

# Physical Abuse of Children

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## EDITOR'S NOTE

This article stresses the importance of the “sentinel injury,” a physical injury that is unusual for the age of the child and may herald more serious injuries, thereby necessitating further evaluation.

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## Practice Gap

Before receiving a diagnosis of child abuse, 25% to 30% of abused infants have “sentinel” injuries, such as facial bruising, noted by clinicians or caregivers. (1)(2)(3)(4)(5)(6) Although easily overlooked and often considered minor, such injuries are harbingers warning clinicians that pediatric patients require further assessment. Appropriate intervention is critical, and the clinician plays a major role in identifying children who present with signs or symptoms concerning for child physical abuse by ensuring appropriate and expeditious medical evaluations and reports to child protective services.

## Objectives After completing this article, the reader should be able to:

1. Identify which injured children require a child abuse evaluation.
2. Recognize subtle signs and nonspecific symptoms of major trauma in infants.
3. Understand sentinel injuries and their significance.
4. Know which laboratory and imaging studies to obtain when child physical abuse is suspected.
5. Understand the legal obligation to report children with injuries that are suspicious for physical abuse and develop a thoughtful approach to informing parents of this legal obligation.

## CASE PRESENTATION

A private practice pediatrician receives a phone call from a community emergency department (ED) physician regarding one of her patients, a 4-month-old infant being treated for bronchiolitis. The ED physician informs her that the baby's chest

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radiograph has revealed multiple posterior rib fractures in different stages of healing, and physical examination shows a cluster of small bruises on her cheek. The mother denies a history of trauma and has no explanation for the findings. The ED physician is concerned that the baby has been abused and his plan includes admitting the patient to the hospital to obtain a head computed tomography (CT) scan, skeletal survey, complete blood cell count, coagulation studies, electrolytes, and liver function tests. He also plans to consult with the child abuse pediatrician and arrange for an evaluation of the patient's siblings. Lastly, he tells the primary pediatrician that he will explain the clinical findings to the family and file a report with the child welfare system. The primary pediatrician thanks him for contacting her and, recalling no significant medical history, pulls the patient's chart.

The baby's most recent visit was slightly more than 1 week ago for her routine 4-month health supervision visit. She is a term infant who has no prior medical complaints other than colic at 1 month of age that has resolved. On recent physical examination, the baby appeared well, with normal growth and development, and the mother did not raise any concerns during the visit. The primary pediatrician now notes that she documented a small circular bruise on the baby's chest that the mother stated occurred when a 3-year-old sibling hit the baby with a toy. Having had a longstanding relationship with this mother and family, she accepted this explanation for the bruise.

After reviewing the chart, she explores the current literature and management of suspected child physical abuse, including the American Academy of Pediatrics clinical report on evaluation of suspected child physical abuse. (7) She now understands that the bruise she noted on examination was a sentinel injury that should have prompted further evaluation. As a result of the case, her practice group plans to review and implement guidelines for the identification and evaluation of children presenting with signs or symptoms concerning for physical abuse.

## INTRODUCTION

Child physical abuse is a difficult diagnosis to entertain primarily because clinicians are hesitant to accept that caretakers can injure children. The diagnosis is further complicated by the reality that caretakers rarely disclose maltreatment, preverbal or obtunded children cannot provide a history, and signs and symptoms of physical abuse may be subtle and confused with other common pediatric diagnoses.

Clinicians must appreciate that with few exceptions, almost any injury can be either abusive or accidental.

Once considered a strictly social problem, child abuse is now also recognized as a medical problem. A recent survey by the Children's Hospital Association revealed that more than 90% of responding hospitals have child protection teams, and more than 50% have at least 1 of the 324 board-certified child abuse pediatricians in the United States on staff. (8)

Recognition of the profound impact of childhood experiences on adult health and well-being, beginning with Feleitti's landmark adverse childhood experiences study, further solidifies the need for clinicians to recognize possible maltreatment and intervene. (9) Adverse childhood experiences have wide-ranging, cumulative, and direct impacts on adult health, increasing the incidence of chronic diseases and early death. (9)(10) The role of the clinician is therefore not only limited to promoting wellness but also to decreasing or eliminating long-term health consequences resulting from childhood exposure to trauma and violence.

## EPIDEMIOLOGY

In 2014, over 3.5 million children were subjects of child maltreatment reports. Of those, 702,000 children (20%) were found to have evidence of maltreatment. (11) This translates to an annual victimization rate of 9.4 children per 1,000 in the United States and a prevalence rate of 1 in 8 children by age 18 years. (12) Neglect is the most common form of child maltreatment, constituting 75% of indicated reports; 7% are attributable to physical abuse. In 80% of child physical abuse cases, a biological parent is the perpetrator. Children in their first postnatal year have the highest victimization rate (24.4 per 1,000), and children younger than age 3 years have the highest fatality rate, comprising over 70% of the nationally estimated 1,580 child maltreatment deaths in 2014. Child welfare data and trends, however, are dubious because of a lack of standardized terminology and differences in report and response types across states.

## RISK FACTORS FOR CHILD PHYSICAL ABUSE

Risk factors for abuse are commonly categorized into parental, child, and social characteristics. Identification of risk factors aids in the assessment of abuse but more importantly aids in the ability to counsel parents and develop preventive strategies. Risk factors are not, in and of themselves, diagnostic. Many families have risk

factors and never abuse their children, while others have no apparent risk factors and do abuse their children. Child abuse does not discriminate; it affects children of all ages, socioeconomic classes, and ethnic groups.

Parental/household risk factors include substance abuse, mental illness, interpersonal violence (IPV), single and/or teen parent, and a nonrelated adult in the home. Among the social risk factors are social isolation, poverty, lower levels of education, and large family size. Child-related risk factors include prematurity, low birthweight, intrauterine drug exposure, and developmental and physical disabilities. The most significant risk factor for abuse is the age of the child, with infants and toddlers being at greatest risk for serious and fatal child physical abuse.

