CHAMP Practice Recommendations

Skeletal Survey

The skeletal survey is a series of radiographic images of all parts of the body in multiple views. It is currently the method of choice for global skeletal imaging in cases of suspected child abuse.

Since the CHAMP Skeletal Survey Practice Recommendations were first drafted in 2008, the research on this topic has widely expanded our knowledge in the use of this radiographic method to identify acute and healing fractures. New literature, replete with many offerings of guidelines, has greatly improved our ability to manage children when physical abuse and fractures from abuse are suspected. In addition to skeletal surveys, other imaging may be required, such as neuroimaging or abdominal imaging. Further information as well as active links to underlined citations regarding imaging in suspected child abuse can be found in the annotated bibliography.

These published practice recommendations are recommended for all providers of child abuse pediatric evaluations:

- The Radiological Investigation of Suspected Physical Abuse in Children (The Royal College of Radiologists and The Society and College of Radiographers, 2018)
- The ACR-SPR Practice Parameter for the Performance and Interpretation of Skeletal Surveys in Children (American College of Radiology and Society for Pediatric Radiology, 2016)
- Development of Guidelines for Skeletal Survey in Young Children with Fractures (Wood et al., 2014)
- Imaging of Non-accidental Injury; What is Clinical Best Practice? (Nguyen and Hart, 2014)
- Diagnostic Imaging of Child Abuse (The American Academy of Pediatrics, Section on Radiology, 2009)

Recommendations Overview

A summary and key decision point recommendations are offered here. The recommendations are intended to guide the medical provider in ordering appropriate radiographic studies to better identify skeletal injuries and to assess the likelihood of injuries being non-accidental in nature (AAP, 2009; ACR-SPR, 2016). **Important disclaimer: Suspicion of child abuse should be based on disclosures of abuse and/or objective medical or forensic evidence. Having and following an objective protocol for workup of any injuries in young children will help to avoid implicit bias in reporting, testing and diagnosis. Recommendations provided are based on current literature and should be reviewed for consistency with any later publications.**

Please cite this document as **Botash AS and Ashraf I. CHAMP Practice Recommendation: *Skeletal Survey*. February 2021. https://www.champprogram.com/pdf/skeletal-survey-march-2021.pdf**

A skeletal survey is recommended for infants and children under the age of 2 years when non-accidental trauma is known or suspected, even when injuries may not be clinically evident. Some children who have been physically or sexually abused or maltreated may have overt signs and/or symptoms of injuries. Others may have occult injuries or fractures. Some may have both overtly evident and occult injuries. Sentinel injuries are most often bruises and may be seemingly minor injuries, such as subconjunctival hemorrhages or frenular tears. They may be the first or only sign of more significant trauma. Skeletal surveys are recommended when sentinel injuries are identified and assist in the diagnosis of further injury.

- Because young children are most at risk for missed abuse, the American Academy of Pediatrics (AAP) recommends:
  - A skeletal survey for all children less than 2 years of age who are suspected victims of physical abuse (CW Christian and Committee on Child Abuse and Neglect, 2015).
  - A skeletal survey and neuroimaging for children under 1 year of age.
- A skeletal survey should be performed only after a complete physical examination of the child.
- A complete evaluation for physical abuse should follow the AAP recommendations for the evaluation of suspected child physical abuse (CW Christian and Committee on Child Abuse and Neglect).
- Negative radiographic studies (even the follow-up skeletal survey) can occur in situations of child abuse, and occult fractures can be missed despite the use of appropriate tests and techniques of study. A negative skeletal survey does not preclude the diagnosis of child abuse.
- As with other tests recommended in protocols for non-accidental trauma workups, when there is a clear indication to perform radiological imaging and imaging is not obtained, the reasons for not obtaining the test should be well documented in the patient's medical record.
- When a skeletal survey for suspected sexual abuse has been deemed necessary due to suspicion of child physical abuse, reporting the case is mandated.
- According to NYS Social Services Law, Section 416, "Any person or official required to report cases of suspected child abuse and maltreatment may take or cause to be taken at public expense photographs of the areas of trauma visible on a child who is subject to a report and, if medically indicated, cause to be performed a radiological examination on the child." Relevant laws should be reviewed by providers in other geographic locations.
- Although consent is not required when abuse is suspected and a skeletal survey is indicated, discussion with the parent(s) or caregivers regarding the medical provider's conversation about the need for a skeletal survey should be documented in the medical record. Verbal assent should be obtained as with any other lab or radiologic study for patients. Refusals should be addressed based on risk/benefit analysis and protocol driven steps for involvement of risk/management and/or legal interventions.
- The request (order in the patient chart) for a skeletal examination should include sufficient clinical information to demonstrate the medical necessity of the examination.

