

# Diagnostic Imaging Pathways - Paediatric, Injury (Non-Accidental)

## Population Covered By The Guidance

This pathway provides guidance on imaging a child suspected at risk of 'non accidental injury'.

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## Quick User Guide

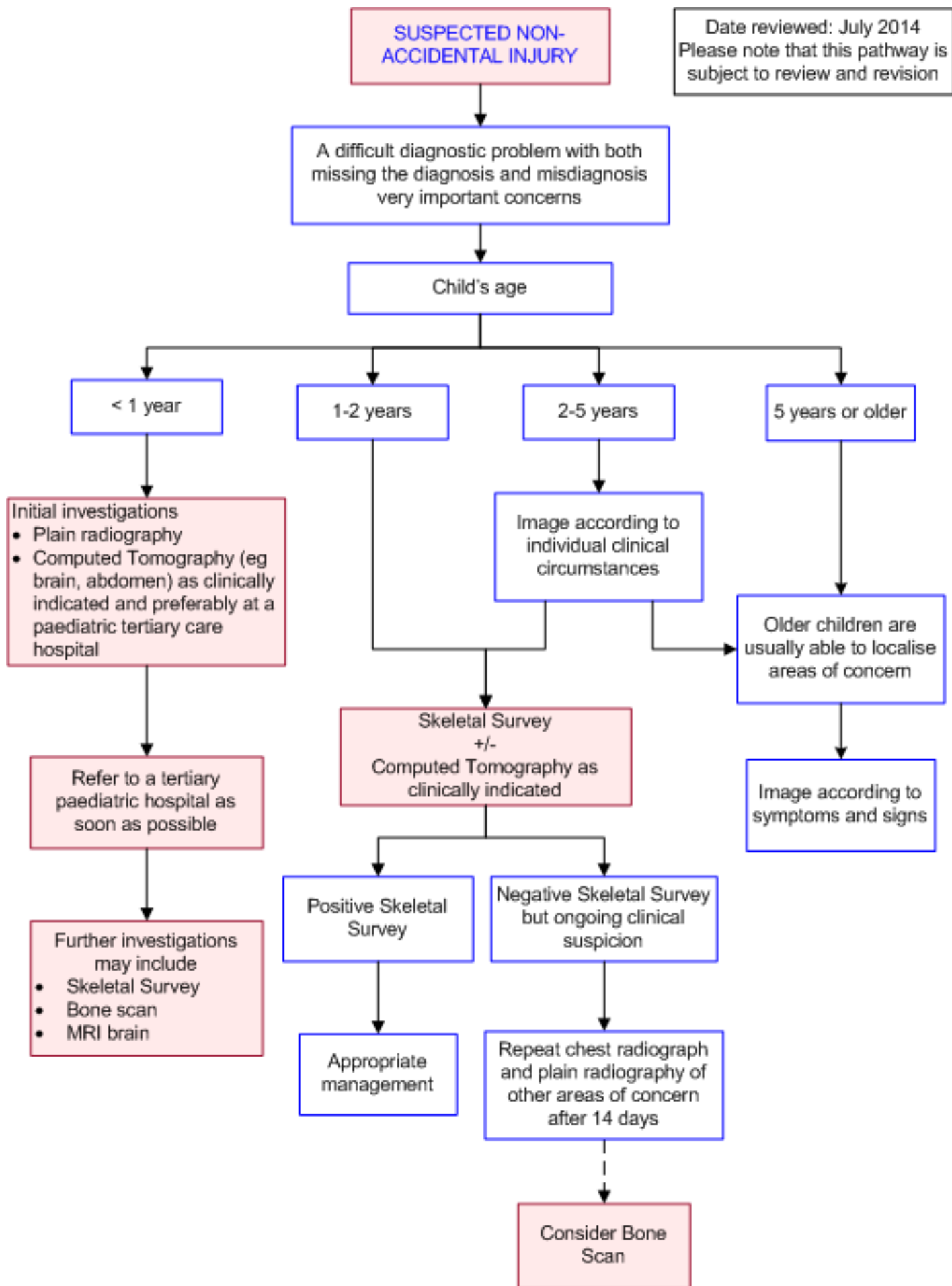
Move the mouse cursor over the PINK text boxes inside the flow chart to bring up a pop up box with salient points.

Clicking on the PINK text box will bring up the full text.

The relative radiation level of each imaging investigation is displayed in the pop up box.

