ASK THE QUESTION

**Question 1:** In infants and children admitted with suspected physical abuse what is the appropriate timing of imaging as well as the timing of follow up imaging?

**Question 2:** In infants and children with either bruising or intracranial hemorrhage (ICH) and suspected child abuse, should routine screening for bleeding disorders be performed?

**Question 3:** In infants and children admitted with suspected physical abuse is it appropriate to get a CMP to screen for occult abdominal injury in all children and if so what is the threshold that should be used to trigger a follow-up confirmatory study (i.e. abdominal CT scan)?

**Question 4:** For infants and children admitted to the hospital with bony fractures concerning for abuse what is the appropriate lab evaluation to assess for other medical disorders that could result in or predispose to bony fractures?

**Objectives:**
- To determine appropriate use of skeletal surveys for infants and children admitted with concerns for abuse as well as timing of follow up imaging.
- To determine recommended screening labs for children with suspicion of child abuse and either bruising or intracranial hemorrhage (ICH).
- To determine the need for screening all patients admitted with suspected child abuse for occult abdominal trauma by obtaining a CMP and to determine what results from the CMP should trigger the ordering of an abdominal CT scan.
- To determine the appropriate lab evaluation for metabolic bone disease predisposing to fractures in infants and children admitted for fractures concerning for non-accidental trauma.

**Background:** The American Academy of Pediatrics recommends skeletal surveys in all children under 2 years of age with suspected physical abuse. Some studies suggest this imaging in older children as well. Additionally, a follow up skeletal survey is recommended approximately 2 weeks after the initial imaging is done when abuse is suspected.
Bruising is a common finding amongst pediatric patients and is often a reason for suspicion of child abuse, however, bruising may be the first sign of an underlying bleeding disorder. Pediatric patients with ICH are often evaluated for potential child abuse but this clinical finding may also be a sign of an underlying bleeding disorder. It is difficult for clinicians to determine which children should be screened for bleeding disorders and which specific labs should be sent.

Abusive abdominal trauma is the second leading cause of death among children who have been physically abused and may also lead to significant morbidity. It can be difficult to diagnosis abdominal trauma, especially in non-verbal children, leading to a significant risk of missing serious injuries if appropriate screening protocols are not in place. A 2007 statement published in Pediatrics by Kellogg simply states “Liver and pancreatic enzyme tests are helpful in screening children for abdominal trauma, especially when the child presents with acute symptoms or shortly after the incident has occurred.”

Child abuse and neglect is a significant health issue with implications for both under- and over-diagnosis. Fractures are the second most common manifestation of child abuse yet certain rare metabolic disorders may predispose to fractures resulting in a misdiagnosis of CAN. The AAP recommends consideration of metabolic bone disease in the differential diagnosis of fractures in children and advises that clinical evaluation should guide laboratory evaluation. It is recommended that calcium, phosphorous, and alkaline phosphatase levels be reviewed and that further evaluation with parathyroid hormone, vitamin D and urinary calcium excretion should be considered if there is evidence of osteopenia or metabolic bone disease on radiologic imaging.

SEARCH FOR EVIDENCE

Search strategies included research-based articles published in English over the last 30 years

Databases included PubMed

Key words/terms child abuse, non-accidental trauma, fracture, inflicted injury, imaging, skeletal survey, follow up, abdominal trauma, liver laceration, hepatic laceration, screening blood work, liver function tests, transaminases, metabolic bone disease, rickets, osteogenesis imperfecta, coagulopathy, bleeding disorders, bruising, intracranial hemorrhage

CRITICALLY ANALYZE THE EVIDENCE
**Question 1:** In infants and children admitted with suspected physical abuse what is the appropriate use of the skeletal survey (SS) as well as the timing of follow up imaging?

**Practice Recommendation:** Skeletal surveys should be performed in all children under 2 years of age and considered in children under 5 years of age with suspected child abuse. A follow up skeletal survey should be performed 2-3 weeks after the initial exam if abuse is strongly suspected. Strong Recommendation, Moderate Quality Evidence.

Three studies evaluated the use of skeletal surveys in the initial evaluation of a patient with suspected abuse. All recommend a skeletal survey for all patients ≤ 2 years of age with suspected abuse, with 1 suggesting utility for all patients ≤ 3 years. The AAP recommends a skeletal survey be completed for all patients ≤ 2 years of age with suspicion of child abuse.

All studies were retrospective though with overall strong sample sizes. 2/3 were single-center.

