Education Modules for Appropriate Imaging Referrals

PAEDIATRIC ANKLE TRAUMA

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.
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1. INTRODUCTION

WHAT IS ANKLE TRAUMA?

Foot and ankle injuries account for up to 30% of medical visits for sports related injuries, and are the most common sports related presentation in the primary care setting. Around 85% of ankle injuries are sprains with fractures making up to 15% of injuries, and ankle fractures account for about 5% of all paediatric fractures. Ankle injuries are most common in the 10-16 year age group.

Ankle sprains are the most common injuries, with the lateral (fibular) ligaments most commonly involved. Younger children have an increased risk of injury to the physis (growth plate) of the ankle. In the immature skeleton most ankle fractures are related to the growth plate and are classified using the Salter-Harris Classification (see Figure 1).

Ankle injury is suspected when there is a history of ankle trauma — most commonly inversion and plantar flexion. To aid with identification of injuries not associated with fractures, clinical decision rules have been developed and validated in both adults and children (and can be used with confidence in children as young as 5 years of age). The best CDR is the Ottawa Ankle Rule (OAR)\(^1\). Using the OAR allows identification of patients at minimal risk of fracture allowing management to continue without plain radiography (x-ray). All injuries that cannot be excluded by the OAR should undergo plain radiography of the ankle.

The Ottawa Ankle Rules have been validated for use in foot and ankle trauma by many studies involving mixed adult and paediatric as well as exclusively paediatric populations. The population sizes in the exclusively paediatric studies are smaller than for the adult studies, especially in the youngest age groups, as they experience fewer injuries.

Treatment of ankle sprains is with rest, support of a brace or splint for up to 5 days when weight bearing is not well tolerated, and graded return to functional activity. Fractures are managed according to the displacement or angulation of the bones, and disruption of the ankle mortise. They may require immobilisation with a splint or plaster, manipulation under general anaesthesia or internal fixation to maintain the alignment of the ankle joint. A complicated fracture identified on plain imaging will often be further investigated with CT or MRI to accurately outline the fragment positions and inform operative intervention.

As ankle injury is such a frequent problem, and because the incidence of fracture is low there are substantial costs associated with the practice of performing radiography in all cases of paediatric ankle trauma. The financial burden of many unnecessary x-rays, the extra time in the emergency department, the delay in management for the individual patient and unnecessary radiation exposure, all contribute to significant social cost. Therefore judicious use of imaging, guided by validated CDRs is of benefit to the patient and the community. There is no role for CT or MRI in the investigation of any but the most complicated fractures, and certainly no role as the initial investigative tool.
Types of Fractures:

- Type II fractures are the commonest. The fracture line extends along the growth plate as for Type I and then through the distal metaphysis, distinguishing it from a Type I Fracture.
- Type III fractures extend along the growth plate but into the epiphysis instead of the metaphysis.
- Type IV injuries involve epiphysis and metaphysis and cross the growth plate but do not extend along it.
- Type V injuries involve axial loading or “crush” injury to the growth plate.
- Type I and II injuries have the best prognosis with regard to the development of later growth arrest of the bone. Due to growth plate injury, Type V has the worst prognosis but is fortunately the rarest type of Salter-Harris Fracture.

Figure 1: Salter-Harris Classification of Fractures Involving the Growth Plate
HOW CAN CLINICAL DECISION RULES HELP TO STANDARDISE PRE-TEST RISK EVALUATION OF PAEDIATRIC PATIENTS WITH ANKLE TRAUMA?

When evaluating paediatric patients with blunt ankle/foot trauma, one of the key issues to be addressed is whether or not the patient should be investigated using imaging to confirm or refute the presence of ankle or foot fracture. When attempting to make the decision about whether or not to use diagnostic imaging, it is important to focus on features of the history and physical exam that have been found to be associated with the presence of clinically important acute ankle injury.

At first, it might seem simpler, quicker, and safer simply to perform an imaging test like a radiograph (or “x-ray”) on everyone with possible acute ankle injury. When the pre-test probability of clinically important acute ankle or foot injury (such as fracture or dislocation) is higher, the costs and risks of diagnostic imaging are more than outweighed by the considerable benefits of earlier diagnosis. These benefits can include simpler, less invasive treatment or guidance for surgical or medical therapy that prevent later disability.

However, there are a number of disadvantages to the practice of referral of patients for imaging without first considering what the pre-test probability of a condition is likely to be. They include:

- **Unnecessary exposure to ionising radiation.** This is particularly important in babies, children, and adolescents who are more sensitive to the carcinogenic effects of exposure to ionising radiation. CT scanning is associated with around 100 times the dose of radiation delivered by a plain radiograph (or x-ray).
- **Financial cost to the patient and health system of unnecessary testing.** These costs are both direct and indirect (the latter due to waiting time in emergency departments, prolonged length of stay in a hospital, time away from work and other responsibilities for patients and their parents due to waiting for imaging to be performed, having it performed, and then waiting for the result).

Continued increases in healthcare costs are a global problem. More than ever before, medical practitioners are being asked to be accountable for utilisation of finite health care resources and to add value and reduce waste in the care they deliver to patients. Reducing inappropriate use of diagnostic imaging in situations where it is highly unlikely to result in a net benefit to the patient is an important way to reduce waste and improve quality of care.

Clinical decision rules (CDRs) can help you to focus on the aspects of the history and examination that best discriminate between:

- **patients with low-to-no risk of significant pathology** who are, therefore, unlikely to benefit from diagnostic imaging; and
- **patients who do not have negligible risk** who need imaging to guide further specific treatment including in some cases in-hospital monitoring, medical therapy, or even surgery.