SYMBOL	RRL	EFFECTIVE DOSE RANGE
	None	0
	Minimal	< 1 millisieverts
	Low	1-5 mSv
	Medium	5-10 mSv
	High	>10 mSv

## Pathway Diagram



## Image Gallery

*Note: These images open in a new page*

1a



### Acute Tibial Fracture and Healing Radial Fracture

Image 1a, 1b and 1c (Part of Skeletal Survey): Acute 9cm spiral fracture affecting the mid to distal shaft of the left tibia with slight posterior displacement (arrows). A healing left distal radial fracture of a few weeks duration is also noted (arrow). No other abnormalities were seen on the other films comprising the skeletal survey which are not illustrated here.

1b



1c



## Teaching Points

- Situations that evoke suspicion of non-accidental injury in children include
  - Fractures which raise suspicion for non-accidental injury eg rib fractures in young children and metaphyseal, corner or bucket handle fractures
  - Skull fractures without a history of trauma
  - Fractures of varying ages
  - Injuries which are not consistent with the history proffered
- If NAI is suspected it is important to seek specialist advice from a child protection unit at a major tertiary paediatric centre
- Investigations that may be utilised include plain radiographs, skeletal survey, computed tomography and bone scan

## Radionuclide Bone Scan

- Has a complementary role with plain radiography in the evaluation of suspected non-accidental injury [9](#)

- Some injuries are shown on radiography and not on bone scan and vice-versa [9-14](#)
- Although there is no gold standard investigation for comparison, it is generally considered that both skeletal survey and bone scan have a reasonably high sensitivity for non-accidental injury with the skeletal survey having a higher specificity compared to bone scan
- If bone scan is performed as first line, confirmatory radiographs of abnormal areas on bone scintigraphy must be performed to rule out false-positive findings [15](#)
- In general most cases of suspected non-accidental injury will initially have a skeletal survey followed by a bone scan if there is still diagnostic uncertainty and ongoing high suspicion
- Some advocate that all children with suspected non-accidental injury should have both a skeletal survey and bone scan [9](#)
- Limitations compared to skeletal survey
  - Often requires sedation
  - Higher cost
  - Higher radiation exposure
  - More limited availability
  - Lower specificity compared to skeletal survey
  - Higher incidence of false-negative results for skull fractures, metaphyseal and epiphyseal fractures [15](#)
- Advantages compared to skeletal survey
  - Identifies rib fractures and acute fractures not easily seen visible on skeletal survey [15](#)

## Skeletal Survey

- Skeletal survey protocols vary slightly between centres but commonly comprise of [16,17](#)
  - Skull - AP and lateral films. Additional views if needed eg. Townes film if occipital injury suspected
  - Thorax - Routine AP. Oblique views of the ribs increase diagnostic yield of rib fractures
  - Abdomen - AP film with pelvis and hips
  - Cervical and lumbar spine - lateral +/- AP film
  - Long bones of upper and lower limbs - routine AP films. Additional views if required e.g. views centred on joints or lateral views
  - Hands and feet - PA hands. AP feet
- The aim of the skeletal survey is to identify fractures that assist in making the diagnosis of non-accidental injury and to enable documentation of injuries
- The skeletal survey is generally considered mandatory in all cases of suspected NAI for children younger than 2 but has little value in children over 5, who can normally localise areas of concern. Imaging of children aged between 2-5 should be handled on an individual basis [7](#)
- "Babygrams" in which many bones are x-rayed on the one film is not recommended due to low sensitivity and high radiation dose
- Repeating the skeletal survey two weeks after the initial study may increase the diagnostic yield, clarifies tentative findings on the first survey and gives additional information on the age of the fracture [8,15](#)
- Skeletal surveys predominantly miss rib fractures, periosteal injury and rare fractures of the pelvis or foot. Hence, routine oblique views of the ribs has been recommended as part of a skeletal survey [15](#)

## Suspected Non-Accidental Injury in Children

- Is a difficult diagnostic problem with both missing the diagnosis and misdiagnosis very important concerns [1](#)
- Situations that evoke suspicion of non-accidental injury in children include [1-5](#)
  - Fractures that are specific for non-accidental injury eg rib fractures in young children and metaphyseal, corner, or bucket handle fractures
  - Skull fractures without a history of trauma
  - Fractures of varying ages
  - Injuries which are not consistent with the history proffered
- Consideration of the differential diagnosis of non-accidental injury is important to avoid misdiagnosis [6](#)

