusion lung scan in a patient with suspected pulmonary embolism. It has been extensively validated by investigators apart from those who developed it.

Reference:
ACUTE LOW BACK PAIN
Imaging decision flow chart for Acute Low Back Pain

Major risk factors for cancer
- new onset of low back pain with history of cancer

Risk factors for (or signs of) cauda equina syndrome
- new urine retention
- faecal incontinence
- saddle anaesthesia

Risk factors for vertebral fracture
- use of corticosteroids
- significant trauma
- older age (>70 yrs)
- female gender

With a pre-test probability of 0.5%
the post-test probability of spinal fracture is:
1 positive feature: 1%
2 positive features: 7%
≥3 positive features: 52%

Risk factors for or symptoms of spinal stenosis
in patients who are candidates for surgery
- radiating leg pain
- older age
- pseudosclerotic

Risk factor(s) for spinal infection
- new onset of low back pain in the presence of risk factors:
  - fever
  - history of intravenous drug use, recent infection, or recent invasive procedure
  - elevated CRP or WBC count
  - high clinical suspicion in an at-risk patient

Severe neurologic deficits
- progressive motor weakness
- motor deficits at multiple neurologic levels

Overview
- Defer MRI after a trial of therapy
- Plain radiography
  - If negative and persistent clinical suspicion then MRI
- Defer imaging after a trial of therapy
  - Magnetic resonance imaging
- No imaging

No criteria for immediate imaging and back pain improves or resolved after a 1-month trial of therapy

Previous spinal imaging with no change in clinical status.

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Acute Low Back Pain (ALBP) due to Malignancy

Algorithm:

<table>
<thead>
<tr>
<th>Clinical feature</th>
<th>Post-test probability (%)</th>
<th>Pre-test probability 1%</th>
<th>Pre-test probability 5%</th>
</tr>
</thead>
<tbody>
<tr>
<td>No relief with bed rest</td>
<td></td>
<td>1.7</td>
<td>8.3</td>
</tr>
<tr>
<td>Age ≥ 50</td>
<td></td>
<td>2.2</td>
<td>10.4</td>
</tr>
<tr>
<td>Duration of pain &gt; 1 month</td>
<td></td>
<td>2.5</td>
<td>12.1</td>
</tr>
<tr>
<td>Not improved after 1 month</td>
<td></td>
<td>2.9</td>
<td>13.7</td>
</tr>
<tr>
<td>Previous history of cancer</td>
<td></td>
<td>19.2</td>
<td>55.7</td>
</tr>
<tr>
<td>Laboratory test result</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anaemia</td>
<td></td>
<td>3.8</td>
<td>17.1</td>
</tr>
<tr>
<td>WBC* ≥ 12,000</td>
<td></td>
<td>3.9</td>
<td>17.9</td>
</tr>
<tr>
<td>Haematocrit &lt; 30%</td>
<td></td>
<td>15.4</td>
<td>49.1</td>
</tr>
<tr>
<td>ESR† ≥ 20 mm/h</td>
<td></td>
<td>2.3</td>
<td>10.9</td>
</tr>
<tr>
<td>ESR ≥ 50 mm/h</td>
<td></td>
<td>15.3</td>
<td>48.8</td>
</tr>
<tr>
<td>ESR ≥ 100 mm/h</td>
<td></td>
<td>35.7</td>
<td>74.7</td>
</tr>
<tr>
<td>Positive clinician judgement</td>
<td></td>
<td>10.8</td>
<td>39.1</td>
</tr>
<tr>
<td>Age ≥ 50 or unexpected weight loss or previous history of cancer or failure to improve over 1 month</td>
<td></td>
<td>2.3</td>
<td>11.3</td>
</tr>
</tbody>
</table>

Changes in the probability of cancer with a positive response to each red flag. Analysis is conducted for pre-test probabilities of 1 and 5%

*WBC white blood cell count
†ESR erythrocyte sedimentation rate
Inclusions:
- Adults (>18 years)
- Consulted health practitioner about acute low back pain

Exclusions:
None

Summary Statement:
A Cochrane Diagnostic Test Accuracy review by Henschke et al in 2013 evaluated clinical risk factors associated with the presence of malignancy in 8 studies enrolling a total of 7,361 patients. The review found that overall the reporting of methodology of the eight studies included in the review was poor and the quality of the included studies low, based on evaluation of study methodology with the QUADAS tool which is used for quality appraisal of studies of diagnostic accuracy. However, the review identified some risk factors as having high positive likelihood ratios (but poor sensitivity) for the identification of patients who had a malignant cause for their ALBP (for full table refer back to the Acute Low Back Pain Module).

The data shows that cancer is rare in patients presenting to primary care with low back pain and that most red flags are uninformative because they do not meaningfully increase the probability of cancer when present. The exception is a previous history of cancer.

Unfortunately it was not possible to determine whether a combination of the risk factors would have identified these patients with greater sensitivity because this was not evaluated within the studies.

Therefore, while the presence of any one of these risk factors should certainly alert the clinician to the increased risk of malignancy as the cause for an ALBP presentation, and thus the need for further investigations (including imaging), the absence of all of these risk factors is not necessarily good evidence that malignancy is not the cause of the ALBP based on this systematic review.

Reference:
Acute Low Back Pain (ALBP) due to Fracture

Algorithm:

<table>
<thead>
<tr>
<th>Red flag question</th>
<th>No. (%) red flag positive</th>
<th>Sensitivity, (%)</th>
<th>Specificity, (%)</th>
<th>Positive LR (95% CI)</th>
<th>Negative LR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age &gt;70 years</td>
<td>56 (4.8)</td>
<td>50</td>
<td>96</td>
<td>11.19 (4.65-19.48)</td>
<td>0.52 (0.23-0.82)</td>
</tr>
<tr>
<td>Significant trauma (major in young, minor in elderly)</td>
<td>31 (2.6)</td>
<td>25</td>
<td>98</td>
<td>10.03 (2.76-26.36)</td>
<td>0.77 (0.42-0.95)</td>
</tr>
<tr>
<td>Prolonged use of corticosteroids</td>
<td>8 (0.7)</td>
<td>25</td>
<td>100</td>
<td>48.50 (11.62-165.22)</td>
<td>0.75 (0.41-0.93)</td>
</tr>
<tr>
<td>Sensory level (altered sensation from trunk down)</td>
<td>19 (1.6)</td>
<td>0</td>
<td>98</td>
<td>0.00 (0.00-21.01)</td>
<td>1.02 (1.02-1.03)</td>
</tr>
<tr>
<td>Clinical diagnosis of fracture</td>
<td>7 (0.6)</td>
<td>50</td>
<td>100</td>
<td>194.00 (52.10-653.61)</td>
<td>0.50 (0.22-0.79)</td>
</tr>
</tbody>
</table>

* LR = likelihood; 95% CI = 95% confidence interval.