One retrospective study evaluated the utility of skeletal surveys in the 2nd year of life. 22% of SS in this study contributed new findings and the likelihood of new findings was the similar for ages 0-11mo and 12-23mo (22.7% vs 18.9%, p=0.45). This study’s findings support the AAP recommendation for use of skeletal surveys in all children under 2 years of age (Hansen et al., 2009).

A retrospective analysis examined a consecutive sample of children undergoing skeletal surveys and found that 10.8% of studies performed found new fractures not previously suspected. Infants <6mo had higher rates of positive studies compared to children >6mo (16.8% vs 6.8%, p<0.00) and children with suspected abusive head injuries had higher rates of positive skeletal survey results compared to children who had the study for other reasons (23% vs 9.1%, p<0.00). Half of the skeletal surveys performed changed the likelihood of a diagnosis of abuse (Duffy et al., 2011).

Finally, a third retrospective study with the largest sample size, covering 20 child abuse teams in the US, found that 78% of children with suspected abuse underwent a skeletal survey, 89% of which were ≤ 2 years old. 18% of skeletal surveys overall identified a new fracture. The percent of patients with new fractures identified via SS was similar for patients 12-24mo and those 24-36mo of age (12% vs 10.3%) (Lindberg et al., 2014)

4 studies evaluated the appropriate use of follow up skeletal surveys. The AAP currently recommends that a follow up skeletal survey be performed 10-21 days after the initial imaging study in cases of likely abuse.
The AAP recommendation for follow up studies originated from 2 small initial studies. In the first, 23 follow up SS were done out of 181 initial SS performed. Repeat imaging was performed about 2 weeks after the initial study. Indications for follow up studies were if fractures were noted on the original study that strongly suggested abuse, if fracture did not appear consistent with history, or if additional imaging or clinical findings strongly indicated abuse. Additional information was provided by the follow up SS in 13 cases (61%) and increased the total number of definite fractures from 70 to 89 (27%, p=0.005). 13 of 19 (68%) of additional fractures were not noted on initial SS, 6 were suspected but not definite (32%) (Kleinman et al., 1996).

The 2nd study on which the AAP recommendations are based was a prospective study with 48 follow up SS with a mean time between initial and follow up imaging of 21.4 days. Follow up studies were recommended if there were multiple fractures or fractures of varying age on initial SS, if fracture was inconsistent with history, if initial SS was concerning but not diagnostic, if physical exam or other imaging was consistent with child abuse. The follow up SS yielded additional information in 22/48 studies (46%). 27 previously unidentified fractures were found in 11 patients and 29 “tentative” findings were clarified in 15 patients. Follow up studies in 11 patients with normal initial SS yielded no new information. The diagnosis of child abuse was modified in 2 patients (Zimmerman et al., 2005).

A further prospective study had a large sample size to determine the proportion of follow up SS that yielded new findings. 77% of recommended follow up SS were performed, 16% of follow up studies demonstrated new fractures, more than half of which were a finding of multiple fractures. 7.1% of patients with a positive follow up SS had a negative initial SS. 7% of initial SS which had been felt to show fracture were determined to not be fracture in follow up. Overall new information was identified by follow up SS in 22% of subjects. Likelihood of abuse increased in 34% and decreased in 47% after follow up SS (Harper et al., 2012).

Finally, a retrospective descriptive study found that 11% of children with suspected abuse underwent follow up SS at a single institution. 75% of patients who underwent follow up SS had a positive initial SS and 46% had a diagnosis of “definite abuse”. 14% had a positive follow up SS. 8 cases with a positive follow up SS received a diagnosis of “definite abuse” after the follow up imaging, 6 of who had a negative initial SS (Singh et al., 2012).

<table>
<thead>
<tr>
<th>PICO Question # 1: In infants and children admitted with suspected physical abuse what is the appropriate use of the skeletal survey (SS) as well as the timing of follow up imaging?</th>
<th>Lower Quality Rating if:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Author/Date/Journal</strong></td>
<td>Duffy, S. O. et al (2011). Pediatrics,</td>
</tr>
<tr>
<td>Purpose of Study</td>
<td>Assess the use of the skeletal survey to</td>
</tr>
<tr>
<td>Study Design</td>
<td>Retrospective descriptive study</td>
</tr>
<tr>
<td>Sample &amp; Setting</td>
<td>Consecutive sample of all children</td>
</tr>
<tr>
<td>Outcomes</td>
<td>97.2% had SS performed (median age 8mo (4d-12y); 84% &lt;2yo, 15% 2y-5y);</td>
</tr>
<tr>
<td>Design Limitations</td>
<td></td>
</tr>
</tbody>
</table>