Clinical decision rules have been developed by gathering detailed clinical datasets from large numbers patients with a particular condition, such as adults presenting to an emergency department following head trauma. They are comprised of a series of key examination findings (such as level of consciousness) and aspects of the history (such as injury mechanism, amnesia, or number of episodes of vomiting) that have been found, when absent, to be associated with such a low risk (or pre-test probability) of clinically important disease or injury that imaging is not required to further reduce this risk.

The emphasis of the current educational modules is on CDRs that involve risk assessment of patients with regard to their requirement for diagnostic imaging, but CDRs for other outcomes (such as prognosis) have also been developed.
The usefulness of CDRs is that they help to reduce the subjectivity and inter-observer variation involved in the clinical assessment of patients with specific conditions that sometimes, but not always, require imaging. Imaging is sometimes performed in these conditions to allow diagnosis of serious pathology. Using CDRs can help to increase your confidence about the safety of managing your patient without imaging when recognised clinical risk factors for serious pathology are entirely absent. Documentation in the medical record that you have used a high quality CDR to evaluate your patient and make management decisions based on this is not only good practice but increases the likelihood that another medical practitioner evaluating your patient would come to the same conclusions as you did about management.

Please see the Clinical Decision Rules Module for more information about:

- what CDRs are;
- how they are developed; and
- what the characteristics of a high quality CDR are.

Resources:

Something that will become apparent as you work through these modules is the difficulty involved in trying to commit the elements of CDR to memory. It is a good idea to refer to an electronic or hard copy of the CDR each time you use it to ensure that you are applying it correctly. To support this, the following resources are provided:

- Printable PDFs of all of the CDRs
- “Pocket-sized” PDFs suitable for printing, lamination, and attachment to a lanyard
- Links to the website www.mdcalc.com where you will find a calculator that allows you to enter clinical data for your patient into a clinical decision rule. This website does not feature all published CDRs for a particular condition and does not discuss the reasons for featuring some and not others. This module will help you develop an understanding of how to use the Ottawa Ankle Rules and who you can and cannot apply it to in a paediatric population. Go to the website now and try out the calculator for the Ottawa Ankle Rules CDR:
  - www.mdcalc.com/ottawa-ankle-rules/
- For more information about specific imaging tests and procedures please see:
  - www.insideradiology.com.au
QUESTION 1.

Which of the following imaging modalities involve exposure of the patient to ionising radiation when imaging the foot and ankle? Select all possible answers.

1A. Plain radiographs.
1B. CT scanning.
1C. Radionuclide bone scanning (bone scan).
1D. Ultrasound.
1E. Magnetic Resonance Imaging (MRI).

CORRECT ANSWERS:

Which involve exposure to ionising radiation?
1A. Plain radiographs.
1B. CT scanning.
1C. Radionuclide bone scanning (bone scan).

QUESTION 2.

How much more ionising radiation exposure is conferred to the patient by a CT of the foot compared with a plain radiograph series of the foot?

2A. 3 times.
2B. 8 times.
2C. 70 times.
2D. 400 times.

CORRECT ANSWER:

How much more ionising radiation exposure is conferred to the patient by a CT of the foot compared with a plain radiograph series of the foot?
2C. 70 times.

FEEDBACK: The doses for a plain radiograph series of the foot and a CT of the foot are 0.001 and 0.07 millisieverts, respectively, both very small doses compared with CT scans of the head, chest or abdomen which deliver between 1 and 10 millisieverts. 70 times more ionising radiation exposure is conferred to the patient by a CT of the foot compared with a plain radiograph series of the foot.
2. CLINICAL DECISION RULES

THE OTTAWA ANKLE RULES

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 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%”.

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), 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:
Various validation studies of the OARs in children have employed different and/or more stringent exclusion criteria than did the original derivation study performed in adults. 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 (in other words, when the OAR was negative but one of these types of fractures were present on radiographs, this was not counted as a “failure” of the rule due to the trivial nature of the injury).
- 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.

Note:
There are 2 tables in the appendix that provide more information:

- Table 1 – Best bets review (2005) for the performance of the Ottawa Ankle Rules in children
- Table 2 – A systematic review by Bachmann et all (2003) assessing the accuracy of the Ottawa Ankle Rules for exclusion of fractures of the ankle and mid-foot
Algorithm:

Applying the Ottawa Ankle 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 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

**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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**FIGURE 2: THE OTTAWA ANKLE RULES**
**REVIEW SECTION**

Where would you palpate for tenderness in a walking patient with acute ankle and foot trauma to assess whether they need radiographs of the ankle?

1. A – Posterior edge or tip of the lateral malleolus.
2. B – Base of the 5th metatarsal.
3. C – Posterior edge or tip of the medial malleolus.

The correct answers are A and C

Where would you palpate for tenderness in a walking patient with acute ankle and foot trauma to assess whether they need radiographs of the foot?

1. A – Posterior edge or tip of the lateral malleolus.
2. B – Base of the 5th metatarsal.
3. C – Posterior edge or tip of the medial malleolus.

The correct answers are B and D
**QUESTION 3.**
A 10 year old boy falls off his skateboard at the skate park. He injures his foot and ankle during the fall. He walks over to a bench on the edge of the skate ramp (about 4 metres away) and a friend calls his mother who comes to get him. He is unable to walk to the car but hops on the uninjured leg while being supported by his mother and the friend. You are the intern in the emergency department he attends the next morning (about 12 hours after the injury) because he cannot walk on the injured foot. On examination, the lateral aspect of the foot is bruised and very swollen. The posterior edges of his medial and lateral malleoli are not tender when you palpate the lower 6 cm. He is tender over the base of the 5th metatarsal but not over the navicular.