A clear association exists between particular developmental stages and physically abusive injuries, such as excessive crying and abusive head trauma or toilet training and inflicted scald burns. Awareness of these developmental triggers should guide anticipatory guidance, with the potential for preventing an abusive injury.

IPV is a substantial risk factor for child abuse, and each health supervision visit should include IPV screening. Exposure to violence itself, even if the child is not physically harmed, has significant and long-lasting effects.

## WHEN TO CONSIDER THE DIAGNOSIS OF CHILD PHYSICAL ABUSE

Injuries are common in childhood. Although most childhood injuries are accidental, the clinician must appreciate that almost any injury can be abusive. With the exception of patterned marks, very few injuries are pathognomonic for abuse. In the nonverbal child, injuries may be apparent or covert; many children present with nonspecific symptoms and a lack of history. Child physical abuse should be entertained in any infant displaying signs or symptoms potentially explained by trauma, such as irritability, lethargy, vomiting, apnea, seizures, or coma.

Several studies of abused children have demonstrated that antecedent sentinel injuries, such as bruises, intraoral lesions, and skeletal trauma, were noted by medical professionals or caregivers before a subsequent abusive act, while children presenting with accidental injuries were not found to have sentinel injuries. (1)(2)(3)(4)(5)(6) Because infants are essentially nonmobile and nonweight-bearing, they should never have bruising. Therefore, any injury in an infant must be viewed as significant and descriptive language such as “minor” should not be used. Identifying a sentinel injury with appropriate evaluation of the child may be lifesaving.

As children become mobile, the incidence of expected accidental trauma increases, and common childhood injuries such as bruises over bony prominences and toddler’s, clavicular, and skull fractures are seen. In contrast to children with abusive injury, witnesses often corroborate accidental injuries in ambulatory children, caregivers seek timely care, they provide a consistent history, and the mechanism described explains the injury observed. Because the incidence of child physical abuse is highest in children younger than age 4 years, the clinician must have a high index of suspicion and add abusive trauma to the differential diagnosis of the ill-appearing young child.

Determining which injured children require an evaluation for child physical abuse should account for the age and developmental ability of the child, the injury sustained, the adequacy of the historical explanation provided, and

TABLE 1. **Criteria for Consideration to Initiate a Child Physical Abuse Assessment**

<b>Age and Development</b>
<ul style="list-style-type: none"> <li>• Nonmobile infant with <i>any</i> injury</li> <li>• Injury in nonverbal child</li> <li>• Injury inconsistent with child’s ability</li> <li>• Statement of harm from a verbal child</li> </ul>
<b>Injury</b>
<ul style="list-style-type: none"> <li>• Any injury in a nonmobile infant</li> <li>• Uncommon in age group</li> <li>• Occult finding</li> <li>• Mechanism not plausible</li> <li>• Multiple injuries, including involvement of multiple organs</li> <li>• Injuries of differing ages</li> <li>• Pattern of increasing frequency or severity of injury over time</li> <li>• Patterned cutaneous lesions</li> <li>• Bruises to torso, ear, or neck in child younger than age 4 years</li> <li>• Burns to genitalia, stocking or glove distribution, branding, or pattern</li> </ul>
<b>History</b>
<ul style="list-style-type: none"> <li>• Chief complaint does not contain caregiver concern for an injury <i>and</i> plausible history</li> <li>• Caretaker response not commensurate to injury</li> <li>• Unexplained delay in seeking care</li> <li>• Lack of, inconsistent, or changing history</li> <li>• Inconsistencies or discrepancies in histories provided by involved caretakers</li> </ul>

clinical findings (Table 1). Fundamentally, when injuries are not explained or historical data provided contain inconsistencies or insufficiencies, a child abuse evaluation is warranted. Any child younger than age 2 years who presents with a suspicious injury should have a skeletal survey. Other studies should be obtained based upon clinical concern and findings. Negative studies do not rule out child abuse.

### **HISTORY OF THE PRESENT ILLNESS AND CHILD PHYSICAL ABUSE**

A thorough history of present illness is the single most useful piece of information to aid the clinician in making a correct diagnosis. The detailed history should be obtained in separate interviews with each caregiver, the child (if possible), verbal siblings, and any other persons in the household. Interviews should be conducted such that each parent or caregiver can give a history in his or her own words. He or she should be allowed to provide the entire history without interruption, decreasing the chance that the interviewer unintentionally redirects or suggests a mechanism. Details about the mechanism of injury, the events leading up to the injury, and whether the injury was witnessed or unwitnessed should be elicited. For example, in injuries related to falls, having parents recreate the scene, describing the height of furniture, flooring, and the position of the child before and after the fall, is essential.

A history of the onset and progression of symptoms since the child last appeared well should be obtained. Determining who was caring for the child and asking each of the caretakers how the child appeared by focusing on descriptions of activity and movement (particularly during feeding, bathing, and diaper changing) can aid in determining when a child may have been injured. For infants with intracranial injury, it may be difficult to develop a timeline of when the child was last well because the infant may be thought of as “well-appearing” while asleep when the child actually may be seriously injured. Important features of the history that should raise concern for an abusive injury include: no history of trauma; a history of trauma inconsistent with the severity, pattern, or timing of the injury; injury inconsistent with the developmental capabilities of the child; multiple or evolving histories; discrepant histories from the same caregiver or between caregivers; injury attributed to a sibling or pet; and a delay in seeking medical care.

In addition to a detailed history of the incident, the patient’s birth, past medical, developmental, and dietary

histories should be obtained. A complete social history identifies risk factors for maltreatment, and a family medical history focusing on illnesses such as bone disease or bleeding tendencies allows for screening and identification of possible underlying medical problems in the patient.

