



The British Society of  
Paediatric Radiology

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## Standard for skeletal surveys in suspected non-accidental injury (NAI) in children

### Introduction

A skeletal survey is a series of radiographic images, which encompass the entire skeleton or anatomical regions appropriate for the clinical indications.

The radiographic skeletal survey is the principal radiological investigation in suspected child abuse. It is frequently critical to diagnosis and is frequently presented as evidence in child protection cases, criminal proceedings and other types of litigation.

The standard is required to help advance the science of radiology and to improve the quality of the radiology service to patients.

### Indications

- Suspected physical NAI in infants and young children. Occult injury is rare > 3 yrs age.
- To exclude NAI in siblings (under 3 years of age) of children with proven NAI.

### Technical requirements for technique

- Quality of equipment: radiographic equipment should include a general purpose radiographic unit equipped with a small focal spot.
- Film requirements: a high contrast general film system designed for extremity use with a speed of no more than 200 and a limiting resolution of at least 10 line pairs per millimetre is required for all anatomical regions in infants. Increasingly computed radiography systems are being used to obtain X-rays on children. Suitable computed radiography systems (including standard resolution imaging plates) may be used for skeletal surveys if they have dedicated paediatric software. Soft copy reporting is advisable to maximise the image quality of the system. A low absorption cassette or front plate is recommended to maximise radiographic detection. These systems should be used without a grid. Beyond infancy, faster general purpose systems will be required for the thicker body regions e.g. lumbar spine.
- Quality of imaging: the skeletal survey examination should be performed in accordance with principles of high quality diagnostic radiography. These include proper technique factors, positioning, collimation, side markers, image identification, restraining methods and patient shielding.

## Personnel requirements

- Radiographers trained in paediatric radiography techniques should perform skeletal surveys in children.
- Appropriately trained radiographic staff must be available in all radiology departments where children are imaged.

## Procedural standards

1. The areas that should be demonstrated will depend on the particular clinical indication.
2. Suspected NAI: each anatomical area should be imaged with a separate radiographic exposure to ensure uniform image density and minimise image unsharpness.
3. X-rays should be exposed to show soft tissue and bone detail.
4. The limbs must be straight. Radiographs of each extremity should be at least of the frontal projection. Radiographs of the axial skeleton should be obtained in two projections if an abnormality is suspected (see Table 1).
5. X-rays (in 2 projections) of acute injury e.g. a fractured femur, should be done as an emergency as required. A skeletal survey should be done on the next working day, not as an emergency on call.
6. If practical, the views of the lower legs should be obtained before Gallows traction is applied. If this is not practical, the lower limb x-rays can be obtained at a later time.
7. It is important to obtain high quality radiographs for the skeletal survey, which are best obtained in normal working hours after the child has received adequate analgesia.
8. The paediatrician is responsible for explaining to the child's carers why a skeletal survey is necessary.
9. The skeletal survey should be performed by two people working together, and with the child at all times. The films should have the correct name and correct side markers, and the date and time of the examination should be clearly marked.
10. The radiographer should sign the technical detail card. To ensure continuity of evidence, the person (parent or nurse) identifying the child to the radiographer should also sign the technical detail record (1).
11. The radiographers should bring the films to a designated consultant radiologist for immediate review so that further views may be obtained as required.
12. The radiology report should document all sites of suspected or definite abnormality. When patterns of injury raise strong suspicion of NAI this should be stated in the report.
13. Doubtful areas should be commented upon and arrangements made for further follow-up films. (eg an interval CXR at 2-3 weeks may reveal healing rib fractures

that were not identifiable on the initial CXR, or periosteal reaction in a suspect long bone).

14. Delayed films (1-2 weeks later) may be needed to help date injuries.

15. The report should be communicated urgently to the referring clinician.

### Targets for outcome

There is insufficient good quality evidence to set a performance target. A literature search through Medline and Embase revealed one study containing relevant information (2). This study gives an indication of the accuracy level that is attainable in radiographic diagnosis of non-accidental injury in children. These figures relate to screen-film radiography, not digital systems.

Outcome	Indication	(95% confidence intervals)
Accuracy	93%	(88% to 98%)
Sensitivity	80%	(75% to 85%)
Specificity	98%	(95% to 100%)

The number of subjects is small (n=20) and the study population is not representative of the clinical environment of radiographic reporting by clinical radiologists. The study group is not representative because 50% of the cases in the series were proven to be child abuse. The percentage of child abuse cases is much lower in clinical practice. Also there was no measure

of inter-observer variability in the study. The data required to calculate the figures from the study were not published and cannot be checked.

### Future development

The development of digital radiographic systems and PACS systems may have an impact on some of the radiographic aspects of the standard.

### References

- (1) Guidance for the provision of forensic radiography services. 1999. The college of radiographers. 2 Carriage Row, 183 Eversholt St., LONDON NW1 1BU
- (2) Skeletal surveys for child abuse: comparison of interpretation using digitised images and screen-film radiographs. Youmans DC et al. American Journal of Radiology 1998; 171: 1415-1419.
- (3) Kleinman PK. Diagnostic imaging of child abuse. 1998. Mosby p 238, 422-423.

### Table 1: Skeletal survey in NAI (3):

A single film ('baby gram') should be avoided as it gives an unsatisfactory exposure and combined views of chest abdomen pelvis and limbs should also be avoided. Limb detail is poor, with oblique projections of most joints.

#### Skull (SXR)

AP and lateral, plus Towne's view for occipital injury.

SXRs should be taken with a skeletal survey even if a CT scan has been performed.

#### Body:

AP/frontal chest (including clavicles)

Oblique views of the ribs (left and right)  
AP Abdomen with pelvis and hips

Spine:

Lateral spine - cervical and thoraco-lumbar

Limbs:

AP humeri, AP forearms

AP femurs, AP Tib/fib

PA hands and AP feet

Supplemented by:

- Lateral views of any suspected shaft fracture.
- Lateral coned views of the elbows/wrists/knees/ankles may demonstrate metaphyseal injuries in greater detail than AP views of the limbs alone. The consultant radiologist should decide this, at the time of checking the films with the radiographers.

Brain imaging:

CT (brain and bone windows) is the method of choice in the acute phase.

A linear skull fracture may not be identified on CT (on bone windows) - see SXR above.

Interval MRI may give greater detail of subdural haematomas and parenchymal injury.

There is a body of opinion among paediatric neuroradiologists in the UK that a CT brain scan should be included routinely with the skeletal survey in suspected NAI for all pre-mobile young children. It is recommended that a CT brain scan is considered for all small children in whom NAI is suspected - if CT is then judged not worthwhile or indicated in that individual case, it is advisable that this be documented in the notes.