You can input the information into the Ottawa Ankle Rules calculator to help you answer the question—www.mdcalc.com/ottawa-ankle-rules/

**What would you do now?**

3A. Refer him for plain radiographs of the ankle only.
3B. Refer him for plain radiographs of the foot only.
3C. Advise non weight bearing and give him a pair of crutches as well as icing and elevation of the foot with review by his GP in 2 days if he is still unable to bear weight.
3D. Refer him for plain radiographs of the ankle and foot.
3E. Seek the opinion of a senior ED physician or an orthopaedic surgeon about the best course of action.

**CORRECT ANSWER:**
You would now:
3D. Refer him for plain radiographs of the ankle and foot.

**FEEDBACK:** Inability to weight bear both at the scene of the injury and at clinical presentation is an indication for both ankle and foot imaging in a patient with acute ankle and/or foot trauma. The additional finding of tenderness over the fifth metatarsal does not preclude the need for ankle imaging because of the additional problem of non-weight bearing at the scene and in the ED the next day.
3. Other considerations when performing diagnostic imaging

What else do you need to think about, other than pre-test probability of a condition, when you are considering performing diagnostic imaging in a patient with blunt ankle trauma?

- The OARs should not be used in children who re-present for the same injury a second time.
- The OARs may not be suitable for children with metabolic disorders that increase the likelihood of fracture with minimal trauma, such as osteogenesis imperfecta.
- Non-accidental injury should be suspected when:
  - There is evidence of multiple injuries that are not explained by the current incident.
  - The presentation for medical care is delayed.
  - The history given by the carer(s) changes or is inconsistent with the observed injury(ies).
  - The child is in an age group at higher risk (babies and toddlers).
### MODALITY TABLE:

<table>
<thead>
<tr>
<th>MODALITY</th>
<th>STRENGTHS</th>
<th>WEAKNESSES</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plain radiography</td>
<td>• Widely available.</td>
<td>• Acute avulsion fractures may be indistinguishable from pre-existing (remote) avulsion fractures when acute soft tissue injury produces swelling around the bone fragment.</td>
<td>First line investigation in the patient with acute blunt ankle or foot trauma who needs imaging.</td>
</tr>
<tr>
<td></td>
<td>• Easy to perform even if patient has limited mobility, other injuries, or is uncooperative.</td>
<td>• Non displaced fractures and fractures in very demineralised bone may be undetectable with plain radiography. CT, MRI, and radionuclide scanning can be useful to identify these in patients with persistent symptoms and normal plain radiography.</td>
<td>CT can be useful for surgical planning in more complex fractures/dislocations demonstrated by plain radiographs.</td>
</tr>
<tr>
<td></td>
<td>• Good for identifying the majority of clinically important fractures in the setting of acute trauma.</td>
<td>• Ligamentous and tendon injuries not demonstrated.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Better than MRI for small avulsion fractures (e.g. of the malleoli).</td>
<td>• Osteochondral injuries are not usually demonstrated unless large.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Other bone lesions (e.g. tumours) that have come to attention because of an episode of blunt trauma may be shown with plain radiographs.</td>
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</tr>
<tr>
<td>CT</td>
<td>• Very sensitive for fracture/dislocation.</td>
<td>• Ligament and tendon injuries cannot be accurately diagnosed using CT.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Useful for pre surgical treatment planning of complex ankle/foot fractures and/or dislocations demonstrated by plain radiographs.</td>
<td>• Isolated cartilage injuries are not demonstrated by non arthrographic CT (i.e. CT scanning performed without injection of contrast medium into the joint). Smaller osteochondral injuries, and acute stress fractures may not be demonstrated by CT.</td>
<td></td>
</tr>
<tr>
<td>MODALITY</td>
<td>STRENGTHS</td>
<td>WEAKNESSES</td>
<td>COMMENTS</td>
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<tr>
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</tbody>
</table>
| MRI | - Very sensitive and moderately specific for ligamentous and tendon injuries of the ankle and foot.  
- Radiographically occult fractures may manifest as localised bone marrow oedema on MRI.  
- Articular cartilage and osteochondral injuries are depicted by MRI. | - Duration of the exam (20 minutes) may be difficult for patients with confusion, other injuries, or difficulties with communication.  
- Metal in or around the ankle may impair interpretability of images.  
- MR incompatible pacemakers are a contraindication to any type of MRI. | Bone marrow oedema in the setting of acute trauma does not always indicate the presence of a fracture requiring treatment – bone contusion (trabecular microfracture) also produces bone marrow oedema and is generally treated symptomatically.  
Acute ligamentous injuries of the foot and ankle are treated symptomatically in the first instance so although they can be demonstrated with MRI, often this will have no bearing on immediate management.  
MRI performed on the acutely injured ankle has low sensitivity for prediction of chronic instability and/or impingement syndrome. |
| Radionuclide bone scanning | - Demonstrates increased uptake of radionuclide tracer in radiographically occult fractures. | - Increased uptake is nonspecific and may be seen in infection, neoplasm, and degenerative changes. Interpretation of the cause of an abnormality often requires correlation with plain radiographs or other imaging. | Used in the subacute/chronic setting if plain radiographs and/or CT are negative when pain and/or tenderness persist. |
QUESTION 4.
Which of the following is true in regards to ankle injuries in children?