## References

References are graded from Level I to V according to the Oxford Centre for Evidence-Based Medicine, Levels of Evidence. [Download the document](#)

- [1.](#) Kleinman PL, Kleinman PK, Savageau J. **Suspected infant abuse: radiographic skeletal survey practices in pediatric health care facilities.** Radiology. 2004;233:477-85. (Level III evidence). [View the reference](#)
- [2.](#) Kenney IJ. **Doubt, difficulties and practicalities in the diagnosis of non-accidental injury - a personal view.** Imaging. 2001;13:295-301. (Review article)
- [3.](#) Barsness KA, Cha E, Bensard DD, et al. **The positive predictive value of rib fractures as an indicator of nonaccidental trauma in children.** J Trauma. 2003;54:1107-10. (Level III evidence)
- [4.](#) Bulloch B, Schubert CJ, Brophy PD, et al. **Cause and clinical characteristics of rib fractures in infants.** Pediatrics. 2000;105:E48 (Level III evidence)
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- [7.](#) American Academy of Pediatrics. **Diagnostic imaging of child abuse.** Pediatrics. 2000;105:1345-8. (Evidence based recommendations). [View the reference](#)
- [8.](#) Kleinman PK, Nimkin K, Spevak MR, et al. **Follow-up skeletal surveys in suspected child abuse.** AJR Am J Roentgenol. 1996;167:893-6. (Level III evidence)
- [9.](#) Mandelstam SA, Cook D, Fitzgerald M, Ditchfield MR. **Complementary use of radiological skeletal survey and bone scintigraphy in detection of bony injuries in suspected child abuse.** Arch Dis Child. 2003;88:387-90. (Level III evidence)
- [10.](#) Conway JJ, Collins M, Tanz RR, et al. **The role of bone scintigraphy in detecting child abuse.** Semin Nucl Med. 1993;23:321-33. (Review article)
- [11.](#) Ablin DS, Greenspan A, Reinhart MA. **Pelvic injuries in child abuse.** Pediatr Radiol. 1992;22:454-7. (Level IV evidence)
- [12.](#) Jaudes PK. **Comparison of radiography and radionuclide bone scan in the detection of child abuse.** Pediatrics. 1984;73:166-8. (Level III evidence)
- [13.](#) Haase GM, Ortiz VN, Sfakianakis GN, Morse TS. **The value of radionuclide bone scanning in the early recognition of deliberate child abuse.** J Trauma. 1980;20:973-5. (Level IV evidence)
- [14.](#) Sty JR, Starshack RJ. **The role of bone scintigraphy in the evaluation of the suspected abused child.** Radiology. 1983;146:369-75. (Level III evidence)
- [15.](#) Kemp AM, Butler A, Morris S, et al. **Which radiological investigations should be performed to identify fractures in suspected child abuse?** Clin Radiol. 2006;61:723-36. (Review article)
- [16.](#) The British Society of Paediatric Radiology. **Standard for skeletal surveys in suspected non-accidental injury (NAI) in children.** Accessed August 2008. [View the reference](#)



17. American College of Radiology. **Practice guideline for skeletal surveys in children.** Accessed December 2014. [View the reference](#)

## Further Reading

1. Kleinman PK (ed). **Diagnostic imaging of child abuse, 2nd ed.** Mosby, St. Louis, 1998.

## Information for Consumers

Information from this website	Information from the Royal Australian and New Zealand College of Radiologists' website
<p><a href="#">Consent to Procedure or Treatment</a></p> <p><a href="#">Radiation Risks of X-rays and Scans</a></p> <p><a href="#">Bone Scan</a></p> <p><a href="#">Computed Tomography (CT)</a></p> <p><a href="#">Magnetic Resonance Imaging (MRI)</a></p> <p><a href="#">Plain Radiography (X-ray)</a></p>	<p><a href="#">Computed Tomography (CT)</a></p> <p><a href="#">Magnetic Resonance Imaging (MRI)</a></p> <p><a href="#">Plain Radiography/X-rays</a></p> <p><a href="#">Radiation Risk of Medical Imaging for Adults and Children</a></p> <p><a href="#">Children's (Paediatric) X-ray Examination</a></p> <p><a href="#">Making Your Child's Test or Procedure Less Stressful</a></p>

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