- Radiation exposure should be minimized and be "as low as reasonably achievable" (ALARA). Follow the ACR Appropriateness Criteria® for evidence-based guidelines for imaging. Also see Slovis (2015).
- Skeletal surveys are also performed to assess for abnormalities in bone mineralization and metabolic conditions, such as in rickets or rickets-like conditions, as well as skeletal dysplasias, certain neoplastic conditions and other disorders.

Age-based Recommendations

Some age-based recommendations for a skeletal survey (SS) are listed below. For further detail please refer to the table (Figure 2) from Wood et al. (2014). It provides recommendations developed by a panel of experts for when a SS should be obtained based on age and type of injury. Additional detailed recommendations for a SS in young children with bruises are incorporated below and described in a table from Wood et al. (2015).

Newborn to 2 years of age:

- A SS is recommended as a first-line investigation.
- A SS is necessary in children ≤ 24 months old if there is confession of abuse, injury during domestic violence, suspicion of abuse due to a delay in seeking care, no history of trauma to explain fracture and additional injuries on exam (i.e., bruises, burns, etc.).
- With regard to bruises, a SS is necessary in children (see Wood et al., 2015) where there is no verifiable mechanism of accidental trauma, bleeding diathesis, or birth trauma history:
  - ≤ 24 months old with patterned bruising, >4 bruises not limited to bony prominences, and bruises of the ear, neck, torso, buttocks, genital region, hands, feet without history of trauma (TEN-4 FACES P);
  - <12 months of age with bruising on cheeks, eye area, ear, neck, upper arms or legs (not bony prominences), hands, feet, torso, buttocks, genital region, and greater than one bruise not limited to bony prominences;
  - <9 months old with >1 bruise in any location;
  - <6 months of age as above and inclusive of situations with one or more bruises to bony prominences (except if a single bruise and there is a clear history of fall).
- With regard to fractures in general, a SS is required:
  - In *all* children 0-11 months with any type of fracture, with some exceptions such as toddler fractures, linear skull fracture with history of fall, and clavicle fracture attributable to birth injury. See Wood et al. (2014) for more details.
  - In most cases, any child less than age 6 months with any type of fracture should have a skeletal survey.
- A SS is required in children 12-23 months with specific fractures commonly observed in abusive trauma (rib fractures, metaphyseal lesions, complex skull fractures, certain humeral fractures, femur fractures). See Wood et al. (2014) for details.
- A SS should be performed in all children < 6 months of age with intracerebral brain hemorrhage (ICH), in children <24 months old with subdural hemorrhage (SDH) that is not

small and under a skull fracture, and in children 6-23 months with EDH. See also Paine et al. (2016).

- A SS should be performed in younger, pre-mobile infants with isolated skull fractures, and in older infants and children based on clinical suspicion for abuse and other characteristics of the skull fracture, i.e., complex skull fractures. See also Laskey et al. (2013); Wood et al. (2009).
- Consider bone scintigraphy as a supplement to the SS when indicated for detection of specific injuries, such as acute injuries not clearly visible on a SS. Bone scintigraphy is not commonly utilized and is generally an adjunct, not first-line, of investigation.
- Confirmatory radiographs must be taken of abnormal areas on a bone scintigraphy and, in some cases, to further delineate areas of concern on a SS.

Over 2 years of age:

- Children who are immobilized or disabled should be studied according to the newborn to 2 years of age category.
- For children between 2 and 5 years of age, the need for a SS should be determined on a case-by-case basis and based on specific clinical indicators of abuse and suspected mechanism of trauma. Examples of potential situations where a skeletal survey might be considered include injured children who are non-ambulatory due to physical delays, have other developmental delays and cannot communicate well, and/or other similar conditions.
- A SS for assessment of suspected non-accidental trauma is usually not recommended for children older than 5 years of age and may be obtained on a case-by-case basis. Example situations described above may also apply to this age group.

Required Radiographs

Per Revised ACR guidelines, skeletal surveys should include the following films (ACR-SPR, 2016; Marine et al., 2018):

Radiograph (number of films)	Views
Skull (2)*	Frontal and lateral, include cervical spine
Cervical spine (1)*	Lateral
Thorax (4)*	AP, lateral, right and left obliques of ribs, and including sternum, thoracic and upper lumbar spine
Lumbosacral spine (1)*	Lateral
Abdomen and Pelvis (1)*	AP, including pelvis and both hips
Humeri (2)	AP
Forearms (2)	AP
Hands (2)	PA
Femurs (2)	AP
Lower Legs (2)	AP
Feet (2)	AP

A minimum of 21 radiographs are required. *Skull, spine and pelvis films can be omitted from a FUSS per guidelines discussed on page 6. A detailed description of these radiographs can be found in Appendix A of the RCR 2018 guidelines. Single, whole-body films are generally unacceptable.