© Center for Evidence-Based Practice, 2014
Quality Management/Library, Medical University of South Carolina
<table>
<thead>
<tr>
<th>Reference</th>
<th>Study Design, Setting, and Participants</th>
<th>Study Objectives</th>
<th>Study Limitations</th>
<th>Level of evidence for studies as a whole</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hansen KK, Campbell KA.</td>
<td>Determine if skeletal surveys are less useful in the 2nd year of life</td>
<td>Retrospective review of children with skeletal surveys</td>
<td>Study Limitations = None</td>
<td>High</td>
</tr>
<tr>
<td>Child Abuse Negl May;33(5):278-281</td>
<td>Single institution study; 4 years data; 379 children with physical abuse &lt;24mo; comparison groups of 0-11mo and 12-23mo</td>
<td>95% had skeletal surveys completed (75% 0-11mo, 25% 12-23mo); 22% of studies added findings; added findings were similar between age groups; no statistically significant difference in utility of study in 1st year and 2nd year of life</td>
<td>Test not performed in representative spectrum of patients, Gold standard not applied to all patients, No independent, blind comparison between index test and gold standard, Other (i.e. descriptive, epidemiologic, case series, longitudinal, cross sectional, QI)</td>
<td>High</td>
</tr>
<tr>
<td>Lindberg DM, et al. J Pediatr 2014 Mar 12.</td>
<td>Determine rates of skeletal survey completion and injury identification as a function of age for children referred for child abuse</td>
<td>Retrospective secondary analysis of observational study 2609 subjects &lt;60mo enrolled in research network covering 20 US child abuse teams</td>
<td>78% of patients underwent skeletal survey (89% &lt;24mo, 45% 24-60mo); 458 subjects with new fracture identified by SS; % having new fracture similar for 12-24mo and 24-36mo</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>Study Limitations = None</td>
<td></td>
<td>Test not performed in representative spectrum of patients, Gold standard not applied to all patients, No independent, blind comparison between index test and gold standard, Other (i.e. descriptive, epidemiologic, case series, longitudinal, cross sectional, QI)</td>
<td>High</td>
</tr>
<tr>
<td>Study</td>
<td>Objective</td>
<td>Methodology</td>
<td>Results</td>
<td>Study Limitations</td>
</tr>
<tr>
<td>-------</td>
<td>-----------</td>
<td>-------------</td>
<td>---------</td>
<td>------------------</td>
</tr>
<tr>
<td>Kleinman PK, et al. AJR Am J Roentgenol 1996 Oct;167(4):893-896.</td>
<td>Assess additional yield of a repeat skeletal survey in identifying and dating skeletal injuries in suspected child abuse</td>
<td>Prospective case series</td>
<td>181 children over 5 year period with initial SS performed for suspected abuse; single institution</td>
<td>23 follow up SS performed approximately 2 weeks after initial study; 61% yielded additional information about presence and age; total number of definite fractures detected increased 27%; 13/19 new fractures not initially noted on initial SS, 6 fractures suspected on initial SS were considered definite on follow up</td>
</tr>
<tr>
<td>Zimmerman S, et al. Utility of follow-up skeletal surveys in suspected child physical abuse evaluations. Child Abuse Negl 2005 Oct;29(10):1075-1083.</td>
<td>Evaluate the utility of a follow up skeletal survey in suspected child abuse</td>
<td>Prospective case series</td>
<td>48 follow up SS performed over 2 years at a single institution</td>
<td>74 recommended follow up SS, 48 completed (65%); mean time between initial and follow up was 21.4 days; 22/48 (46%) of follow up studies had new information; 27 new fractures found in 11 patients, 29 tentative initial findings clarified in 15 patients; diagnosis of abuse modified in 2 patients; 11 follow up studies with normal initial had no new findings</td>
</tr>
<tr>
<td>Harper NS, et al. Determine</td>
<td>Prospective</td>
<td>2890 children</td>
<td>51% had follow up skeletal</td>
<td></td>
</tr>
</tbody>
</table>

- Diagnostic Studies
  - Insufficient sample size
  - Test not performed in representative spectrum of patients
  - Gold standard not applied to all patients
  - No independent, blind comparison between index test and gold standard

- Other (i.e. descriptive, epidemiologic, case series, longitudinal, cross sectional, QI)
  - Insufficient sample size
  - Study methods not clearly described
  - Methods or instruments used to measure the outcomes were not reliable or valid
  - Variables (confounders, exposures, predictors) were not described
  - Outcomes were not clearly described
  - Large losses to FU, if applicable
Question 2: In infants and children with either bruising or intracranial hemorrhage (ICH) and suspected child abuse, should routine screening for bleeding disorders be performed?

