

**American College of Radiology
ACR Appropriateness Criteria®**

Clinical Condition: Suspected Physical Abuse—Child

Variant 1: Child 2 years or less, no focal signs or symptoms.

Radiologic Procedure	Rating	Comments	RRL*
X-ray skeletal survey	9	Includes at least 2 views of the skull.	Med
MRI head	5	For evidentiary purposes only.	None
NUC Tc-99m bone scan whole body	4	May be useful in selected cases. For evidentiary purposes only.	Med
CT head	2		High
US abdomen	2		None

An ACR Committee on Appropriateness Criteria and its expert panels have developed criteria for determining appropriate imaging examinations for diagnosis and treatment of specified medical condition(s). These criteria are intended to guide radiologists, radiation oncologists and referring physicians in making decisions regarding radiologic imaging and treatment. Generally, the complexity and severity of a patient's clinical condition should dictate the selection of appropriate imaging procedures or treatments. Only those exams generally used for evaluation of the patient's condition are ranked. Other imaging studies necessary to evaluate other co-existent diseases or other medical consequences of this condition are not considered in this document. The availability of equipment or personnel may influence the selection of appropriate imaging procedures or treatments. Imaging techniques classified as investigational by the FDA have not been considered in developing these criteria; however, study of new equipment and applications should be encouraged. The ultimate decision regarding the appropriateness of any specific radiologic examination or treatment must be made by the referring physician and radiologist in light of all the circumstances presented in an individual examination.

Clinical Condition:

Suspected Physical Abuse—Child

Variant 4:

Child of any age, visceral injuries, discrepancy with history, physical and laboratory examinations inconclusive.

Radiologic Procedure	Rating	Comments	<u>RRL*</u>
X-ray skeletal survey	9	Includes at least 2 views of the skull.	Med
CT abdomen and pelvis with contrast	9		High
MRI head	2		None
MRI abdomen and pelvis	2		None
CT head	2		High
US abdomen and pelvis	2		None
CT abdomen and pelvis without contrast	2		High
<u>Rating Scale:</u> 1=Least appropriate, 9=Most appropriate			*Relative Radiation Level

An ACR Committee on Appropriateness Criteria and its expert panels have developed criteria for determining appropriate imaging examinations for diagnosis and treatment of specified medical condition(s). These criteria are intended to guide radiologists, radiation oncologists and referring physicians in making decisions regarding radiologic imaging and treatment. Generally, the complexity and severity of a patient's clinical condition should dictate the selection of appropriate imaging procedures or treatments. Only those exams generally used for evaluation of the patient's condition are ranked. Other imaging studies necessary to evaluate other co-existent diseases or other medical consequences of this condition are not considered in this document. The availability of equipment or personnel may influence the selection of appropriate imaging procedures or treatments. Imaging techniques classified as investigational by the FDA have not been considered in developing these criteria; however, study of new equipment and applications should be encouraged. The ultimate decision regarding the appropriateness of any specific radiologic examination or treatment must be made by the referring physician and radiologist in light of all the circumstances presented in an individual examination.

SUSPECTED PHYSICAL ABUSE—CHILD

Expert Panel on Pediatric Imaging: Thomas L. Slovis, MD¹; Wilbur L. Smith, MD²; John D. Strain, MD³; Harris L. Cohen, MD⁴; Lynn Fordham, MD⁵; Michael J. Gelfand, MD⁶; Richard Gunderman, MD, PhD⁷; William H. McAlister, MD⁸; Laura Tosi, MD.⁹

Summary of Literature Review

The kind of imaging necessary in a child suspected of abuse depends on the child's age, signs, and symptoms. Therefore, the suffering child may enter this algorithmic sequence at several points.

Entry point one: Child 2 years of age or younger with a clinical suspicion of abuse but no focal signs or symptoms.

The most basic imaging examination is the skeletal survey, composed of frontal and lateral views of the skull and single frontal views of the long bones, lateral spine, frontal chest, and abdomen. Since rib fracture may be the only skeletal manifestation of abuse, oblique radiographs of the ribs are included in the initial skeletal survey. The goal is to detect fractures for documentation of abuse.