Special Considerations (AAP, 2009)

Evaluation of siblings of an index case (see Lindberg, 2012):

- When serious injuries are identified in a child, other siblings should be evaluated clinically and then studied with a SS and other indicated radiographic tests on a case-by-case basis:
    - Any multiple birth sibling of an index case less than 2 years old should be studied with a SS.
    - Siblings under the age of 2 years who live in the same home as the index child abuse case(s) should also be studied with a complete SS.
    - Note, even if the index case (suspicion of physical abuse) has a normal SS, the above recommendations for imaging in siblings apply.

Children who have been sexually abused:

- In some situations, sexually assaulted children present with evidence of one or more physical injuries consistent with physically abusive trauma. The protocol for physical abuse evaluations, including obtaining a SS when indicated, should be followed.

Children with burn injuries:

- A SS should be performed in infants and young children who have burn injuries suspicious of being a result of abuse. Although studies have shown that there is a lower frequency of occult fractures among children with abusive burns than other abusive injuries, it is still clinically significant at 14% (Hicks and Stolfi, 2007). The most common fractures seen in children with burn injuries are rib fractures followed by femur fractures (Hicks and Stolfi; Belfer et al., 2001).

Children with abusive head trauma (AHT):

- Skeletal injuries are common in infants and young children with AHT. Since patterns of intracranial injury are not definitively diagnostic of abuse, it is important to evaluate for associated occult skeletal injuries that may be highly specific for abuse. For example, classic metaphyseal lesions and rib fractures are among the strong predictors of AHT in those with intracranial injury. Therefore, it is imperative to perform a SS for infants and young children with findings of AHT (Barber and Kleinman, 2014).

Critically-ill children:

- In a critically injured child on life support for whom a SS may be difficult to obtain, effort should be made to obtain one in a timely manner, as results may affect early investigation of the case.

If a SS cannot be obtained immediately:

- If a high quality SS is not available in the emergency department during evening hours, the AAP (2009) recommends hospitalization of the child or placement of the child in a safe haven until a SS can be performed.

Follow-Up Skeletal Survey (FUSS)

- The AAP recommends a FUSS be performed within 2 weeks (generally 10-14 days) after the initial skeletal survey in all children less than 2 years of age who are suspected to be victims of abuse (CW Christian and Committee on Child Abuse and Neglect, 2015). This is to be done even if both a bone scintigraphy and a SS were obtained. Skull, spine and pelvic films may be excluded from the FUSS to reduce radiation exposure if the initial SS was negative and if there is no concern for ongoing abuse (Expert Panel on Pediatric Imaging, 2017; Sonik et al., 2010).
- A FUSS should be performed when abuse is suspected clinically and especially when there are abnormal or equivocal findings on the initial survey.
- A FUSS allows for the detection of acute fractures that may have been missed on the initial survey, can provide further information regarding any abnormal or equivocal findings and could provide some information regarding the dating of fractures (AAP, 2009; ACR-SPR, 2016; Zimmerman et al., 2005; Harper et al., 2013).
- Studies have shown that a FUSS can result in new findings and ultimately affects the perceived likelihood of abuse (Harper, 2013, 2016).
- Studies also suggest that a FUSS should be considered in children with lower initial levels of concern for inflicted injury (Zimmerman et al., 2005; Harper et al., 2013).
- After the initial skeletal survey, it is the practice of many to document: "Note that this examination is not complete until a follow-up skeletal survey has been performed in accordance with the RCR 2018 guidelines."
- Sample FUSS letters are attached in the Appendix.

Bone Scintigraphy (BS)

- BS is not an alternative but is sometimes used as an adjunct to supplement a skeletal survey.
- BS has increased sensitivity for detecting rib fractures, subtle shaft fractures and periosteal injury.
- It is less sensitive for detecting classic metaphyseal lesions and skull fractures. Skull radiographs in at least two projections must supplement a BS.
- BS can be used in the acute setting when the skeletal survey is negative but clinical suspicion of abuse remains high. However, a FUSS in two weeks is the better alternative if the child is in a safe environment in the interim.
- Challenges to bone scintigraphy include:
    - Need for venipuncture and sedation.
    - Increased cost.
    - Need for further radiographic evaluation for all positive findings because scintigraphy can result in false positive findings (AAP, 2009).
    - Increased radiation exposure. The estimated radiation dose for a 5 year old is 6.2mSv. This is a greater exposure than multiple films on a skeletal survey, for example 0.02mSv for two views of the chest (Brody et al., 2007).