Practice Recommendation: Studies describe epidemiology of bleeding disorders among children who present with concern for abuse, but do not directly answer our PICO question. Therefore, in the absence of evidence, we recommend practicing within the parameters of the current AAP guidelines. Recommendations are as follows: For children who present with
bruising that is not OBVIOUSLY abuse or was not WITNESSED abuse, we recommend PT, aPTT, vWF antigen, vWF activity, Factor VIII, Factor IX, CBC. For children who present with ICH that was not WITNESSED abuse or other mechanism consistent with the injury we recommend PT, aPTT, Factor VIII, Factor IX, CBC, d-dimer, fibrinogen.

The Nelson study published in 1999 looked at the prevalence and incidence of intracranial hemorrhage in children with hemophilia. This 14 center longitudinal study included 333 patients age 6-19 with hemophilia. The prevalence of ICH was 12% at the time of study entry. As the patients were followed forward, the incidence rate of ICH was approximately 2% per year.

The Mishra study published in 2008 is a cohort study of 52 patients with congenital factor deficiencies and intracranial hemorrhage. Patients were age 1 month-22 years. Intracranial hemorrhage was the primary bleeding episode leading to detection of factor deficiency in 19.2% of patients suggesting that evaluating for factor deficiency in patients with intracranial hemorrhage is worthwhile and could lead to the diagnosis of previously undetected bleeding disorders.

The Jackson study published in 2012 is a 10 year retrospective chart review of patients at a Hemophilia treatment center to assess how often the initial presentation of hemophilia is concerning for abuse. 15.3% of the 189 children studied had an initial presentation that was concerning for abuse. These children ended up with a diagnosis of von Willebrand disease, or hemophilia in most cases. This study suggests that children with bleeding disorders may present with bruising/bleeding that is highly suggestive of NAT.

The O'Hare study published in 1984 is a cohort study of 50 children with suspected NAT who were investigated to exclude a bleeding disorder. 16% of the patients had abnormal results on lab evaluation (CBC, PT, PTT, fibrinogen, and bleeding time). This study suggests that evidence of a bleeding disorder is not uncommon in the setting of NAT and that the two conditions are not mutually exclusive.

### PICO Question #2: In infants and children with either bruising or intracranial hemorrhage (ICH) and suspected child abuse, should routine screening for bleeding disorders be performed?

<table>
<thead>
<tr>
<th>Author/Date/ Journal</th>
<th>Purpose of Study</th>
<th>Study Design</th>
<th>Sample&amp; Setting</th>
<th>Outcomes</th>
<th>Design Limitations</th>
</tr>
</thead>
</table>
| Nelson MD, Haemophilia 1999 | To determine the prevalence and incidence of ICH in a population of children with haemophilia | Secondary analysis of data collected in a multicenter longitudinal study | 14 center study of children born between 9/70-9/82 with history of frequent factor infusions. 333 male | Prevalence of ICH was 12%, incidence was 2% per year | Study Limitations = 
  ☑ None 
  Non-Experimental/Observational Studies (case-control, cohort, cross sectional, longitudinal, descriptive, epidemiologic, case study/series, QI, survey) 
  ☑ Insufficient sample size 
  ☑ Sample not representative of patients in the population as a whole |