When results of this survey are negative but a clinical suspicion remains high and documentation is still necessary, a bone scan is obtained with meticulous attention to position and technique (pin-hole collimators and differential counts of the metaphysics), and with the understanding that skull fractures will usually not have increased uptake of the radioisotope. A bone scan is especially good for diagnosing rib, spine, pelvic, and acromion fractures.

Entry point two: Child 2 years of age or younger with a history of head trauma but no focal findings or neurologic abnormality. A clinical suspicion of abuse is present.

A skeletal survey, as described above, is obtained. A cross-sectional image procedure of the brain in a child with a normal neurological exam doesn't alter the nature of medical treatment nor the child's clinical course. When the skeletal survey is negative but a strong clinical suspicion of abuse exists, a full skull series and magnetic resonance imaging (MRI) can be obtained for legal documentation of abuse. MRI has a far greater sensitivity for detecting and dating intracranial injury than computed tomography (CT) and avoids unnecessary radiation (see

MRI sequences, DWI, etc., in entry point 3).

If the skeletal survey is negative but a clinical suspicion remains high and documentation is still necessary, a bone scan may be subsequently obtained.

Entry point three: Child up to 5 years of age with neurologic signs and symptoms, and suspicion of abuse with or without other physical findings.

The child needs a careful clinical assessment. If the child is critically ill with serious signs of neurologic injury an immediate noncontrast CT scan of the brain should be performed. If this scan does not detect significant lesions needing rapid neurosurgical intervention, the child should be stabilized and an urgent MR study of the brain performed with a minimum of diffusion imaging, susceptibility imaging, T1, T2, and inversion recovery sequences.

If the child is clinically stable with neurologic symptoms (transient loss of consciousness, seizure, altered mental status, confirmed presence of retinal hemorrhages) MR may be used for the initial neurologic imaging evaluation. Sequences for susceptibility, T1, T2, and inversion recovery should be used. Diffusion imaging may be used depending on the severity of the child's illness.

In either case, if the child is less than 2 years of age, a skeletal survey as defined in entry point one should be performed, and should include a full skull series if fracture is not otherwise documented by CT.

Entry point four: A child of any age with visceral injury that is discrepant with the history, and either the physical examination or the laboratory studies or both do not provide a satisfactory explanation. The visceral injuries would include:

- a. pancreatic pseudocyst
- b. adrenal hemorrhage
- c. free air (bowel perforation) after blunt trauma
- d. contusion or laceration of viscera
- e. traumatic bladder perforation

In this setting, all of these injuries (a-e) should be considered signs of abuse. If the patient is less than 2 years of age, skeletal survey should be done.

In all probability, the child would already have had the injury detected by contrast-enhanced CT (CECT) with oral or intravenous contrast. If a CT was not obtained, it would be the first imaging test. Follow-up imaging relates to the disease process, not abuse. Some authorities prefer not to use oral contrast for this CT study; however, there is not a clear documentation of the superiority of either

¹Co-Author, Children's Hospital of Michigan, Detroit, Mich; ²Co-Author, Detroit Receiving Hospital, Detroit, Mich; ³Panel Chair, The Children's Hospital, Denver, Colo; ⁴Stony Brook School of Medicine, Stony Brook, NY; ⁵University of North Carolina, Chapel Hill, NC; ⁶Children's Hospital Medical Center, Cincinnati, Ohio; ⁷Washington University Medical Center, St. Louis, Mo; ⁸Riley Hospital, Indianapolis, Ind; ⁹Children's National Medical Center, Washington, DC, American Academy of Orthopaedic Surgeons.

Reprint requests to: Department of Quality & Safety, American College of Radiology, 1891 Preston White Drive, Reston, VA 20191-4397.