Diagnostic rule to identify vertebral fracture*

<table>
<thead>
<tr>
<th>Criteria for a positive test</th>
<th>1 positive feature</th>
<th>2 positive features</th>
<th>≥3 positive features</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensitivity, %</td>
<td>88</td>
<td>63</td>
<td>38</td>
</tr>
<tr>
<td>Specificity, %</td>
<td>50</td>
<td>96</td>
<td>100</td>
</tr>
<tr>
<td>Positive LR (95% CI)</td>
<td>1.8 (1.1-2.0)</td>
<td>15.5 (7.2-24.6)</td>
<td>218.3 (45.6-953.8)</td>
</tr>
</tbody>
</table>

Post-test probability of vertebral fracture, (%)

<table>
<thead>
<tr>
<th>Pre-test probability 0.5%</th>
<th>1</th>
<th>7</th>
<th>52</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-test probability 3%</td>
<td>5</td>
<td>32</td>
<td>87</td>
</tr>
</tbody>
</table>

* Four features were included in the rule: female sex, age >70 years, significant trauma (major in young patients, minor in elderly patients), and prolonged use of corticosteroids.

LR = likelihood ratio; 95% CI = 95% confidence interval.
Inclusions:
- Adults (>18 years); AND
- Patients presenting to primary care practitioners about acute low back pain

Exclusions:
None

Summary Statement:
Henschke et al studied adults with ALBP drawn from 170 Australian primary care practitioners (including 73 general medical practitioners, 77 physiotherapists, and 30 chiropractors). This study attempted to create CDRs that would help primary care practitioners identify patients at increased risk of one of the five “serious” causes of ALBP. However, due to the very low prevalence of these five conditions in a primary care patient cohort, valid information only about risk factors for spinal fracture was obtained. The following clinical findings were associated with vertebral fracture:
1. Prolonged use of corticosteroids
2. Age > 70
3. Trauma involving the lower back (minor in the elderly, major in the young)
4. Female gender

When at least 1 of these features was positive, the positive LR was 1.8 (95% CI 1.1–2.0). With at least 2 positive features, the positive LR increased to 15.5 (95% CI 7.2–24.6), and with 3 positive features it increased to 218.3 (95% CI 45.6–953.8). If we presume a pre-test probability of vertebral fracture of ~1% you can use a nomogram to see that it is only when two or more of the features are present that the post-test probability becomes sufficiently high to consider imaging on the initial presentation. When only one feature is present and the pre-test probability is ~1% the post-test probability only rises to ~2%.

This decision tool requires validation in another general practice population and may not be applicable to emergency department and hospital patients.

This list of risk factors represents a type of CDR. In the 8 patients in this study who had fractures as the cause for their low back pain, 1 of the 8 (12.5%) had none of the 4 risk factors. This CDR is a helpful guide in identifying patients who are at greater than average risk of spinal fracture as the cause of their ALBP. However, some caution needs to be exercised when using this CDR in practice for the following reasons:
1. The CDR (comprised of these risk factors) remains to be externally validated.
2. It is unclear whether the elements of the CDR would work just as well in a hospital inpatient or emergency department population.
3. Finally, it is important to note that 1 of the 8 patients with a final diagnosis of spinal fracture did not have any of the 4 clinical features listed above. Hence, it may be that the presence of risk factors other than those evaluated by the study would improve the sensitivity of the CDR.

Reference:
ADULT CERVICAL SPINE TRAUMA
Overview

Does this patient with cervical spine trauma need any imaging?

For patients who satisfy ALL INCLUSION criteria and who have NO EXCLUSION criteria for the Canadian C Spine rule, this should be used in preference to NEXUS due to its higher specificity. Use NEXUS when Canadian C Spine rule cannot be applied.

Canadian C-Spine Rule Inclusion Criteria:
- Adults (defined as ≥ 16 years of age); AND
- Acute trauma to the head or neck; AND
- Stable (i.e. normal vital signs as per Revised Trauma Score); AND
- Alert (GCS ≥ 15); AND
- Injury within previous 48 hours; AND EITHER
  - Neck pain; OR
  - No neck pain but meet the following criteria:
    - Visible injury above the clavicles; AND
    - Non-ambulatory; AND
    - Dangerous mechanism of injury

If the patient:
- Has no penetrating injury,
- And has presented within 48 hours of the traumatic event,
- And can have all 5 NEXUS criteria accurately assessed

NEXUS Criteria:
- Does this patient report mid-line tenderness?
- Is there a change in level of alertness?
- Are there any neurological deficits present?
- Is there evidence of intoxication?
- Are there any painful, distracting injuries present?