References and Annotated Bibliography

Aertsen M. An update on imaging in child abuse. *J Belg Soc Radiol*. 2017; 101(Suppl 1): 9.

- Discusses variations in guidelines for imaging in suspected cases of abuse between relevant guidelines from Europe, the United States and the United Kingdom

American Academy of Pediatrics Section on Radiology. Diagnostic imaging of child abuse. *Pediatrics*. 2009; 123(5): 1430-1435. https://pediatrics.aappublications.org/content/pediatrics/123/5/1430.full.pdf

- This is a policy statement for the diagnostic imaging of child abuse
- Gives imaging recommendations (i.e., radiograph, CT, MRI, ultrasound) based on type of trauma (skeletal, head, spinal, thoraco-abdominal)

American College of Radiology and Society for Pediatric Radiology. *ACR-SPR Practice Parameter for the Performance and Interpretation of Skeletal Surveys in Children*. Revised 2016. Available at: https://www.acr.org/-/media/ACR/Files/Practice-Parameters/Skeletal-Survey.pdf Accessed on 3/2/2020.

https://www.acr.org/Clinical-Resources/ACR-Appropriateness-Criteria Accessed on 2/19/2021.

- Outlines practice parameters for skeletal surveys
- Includes indications, personnel responsibilities and qualifications, exam procedure, technique, radiation safety and documentation

Barber I and Kleinman PK. Imaging of skeletal injuries associated with abusive head trauma. *Pediatr Radiol*. 2014 Dec; 44(Suppl 4): S613-20.

- Discusses importance of skeletal surveys in children with AHT and fractures that are strong predictors of AHT in children with intracranial injury

Belfer RA, Klein BL & Orr L. Use of the skeletal survey in the evaluation of child maltreatment. *Am J Emerg Med*. 2001; 19: 122–124.

- Retrospective observational study to determine incidence of occult fracture detected by skeletal survey and to identify high risk children who would benefit from skeletal survey
- Found 26% incidence of at least one occult fracture, the majority of these occurred in children <1 year of age
- Discusses higher risk presentations and clinical findings to aid in provider decision-making regarding skeletal survey

Born M, Schwier F, Stoever B, Mentzel HJ, Freiberg J. The German evidence-based child protection guideline - imaging in suspected child abuse. *Rofo*. 2020 Apr; 192(4): 343-348. English, German.

- The first fully evidence-based guideline including all aspects of child abuse in Germany

Brody AS, Frush DP, Huda W, Brent RL and the American Academy of Pediatrics Section on Radiology. Radiation risk to children from computed tomography. *Pediatrics*. 2007; 120: 677-682.

- Report discusses radiation safety in children
- Can facilitate discussions among healthcare teams, patients and families

Christian CW and the Committee on Child Abuse and Neglect. The evaluation of suspected child physical abuse. *Pediatrics.* 2015; 135(5): e1337-e1354. https://pediatrics.aappublications.org/content/135/5/e1337

- Outlines the role of the pediatric provider in child abuse evaluation and mandated reporting
- Discusses child abuse risk factors, health impact, missed opportunities (i.e., sentinel injuries), and the evaluation of abuse (concerning history and physical exam findings, diagnostic testing, documentation, treatment)

Chuang YW, Hsu CC, Chang CC, et al. Multiple bony injuries on bone scan in a case of unsuspected child abuse. *Case Rep Med*. 2017; 2017: 3015941.

- Authors suggest skeletal survey and bone scintigraphy as complementary exams that can reduce the false negative rate
- Discusses bone scintigraphy requiring sedation and thus less commonly used, especially in the emergent setting
- Recommends bone scintigraphy in cases where children may be lost to follow up as it will help in the diagnosis of most fractures during the initial assessment, and thus ensure child safety

Cornell EM and Powell EC. Skeletal survey yield in young children with femur fractures. *J Emerg Med*. 2018 Dec; 55(6): 758-763.

- Observational study that found skeletal surveys to identify additional fractures in 7% of the children studied and to be useful for forensic evaluation of non-ambulatory children ≤ 12 months old

Deutsch SA, Henry MK, Lin W, Valentine KJ, Valente C, Callahan JM, Lavelle J, Scribano PV, Wood JN. Quality improvement initiative to improve abuse screening among infants with extremity fractures. *Pediatr Emerg Care*. 2019 Sep; 35(9): 643-650.