An ACR Committee on Appropriateness Criteria and its expert panels have developed criteria for determining appropriate imaging examinations for diagnosis and treatment of specified medical condition(s). These criteria are intended to guide radiologists, radiation oncologists and referring physicians in making decisions regarding radiologic imaging and treatment. Generally, the complexity and severity of a patient's clinical condition should dictate the selection of appropriate imaging procedures or treatments. Only those exams generally used for evaluation of the patient's condition are ranked. Other imaging studies necessary to evaluate other co-existent diseases or other medical consequences of this condition are not considered in this document. The availability of equipment or personnel may influence the selection of appropriate imaging procedures or treatments. Imaging techniques classified as investigational by the FDA have not been considered in developing these criteria; however, study of new equipment and applications should be encouraged. The ultimate decision regarding the appropriateness of any specific radiologic examination or treatment must be made by the referring physician and radiologist in light of all the circumstances presented in an individual examination.

technique; therefore, the issue of oral contrast should be left to the discretion of the radiologist.

It is of interest that of all the cases of bowel perforation after blunt trauma (incidence 1%-5%), most of them (65%) are found in abused children.

Relative Radiation Level Information

Potential adverse health effects associated with radiation exposure are an important factor to consider when selecting the appropriate imaging procedure. Because there is a wide range of radiation exposures associated with different diagnostic procedures, a relative radiation level (RRL) indication has been included for each imaging examination. The RRLs are based on effective dose, which is a radiation dose quantity that is used to estimate population total radiation risk associated with an imaging procedure. Additional information regarding radiation dose assessment for imaging examinations can be found in the ACR Appropriateness Criteria® [Radiation Dose Assessment Introduction](#) document.

Relative Radiation Level Designations	
Relative Radiation Level	Effective Dose Estimate Range
None	0
Minimal	< 0.1 mSv
Low	0.1-1 mSv
Medium	1-10 mSv
High	10-100 mSv

