No Brexit in Child Abuse imaging

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Department of Radiology
Emma Children’s Hospital – Academic Medical Center Amsterdam
Department of Forensic Medicine
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Program

• Update on RCR Guideline

• Current issues.
  – Failure to adhere to guideline
  – Need for follow-up
  – Brothers and sisters
  – Neuroimaging
  – Imaging modalities
  – Reporting

• Conclusion
The radiological investigation of suspected physical abuse in children
Skeletal Imaging: Initial study

- AP and lateral skull
- AP & L & R oblique chest
- AP abdomen and pelvis
- Lateral whole spine

- Upper limbs
  - AP humerus
  - AP radius/ulna
  - DP hand and wrist
  - Coned lateral elbow
  - Coned lateral wrist

- Lower limbs
  - AP femur
  - AP tibia/fibula
  - DP foot
  - Coned lateral knee
  - Coned lateral ankle
  - Coned AP ankle (mortise view)
Skeletal Imaging: Follow-Up study

– 11-14 days
  • Up to 28 days
  • If > 28 days, re-assess the child
– Abnormal/suspicious areas
– AP & L and R oblique chest
– AP humerus
– AP radius/ulna
– AP femur
– AP tibia/fibula
Neuro imaging

• CT
• At presentation
  – < 1yr if abuse suspected
  – ≥1yr if abnormal neurology
• 3D reconstruction
  – Bony windows
  – STILL do skull radiographs

• MRI
• Day 2 - 5
  – Abnormal CT
  – Normal CT plus abnormal neurology
• Include the entire spine
Boy, 8 months

- Unwell during feeding.
  - Failed resuscitation

- No natural cause of death
Pathology specimen

Histology
Failure to adhere to guideline

• RCR or ACR Guideline

ESPR adopts British guidelines for imaging in suspected non-accidental injury as the European standard

Amaka C. Offiah • Catherine Adamsbaum • Rick R. van Rijn
Observational Study of Skeletal Surveys in Suspected Non-accidental Injury

A. C. OFFIAH*, †, C. M. HALL †


50 consecutive skeletal surveys
Suspected Infant Abuse: Radiographic Skeletal Survey Practices in Pediatric Health Care Facilities

Patricia L. Kleinman, RT(R), MPH
Paul K. Kleinman, MD
Judith A. Savageau, MPH

Radiology 2004; 233:477–485
Radiology in suspected non-accidental injury: Theory and practice in the Netherlands

R.R. van Rijn\textsuperscript{a, *}, N. Kieviet\textsuperscript{b}, R. Hoekstra\textsuperscript{b}, H.G.T. Nijs\textsuperscript{c}, R.A.C. Bilo\textsuperscript{c}
Variation in Occult Injury Screening for Children With Suspected Abuse in Selected US Children’s Hospitals

**AUTHORS:** Joanne N. Wood, MD, MSHP,⁠^ab⁠ Chris Feudtner, MD, MPH, PhD,⁠^ab⁠ Sheyla P. Medina, BA,⁠^a⁠ Xianqun Luan, MS,⁠^a⁠ Russell Localio, MPH, PhD,⁠^a,c⁠ and David M. Rubin, MD, MSCE,⁠^a,b⁠
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**WHAT THIS STUDY ADDS:** Adherence to guidelines related to screening for occult fractures in young children diagnosed with physical abuse varies significantly among pediatric hospitals. Use of screening in infants who have injuries associated with a high likelihood of abuse also varies among pediatric hospitals.
Need for follow-up

• RCR Guideline:
  – After 2 weeks FU skeletal survey
  – No skull radiograph
Assessing the use of follow-up skeletal surveys in children with suspected physical abuse

Ranjodh Singh, B Phil, Janet Squires, MD, Janet B. Fromkin, MD, and Rachel P. Berger, MD, MPH, Pittsburgh, Pennsylvania
Boy, 7 weeks old

• Cough.
• Low oxygen saturation.
• Clinical diagnosis: Whooping cough.
• Bruises on left cheek
The Utility of Follow-up Skeletal Surveys in Child Abuse