### **PHYSICAL EXAMINATION AND DIAGNOSTIC EVALUATION**

A thorough and well-documented physical examination of any child with concerns for possible child abuse is imperative. The clinician should be aware that children may suffer more than one type of abuse; the physically abused child may also be neglected or sexually abused. The child’s mental status, affect, and level of activity should be noted. The child must be undressed and all skin surfaces examined with good lighting. The entire body must be evaluated, including areas that may be overlooked, such as the pinnae, behind the ears, the oral cavity including the teeth and frenula, the soles and palms, the genitals, and the anus. Every cutaneous injury should be described according to color, shape, size, and location. Photographic documentation or drawings should be completed and placed in the medical record. The presence or absence of swelling and the ability to move limbs should be noted. Paradoxical comfort (a baby who is more comfortable when not being held but cries when picked up) may be observed in infants with occult injuries such as rib fractures. An assessment of the child’s nutritional status, including completion of a growth chart, is crucial because neglect, malnutrition, and failure to thrive may be comorbidities with physical abuse.

The diagnostic evaluation of suspected physical abuse should always be driven by the history, physical examination, and differential diagnosis. Clinicians must consider the possibility that multiple types of trauma may coexist and recognize that injuries may be occult. Any nonverbal and nonambulatory child with an injury should have a standard child abuse evaluation (Table 2) no matter how “minor” the injury. The most prudent approach is to rule out skeletal trauma in all children younger than 2 years of age with a standard skeletal survey and assess for occult central and/or internal injuries by choosing appropriate imaging and laboratory studies (Table 3).

### **ABUSIVE HEAD TRAUMA**

Abusive head trauma (AHT) has the highest mortality of all forms of child physical abuse, with an estimated fatality rate greater than 20%. Survivors have irreversible sequelae of brain injury, ranging from minor behavioral

**TABLE 2. Protocol for the Evaluation of Suspected Child Physical Abuse**

<p><b>History of Present Illness</b></p> <ul style="list-style-type: none"> <li>• Interview primary caretakers separately; note historian's ability to provide history</li> <li>• Ask caretakers about age-appropriate developmental abilities of child. Observe child if possible</li> <li>• Develop a timeline from when the child was last agreed upon to be in his or her usual state of good health and note the following:             <ul style="list-style-type: none"> <li>○ Onset of symptoms and progression</li> <li>○ The patient's observed mental status and activity level. Ask specifically about how the child appeared at time of hand off between caretakers</li> </ul> </li> <li>• Note if there were any witnesses, photos taken of child, or other corroborating information</li> </ul>
<p><b>Social History</b></p> <ul style="list-style-type: none"> <li>• List all adults having access to the child, including age, relationship, and contact information</li> <li>• List all children, including age and relationship; identify in which home they reside</li> <li>• Note history of drug or alcohol abuse, intimate partner violence, mental illness, prior history of involvement with child protective services</li> </ul>
<p><b>Relevant Past Medical History</b></p> <ul style="list-style-type: none"> <li>• Skeletal trauma: child or family history of bone disease, diet history</li> <li>• Abusive head trauma (AHT) and cutaneous injuries: child or family history of bleeding diathesis, eg, prolonged bleeding after circumcision, umbilical cord removal, or surgery or as a result of past injuries</li> </ul>
<p><b>Physical Examination</b></p> <ul style="list-style-type: none"> <li>• Examine closely for possible intraoral injuries such as frenulum tears; explore all unexposed surfaces: behind ears, genital region, and bottoms of feet</li> <li>• Growth chart: obtain prior growth data, and with regard to AHT, note trajectory of head circumferences</li> </ul>
<p><b>Photodocumentation</b></p> <ul style="list-style-type: none"> <li>• If photos are obtained, document in the medical record details of the photos taken, including location of injuries, number of photos taken, date, and photographer</li> <li>• If photodocumentation is unavailable, use a body diagram noting all cutaneous lesions by size, location, and color</li> </ul>
<p><b>Evaluation</b></p> <ul style="list-style-type: none"> <li>• Indicated laboratory and imaging studies for current illness or injury</li> <li>• Studies to assess occult injuries, such as skeletal survey</li> <li>• Communication with appropriate subspecialists regarding findings and treatment, including child abuse pediatricians when appropriate for referral and consultation</li> </ul>
<p><b>Mandated Reporting and Safety</b></p> <ul style="list-style-type: none"> <li>• Develop dialogue to inform parents about mandated reporting, safety, and reason for report</li> <li>• Ensure that forms and phone numbers for reporting are accessible</li> <li>• Establish office process for specific scenarios with regard to obtaining imaging and laboratory studies and process for transfer to appropriate facility for evaluation and treatment, including protocol for accessing expertise of child abuse pediatrician</li> <li>• Facilitate thorough sibling assessment, including appropriate imaging, laboratory studies, and interpretation; establish protocol to ensure results of sibling assessments are communicated to others in the investigation, including primary care clinician</li> <li>• Ensure medical record and photodocumentation accessibility for investigators (consent not required after report to child welfare)</li> <li>• Discuss disposition of, medical follow-up, and supportive services for patient with child welfare case worker</li> </ul>

issues and neurodevelopmental delays to significant neurodevelopmental delays, seizures, blindness, and paralysis. (13) The incidence of AHT is 15 to 30 cases per 100,000 infants annually in the United States. AHT

occurs most often in children younger than age 2 years and crying is the most commonly identified trigger. Recognizing that the phrase “shaken baby syndrome” implies a specific mechanism, in 2009 the American

Academy of Pediatrics (AAP) recommended that AHT replace this terminology to acknowledge that multiple mechanisms, either separately or together, can cause calvarial, brain, and cervical injuries. (14)

Infants and young children who have AHT can present with signs and symptoms ranging from mild to life-threatening, with a clinical spectrum that includes irritability, vomiting, lethargy, seizures, apnea, coma, and death. Often there are no external findings suggestive of trauma and the history is lacking or misleading. Thus, depending on the extent and severity of the injuries, traumatic brain injury is often misdiagnosed as colic, viral syndrome, otitis media, gastroenteritis, gastroesophageal reflux, or pyloric stenosis. Clinicians must keep AHT in their differential diagnoses and have a high index of suspicion to obtain a thorough history and perform the appropriate diagnostic tests.