Lower Quality Rating if:
- Studies inconsistent  
  (When there are differences in the direction of effect, the size of the differences of effect, and the significance of the differences that cannot be reasonably explained)
- Studies are indirect  
  (Your PICO question is quite different from the available evidence in)
<table>
<thead>
<tr>
<th>Mishra P, Haemophilia, 2008</th>
<th>Describe the presentation of ICH amongst a population of children with hemophilia (congenital factor deficiencies)</th>
<th>Retrospective study of data on patients with bleeding disorders who presented with ICH</th>
<th>52 patients with 57 episodes of ICH from 1998-2007.</th>
<th>ICH was the primary bleeding episode leading to detection of factor deficiency in 19.2% of patients. 38 were severe hemophiliacs (factor XIII, X, V deficiency and VWD)</th>
<th>Median age 8</th>
<th>Study Limitations = Non-Experimental/Observational Studies (case-control, cohort, cross sectional, longitudinal, descriptive, epidemiologic, case study/series, QI, survey)</th>
<th>Increase Quality Rating if: Large Effect</th>
<th>Level of evidence for studies as a whole:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jackson J, 2012 Child Abuse and Neglect</td>
<td>Describe children with congenital bleeding disorders that present in a manner concerning for NAT</td>
<td>10 year retrospective chart review of patients at a hemophilia treatment center</td>
<td>Single institution hemophilia treatment center. 189 children studied.</td>
<td>29 (15.3%) had initial presentation that was concerning for NAT, 75% of these were &lt;5 years of age, 44.8% had WWD, 51% had hemophilia, and 48% had family history of bleeding disorder. Children 9 mo-5 years more likely to present with findings concerning for abuse. No children had patterned bruising.</td>
<td>Infants and young mobile</td>
<td>Study Limitations = Non-Experimental/Observational Studies (case-control, cohort, cross sectional, longitudinal, descriptive, epidemiologic, case study/series, QI, survey)</td>
<td>Insufficient sample size Sample not representative of patients in the population as a whole Variables (confounders, exposures, predictors) were not described Outcome criteria not objective or were not applied in blind fashion Insufficient follow-up, if applicable For prognostic study, sample not defined at common point in course of disease/condition For diagnostic study, gold standard not applied to all patients For diagnostic study, no independent, blind comparison between index test and gold standard</td>
<td>High Moderate Low Very Low</td>
</tr>
<tr>
<td>O’Hare AE, 1984, Archives of Disease in Childhood</td>
<td>To determine the prevalence of bleeding disorders among children who present to single institution with suspected non-accidental injury.</td>
<td>Prospective cohort study</td>
<td>Single institution, 50 children referred consecutively over a two year period from Jan 81-Jan 83. All children had CBC, plt size, shape, pt, ptt, fibrinogen, BT</td>
<td>16% of the 50 children had abnormal results. Four of these children had a ptt. Study Limitations = Non-Experimental/Observational Studies (case-control, cohort, cross sectional, longitudinal, descriptive, epidemiologic, case study/series, QI, survey) ☑ Insufficient sample size ☑ Sample not representative of patients in the population as a whole ☑ Variables (confounders, exposures, predictors) were not described ☑ Outcome criteria not objective or were not applied in blind fashion ☑ Insufficient follow-up, if applicable ☑ For prognostic study, sample not defined at common point in course of disease/condition ☑ For diagnostic study, gold standard not applied to all patients ☑ For diagnostic study, no independent, blind comparison between index test and gold standard</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Question 3:** In infants and children admitted with suspected physical abuse is it appropriate to get a CMP to screen for occult abdominal injury in all children and if so what is the threshold that should be used to trigger a follow-up confirmatory study (i.e. abdominal CT scan)?

**Practice Recommendation:** Among hospitalized children with suspected child abuse, all patients (age ≤ 5) should have a screening CMP and order reflexive imaging (Abdominal CT scan) if either the AST or ALT is ≥80. Strong Recommendation; Moderate Quality Evidence.

The Coant study published in 1992 was one of the first studies to look at using liver enzymes as a screening tool in children with suspected physical abuse without clinical evidence of abdominal trauma. The authors included 49 patients, without evidence of
abdominal trauma after history and physical, who were seen in an ED for evaluation for suspected child abuse. 4 of these children had elevated transaminases and 3 of these 4 had liver lacerations on CT scan.

The Lindberg study published in 2009 is a prospective, multicenter observational study of children younger than 60 months who had been referred for subspecialty evaluation of possible physical abuse. 1272 of the 1676 patients had transaminase testing. Fifty-four of these patients ended up having identified abdominal injuries. A threshold of 80 for either AST or ALT gives a sensitivity of 77% and a specificity of 82%. 26% of the injuries with elevated transaminases were clinically occult.

The Gwirtzman Lane study published in 2009 was a retrospective chart review of children evaluated for abusive injury. Charts were reviewed to determine whether screening labs were drawn as well as results of labs and any injury identified. Only 20% of eligible children were screened. Forty-one percent had positive results. Five percent of children age 12 to 23 months had occult abdominal trauma identified through imaging studies.