4A. Clinical decision rules derived in an adult population are not applicable to paediatric patients
4B. CT Scan is the preferred initial method of imaging to ensure all relevant information is gained on the first investigation.
4C. Use of validated CDRs in children will reduce the need for imaging by up to 40%.
4D. The OARs are only valid for ankle injuries.
4E. The mechanism of injury can be used to determine the need for imaging.

CORRECT ANSWER:
Regarding ankle injuries in children:
4C. Use of validated CDRs in children will reduce the need for imaging by up to 40%.

FEEDBACK: Validation studies have shown a reduction in plain radiography (x-ray) use of 30-40%. Although derived in adults some CDRs have been well validated in paediatric populations. The existing CDRs are valid for ankle and some midfoot injuries. The Ottawa ankle rules do not include the mechanism of injury as it is not a validated risk stratifier for likelihood of ankle fracture. Plain x-ray is preferred initially because very a few patients will require further investigation, and it is desirable to minimize radiation exposure to the majority of patients.

QUESTION 5.
Which of the following are predictors of need for plain radiography (x-ray) in ankle injury?

5A. Degree of swelling of the lateral malleolus.
5B. Severity of pain on walking.
5C. Presence of a large amount of bruising over the lateral malleolus.
5D. Bony tenderness over the posterior aspect of the lateral malleolus.
5E. History of previous fracture of the same ankle.

CORRECT ANSWER:
The single best answer:
5D. Bony tenderness over the posterior aspect of the lateral malleolus

FEEDBACK: If this is elicited, regardless of the ability to walk, the patient requires radiography (x-ray). Swelling alone does not predict fracture - it must be associated with localised posterior bony tenderness OR the inability to walk both at the scene of the injury AND when examined in the emergency department. Pain is needed to implement the ankle rules but is not a predictor of need for x-ray. Inability to walk 4 steps is a predictor if the patient cannot walk now nor were they able to walk immediately after the injury. The degree of bruising does not determine the likelihood of an ankle fracture. Inability to walk or specific bony tenderness is required. Previous injury is not a risk factor for current injury. Remember that children with bone diseases such as osteogenesis imperfecta are more likely to sustain a fracture when subjected to the same trauma as those with normal bones.
QUESTION 6.
Which of the following are used as part of the Ottawa Ankle Rules?

6A. Tenderness on examination in the posterior malleolar or midfoot zone.
6B. Inability to walk BOTH at the scene AND at the time of assessment.
6C. Tenderness at the posterior edge of the lateral malleolus.
6D. Tenderness at the posterior edge of the medial malleolus.
6E. All of the above.

CORRECT ANSWER:
The single best answer is:
6E. All of the above.

FEEDBACK: See the Ottawa Ankle Rule figure below.
QUESTION 7.
Which of the following are true in regard to imaging modalities in paediatric ankle fractures? Select all possible answers.

7A. Using the Ottawa ankle rules can determine patients who need plain ankle radiography (x-ray) due to them having a greater than 20% chance of a fracture.
7B. CT scan is a better imaging modality and should be used for all ankle fractures.
7C. Children with evidence of multiple trauma and children who re-present a second time after a foot and ankle injury in general are not suitable candidates for use of the OARs.
7D. The Ottawa ankle rules can be used with high accuracy up to one week after the acute injury.
7E. All ankle injuries should have plain films performed to ensure subtle bony abnormalities are not missed.

CORRECT ANSWERS:
Regarding imaging modalities in paediatric ankle fractures:
7A. Using the Ottawa ankle rules can determine patients who need plain ankle radiography (x-ray) due to them having a greater than 20% chance of a fracture.
7C. Children with evidence of multiple trauma and children who re-present a second time after a foot and ankle injury in general are not suitable candidates for use of the OARs.

FEEDBACK: The Ottawa ankle rules are specifically designed to determine which patients do not need (and therefore which patients should have) ankle radiography (x-ray). Various exclusion criteria have been applied to children in various situations in the studies that have attempted to validate the OARs in children. CT scanning should be confined to imaging complex fractures to assist with surgical management. Children who present more than a few days after sustaining the trauma to their foot or ankle should not have a fracture excluded using the OARs. Soft tissue injuries of the ankle and foot without an underlying fracture and requiring only supportive treatment are common in childhood.

QUESTION 8.
Which of the following are true in regards to ankle injuries in children? Select all possible answers.

8A. The severity of pain is important, as severe pain means a fracture is much more likely.
8B. The fact that a patient has had opioid analgesia before being clinically assessed can make further assessment using the OARs less reliable.
8C. The degree of bruising is an indicator for imaging as a large amount bleeding indicates a fracture.
8D. Bony tenderness on the posterior aspect of the medial or lateral malleolus means there is an increased likelihood of a fracture.

TRUE ANSWERS:
Regarding ankle injuries in children:
8B. The fact that a patient has had opioid analgesia before being clinically assessed can make further assessment using the OARs less reliable.
8D. Bony tenderness on the posterior aspect of the medial or lateral malleolus means there is an increased likelihood of a fracture.
REFERENCES


# Appendix One: Evidence Summary Table

<table>
<thead>
<tr>
<th>Author and date</th>
<th>Name of CDR</th>
<th>Derivation or validation</th>
<th>Inclusion</th>
<th>Exclusion</th>
<th>Sensitivity (95%CI)</th>
<th>Specificity (95% CI)</th>
<th>LR- (95%CI)</th>
<th>High performance* (Y/N)</th>
<th>Hierarchy **</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stiell (1992)</td>
<td>Ottawa ankle rules</td>
<td>Derivation</td>
<td>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 if the tuberosities of the calcaneus were not included in this definition.</td>
<td>Age under 18 years old</td>
<td>Ankle Series: 100%</td>
<td>Ankle Series: 40.1%</td>
<td>Ankle Series: 0%</td>
<td>Ankle Series: uncertain</td>
<td>Ankle Series: I-II</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Pregnancy</td>
<td>Foot Series: 100%</td>
<td>Foot Series: 24.7%</td>
<td>Foot Series: 0%</td>
<td>Foot Series: uncertain</td>
<td>Foot Series: I-II</td>
</tr>
</tbody>
</table>