**AUTHORS:** Nancy S. Harper, MD, Sonja Eddleman, RN, CFN, and Daniel M. Lindberg, MD, for the ExSTRA Investigators

**TABLE 1** Rates of Initial SS, FUSS, and Injury Identification

<table>
<thead>
<tr>
<th></th>
<th>0–24 mo(^a) (n = 1975)</th>
<th>&gt;24 mo(^a) (n = 915)</th>
<th>Total (n = 2890)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SS obtained</td>
<td>1750 (88.6)</td>
<td>299 (32.7)</td>
<td>2049 (70.9)</td>
</tr>
<tr>
<td>SS shows new injury</td>
<td>417 (23.8)</td>
<td>54 (18.1)</td>
<td>471 (23.0)</td>
</tr>
<tr>
<td>FUSS recommended</td>
<td>969 (55.4)</td>
<td>69 (23.1)</td>
<td>1038 (50.7)</td>
</tr>
<tr>
<td>FUSS obtained</td>
<td>752 (43.0)</td>
<td>44 (15.4)</td>
<td>796 (38.8)</td>
</tr>
<tr>
<td>FUSS shows new injury</td>
<td>119 (15.8)</td>
<td>5 (11.4)</td>
<td>124 (15.6)</td>
</tr>
<tr>
<td>FUSS reassuring</td>
<td>52 (6.9)</td>
<td>3 (7.1)</td>
<td>55 (6.9)</td>
</tr>
</tbody>
</table>
**WHAT THIS STUDY ADDS:** Across several centers, follow-up skeletal surveys revealed new information in \( \geq 20\% \) of cases and frequently affected the perceived likelihood of abuse, even in cases where the initial level of concern for abuse was moderate.

**TABLE 2** Rates of FUSS Recommendation and Completion and Rates of New Fracture Identification According to Initial Perceived Level of Concern for Abuse

<table>
<thead>
<tr>
<th>Initial Perceived Likelihood of Abuse</th>
<th>SS Obtained, ( n )</th>
<th>FUSS Recommended, ( n (%) )</th>
<th>FUSS Completed, ( n (%) )</th>
<th>New Fracture Identified, ( n (%) )</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Definitely not inflicted injury</td>
<td>78</td>
<td>6 (7.7)</td>
<td>3 (50.0)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>2. No concern for inflicted injury</td>
<td>345</td>
<td>39 (11.3)</td>
<td>25 (64.1)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>3. Mildly concerning for inflicted</td>
<td>306</td>
<td>113 (36.9)</td>
<td>82 (72.6)</td>
<td>6 (7.3)</td>
</tr>
<tr>
<td>injury</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Intermediately concerning for</td>
<td>270</td>
<td>158 (58.5)</td>
<td>119 (75.3)</td>
<td>7 (5.9)</td>
</tr>
<tr>
<td>inflicted injury</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Very concerning for inflicted</td>
<td>312</td>
<td>200 (64.1)</td>
<td>164 (82.0)</td>
<td>17 (10.4)</td>
</tr>
<tr>
<td>injury</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Substantial evidence of inflicted</td>
<td>321</td>
<td>238 (74.1)</td>
<td>181 (76.1)</td>
<td>41 (22.7)</td>
</tr>
<tr>
<td>injury</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. definite inflicted injury</td>
<td>417</td>
<td>285 (68.3)</td>
<td>222 (77.9)</td>
<td>53 (23.8)</td>
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<tr>
<td>Total</td>
<td>2049</td>
<td>1038 (50.7)</td>
<td>796 (76.6)</td>
<td>124 (15.6)</td>
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</table>
Need for follow-up

• Tip:
  – Book follow-up study at the time of initial skeletal survey!
Brothers and sisters
Prevalence of Abusive Injuries in Siblings and Household Contacts of Physically Abused Children

**AUTHORS:** Daniel M. Lindberg, MD, a,b Robert A. Shapiro, MD, c Antoinette L. Laskey, MD, MPH, d Daniel J. Pallin, MD, MPH, e,b Emily A. Blood, PhD, e and Rachel P. Berger, MD, MPH f for the ExSTRA Investigators