Brain injuries seen in 80% of AHT cases include subdural hemorrhage that is interhemispheric, posterior, often layering over the tentorium, and/or a thin subdural layer over either or both of the convexities. Mass effect results not from the subdural trauma itself but rather from significant cerebral edema. The parenchymal damage evolves into a clinical picture consistent with hypoxic-ischemic encephalopathy. Although additional injuries need not be present to diagnose AHT, these neurologic injuries are frequently associated with other traumatic findings, such as retinal hemorrhages, posterior rib fractures, and classic metaphyseal lesions (CMLs). Bruising to the scalp or other parts of the body may or may not be present. The clinician must be mindful to ensure a thorough evaluation for other occult injuries, including neck, internal, and other skeletal trauma.

A short fall leading to fatal head trauma is exceptionally rare, with a calculated risk of less than 1 per 1,000,000 children annually. (15) A unique situation is the development of an epidural hematoma after minor blunt trauma in which a temporal linear skull fracture may sever the middle meningeal vessels and lead to an accumulation of blood that results in mass effect. This is one circumstance in which a child may be neurologically intact after minor or trivial trauma but experience deteriorating mental status and acute symptoms as a result of mass effect.

Head and neck imaging must be obtained for any child for whom there are concerns for AHT. A CT scan is the initial imaging modality of choice because it can be performed quickly in the critically ill child. However, CT scan does not reveal parenchymal injuries, cannot reliably differentiate between subdural and subarachnoid collections, and involves substantial radiation exposure. Magnetic resonance imaging (MRI) should be performed once the

patient is stable, ideally a few days after admission, to optimize visualization of the parenchyma and evaluate for edema, stroke, and thromboses. MRI can also elucidate the location of extra-axial fluid collections and aid in the aging of intracranial hemorrhages. MRI imaging of the spine is also indicated because studies have now demonstrated injury to the cervical spine, such as ligamentous injury and spinal subdural hemorrhage, in children with AHT. (16)(17) MRI is also preferred over CT scan when clinical findings such as rapidly increasing head circumference or focal neurologic issues suggest remote injury. MRI does not entail radiation exposure, but it is a longer study that most often requires sedation.

Retinal injuries such as hemorrhages, schisis or tearing, and folds are associated with AHT and may be seen in up to 80% of cases. Hemorrhagic retinopathy from AHT is classically described as multilayered, with hemorrhages that are too numerous to count and extend to the ora serrata. This very specific finding is unique to AHT and is not due to increased intracranial pressure, blunt head trauma, or cardiopulmonary resuscitation. Retinoschisis and macular folds are reported almost exclusively in children who have sustained violent craniorotational injury and are specific to this mechanism. Any infant or child who has intracranial injuries suspicious for abuse should be evaluated by an ophthalmologist who can meticulously and precisely document the ocular findings, preferably with use of photo imaging. The rate of healing varies from days to weeks and aging of retinal hemorrhages is imprecise. Of note, an ophthalmologic examination is not a screening tool for AHT but is indicated when there is evidence of intracranial injury.

## CUTANEOUS INJURIES

The skin is the most frequently injured organ in child abuse, with bruises, bites, and burns accounting for many child maltreatment injuries. Although cutaneous injuries are very common in childhood, they are rare in the preambulatory child: “those who don’t cruise don’t bruise.” (18)(19) Considerable data support that bruising is not only extremely uncommon in infants but highly correlated with child abuse. (20)(21) Thirty percent or more of seriously injured or fatally abused children have been noted to have bruises, which are sentinel signs (Figure 1), reported on physical examination before subsequent severe or fatal abuse. These data support the directive that any nonmobile infant who has a bruise must receive a full child abuse evaluation (Table 2) and a report to child welfare for investigation. (3)(4)(5)(6)

**TABLE 3. Child Physical Abuse Medical Evaluation: Imaging and Laboratory Studies**

<b>STANDARD CHILD PHYSICAL ABUSE MEDICAL EVALUATIONS</b>
<b>Skeletal Injuries</b>
<ul style="list-style-type: none"> <li>• Skeletal survey (with views according to the collaborative practice parameter issued by the American College of Radiology and the Society for Pediatric Radiology)</li> <li>• Follow-up skeletal survey is indicated in 2 weeks when abuse is suspected on clinical grounds and/or initial findings are abnormal or equivocal</li> <li>• Core laboratory studies for bone health: calcium, magnesium, phosphate, and alkaline phosphatase</li> <li>• If concerns for vitamin D deficiency (elevated alkaline phosphate, abnormal bone density, or dietary concerns), consider 25-hydroxyvitamin D and parathyroid hormone level</li> </ul>
<b>Central Imaging</b>
<ul style="list-style-type: none"> <li>• Head computed tomography (CT) scan (useful for screening, and/or monitoring an ill child)</li> <li>• Magnetic resonance imaging (MRI) of head and spine (useful for elucidating extra-axial spaces, parenchymal disease, and spinal injury)</li> </ul>
<b>Routine Trauma Laboratory Tests</b>
<ul style="list-style-type: none"> <li>• Hematologic: complete blood cell count and platelets</li> <li>• Coagulation: international normalized ratio, prothrombin time, and activated partial thromboplastin time</li> <li>• Metabolic: glucose, blood urea nitrogen, creatinine, calcium, magnesium, phosphate, albumin, and protein</li> <li>• Urinalysis: urine toxicology screen, order myoglobin if urinalysis positive for blood and red cells are not seen on smear</li> <li>• Liver function tests: aspartate aminotransferase and alanine aminotransferase (&gt;80 U/L [1.34 <math>\mu</math>kat/L] is concerning for occult injury)</li> <li>• Pancreatic enzymes: amylase and lipase</li> </ul>
<b>ADDITIONAL POTENTIAL TESTS</b>
<b>Ophthalmologic Examination</b>
<ul style="list-style-type: none"> <li>• Indicated if evidence of either acute or remote central nervous system trauma</li> <li>• Not a screening tool for abusive head trauma</li> </ul>
<b>Abdominal (Thoracoabdominal) Imaging: CT Scan With Intravenous Contrast</b>
<ul style="list-style-type: none"> <li>• Elevated liver or pancreatic enzyme values</li> <li>• Comatose patient</li> <li>• Evidence of trauma with delay in care (liver function tests may have decreased to normal levels)</li> </ul>
<b>Concerns for Bleeding Diathesis (Family History or Clinical Concerns)</b>
<ul style="list-style-type: none"> <li>• von Willebrand antigen, von Willebrand activity (ristocetin co-factor), Factor VIII, Factor IX, platelet function assay</li> <li>• Hematology consultation</li> </ul>
<b>Metabolic Diseases</b>
<ul style="list-style-type: none"> <li>• Genetics consultation</li> </ul>