References

- Merten DF, Radkowski MA, Leonidas JC. The abused child: a radiological reappraisal. *Radiology* 1983; 146(2):377-381.
- Merten DF, Carpenter BL. Radiologic imaging of inflicted injury in the child abuse syndrome. *Pediatr Clin North Am* 1990; 37(4):815-837.
- Dalton HJ, Slovis T, Helfer RE, et al. Undiagnosed abuse in children younger than 3 years with femoral fracture. *Am J Dis Child* 1990; 144(8):875-878.
- Sty JR, Starshak RJ. The role of bone scintigraphy in the evaluation of the suspected abused child. *Radiology* 1983; 146(2):369-375.
- Pickett WJ, Faleski EJ, Chacko A, Jarrett RV. Comparison of radiographic and radionuclide skeletal surveys in battered children. *South Med J* 1983; 76(2):207-212.
- Leventhal JM, Thomas SA, Rosenfield NS, Markowitz RI. Fractures in young children: distinguishing child abuse from unintentional injuries. *Am J Dis Child* 1993; 147(1):87-92.
- Conway JJ, Collins M, Tanz RR, et al. The role of bone scintigraphy in detecting child abuse. *Semin Nucl Med* 1993; 2(4):321-333.
- Helfer RE, Slovis TL, Black M. Injuries resulting when small children fall out of bed. *Pediatrics* 1977; 60(4):533-535.
- Haller JO, Kleinman PK, Merten DF, et al. Diagnostic imaging of child abuse. *Pediatrics* 1991; 87(2):262-264.
- Kleinman PK, eds. Diagnostic imaging of child abuse. 2nd edition. St Louis, Mo: Mosby, 1998; 285-342.
- Saulsbury FT, Alford BA. Intracranial bleeding from child abuse: the value of skull radiographs. *Pediatr Radiol* 1982; 12(4):175-178.
- Goldstein B, Kelly MM, Bruton D, Cox C. Inflicted versus accidental head injury in critically injured children. *Crit Care Med* 1993; 21(9):1328-1332.
- Bernardi B, Zimmerman RA, Bilaniuk LT. Neurologic evaluation of pediatric craniocerebral trauma. *Top Mag Res Imag* 1993; 5(3):161-173.
- Sato Y, Yuh WT, Smith WL, et al. Head injury in child abuse: evaluation with MR imaging. *Radiology* 1989; 173(3):653-657.
- American Academy of Pediatrics Committee on Child Abuse and Neglect. Shaken baby syndrome: rotational cranial injuries-technical report. *Pediatrics*. 2001; 108(1):206-210.
- Sivit CJ, Taylor GA, Eichelberger MR. Visceral injury in battered children: a changing perspective. *Radiology* 1989; 173(3):659-661.
- Cobb LM, Vinocur CD, Wagner CW, Weintraub WH. Intestinal perforation due to blunt trauma in children in an era of increased nonoperative treatment. *J Trauma* 1986; 26(5):461-463.
- Mogbo KI, Slovis TL, Canady AI, et al. Appropriate imaging in children with skull fractures and suspicion of abuse. *Radiology* 1998; 208(2):521-524.
- Barness KA, Cha ES, Bensard DD, et al. The positive predictive value of rib fractures as an indicator of nonaccidental trauma in children. *J Trauma* 2003; 54(6):1107-1110.
- Ingram JD, Connell J, Hay TC, et al. Oblique radiographs of the chest in nonaccidental trauma. *Emerg Radiol* 2000; 7(1):42-46.
- Prosser I, Maguire S, Harrison SK, et al. How old is this fracture? Radiologic dating of fractures in children: a systematic review. *AJR* 2005; 184(4):1282-1286.
- Loneragan GJ, Baker AM, Morey MK, Boos SC. From the archives of the AFIP. Child abuse: radiologic-pathologic correlation. *Radiographics* 2003; 23(4):811-845.
- Alexander RC, Schor DP, Smith WL Jr. Magnetic resonance imaging of intracranial injuries from child abuse. *J Pediatr* 1986; 109(6):975-979.
- Chabrol B, Decarie JC, Fortin G. The role of cranial MRI in identifying patients suffering from child abuse and presenting with unexplained neurological findings. *Child Abuse Negl* 1999; 23(3):217-228.
- Lloyd DA, Carty H, Patterson M, et al. Predictive value of skull radiography for intracranial injury in children with blunt head injury. *Lancet* 1997; 349(9055):821-824.
- Quayle KS, Jaffe DM, Kuppermann N, et al. Diagnostic testing for acute head injury in children: when are head computed tomography and skull radiographs indicated? *Pediatrics* 1997; 99(5):E11.
- Gruskin KD, Schutzman SA. Head trauma in children younger than 2 years: are there predictors for complications? *Arch Pediatr Adolesc Med* 1999; 153(1):15-20.
- Schaefer PW, Grant PE, Gonzalez RG. Diffusion-weighted MR imaging of the brain. *Radiology* 2000; 217(2):331-345.
- Mogbo KI, Slovis TL, Canady AI, et al. Appropriate imaging in children with skull fractures and suspicion of abuse. *Radiology* 1998; 208(2):521-524.
- Rubin DM, Christian CW, Bilaniuk LT, et al. Occult head injury in high-risk abused children. *Pediatrics* 2003; 111(6 Pt 1):1382-1386.
- Laskey AL, Holsti M, Runyan DK, Socolar RR. Occult head trauma in young suspected victims of physical abuse. *J Pediatr* 2004; 144(6):719-722.
- McAleer IM, Kaplan GW. Pediatric genitourinary trauma. *Urol Clin North Am* 1995; 22(1):177-188.
- Sirotnak AP. Intraperitoneal bladder rupture: an uncommon manifestation of child abuse. *Clin Pediatr (Phila)* 1994; 33(11):695-696.

An ACR Committee on Appropriateness Criteria and its expert panels have developed criteria for determining appropriate imaging examinations for diagnosis and treatment of specified medical condition(s). These criteria are intended to guide radiologists, radiation oncologists and referring physicians in making decisions regarding radiologic imaging and treatment. Generally, the complexity and severity of a patient's clinical condition should dictate the selection of appropriate imaging procedures or treatments. Only those exams generally used for evaluation of the patient's condition are ranked. Other imaging studies necessary to evaluate other co-existent diseases or other medical consequences of this condition are not considered in this document. The availability of equipment or personnel may influence the selection of appropriate imaging procedures or treatments. Imaging techniques classified as investigational by the FDA have not been considered in developing these criteria; however, study of new equipment and applications should be encouraged. The ultimate decision regarding the appropriateness of any specific radiologic examination or treatment must be made by the referring physician and radiologist in light of all the circumstances presented in an individual examination.