[Flowchart image showing the process of identifying and evaluating abuse]
<table>
<thead>
<tr>
<th>Age, (mo) (^a)</th>
<th><strong>Index Children</strong> (n = 2890) (%)</th>
<th><strong>Physically Abused Index Children</strong> (n = 627) (%)</th>
<th><strong>All Contacts</strong> (n = 1927)</th>
<th><strong>Contacts of Physically Abused Index Children</strong> (n = 479) (%)</th>
</tr>
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<tr>
<td>0–6</td>
<td>980 (33.9)</td>
<td>331 (52.8)</td>
<td>170 (8.8)(^b)</td>
<td>25 (5.2)</td>
</tr>
<tr>
<td>6–12</td>
<td>521 (18.0)</td>
<td>110 (17.5)</td>
<td></td>
<td>21 (4.4)</td>
</tr>
<tr>
<td>12–24</td>
<td>474 (16.4)</td>
<td>68 (10.8)</td>
<td>270 (14.0)</td>
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<td>24–60</td>
<td>634 (21.9)</td>
<td>102 (16.3)</td>
<td>839 (43.5)</td>
<td>221 (46.1)</td>
</tr>
<tr>
<td>60–120</td>
<td>281 (9.7)</td>
<td>16 (2.6)</td>
<td>617 (32.0)</td>
<td>115 (24.0)</td>
</tr>
<tr>
<td>Unknown</td>
<td>NA</td>
<td>NA</td>
<td>31 (1.6)</td>
<td>9 (1.9)</td>
</tr>
</tbody>
</table>

<table>
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<tr>
<th>Gender</th>
<th><strong>Index Children</strong> (n = 2890) (%)</th>
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<tr>
<td>Male</td>
<td>1687 (58.4)</td>
<td>355 (56.6)</td>
<td>871 (45.2)</td>
<td>208 (43.4)</td>
</tr>
<tr>
<td>Female</td>
<td>1203 (41.6)</td>
<td>272 (43.4)</td>
<td>874 (45.4)</td>
<td>223 (46.6)</td>
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<td>Unknown</td>
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<td>182 (9.4)</td>
<td>48 (10.0)</td>
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SS identified ≥1 abusive fracture in 16 of 134 contacts (11.9%, 95% CI 7.5–18.5).

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<th>Contacts n = 16 (%)</th>
<th>Fractures n = 51 (%)</th>
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<td>Ribs</td>
<td>9 (56)</td>
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<td>Hand/foot</td>
<td>4 (25)</td>
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<td>CML</td>
<td>3 (19)</td>
<td>10 (20)</td>
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<tr>
<td>Long bone&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3 (19)</td>
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The number of contacts does not sum to 16 because contacts with multiple types of fractures are counted more than once. CML, classic metaphyseal lesion.

<sup>a</sup> Long bones affected were humerus (2) and tibia (2).
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Among the 134 contacts meeting protocol criteria for SS, 16 (11.9%) were twins, and 9 of these (56.3%) had fractures on SS. Twins were significantly more likely than nontwin contacts to have a fracture identified on SS (odds ratio 20.1, 95% CI 5.8–69.9).
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**WHAT THIS STUDY ADDS:** Contacts of abused children with serious injuries have fractures identified on skeletal survey at significant rates. Twins are at substantially increased risk for fracture. Physical examination findings were not sensitive for fractures.
Other imaging modalities
Other imaging modalities

• Low dose CT:
  – Can be considered.
Other imaging modalities

- Low dose CT:
  - Can be considered.
  - Post-mortem routine
Other imaging modalities

• MRI:
  – Role unclear.
Other imaging modalities

• MRI:
  – Role unclear.
Other imaging modalities

• Ultrasound:
  – Can be considered for equivocal lesions.
Other imaging modalities

- Ultrasound:
  - Can be considered for equivocal lesions.

Sonographically detected costo-chondral dislocation in an abused child

* A new sonographic sign to the radiological spectrum of child abuse

A. J. Smeets, S. G. F. Robben and M. Meradji

Other imaging modalities

• Scintigraphy:

![No symbol]
Neuroimaging

• In suspected physical child abuse
  – Under 1-2 years perform neuro imaging.