As children start to ambulate, the incidence of bruising increases. Bruise location and morphology are important factors to consider when assessing for child physical abuse in ambulatory children. Accidental injuries tend to occur over bony prominences (shins and elbows) in contrast to bruises due to abuse, which are located on the face, head, neck, torso, flanks, buttocks, and thighs. The mnemonic

“TEN 4” is useful to recall which bruise locations are concerning for abuse: Torso, Ear, Neck, and 4 signifying children younger than age 4 years and any bruising noted in infants younger than 4 months. (20) Bruising and abrasions that occur on more than one body surface, are in multiple stages of healing, and are patterned or well demarcated are more likely to be the result of abuse. Patterned injuries

reflect the shape of the instrument, such as loop marks from a cord or cable, linear bruises from belts, or multiple parallel linear bruises equally distributed from a slap with a hand. Contrary to some common beliefs, children do not bruise more easily than adults and bruises cannot be aged precisely. The appearance of a bruise is related to many factors, including the state of hemoglobin degradation, the color of skin pigment, the depth of the bruise, the location on the body, the lighting in the room, and the patient's metabolism and circulation. Bruises of differing colors do not signify different times or incidents. Finally, because bruises or soft-tissue injury may be painful for days, the presence of tenderness does not necessarily mean the injury is acute.

Determining whether marks or bruising from corporal punishment constitutes abuse is a difficult task. Legally, some states condone corporal punishment as an acceptable form of behavioral modification while others define it as a form of child maltreatment and require reporting to child welfare. The AAP and the American Academy of Child and Adolescent Psychiatry do not condone corporal punishment due to its limited effectiveness and potential deleterious effects. Although known to be immediately effective, spanking and corporal punishments have significant adverse outcomes, such as increased aggression and decreased development of appropriate behavior. (22)(23) (24) Both groups advise against the use of corporal punishment and encourage alternative methods of behavioral modification – such as time out, loss of privileges, positive reinforcement, and opportunities for positive touch like hand holding and hugging – that have healthier, long-lasting effects. From a practical standpoint, each clinician must be versed in his or her state laws. More importantly, the clinician must develop a thoughtful and culturally sensitive



**Figure 1.** Infant displaying bruising that represents a sentinel sign for physical abuse.

dialogue with parents that promotes alternative methods of discipline.

Bite marks are another patterned skin injury noted in abused children. Clinicians can discern between animal and human bites by assessing the shape: animal bite marks are puncture wounds with a sharply angulated arch, while human bite marks are crush injuries consisting of an ovoid pattern of tooth marks that may surround an area of central bruising. In general, adult bite marks measure greater than 2 cm between the maxillary canines. Consultation with a forensic odontologist may assist in the evaluation of well-demarcated bite marks. Multiple bites on different body planes, bites on soft-tissue areas, and bites on areas generally covered by clothing should raise a suspicion of abuse. Bites to the genitalia, buttocks, and/or breasts should raise a concern of possible sexual abuse. Acute bites to the genitalia, buttocks, and/or breasts may warrant collection of forensic evidence for DNA by swabbing the area with a cotton swab moistened with distilled water.

Hot liquid, grease, steam, hot objects, chemicals, electricity, or microwave ovens may cause abusive burns. Compared to accidental burns, abusive burns are more severe, more likely to be full-thickness, and require more extensive treatment, including grafting. Children who are abusively burned are most often younger than 4 years and inflicted immersion burns to the buttocks and genitalia are commonly associated with toilet training.

Abusive burns most often take the form of immersion scald burns, characterized by well-demarcated areas of confluent depth with no splash or cascading flow pattern. Immersion burns may involve the buttocks, perineum, extremities, hands, or feet. Circumferential burns affecting the feet and/or hands are sometimes referred to as having a “stocking” or “glove” distribution. In immersion burns, the position in which the child was held may be surmised by the burn pattern and depth. If the child's buttocks come into contact with the tub surface, a “doughnut” type pattern may be noted with relative sparing of the part of the anatomy coming into contact with the tub. Sparing of the flexion creases is often observed. Persons who inflict these burns generally do not suffer burns themselves. A careful scene reconstruction and investigation, including water temperature, may help determine the length of time the child was held in the water. Generally, the hotter the water, the shorter the duration of submersion. Partial-thickness burns develop in minutes at 48.9°C (120°F) but take mere seconds at 65.6°C (150°F). (25)

Children often come into contact with hot objects, such as irons, hair tools, radiators, and stovetops. Resultant burns are related to the heat of the object and period of contact with

the skin. Both abusive and accidental contact burns can result in a patterned mark, making discernment based on appearance difficult. Suspicious contact burns require a thorough scene investigation and corroboration, particularly if the child is nonverbal. In general, abusive contact burns are deeper and leave a clear imprint while those that result from grazing against a hot object are not as deep or well-demarcated.