- Observational study to evaluate the effectiveness of the implementation of a clinical pathway and quality improvement interventions to increase the rate of abuse workups, including skeletal surveys, for infants with extremity fractures
- Found the rate of skeletal surveys increased with pathway and active QI and that the rate was maintained in the post-QI period
- Also found 20% of skeletal surveys revealed occult fractures

Duffy SO, Squires J, Fromkin JB, Berger RP. Use of skeletal surveys to evaluate for physical abuse: Analysis of 703 consecutive skeletal surveys. *Pediatrics*. 2011; 127(1): e47-e52.

- Retrospective descriptive study to identify characteristics of children more likely to have occult fractures and also to evaluate the influence of skeletal survey results on the diagnosis of abuse
- Positive skeletal surveys in 11% of patients, and 50% of those were diagnosed with abuse after positive skeletal survey results
- Authors recommend broader use of skeletal surveys, particularly in high risk children

Expert Panel on Pediatric Imaging: Wootton-Gorges SL, Soares BP, Alazraki AL, Anupindi SA, Blount JP, Booth TN, Dempsey ME, Falcone RA Jr, Hayes LL, Kulkarni AV, Partap S, Rigsby CK, Ryan ME, Safdar NM, Trout AT, Widmann RF, Karmazyn BK, Palasis S. ACR Appropriateness Criteria® suspected physical abuse—child. *J Am Coll Radiol*. 2017 May; 14(5S): S338-S349.

- Evidence-based guidelines rate the appropriateness of imaging procedures for specific clinical scenarios that are reviewed annually by a multidisciplinary expert panel
- Discusses the criteria specific to suspected child abuse

Harper NS, Eddleman S, Lindberg DM and for the ExSTRA Investigators. The utility of follow-up skeletal surveys in child abuse. *Pediatrics*. 2013; 131(3): e672-e678.

- Prospective secondary analysis of an observational study evaluating FUSS completion rates and change in perceived likelihood of abuse before and after FUSS
- FUSS was found to significantly affect the perceived likelihood of abuse
- Results of this study led authors to recommend FUSS be considered when there is lower initial level of concern for abuse

Harper NS, Lewis T, Eddleman S, Lindberg DM, ExSTRA Investigators. Follow-up skeletal survey use by child abuse pediatricians. *Child Abuse Negl*. 2016 Jan; 51: 336-42.

- Prospective observational study to determine variability between sites in rates of FUSS recommendation, completion and fracture identification
- Resultant variability in FUSS utilization was not explained by variability in occult fracture prevalence
- Highlights need for specific FUSS utilization guidelines

Hicks RA and Stolfi A. Skeletal surveys in children with burns caused by child abuse. *Pediatr Emerg Care*. 2007; 23(5): 308-313. doi:10.1097/01.pec.0000270174.39228.30.

- Retrospective observational study to determine the frequency of occult fractures in children with suspicious burns compared to those found in other types of physical abuse
- Results from this study indicate a skeletal survey should be considered in infants and young children with suspicious burns

Hinton C and Trop A. TEN-4 FACES P: A mnemonic to help you spot signs of child abuse. ACEP*Now.* August 19, 2020. Available at: https://www.acepnow.com/article/ten-4-faces-p-a-mnemonic-to-help-you-spot-signs-of-child-abuse/ Accessed 2/19/2021.

Howell S, Bailey L, Coffman J. Evaluation of drug-endangered children: The yield of toxicology and skeletal survey screening. *Child Abuse Negl*. 2019 Oct; 96: 104081.

- Study to evaluate yield of skeletal survey screening in drug endangered children, as they are known to be at high risk for associated physical abuse
- Skeletal survey screening was found to be useful in drug endangered children to identify those with physical abuse and should be considered as a standardized screening tool

Karmazyn B, Marine MB, Wanner MR, Delaney LR, Cooper ML, Shold AJ, Jennings SG, Hibbard RA. Accuracy of ultrasound in the diagnosis of classic metaphyseal lesions using radiographs as the gold standard. *Pediatr Radiol*. 2020 Jul; 50(8): 1123-1130.

- Found negative ultrasound does not exclude CML, as it has low sensitivity and high specificity in CML detection
- Positive ultrasound can help substantiate CML diagnosis when radiographs are equivocal

Kemp AM, Butler A, Morris S, Mann M, Kemp KW, Rolfe K, Sibert JR, Maguire S. Which radiological investigations should be performed to identify fractures in suspected child abuse? *Clinical Radiology*. 2006; 61: 723-736.

- Literature review of previously published studies to compare radiological investigations for child abuse
- Discusses skeletal survey, bone scintigraphy and FUSS with recommendations of which study or combination of studies optimize identification of fractures

Kleinman PK, Morris NB, Makris J, Moles RL, Kleinman PL. Yield of radiographic skeletal surveys for detection of hand, foot, and spine fractures in suspected child abuse. *AJR Am J Roentgenol*. 2013; 200(3): 641-644. doi:10.2214/AJR.12.8878.