IF plain radiography is inadequate, equivocally abnormal or abnormal

Perform CT

Imaging Required:
PERFORM 5 VIEW RADIOGRAPHY
Interpreted by a Radiologist

CT recommended
unless the patient is pregnant when consideration of 5 view plain radiography first is recommended

Use Canadian C-Spine Rule to determine if imaging is required

Any high-risk factor that mandates radiography?
- Age ≥ 65 or
- "Dangerous mechanism or
- Paraesthesia in extremities

Any low-risk factor that allows safe assessment of range of movement?
- Simple rear-end MVC Or
- Sitting position in ED Or
- Ambulatory at any time Or
- Delayed onset of neck pain Or
- Absence of midline c-spine tenderness

NO to all

Able to actively rotate neck?
- → 45° left and right

IMAGING NOT RECOMMENDED

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Notes

*Simple facial lacerations

^Dangerous mechanism:
- Fall from ≥ 1 metre / 5 stairs
- Axial load to head, eg diving
- MVC high speed (≥ 100 km/hr), rollover, ejection
- Motorised recreational vehicle
- Bicycle collision

¥Delayed:
- Not immediate onset of neck pain

§Simple rear-end MVC excludes
- Pushed into oncoming traffic
- Hit by bus / large truck
- Rollover
- Hit by high speed vehicle
The Canadian C-Spine Rule

Algorithm:

**Inclusion Criteria:**
- Adults (defined as ≥16 years of age); AND
- Acute trauma to the head or neck; AND
- Stable (i.e. normal vital signs as per Revised Trauma Score); AND
- Alert (GCS = 15); AND
- Injury within previous 48 hours; AND EITHER
  - Neck pain; OR
  - No neck pain but meet the following criteria:
    - Visible injury above the clavicles; AND
    - Non-ambulatory; AND
    - Dangerous mechanism of injury*

**Exclusion Criteria:**
- Trivial injuries (e.g. Simple facial lacerations) and did not fulfill the “at risk” inclusion criteria;
- Penetrating trauma;
- Presented with acute paralysis;
- Known vertebral disease (e.g. ankylosing spondylitis, rheumatoid arthritis, spinal stenosis, or previous cervical surgery) as determined by the examining physician;
- Returned to ED for reassessment of same injury;
- Pregnancy.

---

**IMAGING RECOMMENDED**

1. Any high-risk factor that mandates radiography?
   - Age ≥ 65
   - *Dangerous mechanism* OR
   - Paraesthesia in extremities

2. Any low-risk factor that allows safe assessment of range of movement?
   - Simple rear-end MVC
   - Sitting position in ED
   - Ambulatory at any time
   - Delayed onset of neck pain
   - Absence of midline c-spine tenderness

3. Able to actively rotate neck?
   - 45° left and right

**IMAGING NOT RECOMMENDED**

*Dangerous mechanism:
- Fall from ≥1 metre / 5 stairs
- Axial load to head, e.g. diving
- MVC high speed (≥100 km/hr), rollover, ejection
- Motorised recreational vehicle
- Bicycle collision

Simple rear-end MVC excludes
- Pushed into oncoming traffic
- Hit by bus / large truck
- Rollover
- Hit by high speed vehicle

Delayed:
- Not immediate onset of neck pain
Inclusion Criteria:
- Adults (defined as >16 years of age); and
- Acute trauma to the head or neck; and
- Stable (i.e. normal vital signs as per Revised Trauma Score); and
- Alert (GCS = 15); and
- Injury within previous 48 hours.
  - Neck pain: OR
  - No neck pain but met the following criteria:
    - Visible injury above the clavicles; OR
    - Non-ambulatory; OR
    - Dangerous mechanism of injury.
- Neck pain: OR
- No neck pain but met the following criteria:
  - Visible injury above the clavicles; OR
  - Non-ambulatory; OR
  - Dangerous mechanism of injury.

Exclusion Criteria:
- Trivial injuries (e.g. Simple facial lacerations) and did not fulfil the “at risk” inclusion criteria;
- Penetrating trauma;
- Presented with acute paralysis;
- Known vertebral disease (e.g. ankylosing spondylitis, rheumatoid arthritis, spinal stenosis, -or previous cervical surgery) as determined by the examining physician;
- Returned to ED for reassessment of same injury;
- Pregnancy.

Summary Statement:
The Canadian C-Spine Rule (CCR) evolved from a landmark study aimed at unifying the approach to emergency department decision-making in cervical spine assessment for alert and stable patients, to identify ‘clinically important’ cervical spine injury defined as:

“any fracture, dislocation or ligamentous instability evident on radiographic imaging except isolated injuries including osteophytic avulsion fracture, transverse process fracture exclusive of the facet, and spinous process fracture exclusive of the lamina, in neurologically intact patients”.

The authors reported the proportion of patients with clinically important injury as 1.7%, with 0.3% of patients identified as having clinically unimportant injury. A reduction in the ordering of cervical spine imaging by 15.5% occurred during the study. The sensitivity of the CCR was reported as 100% (95% CI: 98-100) and the specificity as 42.5% (95% CI: 40-44).

Following this study, the CCR was also found to be valid and effective when used in the pre-hospital setting by paramedics and in the emergency department when used by nursing staff. The CCR has consistently been found to have a sensitivity of > 99% and therefore it is unlikely that a serious cervical spine injury will be missed. Specificity has been found to range between 0.01 and 0.77. Only one direct comparison of the CCR and NEXUS has been completed. Based on this study the CCR should be recommend for use over the NEXUS as it is a more sensitive and specific rule.

References:
National Emergency X-Radiography Utilization Study (Nexus)

Algorithm:

Adult NEXUS

Inclusion Criteria:
- Patients presenting to the emergency department with blunt trauma to the cervical spine

NO → Exclude

YES → Exclusion Criteria:
- Penetrating trauma
- Remote Trauma (>48 hours before presentation)
- Insufficient information obtained to correctly apply NEXUS criteria

YES to ANY → Exclude

NO to ALL →

Does this patient report mid-line tenderness?

YES → NON-LOW RISK:
IMAGING
RECOMMENDED

NO

Is there a change in level of alertness?

YES → NON-LOW RISK:
IMAGING
RECOMMENDED

NO

Are there any neurological deficits present?

YES → NON-LOW RISK:
IMAGING
RECOMMENDED

NO

Is there evidence of intoxication?

YES → NON-LOW RISK:
IMAGING
RECOMMENDED

NO

Are there any painful, distracting injuries present?

YES

LOW RISK
IMAGING NOT RECOMMENDED

NO
Inclusion Criteria:

- Patients presenting to the emergency department with blunt trauma to the cervical spine.