*High performance (Y/N) for the derivation study defined as:
- Sens > 0.95 AND
- Lower limit of 95%CI for sensitivity >0.95 AND
- LR<-0.1 AND
- Upper limit of LR-95% CI < 0.1

 Likelihood ratio for negative test result = proportion of patients WITH disease who have a negative test result (1 - SENSITIVITY) / proportion of patients WITHOUT disease who have a negative test result (SPECIFICITY) = (1 - SENSITIVITY) / SPECIFICITY

**Hierarchy (see reference I. below)

- Level I: can be used in a variety of clinical settings and includes at least one validation study (external) and at least one impact analysis showing favourable change in clinician behaviour when the CDR is used/implemented
- Level II: can be used in various setting with confidence about accuracy (1 prospective validation in heterogeneous population or several smaller ones)
- Level III: use with caution in narrowly defined group of patients (validated in one narrow prospective sample)
- Level IV: CDRs requiring more evaluation before they are implemented (no validation or only validated with statistical techniques or retrospective databases, or split samples)

### Appraisal Table References:


APPENDIX TWO: OTTAWA ANKLE RULES

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 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

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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## Appendix Three: Best Bets Review Table:

<table>
<thead>
<tr>
<th>Author, and date</th>
<th>Patient group</th>
<th>Study type (level of evidence)</th>
<th>Outcomes</th>
<th>Key results</th>
<th>Study Weaknesses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chande VT, 1995</td>
<td>68 patients aged 2-18 years</td>
<td>Prospective survey with 24 variables obtained by physicians; x rays were taken of all study participants with blinding of investigator as to results of x rays when applying OAR to evaluate for qualification of x ray</td>
<td>Inclusion All types of fractures Exclusion Open fractures, patients without follow-up</td>
<td>Sensitivity 100% (95% Cl. 77% to 100%). Specificity 32% (95% Cl. 21% to 43%)</td>
<td>Small sample size</td>
</tr>
<tr>
<td>McBride KL 1997</td>
<td>318 adults and children (37 of 318 were children) presenting with ankle injury to a community ED</td>
<td>Prospective survey looking at the ability of OAR to decrease need for x ray after instructing family practitioners in the ER setting on the use of these rules</td>
<td>Inclusion Fracture &lt;3mm Exclusion Pregnancy, open injury, presentation &gt;1 week after injury, enrolment one time per patient</td>
<td>100% sensitivity (95% Cl=0.87-1.0). Specificity 28% (95% Cl=0.14-0.39)</td>
<td>Small study</td>
</tr>
<tr>
<td>Plint AC et al, 1999</td>
<td>670 patients aged 2-16 years</td>
<td>Patients were evaluated by staff and fellows trained in OAR at two hospital EDs; x rays were obtained based on each hospital’s practices. Data forms with physical exam findings were filled out prior to viewing the x ray. The principal investigator reviewed the data forms and made a decision regarding positive or negative OAR</td>
<td>Inclusion Present with injury within 48 hours, fractures =&gt;3mm Exclusion Salter-Harris I, insignificant fractures defined as</td>
<td>Sensitivity 100% (95% CI = 0.581.0) Specificity 27% (95% CI = 0.110.42)</td>
<td>119 Salter-Harris I fractures, 32 insignificant fractures *when calculating the 2x2 table, 96 patients were counted twice (once for ankle fractures and a second time for foot fracture) therefore the N in this study was 766). Mid-foot injuries were included in this study Inter-rater reliability was not assessed</td>
</tr>
<tr>
<td>Libetta C et al, 1999</td>
<td>761 patients aged 1-15 years</td>
<td>A historical control group was included prior to the implementation of OAR in this prospective evaluation as a comparison to predict need for x ray</td>
<td>Inclusion Patients that had ability to walk prior to injury Exclusion Patients were excluded in August in order to give the staff one month to learn and implement the Ottawa ankle rules</td>
<td>Sensitivity 98% (95% Cl = 0.951.0) Specificity 46% (95% Cl = 0.430.51)</td>
<td></td>
</tr>
<tr>
<td>Karpas et al, 2002</td>
<td>190 patients evaluated ages 5-19 years</td>
<td>Blinded cross-sectional study that implemented OAR after two nurse training sessions</td>
<td>Inclusion Patients who presented within 48 hours of injury and all fractures Exclusion: Open fracture, multiple traumas, developmental delay, referral with x ray, recurrent visits for the same injury in the last 2 weeks</td>
<td>Sensitivity 96% (95% Cl = 0.820.99) Specificity 27% (95% Cl = 0.180.32)</td>
<td>Study included one patient with Salter-Harris I and negative rules</td>
</tr>
<tr>
<td>Author, and date</td>
<td>Patient group</td>
<td>Study type (level of evidence)</td>
<td>Outcomes</td>
<td>Key results</td>
<td>Study Weaknesses</td>
</tr>
<tr>
<td>------------------------</td>
<td>----------------------------------------</td>
<td>-----------------------------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Cuello-Garcia et al, 2004</td>
<td>111 patients evaluated aged &gt;18 years</td>
<td>Prospective evaluation by paediatric nurses, third year residents, and attendings in the ED. OAR was applied, and x rays obtained at physician discretion. Radiology was blinded to OAR results</td>
<td>Inclusion: Salter-Harris I-IV Exclusion: Multiple trauma, &gt;7 days from event, changes in consciousness, bony disease, patients who came for re-evaluation, Salter-Harris I fractures</td>
<td>Sensitivity 100% (95% CI = 0.951.0) Specificity 6% (95% CI = 0.010.11)</td>
<td>Salter-Harris I fractures were not included; there were 18 of these total. Patients were followed up at one month with telephone calls, and none of the patients showed later complications or changes in the diagnosis</td>
</tr>
<tr>
<td>Clarke and Tanner, 2003</td>
<td>160 patients evaluated ages &lt;18 years old</td>
<td>Prospective survey with 22 variables; x rays were obtained on all patients with radiologists being blinded to survey results</td>
<td>Inclusion: All types of fractures Exclusion: Age &gt;18, intoxication, previous films, pregnancy, suspected physical abuse, open fractures, OI, metabolic disease, patients without phone contact, neurologic impairment</td>
<td>Sensitivity 83% (95% CI = 0.650.94) Specificity 50% (95% CI = 0.410.58)</td>
<td></td>
</tr>
<tr>
<td>Boutis et al, 2001</td>
<td>607 patients evaluated ages 3-16 years old</td>
<td>Blinded prospective study in 2 similar urban emergency departments with fellows and attending staff as participants. Instruction on the use of OAR was given by orthopaedic surgeons prior to start of study</td>
<td>Inclusion: Isolated ankle trauma within 72 hours of injury Exclusion: Age 16 years or more, pre-existing musculoskeletal disease, coagulopathy, developmental delay, previous history of surgery within 3 months of injury on affected ankle or multi-system trauma</td>
<td>Sensitivity 100%(95% CI = 0.961.0) Specificity 13%(95% CI = 0.110.16)</td>
<td>Patients were divided into low risk and high risk groups. Low risk consisted of isolated pain, tenderness, or both with or without oedema or ecchymosis of the distal fibula below the level of the joint line of the ankle. All other findings were classified as high risk. They also assessed the potential for reduction in radiographs when comparing the low risk clinical findings with those obtained by combining the Ottawa ankle rules</td>
</tr>
</tbody>
</table>