The Lindberg study published in 2013 was a retrospective analysis of a multicenter study of children < 10 years old who were evaluated for physical abuse. Transaminases were obtained in 53% of the 2890 subjects. A threshold of 80 yielded a sensitivity of 83.8% and specificity of 83.1% for abdominal injury.

<table>
<thead>
<tr>
<th>Author/Date/ Journal</th>
<th>Purpose of Study</th>
<th>Study Design</th>
<th>Sample&amp; Setting</th>
<th>Outcomes</th>
<th>Design Limitations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coant PN et al. Pediatrics 1992</td>
<td>To evaluate the use of markers for abdominal trauma in the evaluation of cases of child physical abuse</td>
<td>Prospective case series</td>
<td>Single institution, children &lt;12 years of age presenting to ED between Aug 1989-April 1990 for suspected physical abuse with NO signs of abdominal injury after complete H&amp;P</td>
<td>Patients with NO sign of abdominal trauma by history or physical all had - liver transaminases - LDH - Alk Phos - Amylase - UA Of the 49 children enrolled, 4 had elevated transaminases and LDH, and 3 of these 4 had liver laceration documented on abdominal CT</td>
<td>Study Limitations = Non-Experimental/Observational Studies (case-control, cohort, cross sectional, longitudinal, descriptive, epidemiologic, case study/series, QI, survey) Insufficient sample size Sample not representative of patients in the population as a whole Variables (confounders, exposures, predictors) were not described Outcome criteria not objective or were not applied in blind fashion Insufficient follow-up, if applicable For prognostic study, sample not defined at common point in course of disease/condition For diagnostic study, gold standard not established</td>
</tr>
</tbody>
</table>

Lower Quality Rating if:
- Studies inconsistent (When there are differences in the direction of effect, the size of the differences of effect, and the significance of the differences that cannot be reasonably explained)
- Studies are indirect (Your PICO question is quite different from the available evidence in regard to population, intervention, comparison, or outcome)
- Studies are imprecise (When studies include few patients and few events)
<table>
<thead>
<tr>
<th>Study</th>
<th>Objective</th>
<th>Study Design</th>
<th>Methods</th>
<th>Results</th>
<th>Study Limitations = Non-Experimental/Observational Studies (case-control, cohort, cross sectional, longitudinal, descriptive, epidemiologic, case study/series, QI, survey)</th>
<th>Level of evidence for studies as a whole:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lindberg D. et al. Pediatrics 2009</td>
<td>To determine the sensitivity and specificity of routine transaminase testing in young children who underwent consultation for physical abuse.</td>
<td>Prospective, multicenter, observational study</td>
<td>1272 (out of 1676) children &lt;60 months who were referred for subspecialty evaluation of possible physical abuse had transaminase testing. The CAP team recommended screening transaminases routinely as standard of care for all cases with reasonable concern for physical abuse</td>
<td>54 of the 1676 had identified abdominal injuries. Using a threshold level of 80 for either AST or ALT yielded a sensitivity of 77% and a specificity of 82%. 26% of injuries associated with elevated transaminases levels were clinically occult (no abdominal bruising, tenderness, or distention).</td>
<td>Study Limitations = Non-Experimental/Observational Studies (case-control, cohort, cross sectional, longitudinal, descriptive, epidemiologic, case study/series, QI, survey)</td>
<td>Increase Quality Rating if:</td>
</tr>
<tr>
<td>Gwirtzman Lane et al. Pediatrics 2009</td>
<td>To determine the prevalence of occult abdominal trauma in a sample of children with suspected physical abuse, to assess the frequency of screening, and to assess factors</td>
<td>Single center Retrospective chart review</td>
<td>244 children 0 to 5 years of age who were seen in the pediatric ED and diagnosed as having definite or possible physical abuse but without suggestion of</td>
<td>Only 20% of eligible children had screening labs obtained. Of those screened, positive results were identified for 41%. But only a subset (n=9) underwent confirmatory testing. 5 of these had injuries identified. Children with &quot;probable abusive head trauma were more likely to have screening labs. Consultation</td>
<td>Study Limitations = Non-Experimental/Observational Studies (case-control, cohort, cross sectional, longitudinal, descriptive, epidemiologic, case study/series, QI, survey)</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Moderate</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Very Low</td>
</tr>
<tr>
<td>Lindberg DM et al Pediatrics 2013</td>
<td>To prospectively validate the test characteristics of the 80 threshold (for AST or ALT) and to determine the utility of amylase and lipase to detect occult abdominal injury.</td>
<td>Retrospective analysis of a multicenter prospective study’s data.</td>
<td>Multicenter, children younger than 10 who underwent subspecialty evaluation for physical abuse.</td>
<td>Abdominal injuries were identified in 82 of 2890 subjects. Transaminases were obtained in 1538 subjects. A threshold of 80 had sensitivity of 83% and specificity of 83% with AUC 0.87. Amylase and lipase had AUC of 0.67 and 0.72.</td>
<td>Study Limitations = Non-Experimental/Observational Studies (case-control, cohort, cross sectional, longitudinal, descriptive, epidemiologic, case study/series, QI, survey)</td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Question 4:** For infants and children admitted to the hospital with bony fractures concerning for abuse what is the appropriate lab evaluation to assess for other medical disorders that could result in or predispose to bony fractures?