The most common differential diagnosis of inflicted cutaneous injury is accidental injury. Dermatologic and other conditions such as congenital dermal melanocytosis (mongolian spots), phytophotodermatitis, Henoch-Schönlein purpura, Ehlers-Danlos syndrome, vasculitis syndromes, bleeding dyscrasias, eczema, malignancy, and cultural practices such as cupping and coining (cao gio or gua sha) may lead to cutaneous lesions that appear initially concerning for abuse. Some conditions that may be confused with or mimic burns are impetigo, staphylococcal scalded skin syndrome, herpes, and contact dermatitis. A careful history, physical examination, and diagnostic tests should clarify whether an accident or one of these conditions is the cause of the findings. As always, clinicians should be mindful that the child who has an underlying medical problem might also be physically abused.

## SKELETAL INJURIES

Fractures are the second most common type of child physical abuse. Accidental fractures are common in ambulatory children but not in nonambulatory children. Most abusive fractures occur in nonambulatory children, representing 55% to 70% of fractures in children younger than age 1 year and 80% of all abuse fractures found in children younger than 18 months of age. (26) Age is the single most important risk factor for abusive skeletal injury.

Understanding that different types of fractures result from different forces applied to the bone aids in determining if a given history is plausible. Transverse fractures are due to forces that are perpendicular to the bone or bend the bone, torus or buckle fractures are due to axial loading or compression along the long axis of the bone, spiral fractures are due to twisting, and oblique fractures are due to a combination of transverse and twisting forces.

Abusive skeletal injury may involve any part of the skeleton, but fractures of the extremities are most common. Any fracture can result from abuse, and no fracture is pathognomonic for abuse. Some fractures, however, have a higher specificity for abuse, such as posterior or lateral rib fractures or CMLs, also known as “corner” or “bucket handle” fractures. These fractures occur at the ends of long

bones, resulting from twisting that causes a planar fracture through the spongiosum of the metaphysis.

Some uncommon fractures, such as sternal, spinal, and scapular fractures, are also highly suggestive of child abuse in the absence of a credible and corroborated trauma history. Any child who presents with multiple fractures or fractures in differing stages of healing should raise concern for nonaccidental trauma.

The most common differential diagnosis of abusive fracture is accidental fracture. Some fractures, such as clavicular fractures, may be due to birth trauma. Underlying medical conditions and metabolic bone diseases should be considered in the differential diagnosis of skeletal trauma and include osteogenesis imperfecta, Menkes syndrome, hyperparathyroidism, hypophosphatasia, and Fanconi syndrome. Although vitamin D deficiency is prevalent, rickets is not, and research demonstrates that the incidence of fractures in skeletal trauma is not influenced by vitamin D deficiency. (27)(28)

## IMAGING OF SKELETAL INJURIES

Skeletal injuries may be clinically silent in children younger than age 2 years and in developmentally delayed or nonverbal children. A skeletal survey to identify acute or healing fractures should be performed when there is concern for any form of child physical abuse. If an abused child has siblings who are younger than 2 years, skeletal surveys should be performed to evaluate these siblings. The current recommendation by the American College of Radiology for skeletal survey consists of 21 dedicated views, including oblique views of the chest to aid in the detection of rib fractures. (29) Although the clinician must be mindful of radiation exposure, the discovery of an occult injury is a major determinant in the diagnosis of child abuse and, thus, outweighs radiation risk. Infants may have positive skeletal surveys in up to 20% of cases. (30)

Some fractures with high specificity for child abuse, such as rib fractures and CMLs, may not be apparent on the initial skeletal survey. With healing and new bone formation, these injuries become more obvious. Thus, a repeat skeletal survey obtained 10 to 14 days after the initial survey is recommended to re-evaluate for fractures. Bone scans are no longer obtained as a complementary test to detect possible injury because of their serious limitations, including problems with motion artifact, inability to estimate age of injury, and lack of specificity. Due to radiation exposure concerns, CT scan is not a preferred imaging modality to detect fractures. If chest or abdominal CT scan is performed for other reasons, it can be useful in detecting nondisplaced rib fractures. Skull fractures

in the line of the axial plane are often missed on head CT scan. The addition of 3-dimensional CT scan reconstruction enhances the identification and morphology of skull fractures and helps ensure their detection and diagnosis.

Aging of bone fractures is imprecise and must be based upon history and clinical examination findings as well as radiographic known patterns of healing. In young children with long bone fractures, new bone is visible within 1 to 2 weeks, followed by callous development, disappearance of the fracture line, and finally resolution. Some fractures, such as skull fractures or CMLs, do not follow a predictable healing process and cannot be aged based on radiographs alone.

### CHEST AND ABDOMINAL INJURIES

Abdominal trauma is the second leading cause of fatalities due to child physical abuse. This is likely due to delays in seeking medical care, a misleading history of no or only trivial trauma, and the greater severity of injury in abusive as compared to accidental abdominal trauma. Early signs and symptoms, such as loss of appetite, vomiting, and abdominal pain, are nonspecific and may be misdiagnosed. Furthermore, physical examination generally does not reveal bruising to the chest or abdomen. Some children with abdominal trauma may be battered and have "distracting injuries," such as AHT or a fracture, that may delay recognition of the abdominal injury. Because signs and symptoms of chest and abdominal injuries may be subtle or overlooked, meticulous physical examination is imperative. Signs and symptoms of occult abdominal trauma vary, depending on the age of child and presence of associated injuries such as intra-abdominal hemorrhage or peritonitis. The clinician should palpate the chest wall to examine for rib deformities. Chest wall tenderness and/or palpable callus may suggest the presence of healing rib fractures. Auscultation for equal breath sounds as well as clear heart tones and bowel sounds and palpation of the abdomen must be performed. Because the physical examination results can be misleading, with a lower sensitivity for trauma in younger children, laboratory screening should be considered, particularly in any nonverbal or nonambulatory child.