**Table 1 - BEST BETS REVIEW (2005) FOR THE PERFORMANCE OF THE OTTAWA ANKLE RULES ON CHILDREN**

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## APPENDIX FOUR: A SYSTEMATIC REVIEW

<table>
<thead>
<tr>
<th>Study</th>
<th>No of patients</th>
<th>Specification</th>
<th>Prospective data collection</th>
<th>Exclusion of patients &lt;18 years</th>
<th>Mean age</th>
<th>Consecutive enrolment</th>
<th>Blinding of radiologist</th>
<th>Radiography in all patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ankle assessment</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Aginaga et al 1999</td>
<td>463</td>
<td>Doctors applied OARs in adults in regional hospital in Spain</td>
<td>Yes</td>
<td>Yes</td>
<td>37.1</td>
<td>Not Reported</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Auleley et al 1998</td>
<td>130</td>
<td>Compared radiography request rates between senior house officers and nurse practitioners using OARs in adults in university hospital in France</td>
<td>Yes</td>
<td>Yes</td>
<td>34</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Kerr et al 1994</td>
<td>350</td>
<td>OARs applied in convenience (not otherwise specified; easy to approach) sample of adults in four hospitals (two university, one community, and one provincial) in New Zealand. Mid-foot injuries not assessed</td>
<td>Yes</td>
<td>Not reported</td>
<td>Not Reported</td>
<td>No</td>
<td>Not Reported</td>
<td>No</td>
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<tr>
<td>Lucchesi et al 1995</td>
<td>422</td>
<td>OARs in convenience sample of adults in suburban community teaching trauma centre in United States</td>
<td>Yes</td>
<td>Yes</td>
<td>35</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
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<tr>
<td>Mann et al 1998</td>
<td>700</td>
<td>Compared radiography request rates between senior house officers and nurse practitioners applying OARs in patients enrolled within 48 hours after injury to large accident and emergency department in United Kingdom. No mid-foot assessment</td>
<td>Yes</td>
<td>No</td>
<td>Not Reported</td>
<td>Not Reported</td>
<td>Not Reported</td>
<td>Yes</td>
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<tr>
<td>Papacostas et al 2001</td>
<td>79</td>
<td>OARs in athletes and people engaged in sport at least three times a week, injured during sports activities attending district general hospital and sports injuries clinic in Greece</td>
<td>Yes</td>
<td>Yes</td>
<td>29</td>
<td>Not Reported</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Perry et al 1999</td>
<td>577</td>
<td>OARs assessed in urban teaching hospital in United Kingdom. No mid-foot assessment</td>
<td>Yes</td>
<td>Yes</td>
<td>Not Reported</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>Singh-Ranger and Marathias 1999</td>
<td>18</td>
<td>Compared conventional ordering of radiography to use of OARs in district general hospital in United Kingdom. No mid-foot assessment reported</td>
<td>Yes</td>
<td>No</td>
<td>Not Reported</td>
<td>Yes</td>
<td>Not Reported</td>
<td>Yes</td>
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<tr>
<td>Stiell et al 1992</td>
<td>689</td>
<td>Development of OARs in two university hospital emergency departments in Canada</td>
<td>Yes</td>
<td>Yes</td>
<td>35.1</td>
<td>Not Reported</td>
<td>Yes</td>
<td>No</td>
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<tr>
<td>Stiell et al 1993</td>
<td>1032</td>
<td>OARs applied in adults attending one of two university hospital emergency departments in Canada. Refinement of 1992 rules</td>
<td>Yes</td>
<td>Yes</td>
<td>35</td>
<td>Not Reported</td>
<td>Yes</td>
<td>No</td>
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<tr>
<td>Stiell et al 1993</td>
<td>453</td>
<td>OARs applied in adults attending one of two university hospital emergency departments in Canada. Validation of refined rules</td>
<td>Yes</td>
<td>Yes</td>
<td>36</td>
<td>Not Reported</td>
<td>Yes</td>
<td>No</td>
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<tr>
<td>Stiell et al</td>
<td>565</td>
<td>Implementation study of OARs using refined 1993 OARs. OARs</td>
<td>Yes</td>
<td>Yes</td>
<td>36</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
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<td>Year</td>
<td>Authors</td>
<td>Sample Description</td>
<td>OARs Applied</td>
<td>OARs Validated</td>
<td>OARs Refinement</td>
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<td>1994&lt;sup&gt;13&lt;/sup&gt;</td>
<td>Yuen et al. 2001&lt;sup&gt;16&lt;/sup&gt;</td>
<td>OARs applied in Chinese population of district hospital of Hong Kong</td>
<td>Yes</td>
<td>No</td>
<td>37</td>
<td>Yes</td>
<td>Yes</td>
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<td>Foot assessment</td>
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<tr>
<td>1999&lt;sup&gt;14&lt;/sup&gt;</td>
<td>Aginaga et al. 1999&lt;sup&gt;14&lt;/sup&gt;</td>
<td>Doctors applied OARs on adults in regional hospital in Spain</td>
<td>Yes</td>
<td>Yes</td>
<td>37.1</td>
<td>Not Reported</td>
<td>Yes No</td>
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<tr>
<td>1998&lt;sup&gt;15&lt;/sup&gt;</td>
<td>Auleley et al. 1998&lt;sup&gt;16&lt;/sup&gt;</td>
<td>Compared radiography request rates between senior house officers and nurse practitioners using OARs</td>
<td>Yes</td>
<td>Yes</td>
<td>34</td>
<td>Yes</td>
<td>0</td>