**Practice Recommendation:** Serum calcium, phosphorous, and alkaline phosphatase should be performed on children admitted with a fracture suspicious for abuse. Abnormalities in initial studies or radiographic appearance of bone suspicious for metabolic bone disease should prompt further evaluation with parathyroid hormone level, 25-hydroxyvitamin D level and urinary calcium excretion. Testing for osteogenesis imperfecta should be pursued only if clinical findings or family history supports this diagnosis and there are no other signs of abuse. Weak Recommendation, Low Quality Evidence.

Evidence is slim due to rare outcomes. 2 studies evaluated the utility of testing for osteogenesis imperfect (OI) and one study provides evidence on testing vitamin D status.
In one systematic review, 5 studies were included with 155 cases in which child abuse was the incorrect diagnosis for a patient with metabolic bone disease. 80% of misdiagnoses were OI, all either OI or metaphyseal dysplasia. Most patients with OI had either abnormal physical exam findings or a family history of multiple fractures or OI. Based on this systematic review, we can make a weak recommendation that genetic evaluation for osteogenesis imperfecta be completed if the clinical and historical variables are suggestive but the prevalence is too low for testing to be useful unless clinical findings are suggestive (Pandya et al).

Similarly, the retrospective chart review had limited numbers. Of 262 children for whom OI testing was performed, only 11 were definitively diagnosed with OI, 11 with indeterminate testing. Most (10/15 with possible OI and full documentation) had clinical suspicion of OI but no combination of clinical factors identified all patients with OI. No children with other signs of abuse were diagnosed with OI (Marlowe et al).

Finally, a cross-sectional observational study evaluated vitamin D status in children admitted with fractures. 118 subjects were enrolled and had vitamin D testing. 8% were vitamin D deficient, 31% vitamin D insufficient. Patients who were vitamin D deficient and insufficient were more likely to have low calcium (p=0.002) and high alkaline phosphatase (p=0.05) values. Vitamin D sufficiency was not correlated with diagnosis of abuse (p=0.32) or presence of multiple (p=0.24) fractures. This study suggests that it is unlikely that vitamin D status accounts for fractures felt due to abuse (Schilling et al).

| PICO Question # 4: For infants and children admitted to the hospital with bony fractures concerning for abuse, what is the appropriate lab evaluation to assess for other medical disorders that could result in or predispose to bony fractures? |
|---|---|---|---|---|---|
| Author/Date/Journal | Purpose of Study | Study Design | Sample & Setting | Outcomes | Design Limitations |
| Pandya NK, et al. *Clin Orthop Relat Res* 2011 Mar;469(3):805-812. | Systematic review of literature to address 1) what diseases/conditions cause easy fracture can be confused with CAN? 2) What types of OI are most commonly confused with CAN and why? 3) What specific | Systematic review | Pooled studies included 914 patients, 155 mistakenly identified as CAN | 5 studies identified for review: 914 patients, 155 mistaken cases of CAN. All mistaken cases either metaphyseal dysplasia or OI. 73% had abnormal scleral color, 50% positive family history of multiple fractures, 37% had family history of OI. Patients with OI were more likely to have multiple fractures on presentation or radiographic evidence of old. | Study Limitations = None. Systematic Review. Important, relevant studies were likely missed. Inappropriate inclusion criteria. Included studies not valid for question asked. Results of studies were inconsistent. Other (i.e. descriptive, epidemiologic, case |