- Cross-sectional retrospective study to evaluate usefulness of imaging the spine, hands and feet on an initial skeletal survey in cases of suspected abuse, as it was suggested by some authors to eliminate these regions from skeletal survey evaluation
- Authors determined that fractures in these locations are identified by skeletal surveys and suggest the benefits of eliminating these views from skeletal surveys should be carefully weighed against the cost of missing these injuries

Laskey AL, Stump TE, Hicks RA, Smith JL. Yield of skeletal surveys in children ≤ 18 months of age presenting with isolated skull fractures. *J Pediatr.* 2013 Jan; 162(1): 86-9.

- Retrospective observational study to measure the yield of skeletal surveys in children presenting with isolated skull fracture
- Results indicate importance of clinical and forensic data that skeletal surveys provide but also discusses possibility of restricting skeletal surveys to younger (pre-mobile) infants

Lindberg DM, Shapiro RA, Laskey AL, et al. Prevalence of abusive injuries in siblings and household contacts of physically abused children. *Pediatrics*. 2012;130: 193.

- Protocol-indicated skeletal surveys identified at least 1 abusive fracture in 16 of 134 contacts < 24 months of age, with no fractures having associated findings on physical examination
- Relative to non-twins, twins were at increased risk of fracture

Mandelstam S, Cook D, Fitzgerald M, Ditchfield M, Carty H. Complementary use of radiological skeletal survey and bone scintigraphy in detection of bony injuries in suspected child abuse. *Arch Dis Child*.2003 May; 88(5): 387–390.

- Retrospective observational study comparing the effectiveness of skeletal survey and bone scintigraphy
- Investigators found that they are complementary studies and suggest both be performed in cases of suspected child abuse

Marine M, et al. Skeletal survey for suspected child abuse: Guidance for following ACR-SPR Practice. Available at: https://www.pedrad.org/Portals/5/Subspecialties/ChildAbuse/Educational%20Poster%20on%20skeletal%20survey.pdf?ver=2018-01-04-114010-953 Accessed on 03/02/2020.

- Poster illustrating specific skeletal survey images and technique
- Additional information for the radiologist/technician

Martin A, Paddock M, Johns CS, Smith J, Raghavan A, Connolly DJA, Offiiah AC. Avoiding skull radiographs in infants with suspected inflicted injury who also undergo head CT: "a no-brainer?" *European Radiology*. 2020; 30: 1480-1487.

- Recommends skull radiographs can be omitted from initial skeletal surveys when head CT with 3D reconstruction is performed as it is more sensitive and specific for the diagnosis of skull fractures

Melville JD, Hertz SK, Steiner RD, Lindberg DM, ExSTRA Investigators. Use of imaging in children with witnessed physical abuse. *Pediatr Emerg Care*. 2019 Apr; 35(4): 245-248.

- Retrospective analysis of the Examination of Siblings to Recognize Abuse cohort of children to compare imaging results in children with and without injuries on physical exam
- Recommends imaging (skeletal survey and neuroimaging) in children with witnessed abuse regardless of absence of injury on exam

New York Consolidated Laws, Social Services Law - SOS § 416. Obligations of persons required to report. Available at: https://codes.findlaw.com/ny/social-services-law/sos-sect-416.html Accessed on 2/19/2021.

Nguyen A and Hart R. Imaging of non-accidental injury; what is clinical best practice? *J Med Radiat Sci*. 2018; 65(2): 123-130. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5985993/

- A literature review to address the radiological evaluations and findings in non-accidental trauma
- Discusses differential diagnoses of imaging findings

Paine CW, Scribano PV, Localio R, Wood JN. Development of guidelines for skeletal survey in young children with intracranial hemorrhage. *Pediatrics*. 2016 Apr; 137(4): e20153024.

- Evidence and expert opinion-based guidelines for performing skeletal surveys in children <24 months of age with ICH

Paine CW and Wood JN. Skeletal surveys in young, injured children: A systematic review. *Child Abuse Negl*. 2018 Feb; 76: 237-249.

- Systematic literature review to evaluate the variability in skeletal survey utilization patterns
- Based on findings, recommends the need for interventions to standardize skeletal survey utilization to decrease disparities

Phillips KL, Bastin ST, Davies-Payne D, Browne D, Bird HL, Craw S, Duncan DR, Dupree P, Leigh A, McLaughlin A, Metcalfe R, Murdoch J, Pearce K, Perry D, Thomas I, Thomson GD, Vogel S, Wilson F, Teele. Radiographic skeletal survey for non-accidental injury: Systematic review and development of a national New Zealand protocol. *J Med Imaging Radiat Oncol*. 2015 Feb; 59(1): 54-65.