• Acute setting ➔ CT
• Follow-up imaging ➔ MRI
Additional Injuries in Young Infants with Concern for Abuse and Apparently Isolated Bruises

Nancy S. Harper, MD¹, Kenneth W. Feldman, MD², Naomi F. Sugar, MD³,*, James D. Anderst, MD, MSCI⁴, and Daniel M. Lindberg, MD⁵,⁶, for the Examining Siblings To Recognize Abuse Investigators†

<table>
<thead>
<tr>
<th>Characteristics for study cohort, total = 146 infants</th>
<th>Any new injury identified, total = 73 infants, n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of bruises</td>
<td></td>
</tr>
<tr>
<td>1, n = 50</td>
<td>30 (60.0)</td>
</tr>
<tr>
<td>2-5, n = 76</td>
<td>32 (42.1)</td>
</tr>
<tr>
<td>6-10, n = 12</td>
<td>7 (58.3)</td>
</tr>
<tr>
<td>&gt;10, n = 8</td>
<td>4 (50.0)</td>
</tr>
</tbody>
</table>
Additional Injuries in Young Infants with Concern for Abuse and Apparentley Isolated Bruises

Nancy S. Harper, MD¹, Kenneth W. Feldman, MD², Naomi F. Sugar, MD³,* James D. Anderst, MD, MSCI⁴, and Daniel M. Lindberg, MD⁵,⁶, for the Examining Siblings To Recognize Abuse Investigators†

<table>
<thead>
<tr>
<th>Screening study</th>
<th>Total, n = 2890, n (%)</th>
<th>0-6 months, n = 980, n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SS obtained</td>
<td>2049 (70.9)</td>
<td>909 (95.3)</td>
</tr>
<tr>
<td>SS shows new injury</td>
<td>471 (16.3)</td>
<td>253 (25.8)</td>
</tr>
<tr>
<td>Neuroimaging obtained</td>
<td>1692 (58.5)</td>
<td>857 (87.4)</td>
</tr>
<tr>
<td>Neuroimaging shows new injury</td>
<td>727 (25.2)</td>
<td>368 (37.6)</td>
</tr>
<tr>
<td>Hepatic transaminases obtained</td>
<td>1538 (53.2)</td>
<td>708 (72.2)</td>
</tr>
<tr>
<td>Abdominal CT obtained</td>
<td>292 (10.1)</td>
<td>105 (10.7)</td>
</tr>
<tr>
<td>Abdominal imaging shows new injury</td>
<td>73 (2.5)</td>
<td>22 (2.2)</td>
</tr>
</tbody>
</table>
Reporting

• Preferably a paediatric radiologist.
  – Experience in child abuse imaging.
  – Knowledge of relevant literature.

• Mention child abuse in conclusion if suspected!
Conclusion
What imaging is required?

1. Imaging should always include skeletal survey in children under two years old and skeletal survey and computed tomography (CT) head scan in children under one year old. See Appendix A for the standards views to be obtained.

2. Children who are older than one year and have external evidence of head trauma and/or abnormal neurological symptoms or signs should also have a CT head scan.

3. Skeletal survey may occasionally be indicated in older children; this should be considered on a case-by-case basis.
What imaging is required?

4. Where a child is suspected of being the victim of physical abuse, the following children under two years old should also undergo imaging regardless of the findings from any physical examinations:
   - Any multiple birth sibling such as a twin, triplet or quad
   - Siblings and children living in the same household or family.

5. Children who have been abused may suffer other forms of injury including trauma to the chest and abdomen. The investigation of suspected abdominal and thoracic injuries in suspected physical abuse should be no different from the imaging used for accidental trauma and body CT is the imaging modality of choice.

6. Although it has been shown that CT has a greater sensitivity than radiography for the detection of rib (vertebral and scapular) fractures, there is currently insufficient evidence regarding which patients would benefit or the concurrent role of 3/4 view chest radiography. Consider chest CT when abuse is suspected and there is doubt regarding the nature of rib abnormality identified on chest radiograph(s).
Conclusion

• Follow the guideline
  – Feedback will lead to better studies.
    • Mention it in revision reports.
  – Education will lead to better studies.
  – Adopt the RCR guideline.
    • Like the ESPR.
danke für ihre aufmerksamkeit