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<td>1995&lt;sup&gt;17&lt;/sup&gt;</td>
<td>Lucchesi et al. 1995&lt;sup&gt;18&lt;/sup&gt;</td>
<td>OARs applied on convenience sample of adults of suburban community teaching trauma centre in United States</td>
<td>Yes</td>
<td>Yes</td>
<td>35</td>
<td>Yes</td>
<td>Yes No</td>
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<tr>
<td>2001&lt;sup&gt;19&lt;/sup&gt;</td>
<td>Papacostas et al. 2001&lt;sup&gt;20&lt;/sup&gt;</td>
<td>OARs in athletes and people engaged in sport at least three times a week, injured during sports activities attending district general hospital and sports injuries clinic in Greece</td>
<td>Yes</td>
<td>Yes</td>
<td>29</td>
<td>Not Reported</td>
<td>Yes Yes</td>
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<td>1992&lt;sup&gt;21&lt;/sup&gt;</td>
<td>Stiell et al. 1992&lt;sup&gt;22&lt;/sup&gt;</td>
<td>Development of OARs in two university hospital emergency departments in Canada</td>
<td>Yes</td>
<td>Yes</td>
<td>35.1</td>
<td>Not Reported</td>
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<td>1993&lt;sup&gt;23&lt;/sup&gt;</td>
<td>Stiell et al. 1993&lt;sup&gt;24&lt;/sup&gt;</td>
<td>OARs applied in adults attending one of two university hospital emergency departments in Canada. Refinement of 1992 rules</td>
<td>Yes</td>
<td>Yes</td>
<td>35</td>
<td>Not Reported</td>
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<td>1993&lt;sup&gt;25&lt;/sup&gt;</td>
<td>Stiell et al. 1993&lt;sup&gt;26&lt;/sup&gt;</td>
<td>OARs applied in adults attending one of two university hospital emergency departments in Canada. Validation of refined rules</td>
<td>Yes</td>
<td>Yes</td>
<td>36</td>
<td>Not Reported</td>
<td>Yes No</td>
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<tr>
<td>1994&lt;sup&gt;27&lt;/sup&gt;</td>
<td>Stiell et al. 1994&lt;sup&gt;28&lt;/sup&gt;</td>
<td>Implementation study of OARs using refined 1993 OARs. OARs applied on adults attending university hospital in Canada</td>
<td>Yes</td>
<td>Yes</td>
<td>36</td>
<td>Yes</td>
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<td>2001&lt;sup&gt;29&lt;/sup&gt;</td>
<td>Yuen et al. 2001&lt;sup&gt;30&lt;/sup&gt;</td>
<td>OARs applied in Chinese population of district hospital of Hong Kong</td>
<td>Yes</td>
<td>No</td>
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<tr>
<td>2001&lt;sup&gt;31&lt;/sup&gt;</td>
<td>Chandra and Schafmayr 2001&lt;sup&gt;32&lt;/sup&gt;</td>
<td>OARs applied in adults attending city hospital in Germany</td>
<td>Yes</td>
<td>Yes</td>
<td>Not reported</td>
<td>No</td>
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<td>2001&lt;sup&gt;33&lt;/sup&gt;</td>
<td>Garces et al. 2001&lt;sup&gt;34&lt;/sup&gt;</td>
<td>OARs in two community hospitals in Spain</td>
<td>Yes</td>
<td>Yes</td>
<td>35.6</td>
<td>Not reported</td>
<td>Not reported Yes</td>
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<tr>
<td>2002&lt;sup&gt;35&lt;/sup&gt;</td>
<td>Glas et al. 2002&lt;sup&gt;36&lt;/sup&gt;</td>
<td>Compared OARs and Leiden ankle rule assessed in adults of mid-sized teaching hospital in Netherlands.</td>
<td>Yes</td>
<td>Yes</td>
<td>35</td>
<td>Yes</td>
<td>Yes Yes</td>
<td></td>
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<tr>
<td>1998&lt;sup&gt;37&lt;/sup&gt;</td>
<td>Keogh et al. 1998&lt;sup&gt;38&lt;/sup&gt;</td>
<td>Compared current local guidelines with OARs in patients &gt;16 years attending teaching hospital in United Kingdom</td>
<td>Yes</td>
<td>No</td>
<td>32</td>
<td>Yes</td>
<td>Yes No</td>
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<td>Criteria</td>
<td>OARs Applied</td>
<td>Clinical Examination</td>
<td>OARs Accuracy</td>
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<td>Mid-Foot</td>
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<td>Leddy et al 1998</td>
<td>78</td>
<td>OARs applied in patients &gt;12 years, attending university based community sports medical centre in the United States</td>
<td>Yes</td>
<td>No</td>
<td>23.4</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>McBride 1997</td>
<td>259</td>
<td>OARs applied in adults attending common practice with family doctors in community hospital in Canada</td>
<td>Yes</td>
<td>No</td>
<td>30.9</td>
<td>No</td>
<td>Not reported</td>
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<tr>
<td>Pigman et al 1994</td>
<td>71</td>
<td>OARs used by attending doctors and triage nurses in United States</td>
<td>Yes</td>
<td>No</td>
<td>35</td>
<td>Yes</td>
<td>Yes</td>
<td></td>
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<tr>
<td>Salt and Clancy 1997</td>
<td>324</td>
<td>OARs used by triage nurses at university hospital in United Kingdom. Radiography performed on discretion of treating doctor</td>
<td>Yes</td>
<td>Yes</td>
<td>Not reported</td>
<td>Yes</td>
<td>Not reported</td>
<td></td>
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<tr>
<td>Tay et al 1999</td>
<td>488</td>
<td>OARs in Asian population (Chinese, Malay, and Indian) attending large teaching hospital in Singapore</td>
<td>Yes</td>
<td>No</td>
<td>Not reported</td>
<td>Yes</td>
<td>No</td>
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<tr>
<td>Verma et al 1996</td>
<td>911</td>
<td>OARs applied in adults attending level 1 trauma centre in Cincinnati, United States</td>
<td>Yes</td>
<td>Yes</td>
<td>Not reported</td>
<td>Not reported</td>
<td>No</td>
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</table>