- Systematic review of skeletal survey protocols to design one standardized protocol to be considered for utilization across New Zealand

Raynor E, Konala P, Freemont A. The detection of significant fractures in suspected infant abuse. *J Forensic Leg Med*. 2018 Nov; 60: 9-14.

- Case series to discuss skeletal survey sensitivity and value of histological exam of bones of children who die soon after injury without opportunity for FUSS
- Found histology to be two times as sensitive in detecting fractures than skeletal surveys

The Royal College of Radiologists and The Society and College of Radiographers. The radiological investigation of suspected physical abuse in children. Revised first edition. 2018. Available at: https://www.rcr.ac.uk/system/files/publication/field_publication_files/bfcr174_suspected_physical_abuse.pdf Accessed on 8/1/2020.

- Guidelines, which are also endorsed by the Royal College of Paediatrics and Child Health, for imaging in cases of suspected non-accidental trauma

Slovis TL, Strouse PJ, Strauss KJ. Radiation exposure in imaging of suspected child abuse: benefits versus risks. J Peds. 2015; 167(5): 963-968.

- Lists basic principles for imaging (Note: All imaging facilities are not the same.)
- Explains radiation metrics in detail and comparisons to equivalent doses
- Explains ALARA
- Provides risk/benefit guidelines

Sonik A, Stein-Wexler R, Rogers KK, Coulter KP, Wootton-Gorges SL. Follow-up skeletal surveys for suspected non-accidental trauma: Can a more limited survey be performed without compromising diagnostic information? *Child Abuse Negl*. 2010; 34(10): 804-806.

- Retrospective observational study to evaluate the clinical usefulness of FUSS
- Recommendation for limited FUSS which excludes pelvis, lateral spine, hands and skull if no injury is detected or suspected in those areas on initial skeletal survey

Stavas N, Paine C, Song L, Shults J, Wood J. Impact of child abuse clinical pathways on skeletal survey performance in high-risk infants. *Acad Pediatr*. 2020 Jan-Feb; 20(1): 39-45.

- Retrospective observational study evaluating the odds of skeletal survey performance when a child abuse pathway is present and if the pathway reduces disparities in skeletal survey performance
- Results found greater odds of skeletal survey performance when a clinical pathway is present
- Regardless of the pathway, skeletal survey performance differences existed between children with public vs. private insurance

Wood JN, Christian CW, Adams CM, Rubin DM. Skeletal surveys in infants with isolated skull fractures. *Pediatrics*. 2009 Feb; 123(2): e247-e252.

- Retrospective observational study to evaluate utility of skeletal surveys in infants with isolated skull fractures
- Found that skeletal surveys rarely added information that would support a report to child protective services beyond the history and physical exam findings

Wood JN, Fakeye O, Feudtner C, Mondestin V, Localio R, Rubin DM. Development of guidelines for skeletal survey in young children with fractures. *Pediatrics*. 2014; 134(1): 45-53. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4067633/

- Multispecialty expert panel applied evidence from literature review to develop guidelines for children <24 months old with fractures, with the goal to decrease disparities and increase detection of abuse
- Panel came to consensus on multiple clinical scenarios for which an initial skeletal survey is indicated for children with fractures https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4067633/figure/fig2/

Wood JN, Fakeye O, Mondestin V, Rubin DM, Localio R, Feudtner C. Development of hospital-based guidelines for skeletal survey in young children with bruises. *Pediatrics*. 2015; 135(2): e312-e320. https://pediatrics.aappublications.org/content/135/2/e312

- Multispecialty expert panel applied evidence from literature review to develop guidelines for children <24 months old with bruises, with the goal to decrease disparities and increase detection of abuse.
- Defines need for skeletal surveys based on findings of bruises and consensus of panel of experts https://pediatrics.aappublications.org/content/pediatrics/135/2/e312/F2.large.jpg

Wood JN, Henry MK, Berger RP, Lindberg DM, Anderst JD, Song L, Localio R, Feudtner C. Use and utility of skeletal surveys to evaluate for occult fractures in young injured children. *Acad Pediatr*. 2019 May-Jun; 19(4): 428-437.

- Retrospective observational study to evaluate rate and characteristics of children <24 months of age who undergo skeletal surveys and have occult fractures
- Found high rates in those aged 0-5 months and recommends further research in older children and toddlers to identify injury characteristics in those most at risk for occult fractures

Zimmerman S, Makoroff K, Care M, Thomas A, Shapiro R. Utility of follow-up skeletal surveys in suspected child abuse evaluations. *Child Abuse Negl*. 2005; 29: 1075-1083.