© Center for Evidence-Based Practice, 2014
Quality Management/Library, Medical University of South Carolina
<table>
<thead>
<tr>
<th>Study</th>
<th>Question</th>
<th>Design</th>
<th>Population</th>
<th>Findings</th>
<th>Study Limitations</th>
<th>Recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marlowe A, et al. (2002)</td>
<td>To examine if laboratory testing for osteogenesis imperfecta identifies children unrecognized in whom NAT is considered as the cause of fracture</td>
<td>Retrospective case review</td>
<td>262 children (fracture felt due to NAT with OI testing performed); case information reviewed by pathologists examining tissue samples for OI; 138 children had sufficient documentation to establish if OI could be diagnosed clinically</td>
<td>11 out of 262 identified as having OI; in 11 could not exclude OI; 15 with OI or undetermined had full documentation-of those 10/15 suspected OI clinically but no combination of clinical factors distinguished all affected from unaffected; no child with other evidence of abuse was identified as having OI</td>
<td>Study Limitations = None</td>
<td></td>
</tr>
<tr>
<td>Schilling S, et al.</td>
<td>Examine Vit D</td>
<td>Cross-sectional</td>
<td>Children &lt;2y</td>
<td>118 enrolled subjects; 8%</td>
<td>Study Limitations = Few patients and few events and thus have wide confidence intervals and the results are uncertain</td>
<td></td>
</tr>
</tbody>
</table>

Level of evidence for studies as a whole:
- High
- Moderate
- Low
- Very Low
levels in children with suspected abusive and accidental fractures, single and multiple fractures, and fracture types highly associated with inflicted trauma | sectional observational | admitted at single institution with fracture over 1 year period | vitamin D deficient; 31% Vit D insufficient, 61% Vit D sufficient; Vit D def and Vit D insuff more likely to have low Ca and elev alk phos than Vit D suff; Vit D insuff and def not more common in abused children or those w multiple fractures |

**APPLY THE EVIDENCE**

- Evidence supports the AAP policy for skeletal surveys in all children \( \leq 2 \) years with a concern for child abuse. Skeletal surveys should be strongly considered for children age 2-3 years with concern for abuse.

- Literature supports that new information can be obtained through the use of follow up skeletal surveys 2-3 weeks after the initial study in children evaluated for child abuse.

- In the absence of high quality evidence, we recommend practicing within the parameters of the current AAP guidelines. Recommendations are as follows: For children who present with bruising that is not OBVIOUSLY abuse or was not WITNESSED abuse, we recommend PT, aPTT, vWF antigen, vWF activity, Factor VIII, Factor IX, CBC. For children who present with ICH that was not WITNESSED abuse or other mechanism consistent with the injury we recommend PT, aPTT, Factor VIII, Factor IX, CBC, d-dimer, fibrinogen.

- Among hospitalized children with suspected child abuse, all patients (age \( \leq 5 \)) should have a screening CMP and the provider should order imaging (Abdominal CT scan) if either the AST or ALT is \( \geq 80 \).

- There is limited evidence to support investigation into metabolic bone disease in the setting of fractures suspicious for abuse. Studies are limited by rare outcomes.
AAP and expert opinion recommend a limited initial evaluation with calcium, phosphorous and alk phos levels in all children admitted with fracture felt due to abuse

**EVALUATE THE EVIDENCE**

**Outcome & Process Measures:** Evaluation of order set use as well as appropriate use of Imaging and laboratory evaluation prior to implementation of the EBP order set and comparison to appropriate use after implementation will indicate if there is improved adherence to recommendations with the order set in place.

**Implementation Plan:** Creation and implementation of EBP order set with stakeholder input and recommendations for practice.
REFERENCES


2) Hansen KK, Campbell KA. How useful are skeletal surveys in the second year of life? *Child Abuse Negl 2009 May;33*(5):278-281.


16) Lane WG, Dubowitz H, Langenberg P. Screening for occult abdominal trauma in children with suspected physical abuse. 
18) Pandya NK, Baldwin K, Kamath AF, Wenger DR, Hosalkar HS. Unexplained fractures: child abuse or bone disease? A 
19) Horan FT, Beighton PH. Infantile metaphysial dysplasia or "battered babies"? A reassessment of material in the Fairbank 
20) Paterson CR, Burns J, McAllion SJ. Osteogenesis imperfecta: the distinction from child abuse and the recognition of a variant 
   9;299(6713):1451-1454.
23) Steiner RD, Pepin M, Byers PH. Studies of collagen synthesis and structure in the differentiation of child abuse from 