Exclusion Criteria:

- Penetrating trauma.
- Remote Trauma (>48 hours before presentation).
- Insufficient information obtained to correctly apply NEXUS criteria.

Summary Statement:

In 2000, Hoffman et al published the results of a large multicentre prospective observational study that enrolled 34,069 patients from 21 hospitals who presented to the emergency department with cervical spine symptoms following blunt trauma. These findings established the validity of the NEXUS criteria, a set of five clinical assessment items to identify patients at very low risk of cervical spine injury. Patients were considered to be at low risk of cervical spine injury if all of the criteria were fulfilled, in which case, clinical clearance of the cervical spine could occur without radiographic imaging.

The outcome measure of this study was ‘clinically significant injury,’ which the authors defined as:

“any injury except isolated injury in the absence of associated bony, ligamentous or spinal cord injury which would be unlikely to result in harm to the patient if undetected”.

Such insignificant minor injuries were categorised as fracture of the spinous or transverse process, endplate or trabecular bone; osteophyte fracture exclusive of corner or teardrop configuration; vertebral body compression fracture with less than 25% loss of height; Anderson and D’Alonzo Type I odontoid process fracture, and avulsion without ligamentous involvement.

The main limitations of NEXUS include the lack of precise definitions of the five criteria which may result in significant variability in the application of the tool. Whilst the definition of altered mental status is generally accepted to be a Glasgow Coma Scale (GCS) score of less than 15, the interpretation of intoxication and painful distracting injury may vary considerably between emergency medicine physicians who are unfamiliar with how these were originally defined in the derivation study.

Reference:

ADULT HEAD TRAUMA
The Canadian CT Head Rule

Algorithm:

**Exclusion Criteria?** For use in patients with:
- Blunt trauma to the head resulting in one or more of the following:
  - Witnessed loss of consciousness; or
  - Witnessed disorientation (no matter how brief, as reported by the patient or witness)
- Initial emergency department GCS score of 13, 14 or 15 as determined by the treating physician

**Inclusion Criteria: For use in patients with:**
- Blunt head trauma, do not use CCHR if ANY of the following apply:
  - Emergency department GCS score less than 13
  - An obvious penetrating skull injury or obvious depressed skull fracture
  - Unstable vital signs associated with major trauma
  - Focal neurological deficit
  - Seizure prior to assessment in ED
  - Bleeding disorder or use of oral anticoagulants
  - Pregnant
  - Age less than 16 years old
  - Minimal head injury (i.e. loss of consciousness, or disorientation)

**Decision to perform cranial imaging (CT or MRI) should be based on clinical judgement:**
- No clear history of trauma as the primary event
- Head injury occurred more than 24 hours previously

**IMAGING NOT RECOMMENDED**
- Patients with no high risk criteria and one or more medium risk criteria may not require CT if they can be monitored for a period (may be considered at the discretion of the managing medical practitioner).

**IMAGING RECOMMENDED**
- CT should be performed due to the higher likelihood of clinically important intracranial injury

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Summary Statement:
The Canadian CT Head Rule (CCHR) is a widely validated CDR for use in the emergency department for patients with minor head injury to identify clinically important brain injuries on CT scan that may require neurosurgical intervention. It has 5 high-risk clinical factors that, if any are present, indicate a substantial risk that the patient will require neurosurgical intervention. An additional 2 medium-risk factors can be used to determine if the patient has a risk of clinically important lesions on CT that would not require neurosurgical intervention.

Inclusion Criteria:
- Blunt trauma to the head resulting in **witnessed loss of consciousness, definite amnesia, or witnessed disorientation** (no matter how brief, as reported by the patient or witness)
- **Initial** emergency department **GCS score of 13, 14 or 15** as determined by the treating physician
- Injury within the **previous 24 hours**

Exclusion Criteria:
If you answer ‘Yes’ to all of the inclusion criteria, then ask yourself does your patient have any exclusion criterion that would prevent the rule being applied to them?
- Age less than 16 years old (other clinical decision rules such as PECARN are available for use in people under 16 – see Paediatric Head Trauma Module for more details)
- **Emergency department GCS score less than 13**
- Minimal head injury (i.e. no loss of consciousness, amnesia, or disorientation)
- No clear history of trauma as the primary event
- Head injury occurred more than 24 hours previously
- **An obvious penetrating skull injury or obvious depressed skull fracture**
- **Focal neurological deficit**
- **Unstable vital signs associated with major trauma**
- **Seizure prior to assessment in ED**
- **Bleeding disorder or use of oral anticoagulants**
- Returned for assessment of the same injury
- Pregnant

For patients with any of the **exclusion criteria in bold, CT should be performed** due to the higher likelihood of clinically important intracranial injury.

Reference:
ACUTE ANKLE TRAUMA IN ADULTS
Ottawa Ankle Rules

Algorithm:

Applying the Ottawa Ankles Rules for patients aged over 18 years

*Does a patient presenting with acute ankle or foot trauma pain require x-rays of the foot or ankle?*

**Inclusion criteria**

Patients presenting with acute blunt injuries of the ankle (e.g. twisting injuries, falls from height, direct blows and motor vehicle accidents)

- NO → Exclude

- YES

**Exclusion criteria**

Is/does/has the patient:

- Pregnant?
- Have isolated injuries of the skin (superficial lacerations, abrasions or burns)?
- Returning for reassessment of the same ankle injury?
- Suffered the injury more than ten days earlier?