Relative to accidental abdominal trauma, abusive abdominal trauma occurs more often in infants and toddlers, is more severe, and requires a higher rate of surgical intervention. The peak age for abusive abdominal injury is between ages 2 and 3 years. This may be due to child-related behavioral risk factors, such as increased activity level, normal exploration, normal negativism, and toilet training.

Abusive injuries to almost every visceral structure have been reported. The most commonly injured organs are the

liver and spleen, followed by duodenal and proximal jejunal ruptures or hematomas and pancreatic, vascular, and/or renal trauma. Other injuries may involve the bladder, large intestine, stomach, mesentery, and adrenals. The most common mechanism for abdominal injury is focused blunt force trauma to the abdomen that compresses, crushes, or tears the viscera. Because the forces are focused internally, abdominal bruising is rare, and clinicians should not be lulled into a false sense of security by the absence of abdominal bruising. The major diagnostic differential diagnosis for abusive abdominal injury is accidental abdominal injury, which is readily elucidated by history (or lack thereof).

Any child in whom abdominal trauma is suspected should undergo screening, including liver function tests, pancreatic enzymes, hemoglobin to assess for blood loss, and urinalysis to check for hematuria. Plain radiographs are rarely diagnostic but may reveal indirect evidence of visceral injury, such as dilated loops of bowel, air fluid levels, free air, bowel wall air, periportal tracking, or mass effect on the bowel. Abdominal CT scan with contrast is the preferred imaging modality to assess for intra-abdominal injury and is indicated when hepatic enzymes aspartate aminotransferase and alanine aminotransferase measure more than 80 U/L (1.34  $\mu$ kat/L). (31) Liver enzyme values acutely rise but then rapidly fall after blunt trauma; liver enzymes due to infection or liver disease do not resolve in this pattern. In children who have subacute abdominal trauma, liver enzymes may have normalized by the time of evaluation. (32)

Thoracic injuries are mostly related to crush or major blunt trauma and may involve the heart, lungs, rib cage, and mediastinum. Pulmonary hemorrhage and edema due to airway obstruction, shearing injury to the thoracic duct resulting in a chylothorax, pneumomediastinum, pneumopericardium, and commotio cordis have all been described as a result of abusive trauma.

### REPORTING TO CHILD WELFARE AND THE ROLE OF THE CLINICIAN

As mandated reporters, clinicians are required to make a report to child welfare when there is reasonable cause to believe that an injury is the result of abuse or neglect. The clinician need only suspect that maltreatment has occurred to initiate a report. The clinician's role is to initiate evaluation and ensure appropriate treatment and safety of the patient. The final determination of child abuse requires a coordinated interdisciplinary investigation. Access to the expertise of a child abuse specialist is ideal because he or she is accustomed to collaborating with law enforcement, child welfare, and the legal system.

Primary care clinicians may be challenged by their responsibility to inform the caregiver or parent(s) of a report suspicious for child maltreatment. They are understandably concerned about the safety and disposition of their young patients as well as the potential stress and reaction of the family to an investigation. Anticipating a negative family reaction may cause hesitation in reporting. However, the clinician must keep in mind his or her role as the child's advocate and recognize that the report is a medical intervention that may be lifesaving. Developing a thoughtful dialogue to inform a parent of the need to make a report can ease the stress on the reporter as well as the parent.

Clinicians often wonder what happens after a report is made. In every state, a child welfare organization is responsible for investigation of the child maltreatment allegation. The investigative agency may substantiate (indicate) or not substantiate (unfound) a particular allegation. Unsubstantiated findings do not necessarily mean that child maltreatment did not occur. Most investigations do not result in removal of a child from a home and may, in fact, provide opportunities for augmenting the family by offering support to caregivers, such as home visits, parenting classes, access to transportation for follow-up care, and individual or group therapy.

Some cases may progress in the legal system. When there is urgent and immediate concern for a child's safety, the case may be heard in juvenile/family court and result in the temporary removal of a child to ensure his or her safety, health, and well-being. These children are assigned their own attorney, known as a guardian ad litem.

Criminal court testimony is requested when a specific person has been charged with an act leading to an abusive injury. Unlike juvenile court, in which evidence is based upon preponderance (more likely than not), criminal court requires evidence beyond a reasonable doubt. "Managing Child Abuse: General Principles" is an excellent reference (33) that provides a very thoughtful stepwise approach to reporting and navigating the subsequent legal process.

No matter which direction a report may take, the clinician must advocate for his or her patient to have necessary resources and an appropriate medical home.

## PREVENTION AND FUTURE HORIZONS

The monetary cost to society of child abuse has been estimated to be \$80.3 billion per year. (34) However, this does not adequately reflect the true loss of a child due to untimely and preventable death. Child maltreatment is now recognized as a major public health problem and a

significant contemporary source of morbidity and mortality. Appreciation of the adverse impacts of early stressors on adult health has been transformational in validating the role of the pediatric clinician in promoting wellness not only in childhood but also into adulthood. Knowledge of child physical abuse continues to evolve, providing more clarity, as demonstrated by the recent understanding of the significance of sentinel injuries. Increased awareness of child maltreatment by primary care clinicians along with timely intervention ideally can lead to effective prevention of the adverse outcomes of child maltreatment and, along with more dedicated research, to effective primary prevention.

## Summary

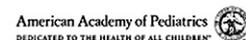
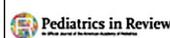
- On the basis of research and consensus, the diagnosis of child physical abuse must be entertained whenever an infant or nonverbal child presents with any injury. Substantial evidence supports that any form of trauma in a baby is significant and deserves complete evaluation. (1)(2)(3)(4)(5)(6)
- Clinicians must consider child abuse in the differential diagnosis of any young child with injuries or symptoms where there are discrepancies between the sustained injuries and the history and/or patient's developmental capabilities. On the basis of strong research and consensus, child abuse is recognized not only as a major source of mortality and morbidity in childhood but also as a direct cause of increased adult morbidity and early death. (9)(10)
- On the basis of consensus, primary care clinicians are in a position to identify children with injuries concerning for child abuse, initiate an appropriate and thoughtful medical evaluation, report to child welfare, and appropriately seek child abuse pediatric consultation.