**Children**

<table>
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<tr>
<th>Study</th>
<th>Sample Size</th>
<th>Criteria</th>
<th>OARs Applied</th>
<th>Clinical Examination</th>
<th>OARs Accuracy</th>
<th>Ankle</th>
<th>Mid-Foot</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boutis et al 2001</td>
<td>607</td>
<td>Clinical examination compared with OARs to identify high risk diagnoses in children attending one of two urban, university affiliated paediatric emergency departments in Canada</td>
<td>Yes</td>
<td>No</td>
<td>12.5</td>
<td>No</td>
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<td>Chande 1995</td>
<td>68</td>
<td>OAR applied in children enrolled within 48 hours after injury at University Hospital of Cleveland, United States</td>
<td>Yes</td>
<td>No</td>
<td>12</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>Karpas et al 2002</td>
<td>186</td>
<td>Paediatric emergency department nurses applying OARs within 48 hours after injury in children attending tertiary care facility in United States</td>
<td>Yes</td>
<td>No</td>
<td>13</td>
<td>No</td>
<td>Yes</td>
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<tr>
<td>Libetta et al 1999</td>
<td>761</td>
<td>OARs applied in children &gt;1 year old, attending large teaching hospital in United Kingdom</td>
<td>Yes</td>
<td>No</td>
<td>11</td>
<td>Not reported</td>
<td>No</td>
</tr>
<tr>
<td>McBride 1997</td>
<td>37</td>
<td>OARs applied in children attending common practice with family doctors in community hospital in Canada</td>
<td>Yes</td>
<td>No</td>
<td>13.2</td>
<td>No</td>
<td>Not reported</td>
</tr>
<tr>
<td>Plint et al 1999</td>
<td>559</td>
<td>OARs applied in children attending one of two specialist tertiary care units in Canada within 48 hours after injury. Ankle assessment</td>
<td>Yes</td>
<td>No</td>
<td>12.6</td>
<td>Not reported</td>
<td>Yes</td>
</tr>
<tr>
<td>Plint et al 1999</td>
<td>205</td>
<td>OARs applied in children attending one of two specialist tertiary care units in Canada within 48 hours after injury. Foot assessment</td>
<td>Yes</td>
<td>No</td>
<td>12.6</td>
<td>Not reported</td>
<td>Yes</td>
</tr>
</tbody>
</table>

**TABLE 2 - A SYSTEMATIC REVIEW BY BACHMANN ET AL (2003) ASSESSING THE ACCURACY OF THE OTTAWA ANKLE RULES FOR EXCLUDING FRACTURES OF THE ANKLE AND MID-FOOT**