- YES to ANY → Exclude

- NO to ALL

**STEP ONE:** Is there any pain in the malleolar zone and any of these findings?:

1. Bone tenderness at A
2. Bone tenderness at B
3. Inability to bear weight both immediately and in the emergency department

- NO to ALL → IMAGING NOT RECOMMENDED

**STEP TWO:** Is there any pain in the mid-foot zone and any of these findings?:

1. Bone tenderness at C
2. Bone tenderness at D
3. Inability to bear weight both immediately and in the emergency department

- NO to ALL

**Definitions:**

- **The malleolar zone**
  - Posterior aspect of the distal 6 cm of the tibia (medial malleolus)
  - Posterior aspect of the distal 6 cm of the fibula (lateral malleolus)

- **The midfoot zone**
  - navicular
  - cuboid
  - cuneiforms
  - anterior process of the calcaneus
  - the base of the fifth metatarsal

- **NOTE:** Does not include fractures of the body and tuberosity of the calcaneus

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Inclusion Criteria:
All patients presenting with acute blunt injuries of the ankle (e.g. twisting injuries, falls from height, direct blows and motor vehicle accidents), where ankle was broadly defined to include the area involved in common twisting injuries and was subdivided into 2 zones that require assessment by a standard ankle radiographic series (malleolar area) and a standard foot radiographic series (the midfoot):

- The malleolar area: distal 6 cm of tibia, distal 6 cm of fibula, and talus; AND
- The midfoot: navicular, cuboid, cuneiforms, anterior process of the calcaneus, and the base of the fifth metatarsal. The body and tuberosity of the calcaneus were not included in this definition.

Exclusion Criteria:
- Age under 18 years old
- Pregnancy
- Isolated injuries of the skin (superficial lacerations, abrasions or burns)
- Returning for reassessment of the same ankle injury
- Suffered the injury more than ten days earlier

Summary Statement:
The Ottawa Ankle Rules (OARs) aim to determine if a patient presenting with acute ankle or foot trauma pain requires radiographs of the foot or ankle.

The derivation study for the OARs used an adult population as its subjects but extensive validation studies have shown that the OARs can be safely applied to both the adult and paediatric populations. Validation studies by Bachmann et al have found that OARs have an almost 100% sensitivity in many studies in differing clinical settings. Used appropriately, they reduce the unnecessary performance of radiographs by 30-40%.

Reference:
PAEDIATRIC CERVICAL SPINE TRAUMA
Guide to Management of the Potentially Injured Cervical Spine

Unconscious or uncooperative or major distracting injury?

**Apply one-piece semi rigid collar**
- Apply head immobiliser and straps if on spinal board
- Discuss with emergency medicine consultant, neurosurgery or orthopaedic surgery service depending on local practice if any neurological signs

Assess for:
- Neck pain (posterior)
- Neurological deficit

Undo collar, maintain head alignment, and assess for:
- Posterior midline tenderness

If above normal assess for:
- Can the patient turn their head 45° to left and right?

Patient intubated and having urgent CT brain?

**CT cervical spine**
Consult neuro or orthopaedic surgeon
Change to a two-piece collar

CT Scan
- Area of local abnormality
- Area not well visualised
Consult neuro or orthopaedic surgeon
If needing immobilisation for >6 hrs, change to a two-piece collar

Discuss with emergency, neurosurgical or orthopaedic surgeon
Immobilise in a two-piece collar

Cervical spine series
AP, lateral, odontoid View (≥ 5 yrs)

Patient cooperative and no major distracting injury?

Reassess patient for:
- Neurological signs

Undo collar and assess for:
- Posterior midline tenderness
- Muscle spasm
- Can the patient turn their head 45° to left and right?

Leave collar off
No X-ray
Document assessment in history

Leave collar off
Document assessment in history

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Adapted from Cameron et al, Textbook of Paediatric Emergency Medicine (2011)
National Emergency X-Radiography Utilization Study (Nexus)

Algorithm:

Paediatric NEXUS

Inclusion Criteria:
- Under 18 years of age
- Blunt force (not penetrating) trauma with possible cervical spine injury based on symptoms, signs or injury mechanism
- Able to elicit all 5 NEXUS criteria from the patient

Does this patient report mid-line tenderness?
- YES
- NO

Is there a change in level of alertness?
- YES
- NO

Are there any neurological deficits present?
- YES
- NO

Is there evidence of intoxication?
- YES
- NO

Are there any painful, distracting injuries present?
- YES
- NO

NON-LOW RISK:
IMAGING
RECOMMENDED

LOW RISK
IMAGING NOT RECOMMENDED
Inclusion Criteria:

- Under 18 years of age
- Blunt force (not penetrating) trauma with possible cervical spine injury based on symptoms, signs or injury mechanism
- Able to elicit all 5 NEXUS criteria from the patient

Summary Statement:

In the past, there has been little research about the appropriateness of cervical spine imaging in the trauma setting with regard to the paediatric population. In this large, prospective multicentre study, Viccellio et al. (2001) have demonstrated promising results applying the five NEXUS criteria to patients under the age of 18 years who have sustained blunt force trauma. In their study, the decision instrument did not miss any cases of cervical spine injury (CSI) and would have resulted in 20% fewer radiologic examinations. However, it must be remembered that investigation of CDR use in children is complicated by several factors:

1. Small numbers of paediatric patients with actual cervical spine injury
2. Anatomical differences compared to adults with regard to the nature and location of clinically important CSI in children
3. The relatively small incidence of cervical spine injuries in the paediatric population
4. Developmental differences influencing assessment of the NEXUS criteria that were primarily developed for use in adults (e.g. posterior neck tenderness, painful distracting injuries or intoxication). Viccellio et al. point out that the youngest paediatric patients (aged 9 years or less) create most uncertainty about the performance of the NEXUS CDR, given that the number of study participants in this age group is small for both the original NEXUS study and the Viccellio et al. validation, and so too are the number of cervical spine injuries.

Ehrlich et al. (2009) applied the NEXUS criteria retrospectively in a group of 108 paediatric patients who had undergone cervical spine imaging and reported the sensitivity for predicting cervical spine injury as 43%. This is markedly different to the results of the Viccellio study. Booth (2012) cautions that, “overall, there is conflicting information and limited agreement in the literature concerning the use of clinical screening tools in CSI involving the young child”. The use of CDRs in relation to potential cervical spine injury should be applied with caution in paediatric patients, and radiation dose should be minimised to reduce the risk of harmful long-term effects”.