CME quiz and references for this article are at <http://pedsinreview.aappublications.org/content/37/4/146>.

To view PowerPoint slides that accompany this article, visit <http://pedsinreview.aappublications.org> and click on the Supplemental tab for this article.

## Physical Abuse of Children

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## PIR Quiz

There are two ways to access the journal CME quizzes:

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1. A 14-month-old girl is brought to the emergency department with history of a fall from a couch to a tile floor. Her mother and father have accompanied her. The mother believes the fall was about 2.5 feet. She reports that the girl cried immediately and after a few minutes, she seemed to act in a typical manner. She also reports that after about 15 minutes the girl started vomiting and was sleepy. You obtain a computed tomography scan of the brain that shows a 9-mm right-sided epidural hematoma with mass effect. What is the most appropriate next step in management?
  - A. Obtain social work consultation.
  - B. Request consultation from the child abuse specialist.
  - C. Request magnetic resonance imaging (MRI) of the brain.
  - D. Request a neurosurgical consultation.
  - E. Separate the parents and obtain histories from each of them.
2. You see a 3-month-old boy for a health supervision visit. His mother reports that he spits up after most feedings. He has eczema over his face, arms, and chest. He has a nickel-sized bruise behind his left ear. His mother reports that he rolled onto a toy in his crib and this caused the bruise. What is the most appropriate next step in management?
  - A. Obtain complete blood cell count and iron levels.
  - B. Request MRI of the brain.
  - C. Request referral for a dermatology evaluation.
  - D. Request referral to a gastroenterologist.
  - E. Submit a report to child welfare.
3. A 1-year-old boy has bruising over his back and upper arms with several parallel lines of bruising on both upper arms. Several of the bruises are green; other bruises are yellow and purple. You are asked to testify in court regarding the cause and timing of these injuries. You testify that:
  - A. Children bruise more easily than adults.
  - B. The parallel lines of bruising likely represent a hand print injury.
  - C. These sites of bruising are common in accidental injuries.
  - D. Varied colors of bruising show that there were injuries at varied times.
  - E. You are unable to provide any information related to the boy's bruises.
4. You see a 2-year-old boy with vomiting and weight loss over the past several weeks. His father relates that several other family members have had gastrointestinal illness in the past month. On physical examination, the boy's abdomen is mildly distended with bilateral upper quadrant tenderness. He appears mildly dehydrated and drinks small amounts of water during the visit without emesis. He wants to be held and cries throughout the examination. What is the most appropriate next step in management?
  - A. Obtain complete blood cell count, liver transaminases, and pancreatic enzymes.
  - B. Prescribe antacid daily.
  - C. Request MRI of the brain.
  - D. Request referral for ophthalmology evaluation.
  - E. Request referral to a gastroenterologist.
5. You see a 3-year-old girl for a respiratory illness. Her mother states that the girl refuses to go to sleep and wakes multiple times during the night. The girl is resistant to toilet training and her mother reports that she holds her on the toilet to help her potty train. She has had a few successful voids on the toilet with this method. She has several bruises on her right scapula that her mother reports occurred when she fell from a dining room chair. She has a faint bruise on her right facial cheek and her mother is not sure of how this injury occurred. Her physical examination findings are otherwise normal. What is the most appropriate next step in management?

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This journal-based CME activity is available through Dec. 31, 2018, however, credit will be recorded in the year in which the learner completes the quiz.

- A. Obtain laboratory studies for possible bleeding disorder.
- B. Request polysomnography evaluation of her sleep.
- C. Request renal ultrasonography and cystometrography.
- D. Request referral for ophthalmology evaluation.
- E. Submit a report to child welfare.

## Parent Resources from the AAP at HealthyChildren.org

- <https://www.healthychildren.org/English/safety-prevention/at-home/Pages/What-to-Know-about-Child-Abuse.aspx>
- Spanish: <https://www.healthychildren.org/Spanish/safety-prevention/at-home/Paginas/What-to-Know-about-Child-Abuse.aspx>

### Addendum for Meningitis

Regarding the December 2015 *Pediatrics in Review* article “Meningitis” (*Pediatr Rev.* 2015;36(12):514–526, doi: 10.1542/pir.36-12-514):

The incidence of *Haemophilus influenzae* type b (Hib) invasive disease, including meningitis, has decreased tremendously with the increased use of Hib conjugate vaccine in infants. Unfortunately, there is concern that similar to other vaccine-preventable diseases, such as measles and pertussis, an upsurge in Hib meningitis could follow a decrease in Hib vaccine use. Therefore, it is important for clinicians to recognize possible Hib meningitis promptly and treat it effectively.

The footnote to the listing for *Escherichia coli* in Table 6 of the article on meningitis published in *Pediatrics in Review* clearly states “Or other Gram-negative enteric bacilli. Choice of antibiotic is directed by the results of susceptibility testing.” What may not be clear to all readers is that a very small percentage of Hib that are beta-lactamase-negative still have a sufficiently high minimum inhibitory concentration (MIC) for ampicillin to make Hib resistant to ampicillin. Thus, ampicillin is not considered a preferable antibiotic until susceptibility (based on MIC) is available. This is an essential point because the consequences of initial ineffective therapy can be disastrous.

Out of an abundance of caution, we want to remind readers (and have updated the online version of the article with the notation) that The Committee on Infectious Diseases of the American Academy of Pediatrics recommends, “Initial therapy for children with *H influenzae* meningitis is cefotaxime or ceftriaxone. Ampicillin should be substituted if the Hib isolate is susceptible.”

– Mobeen H. Rathore, MD, FAAP  
Pediatrics in Review Editorial Board  
AAP Committee on Infectious Diseases

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