- Prospective study to evaluate the utility of FUSS in suspected child physical abuse to provide additional information
- FUSS yielded additional information in 46% of cases (i.e., changed the outcome of a case)

This Skeletal Survey was revised by Ann S. Botash, MD, Project Director/Author, and Iram Ashraf, MD. It was posted on the CHAMP website in March, 2021.

New York State CHAMP Mentors were an invaluable resource and provided review and input into many aspects of this document. They include Jocelyn Brown, MD, Jamie Hoffman-Rosenfeld, MD, Dana Kaplan, MD, Ann M. Lenane, MD, Lori Legano, MD, Mandy A. O'Hara, MD, Vincent J. Palusci, MD, Alicia Pekarsky, MD, and Ingrid Walker-Descartes, MD. In addition, JoAnne Race, MS, and Trish Booth, MA, provided support for the production of this document.

Appendix

Sample Letters to the Primary Care Provider Upon Hospital Discharge After a Workup for Suspected Physical Abuse

The letter should

- Explain why their patient was admitted.
- Explain the reason for a non-accidental trauma workup and why the initial skeletal survey was done.
- State your level of concern for abuse. Consider consulting the webinar presented by CHAMP Mentors on 1/13/2021, "Levels of certainty for physical abuse: What do our words mean?"
- Give your recommendation for a follow-up skeletal survey and explain why.
- Provide other relevant information, such as evaluation of siblings and other children in the same residence.

Sample Letters

The first is an example of a letter when there is suspected child abuse.

The second is an example of a letter when there is no suspicion of abuse.

4/6/20xx

Re: Ellie Citron (DOB: 7/3/20xx)

Dear [Primary Care Provider]:

Your patient, Ellie Citron, was recently admitted to Upstate Golisano Children's Hospital. At that time a non-accidental trauma workup, including a skeletal survey, was initiated due to concern for possible child abuse. After reviewing her history, physical exam, and the results of the laboratory and radiology studies that have been obtained thus far, it is my opinion that her findings are very concerning for child abuse. Of concern is that there was no history of trauma to explain her injuries, [description of injuries].
Please note, this opinion is subject to change based on forthcoming information.

It is standard protocol for children under the age of two to have a second skeletal survey within 2 weeks (between 10 -14 days) following the initial survey. These surveys are very important as they often can detect skeletal injuries that are not visible in the initial time period following injury. They may also detect ongoing trauma. At this time, it is our recommendation that a second skeletal survey is necessary for this child. The follow-up skeletal survey has been scheduled for [give date]. In addition, the following appointments were scheduled [name appointment and date].

If siblings or other children reside in Ellie's home, please note the following recommendations:

- **Children < 6 months** should be immediately evaluated at the Upstate Downtown Campus Emergency Department for a medical screening exam, neuroimaging and skeletal survey *regardless of clinical findings.* If a Pediatric Radiologist is unavailable, an outpatient skeletal survey can be arranged for a later date assuming the child is in a safe place (i.e., the child is in foster care or there is a safety plan in place). A two-week follow-up skeletal survey is recommended *only if clinically indicated.*
- **Children 6 months - 24 months** who are determined by CPS to be in a safe place (i.e., the child is in foster care or there is a safety plan in place) can be evaluated by their PCP within 24 hours and arrangements can be made to obtain an outpatient skeletal survey as soon as possible *regardless of clinical findings.* In the event there is clear evidence for abuse, the child should be immediately evaluated in the Emergency Department. A two-week follow-up skeletal survey is recommended *only if clinically indicated.*
- **Children > 24 months** who are determined by CPS to be in a safe place (i.e., the child is in foster care or there is a safety plan in place) can be evaluated by their PCP within 24 hours. A skeletal survey is recommended *only if clinically indicated.*

If you have any questions, please do not hesitate to contact me.

[Your name and contact information]

4/6/20xx

Re: Baby Y (DOB: 7/3/20xx)

Dear Primary Care Provider:

Your patient, Baby Y, was recently admitted to Upstate Golisano Children's Hospital. At that time a non-accidental trauma workup, including a skeletal survey, was initiated due to concern for possible child abuse. After reviewing his history, physical exam, and the results of the laboratory and radiology studies that have been obtained thus far, it is my opinion that his findings are not a concern for child abuse because the mechanism of the fall witnessed by the baby sitter explains the injury [description of the injury].

As a result of the findings, there is no current need for a follow-up skeletal survey or further testing/imaging related to this injury. Nor is there a need to test other children in the home.

Please contact me if you have further concerns or questions.

[Your name and contact information]