Reference:


Canadian C-Spine Rule

Algorithm:

**Inclusion Criteria:**
- Age ≥ 16
- Stable vital signs (defined as systolic blood pressure >90mmHg and respiratory rate between 10 and 24/min)
- At risk of C-spine injury either because of:
  - Neck pain from any mechanism of injury, or
  - No neck pain and ALL of the following:
    - some visible injury above the clavicles; AND
    - had not been ambulatory since injury; AND
    - sustained a dangerous mechanism of injury*

**Exclusion Criteria:**
- GCS < 15
- Grossly abnormal vital signs
- Injury occurred > 48 hours prior
- Penetrating trauma
- Presented with acute paralysis
- Known vertebral disease (e.g. ankylosing spondylitis, rheumatoid arthritis, spinal stenosis, or previous cervical surgery) as determined by the examining physician
- Returned to ED for reassessment of same injury
- Pregnancy

**Canadian C-Spine Rule for alert (GCS=15) and stable trauma patients aged 16 and over**

**NO to ANY**

**Exclude**

**YES to ANY**

**IMAGING RECOMMENDED**

**NO to ALL**

1. Any high-risk factor that mandates radiography?
   - Age ≥ 65
   - *Dangerous mechanism* or
   - Paraesthesia in extremities

**YES to ANY**

2. Any low-risk factor that allows safe assessment of range of movement?
   - Simple rear-end MVC
     - Or
   - Sitting position in ED
     - Or
   - Ambulatory at any time
     - Or
   - Delayed onset of neck pain
     - Or
   - Absence of midline c-spine tenderness

**YES to ANY**

3. Able to actively rotate neck?
   - 45° left and right

**Able**

**IMAGING NOT RECOMMENDED**

*Dangerous mechanism:
- Fall from > 1 metre / 5 stairs
- Axial load to head, eg diving
- MVC high speed (≥100 km/hr), rollover, ejection
- Motorised recreational vehicle
- Bicycle collision

Simple rear-end MVC excludes
- Pushed into oncoming traffic
- Hit by bus / large truck
- Rollover
- Hit by high speed vehicle

Delayed:
- Not immediate onset of neck pain

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Inclusion Criteria:

- Age > 16 years of age
- Stable vital signs (defined as systolic blood pressure > 90mmHg and respiratory rate between 10 and 24/min)
- At risk of C-spine injury either because of:
  - Neck pain from any mechanism of injury, or
  - No neck pain but all of the following:
    - some visible injury above the clavicles; AND
    - had not been ambulatory since injury; AND
    - sustained a dangerous mechanism of injury.

Exclusion Criteria:

- GCS < 15
- Grossly abnormal vital signs
- Injury occurred > 48 hours prior
- Penetrating trauma
- Presented with acute paralysis
- Known vertebral disease (e.g. ankylosing spondylitis, rheumatoid arthritis, spinal stenosis, or previous cervical surgery) as determined by the examining physician
- Returned to ED for reassessment of same injury
- Pregnancy

Summary Statement:

Stiell et al (2001) have developed a highly sensitive CDR with significantly higher specificity than NEXUS for use in patients aged 16 years and over with acute cervical spine trauma. Prior to the development of the Canadian C-Spine Rule (CCSR), the NEXUS criteria constituted the best CDR available to aid decisions about whether or not to perform radiologic imaging in the setting of blunt force trauma and possible cervical spine injury. The CCSR has been shown to have higher specificity than NEXUS and because either CDR can be used in the 16 and over age group, use of the CCSR may be expected to result in less imaging being performed on these older adolescents with cervical spine trauma.

The Canadian C-Spine Rule is a high-performance rule. It can be used safely in the defined population to minimise the volume of cervical spine radiology ordered for blunt head and neck trauma, without missing clinically significant cervical spine injuries. Its use has been validated in a number of other studies, across a variety of patient populations and clinical settings.

References:

PAEDIATRIC HEAD TRAUMA
PECARN

Algorithm:

Exclusion Criteria:
- Trivial injury mechanisms: ground level falls, walking or running into stationary objects, no signs or symptoms of head trauma other than scalp abrasions and lacerations
- Penetrating trauma
- Known brain tumours
- Pre-existing neurological disorders
- Neuroimaging at an outside hospital before transfer
- Patients with ventricular shunts
- Bleeding disorders

A - for children younger than 2 years

GCS=14 or other signs of altered mental status\(^1\),
or palpable skull fracture

CT Recommended

Observation versus CT on the basis of other clinical factors including:
- Physician experience
- Multiple versus isolated\(^3\) findings
- Worsening symptoms or signs after emergency department observation
- Age <3 months
- Parental preference

Explanatory Notes:
GCS = Glasgow Coma Scale.
cTBI = clinically-important traumatic brain injury.
LOC = loss of consciousness.
\(^*\) Data are from the combined derivation and validation populations.
\(^\dagger\) Other signs of altered mental status: agitation, somnolence, repetitive questioning, or slow response to verbal communication.
\(^\ddagger\) Severe mechanism of injury:
- Motor vehicle crash with patient ejection, death of another passenger, or rollover
- Pedestrian or bicyclist without helmet struck by a motorised vehicle;
- Falls of more than 0.9 m (3 feet) (or more than 1.5 m (5 feet) for panel B); or
- Head struck by a high-impact object.

\(^\circ\) Patients with certain isolated findings (i.e. with no other findings suggestive of traumatic brain injury), such as isolated LOC, isolated headache, isolated vomiting, and certain types of isolated scalp haematomas in infants older than 3 months, have a risk of cTBI substantially lower than 1%. Risk of cTBI exceedingly low, generally lower than risk of CT-induced malignancies. Therefore, CT scans are not indicated for most patients in this group.

B - for those aged 2 years and older with GCS scores of 14–15 after head trauma

GCS=14 or other signs of altered mental status\(^1\),
or signs of basilar skull fracture

CT Recommended

Observation versus CT on the basis of other clinical factors including:
- Physician experience
- Multiple versus isolated\(^3\) findings
- Worsening symptoms or signs after emergency department observation
- Parental preference

Explanatory Notes:
GCS = Glasgow Coma Scale.
cTBI = clinically-important traumatic brain injury.
LOC = loss of consciousness.
\(^*\) Data are from the combined derivation and validation populations.
\(^\dagger\) Other signs of altered mental status: agitation, somnolence, repetitive questioning, or slow response to verbal communication.
\(^\ddagger\) Severe mechanism of injury:
- Motor vehicle crash with patient ejection, death of another passenger, or rollover
- Pedestrian or bicyclist without helmet struck by a motorised vehicle;
- Falls of more than 0.9 m (3 feet) (or more than 1.5 m (5 feet) for panel B); or
- Head struck by a high-impact object.

\(^\circ\) Patients with certain isolated findings (i.e. with no other findings suggestive of traumatic brain injury), such as isolated LOC, isolated headache, isolated vomiting, and certain types of isolated scalp haematomas in infants older than 3 months, have a risk of cTBI substantially lower than 1%. Risk of cTBI exceedingly low, generally lower than risk of CT-induced malignancies. Therefore, CT scans are not indicated for most patients in this group.
Inclusion Criteria:

(ALL must be satisfied if PECARN algorithm to be applied)

- Age < 18 years old
- GCS 14 or 15
- Presented to ED within 24 hours of head trauma

Exclusion Criteria:

(If ANY are present the algorithm cannot be applied)

- Trivial injury mechanisms: ground level falls, walking or running into stationary objects, no signs or symptoms of head trauma other than scalp abrasions and lacerations
- Penetrating trauma
- Known brain tumours
- Pre-existing neurological disorders
- Neuroimaging at an outside hospital before transfer
- Patients with ventricular shunts
- Bleeding disorders

Summary Statement:

The PECARN clinical decision rule aims to determine which children are at very low risk of important brain injury and who therefore do not require a CT scan of the head. It has been developed from the largest paediatric data set of the three CDRs featured in this module. The PECARN clinical decision rule has been shown in a single, multicentre validation study to be high performing in identifying children who present within 24 hours of blunt head trauma with GCS of 14 or 15 who are at very low risk of a clinically important traumatic brain injury (defined as death, neurosurgical intervention, intubation more than 24 hours or admission of 2 nights or more due to traumatic brain injury). The PECARN clinical decision rule consists of 2 age specific rules: one for children less than 2 years of age, one for children 2 years and older. The elements for both age groups overlap but are not identical.

Reference:

CATCH

Algorithm:

<table>
<thead>
<tr>
<th>Canadian Assessment of Tomography for Childhood Head injury: the CATCH Rule</th>
</tr>
</thead>
<tbody>
<tr>
<td>CT of the head is required only for children with minor head injury* and any one of the following findings:</td>
</tr>
</tbody>
</table>

**High risk (need for neurosurgical intervention)**
1. Glasgow Coma Scale score <15 at two hours after injury
2. Suspected open or depressed skull fracture
3. History of worsening headache
4. Irritability on examination

**Medium risk (brain injury on CT scan)**
5. Any sign of basal skull fracture (e.g. haemotympanum, “raccoon” eyes, otorrhea or rhinorrhea of the cerebrospinal fluid, Battle’s sign)
6. Large, boggy haematoma of the scalp
7. Dangerous mechanism of injury (e.g., motor vehicle crash, fall from elevation ≥3 ft [≥91 cm] or 5 stairs, fall from bicycle with no helmet)

**Note:**
CT = computed tomography.
*Minor head injury is defined as injury within the past 24 hours associated with witnessed loss of consciousness, definite amnesia, witnessed disorientation, persistent vomiting (more than one episode) or persistent irritability (in a child under two years of age) in a patient with a Glasgow Coma Scale score of 13-15.*
Inclusion Criteria:
- Blunt trauma to the head resulting in witnessed loss of consciousness, definite amnesia, witnessed disorientation, persistent vomiting (two or more distinct episodes 15 minutes apart), or persistent irritability in the ED (for children under two years of age)
- Initial GCS of at least 13
- Injury within the past 24 hours

Exclusion Criteria:
- Obvious penetrating skull injury.
- Obvious depressed fracture.
- Acute focal neurological deficit.
- Chronic generalized developmental delay.
- Head injury secondary to suspected child abuse.
- Patients returning for reassessment of a previously treated head injury.
- Pregnancy.

Summary Statement:
The CATCH clinical decision rule aims to determine which children with mild head injuries require a CT scan of the head.

The CATCH rule was developed for children with mild head injuries. The application of the CATCH rule requires two steps. First, it assesses if a patient has a mild head injury defined as GCS of 13-15, witnessed loss of consciousness, definite amnesia, witnessed disorientation, more than one vomit or persistent irritability (in a child under 2 years of age). If a patient has such a head injury, the actual CATCH rule can be applied. For patients who have a milder or more severe injury the CATCH rule does not apply.

The CATCH derivation study found 4 clinical findings that are highly sensitive for the need for neurosurgical intervention (primary outcome) and an additional 3 that are sensitive for predicting brain injury on CT. When the 7 findings are combined, an algorithm is created that can predict the need for CT scanning. The CATCH rule requires external validation.

Reference:
Algorithm:

<table>
<thead>
<tr>
<th>The children’s head injury algorithm for the prediction of important clinical events rule</th>
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<tbody>
<tr>
<td>A computed tomography scan is required if any of the following criteria are present.</td>
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<tr>
<td><strong>History:</strong></td>
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<tr>
<td>▪ Witnessed loss of consciousness of &gt;5 min duration</td>
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<tr>
<td>▪ History of amnesia (either antegrade or retrograde) of &gt;5 min duration</td>
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<td>▪ Abnormal drowsiness (defined as drowsiness in excess of that expected by the examining doctor)</td>
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<td>▪ ≥3 vomits after head injury (a vomit is defined as a single discrete episode of vomiting)</td>
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<td>▪ Suspicion of non-accidental injury (NAI, defined as any suspicion of NAI by the examining doctor)</td>
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<td>▪ Seizure after head injury in a patient who has no history of epilepsy</td>
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<td><strong>Examination:</strong></td>
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<tr>
<td>▪ Glasgow Coma Score (GCS) &lt;14, or GCS&lt;15 if &lt;1 year old</td>
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<tr>
<td>▪ Suspicion of penetrating or depressed skull injury or tense fontanelle</td>
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<td>▪ Signs of a basal skull fracture (defined as evidence of blood or cerebrospinal fluid from ear or nose, panda eyes, Battles sign, haemotympanum, facial crepitus or serious facial injury)</td>
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<tr>
<td>▪ Positive focal neurology (defined as any focal neurology, including motor, sensory, coordination or reflex abnormality)</td>
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<tr>
<td>▪ Presence of bruise, swelling or laceration &gt;5 cm if &lt;1 year old</td>
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<tr>
<td><strong>Mechanism:</strong></td>
</tr>
<tr>
<td>▪ High-speed road traffic accident either as pedestrian, cyclist or occupant (defined as accident with speed &gt;40 m/h)</td>
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<tr>
<td>▪ Fall of &gt;3 m in height</td>
</tr>
<tr>
<td>▪ High-speed injury from a projectile or an object</td>
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</tbody>
</table>

If none of the above variables are present, patient is at low risk of intracranial pathology
Inclusion Criteria:
All must be satisfied for CHALICE to be applied:

- Patients less than 16 years old with a history or signs of injury to head
- Loss of consciousness or amnesia not a requirement

Exclusion Criteria:
None

Summary Statement:
The CHALICE clinical decision rule aims to determine which children with head injuries of any severity require a CT scan of the head.

The CHALICE decision rule is for paediatric patients presenting acutely with head trauma. A validation study is yet to be performed. Many of the variables listed in the algorithm rely on the clinician’s judgement and the accuracy of the information provided by the witness, both of which could be biased by problems with recall and interobserver disagreement due to subjectivity of the CDR elements. This could in turn affect the decision to perform a CT scan. In future validation studies, it would be useful to test reproducibility. The rule has been shown to be sensitive at predicting patients who will either: die from their intracranial injuries; need neurosurgical intervention; or have an intracranial injury on CT scan but required only observation and supportive treatment.

Reference:
PAEDIATRIC ANKLE TRAUMA
Ottawa Ankle Rules

Algorithm:

**Applying the Ottawa Ankles Rules for paediatric patients <18 years**

**Inclusion criteria**
Most validation studies in children did not include children under the age of 2 years (i.e. non-walkers) and therefore the performance of the OARS in this age group is less clear.
- All patients presenting with acute blunt injuries of the ankle (e.g. twisting injuries, falls from height, direct blows and motor vehicle accidents)

**Exclusion criteria**
- Children under 2 years old (i.e. non-walkers)
- Open fractures
- Isolated injuries of the skin
- Presentation >48 hours after trauma
- Suspected non-accidental injury
- Multi trauma in areas away from the foot and ankle
- Patients returning for reassessment of the same ankle injury OR patients referred to the ED with x-rays
- Prior surgery to the symptomatic foot/ankle in the past 3 months
- Neurovascular compromise, diseases predisposing to fractures (e.g. osteogenesis imperfecta)
- Underlying disease with sensory/neural abnormalities of the lower limb(s) (e.g. spina bifida)
- Metabolic disorders or coagulopathy.
- Developmental delay
- Intoxication

**STEP ONE:** Is there any pain in the malleolar zone and any of these findings?:
1. Bone tenderness at A
2. Bone tenderness at B
3. Inability to bear weight both immediately and in the emergency department

**STEP TWO:** Is there any pain in the midfoot zone and any of these findings?:
1. Bone tenderness at C
2. Bone tenderness at D
3. Inability to bear weight both immediately and in the emergency department

**Definitions:**
- **The malleolar zone**
  - Posterior aspect of the distal 6 cm of the tibia (medial malleolus)
  - Posterior aspect of the distal 6 cm of the fibula (lateral malleolus)

- **The midfoot zone**
  - navicular
  - cuboid
  - cuneiforms
  - anterior process of the calcaneus
  - the base of the fifth metatarsal

*NOTE: Does not include fractures of the body and tuberosity of the calcaneus*
Inclusion criteria:
All patients presenting with acute blunt injuries of the ankle (e.g. twisting injuries, falls from height, direct blows and motor vehicle accidents), where ankle was broadly defined to include the area involved in common twisting injuries and was subdivided into 2 zones that require assessment by a standard ankle radiographic series (malleolar area) and a standard foot radiographic series (the midfoot).

Exclusion criteria:
These exclusion criteria vary from study to study but have included some or all of the following:
- Salter-Harris I and non-significant fractures defined as <3mm
- Children under 2 years old
- Open fractures
- Neurovascular compromise
- Diseases predisposing to fractures (e.g. osteogenesis Imperfecta)
- Underlying disease with sensory/neural abnormalities (spina bifida)
- Isolated injuries of the skin
- Patients returning for reassessment of the same ankle injury
- Patients referred to the ED with x-rays
- Intoxication
- Presentation >48 hours after trauma
- Developmental delay
- Neurological disorder of the lower limb such as spina bifida
- Multi trauma in areas away from the foot and ankle
- Suspected non accidental injury
- Prior surgery to the symptomatic foot/ankle in the past 3 months
- Metabolic disorders or coagulopathy

Summary Statement:
The Ottawa Ankle Rules (OARs) aim to determine if a patient presenting with acute ankle or foot trauma-related pain requires plain radiographs of the foot or ankle to exclude a fracture. The OARs were not developed to exclude ligamentous or tendon injuries in the foot and ankle.

The derivation study for the OARs used an adult population as its subjects but validation studies have shown that the OARs can be safely applied to both the adult and paediatric populations. Correct use of the OARs can result in reduction of 30-40% in the need for plain radiographs in people with acute blunt trauma to the ankle and foot.

Myers et al (2005) reviewed paediatric validation studies of the OARs and concluded that: “Based on the mean 21.4% prevalence of fractures among the included studies, and the pooled negative LR of 0.11, the posterior probability of fracture given a negative OAR assessment is approximately 2.9%”.

Reference: