

Chapter 2

Clinical Perspective

History of Present Illness (See Table 2.1)

The Non-verbal Child: Obtaining a History from Caregiver(s)

Once a concerning illness or injury is identified, the history of present illness or injury (HPI) elicited from the caregiver(s) should include a detailed timeline beginning with a state of wellness, and/or the child's typical baseline through to a description of illness or injury event(s). When specific event(s) are noted, caregiver(s) should be asked to **share what and when event(s) happened, who was present, and what happened after event(s)**. For example, a history of a fall is a common injury event in cases of both physical abuse and accidental trauma. When a history of a fall is offered, fall components that should be elicited include what precipitated the fall, whether the child sustained a free fall or struck an object prior to landing, the height of the fall, how the child landed, landing surface and objects near the child's landing location. In cases of abuse, although perpetrators may not accurately describe the actual abusive event, 76% of perpetrators initially accurately described the circumstances surrounding the abusive event; 64% initially mentioned a trigger for the abuse (Flaherty 2006).

There are times when a caregiver does not provide a history of injury event(s), but instead offers signs and symptoms that prompted medical care. Caregiver(s) should be asked to share who was present at change of status, which caregiver(s) noted onset of new/different signs and symptoms, and what were the caregiver(s)' response(s) to the change in the child's status. Caregiver(s) should be asked if and how cardiopulmonary resuscitation was provided prior to Emergency Medical Services (EMS) and/or about any other attempts at pre-hospital treatment by caregiver(s). The HPI typically ends when EMS assumes responsibility for the child. If EMS is not contacted, the HPI ends at the time of hospital triage, or other first contact with the formal medical system. After hospital triage,

Table 2.1 Historical elements in the medical evaluation of suspected child physical abuse

History category	Elements
History of present illness	Source of history Caregiver(s) present at time of injury, illness, or change in status Injury history and/or timeline of symptom(s) Caregiver(s)' response to symptoms Outside hospital or pre-hospital medical care Discrepancies in history
Past medical history	Growth patterns/charts Diagnoses and/or Well-child care Surgeries Acute life threatening events (Southall et al. 1997) Injuries (intraoral, skin, fractures) (Sheets 2013) Bruising and/or bleeding tendencies Seizures <i>if intracranial hemorrhage</i> Dental abnormalities and/or hearing loss <i>if fractures</i> Primary care provider(s) Medication Immunization status
Birth history <i>If child <6 months</i>	Prenatal care, nutrition, diagnoses and trauma Intrauterine drug and/or alcohol exposure(s) Perinatal illnesses (e.g. mother or child with sepsis) Birth complications (e.g. instrumentation, shoulder dystocia) Estimated gestational age, and birth weight Prolonged umbilical stump oozing, delayed separation, or other complications Newborn metabolic screen results Vitamin K administration <i>if intracranial hemorrhage</i>
Developmental history	Milestones Parental concerns about development and/or behavior
Dietary history	Breast and/or formula Dietary restrictions and/or if "Picky eater"
Family history	Suicide attempt(s) and/or serious psychiatric illnesses (Diderich et al. 2013) Genetic disorders Early childhood deaths and/or diseases Bleeding disorders, bleeding tendencies <i>if intracranial hemorrhage</i> Seizures <i>if intracranial hemorrhage</i> Bone fragility, blue sclera, dental abnormalities, hearing loss, and/or short stature <i>if fractures</i>
Social history	Child care setting (e.g. single provider home daycare) Caregiver(s) history of abuse or neglect Family or caregiver(s) history of prior CPS involvement Violence in the home, intimate partner violence (Diderich et al. 2013) Caregiver(s) substance use (Diderich et al. 2013)

Campbell et al. (2015)

statements made by caregiver(s) to other clinicians, including possible discrepancies, can also be noted in the child’s HPI.

The Verbal Child: Obtaining a History from Caregiver(s)

Caregiver(s) and the verbal child should be spoken with separately if the treating clinician believes separation would not be potentially detrimental to caregiver(s) and/or the child. This allows caregiver(s) and clinician to share concerns that may not be appropriate for a child to overhear. Many of the elements discussed in the prior section related to the non-verbal child are applicable to older, verbal children. In addition to the aforementioned elements, when speaking with caregiver(s) of a verbal child, the clinician should ask about caregiver(s)’ recall of any prior concerning statements made by the child. Many clinicians will also listen for caregiver(s)’ statements or ask caregiver(s) about whether they believe the verbal child. When alone with clinicians some caregivers may also discuss adverse behavioral changes such as changes in appetite, activity/interaction, mood, school performance, and sleep pattern. While these behavioral changes are not specific for physical abuse, these changes may indicate that physical abuse has occurred and/or that the child is at increased risk for physical abuse when adverse behaviors are exhibited in the presence of frustrated caregiver(s).

Many adults and some children realize that information gathered during a medical encounter is typically shared among other clinicians for purposes of diagnosis and treatment. If the history of present illness contains elements that are suspicious for child maltreatment (Table 2.2), then the clinician should consider how and when to explain that information shared with a clinician in a case of suspected child maltreatment is also divulged to social services and/or law enforcement professionals.

The Verbal Child: Obtaining a History from the Child

There are multiple advantages to conducting a history with the child. Children frequently perceive physicians and nurses as individuals who can help by treating their bodies. Many clinicians are knowledgeable about child and teen language and

Table 2.2 Suspicious historical elements

No history of trauma in the setting of significant injuries
History inconsistent with injuries
History inconsistent with a child’s development
Substantial changes in an initial history of trauma
Significant injuries attributable either to a short free fall, trivial trauma, or sibling(s)
Past medical history of unusual bruising, intraoral or unexplained injuries (Sheets et al. 2013)
Past medical history of recurrent apneic episodes, acute life threatening events (ALTEs) (Southall et al. 1997)

Hettler and Greenes (2003), Flaherty (2006), Feldman et al. (2001)

developmental milestones. This knowledge will influence how questions are asked by the clinician. A medical history by a clinician prior to an examination also allows a child to observe the examiner and allows the examiner to establish rapport with the child.

Prior to speaking with the child about the possibility of maltreatment, it is best to establish that the clinician will ask questions to help with treatment of the child's body. Near the beginning of the encounter, the clinician might explain why and how she does check-ups and dialog about what the child believes happens when the child is at the doctor's office or hospital. If the clinician anticipates using equipment (such as a camera, ruler) that is not typically in a general practitioner's office then explaining the purpose of equipment alongside discussion about more traditional equipment (stethoscope, otoscope, etc.) with which the child may be familiar, will help establish the medical/clinical nature of the encounter. The clinician may then explain that even though she is a grown-up and a doctor or nurse, she does not know everything that has happened to the child. The clinician must explicitly and repeatedly give the child permission to speak up, ask questions, voice assent to the examination process, and/or say the clinician is wrong or is not understood by the child. Prior to asking questions about event(s) that prompted formal medical care and/or the physical examination, the clinician must also explain to the child that the child is not in trouble with the doctor or nurse, and that she will carefully listen to anything the child would like to share. Some clinicians also explain that what the child says and the words used by the child are important, and as such, the clinician will be writing or typing the child's words during their encounter.

A perfectly scripted medical encounter with a child is rare. Every child-serving clinician can share anecdotes about encounters that simply did not occur as planned. There will be times when the clinician walks into the exam room and has only just begun the process of introducing the clinician when the child begins to disclose concerns. It is the clinician's responsibility to immediately begin to actively listen and look for signs, symptoms and behavioral cues. Clinically, eliciting details about maltreatment is far more important than eliciting a specific number of times the child was maltreated. Finally, clinicians must always remain aware of the child's development, particularly during history taking from the child. The clinician's comments and questions should ideally be short, simple and/or open-ended (Table 2.3). **An open-ended approach ensures the clinician does not introduce or suggest either abusive acts or a potential perpetrator. An open-ended approach also invites the child's narrative which may be replete with idiosyncratic comments and rich and unusual details.**

Taking a history from a verbal child outside of the presence of a caregiver allows the child to speak without simultaneously observing and processing the caregiver's reactions. However, there are instances when either the caregiver or child does not feel separation is appropriate. The caregiver may remain in the

Table 2.3 Suggestions for inviting narratives from a verbal child

What	Tell me why you're getting a check-up today. Tell me more about [X]. Tell me what your body felt like when [X]. Tell me about the time you remember [X] the most. You can tell a doctor/nurse anything that is true. What happened? What happened to your body? What happened next? And then what happened? What did [X] feel like? What did [perpetrator] say to you about [X]?
Where	Where on your body were you [X]? Where did it hurt when [X]? Does anywhere on your body hurt now? Where were you when [X] happened? Tell me where you were when [X] happened.
When	Did [X] happen one time or more than one time? Did [X] happen on one day or more than one day? When was the last time [X] happened? How old were you when [X] happened?
Who	What is the name of the person who did [X] to you? What do grown-ups call [him/her/mom/dad/ suspected perpetrator]?
Ask for clarification when necessary!	I don't understand what you said. Can you say that a different way? I don't know. Can you help me understand by telling me or showing me?

room but seated outside of the direct line of sight of the child when the clinician is speaking to the child.

An investigative or forensic interview sometimes occurs prior to the medical encounter. When this occurs, the clinician should make an effort to obtain details in order to minimize repetition by the child and/or caregiver. Children may perceive repeated questions as being repeated because the adult does not approve of the child's response or does not believe the child's response is accurate and/or true. Nevertheless, even when the clinician has sufficient details about the events around the physical abuse, it remains important that the clinician consider speaking directly to the child. A medical history and/or review of systems may yield additional information, in addition to allowing the child to share his/her concerns.

Physical Examination

A careful and comprehensive physical evaluation can yield important data that will inform the medical diagnosis.

Ocular Injuries

Direct blunt trauma, including child physical abuse, should be considered in young, otherwise healthy children with periorbital ecchymosis, orbital fractures, subconjunctival hemorrhaging, corneal abrasions or lacerations, hyphema and/or retinal pathology (retinal bruising, hemorrhaging, scarring) (David 2000). Indirect blunt trauma, such as blunt forehead trauma may result in unilateral or bilateral periorbital ecchymosis as blood tracks into the relatively loose periorbital tissue. Unilateral pathology (such as globe rupture, lens dislocation, or retinal detachment) in an otherwise healthy child without a credible history of accidental trauma should prompt consideration of abusive trauma (David 2000).

Ocular pathology may be apparent on physical exam. Increased intrathoracic pressure (as a result of a strong Valsalva maneuver or blunt chest trauma) may indirectly result in rupture of small subconjunctival blood vessels. In an otherwise healthy infant or young child without a credible history of accidental trauma, **subconjunctival hemorrhaging (SCH) in isolation or in association with facial, eyelid or neck petechiae should prompt an evaluation for traumatic asphyxia and other forms of child physical abuse** (DeRidder et al. 2013). Inflicted bruising, frenula injuries, fractures, and intracranial pathology have each been documented in infants and children who present for medical care with SCH (DeRidder et al. 2013) (Fig. 2.1). In the setting of infectious, oncologic, or hematologic abnormalities, there should be a more judicious interpretation of SCH, particularly if it is an isolated finding.

Direct and indirect ophthalmoscopy can supplement the physical exam. When the head experiences force(s) so will the vitreous and retinas inside the eyes. Retinal hemorrhaging is an important intraocular finding that must be carefully interpreted. RH severity is significantly higher in abuse vs. accident ($P < 0.0001$) (Binenbaum et al. 2009). Any retinal hemorrhaging on examination in infants less than 6 months is 11.7 times more likely to be due to abusive trauma compared with accidental trauma (OR, 11.7; 95% CI, 2.9–66.8) (Binenbaum et al. 2009). **One factor that helps with the distinction between abusive and accidental trauma is careful description of the number (few, too numerous to count), type (pre-, intra- and sub-retinal) and distribution (posterior pole, mid-periphery, periphery, ora serrata) of the hemorrhages.** A mild non-specific retinopathy with a few intraretinal hemorrhages confined to the posterior pole of the eye can be caused by trauma but also by a multiplicity of medical conditions including bleeding disorders, infection, increased intracranial pressure, hypoxia and glutaric aciduria (David 2000) (Fig. 2.2). The findings in each eye of a second unrelated child are highly concerning for AHT in the absence of high energy accidental trauma such as a crush injury (Figs. 2.3 and 2.4). This level of retinal analysis can only be performed by an experienced ophthalmologist utilizing indirect ophthalmoscopy.

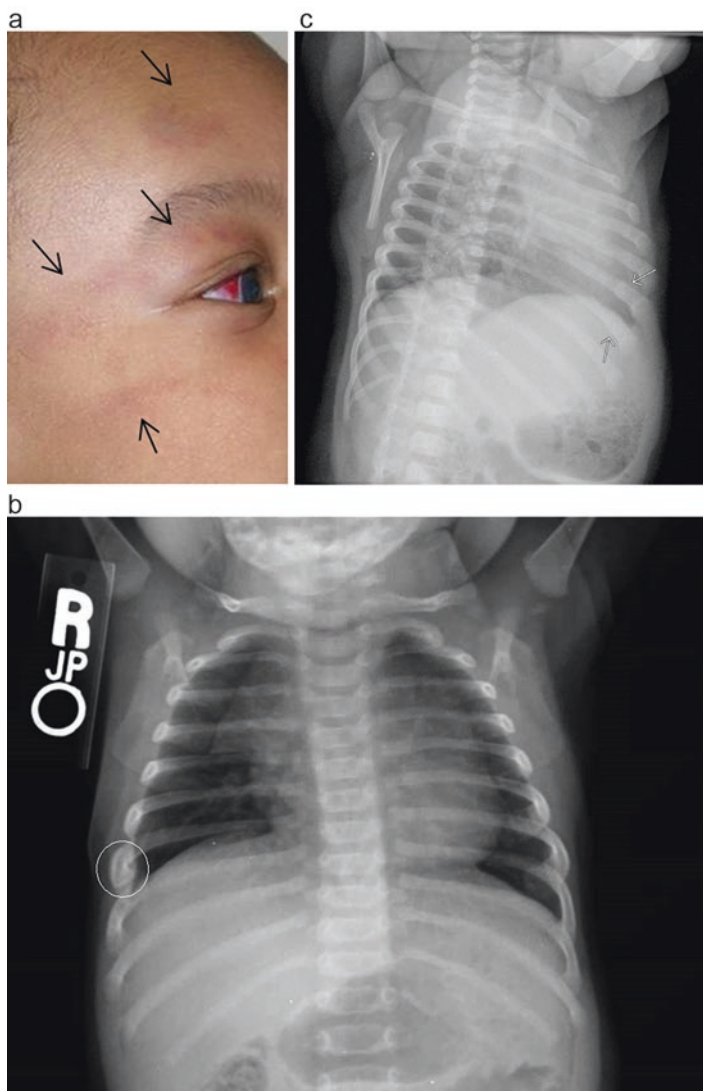


Fig. 2.1 (a) A 3 month old with unexplained forehead, eyelid and cheek bruising and SCH for “a few days.” (b, c) Healing right anterolateral 7th rib and healing left anterolateral 6th and 7th rib fractures were noted on skeletal survey (Courtesy of Children’s National Health System)

Oronasal, Pharyngeal, and Neck Injuries

Oral mucosal injury should ideally be accompanied by a history of an accidental traumatic event followed by oral bleeding or note of bloody saliva. **Oral or oronasal bleeding without an obvious medical etiology or history of accidental trauma should prompt consideration of child physical abuse, particularly in**

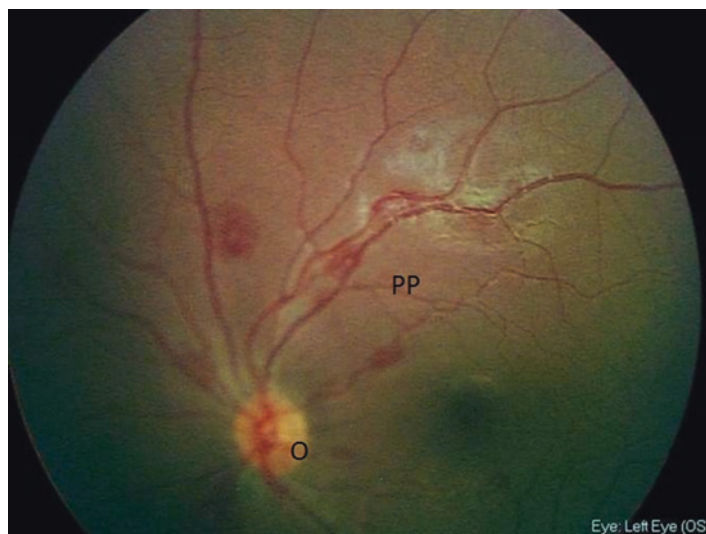


Fig. 2.2 Optic disc (*O*) and posterior pole (*PP*) are noted in this magnified view. A few intraretinal hemorrhages are only found in the posterior pole (Courtesy of Children's National Health System)



Fig. 2.3 Too numerous to count retinal hemorrhages are noted in multiple layers of the retina: pre-retinal (*P*), intraretinal (*I*), and subretinal (*S*) hemorrhages. Hemorrhages extend beyond the posterior pole into the peripheral retina (Courtesy of Children's National Health System)

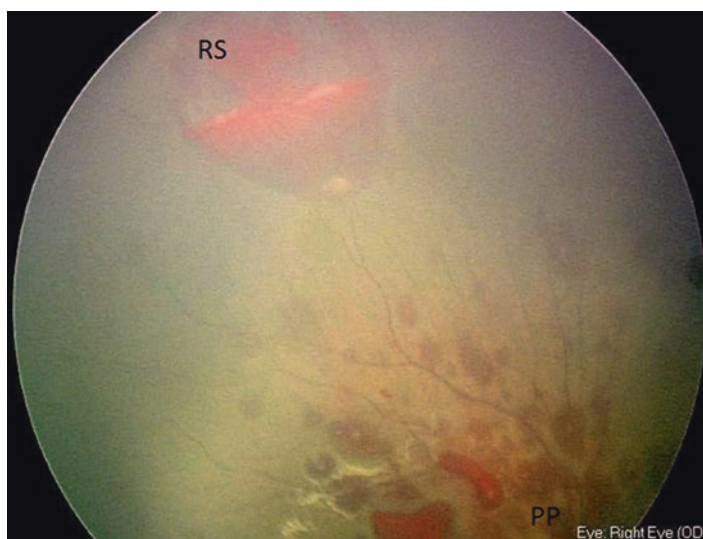


Fig. 2.4 In addition to retinal hemorrhaging extending beyond the posterior pole, there is traumatic splitting of the retinal layer, retinoschisis (*RS*), in the peripheral retina (Courtesy of Children's National Health System)

infants. Injuries to the mouth occur in approximately 7% of young children diagnosed with physical abuse (Naidoo 2000). These injuries include fractured or avulsed teeth, lip lacerations, frenula tears, tongue injuries and mandibular fractures (Naidoo 2000). Injuries to the lips and labial commissure can be due to blunt facial trauma, a gag, burns by hot objects, and even electrical burns; these are fairly easy to detect.

In contrast, injuries to the labial and lingual frenula are generally subtle particularly when they are healing. **A deliberate effort must be made to examine the frenula or injury will be overlooked** (Fig. 2.5) **Frenula injuries are highly concerning for abuse in non-mobile infants** (Thackeray 2007). Frenula injuries may precede or co-exist with other occult abusive injuries (Thackeray 2007; Sheets et al. 2013). Some frenula injuries are believed to be caused by blunt trauma, or by forcible insertion of a fingernail or object into an infant's mouth. Frenula injuries are important sentinels of physical abuse, including subsequent fatal abuse (Sheets et al. 2013). A sublingual hematoma is another concerning oral injury (Mehra et al. 2015). A sublingual hematoma may be a subtle indicator of a mandibular fracture. Detection of a sublingual hematoma, particularly in an infant, should prompt a search for inflicted bruises and fractures (Mehra et al. 2015). In older mobile children, intra-oral injury is less specific for abuse. However, mobility alone does not imply oral injury is accidental; a credible history of an accidental should be offered.

Frank oronasal bleeding is also highly concerning for physical abuse in the absence of a credible history of accidental trauma. It has been described following intentional suffocation by parents, but is not a universal finding in cases of suffoca-

Fig. 2.5 A 3 month old with bloody saliva is noted to have injury to upper labial frenulum (Courtesy of Children's National Health System)



tion (Southall et al. 1997; Truman and Ayoub 2002). Intentional suffocation should be considered in the setting of a history of recurrent apneic episodes, cyanosis, bradycardia, acute life threatening events (ALTEs) and/or seizures, particularly in the setting of negative medical evaluations, a family history of multiple sudden unexplained/unexpected infant deaths, and/or if these events occur only in the presence of a single caregiver (Southall et al. 1997; Truman and Ayoub 2002). Distinguishing among intentional suffocation, accidental suffocation, ALTEs, and sudden unexplained/unexpected infant deaths can be difficult; this process highlights the importance of working with social-services and law enforcement, in addition to medical subspecialists. A comprehensive medical evaluation, retrospective chart review, and scene investigation will augment the few if any findings on physical examination or autopsy of a child with oronasal bleeding.

Oronasal, pharyngeal and neck injuries may also be subtle or non-existent on physical exam following suffocation or strangulation. Cutaneous findings may resolve in less than 60 s after attempted suffocation of infants and toddlers (Samuels et al. 1992). Ligature furrows in neck, along with facial petechiae, are possible following attempted homicide, accidental strangulation or autoerotic asphyxia (Sabo et al. 1996) (Fig. 2.6). Fracture of thyroid horns or hyoid is noted in 25% of fatal strangulation cases (Verma 2007). In other instances, voice changes, dysphagia and pain may be the only oral or respiratory symptoms of strangulation; these signs and symptoms may be accompanied by altered mental status and neurologic changes. Bruising and other cutaneous findings are not universal, even in fatal strangulation cases (Verma 2007).

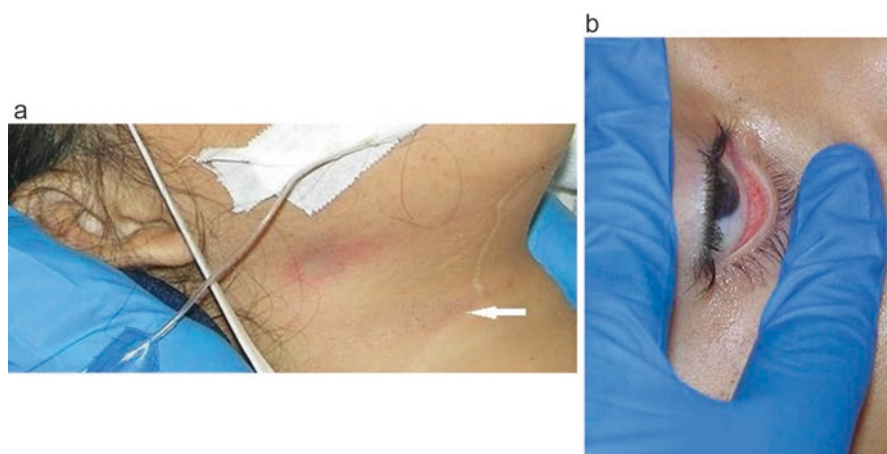


Fig. 2.6 (a, b) A 9 year old with facial and conjunctival petechiae found hanging from scarf in a closet approximately 15 min after being seen in good spirits by family members. Obvious lesion under angle of mandible was due to cervical collar. Subtle slightly oblique abrasion just above the level of the thyroid cartilage was believed to be a ligature injury. She had no occult skeletal or other injuries. Her death was ruled an accident by medical examiner following a CPS and law enforcement investigation (Courtesy of Children's National Health System)

Other forms of pharyngeal injury may occur following physical abuse. In a small case series, infants presented in severe respiratory distress with a history of accidental aspiration of baby wipes. Posterior pharyngeal tears were noted. Concerns for physical abuse arose when clinicians reflected on the infants' development and extent of pharyngeal injuries; this in turn prompted screenings for occult injuries. Infants were noted to have additional skin, skeletal and/or brain injuries (Krugman et al. 2007).

Cutaneous Injuries

Skin injuries are the most common manifestation of physical maltreatment (physical abuse and/or neglect (Naidoo 2000). Findings in pre-school children diagnosed with physical maltreatment in decreasing order of frequency include bruising, fractures, lacerations, subdural hemorrhage, burns and welts (Naidoo 2000).

Skin injuries may have characteristic locations or patterns that suggest an accidental or abusive event. **Bruising occurs in less than 1% (2 of 366) of infants who are less than age 6 months who are not suspected to be abused (Sugar 1999).** Bruises occur in 2.2% (11 of 511) of non-abused young children walking with support (cruisers) (Sugar 1999). While accidental bruising is rare among infants, the prevalence of accidental bruising increases with increased mobility. Approximately 52% of non-

abused walkers have one or more bruises (Sugar 1999). These walkers had a mean of 2.4 accidental bruises which typically occurred on forehead, shins and knees (Sugar 1999). Abdomen, hip, upper arm and posterior trunk bruising occurred in less than 1% of walkers not suspected to be abused (Sugar 1999). Approximately two-thirds of mobile children less than age 6 years have craniofacial injuries following accidental slips, trips and falls (Chang and Tsai 2007). These cutaneous injuries generally occur among the 1–2 year olds in a T shaped distribution involving the forehead, nose, lip and chin; there may also be bruising on the posterior scalp. Only 3% of preschoolers not believed to be abused will sustain injuries in more than on location on the scalp or face (Chang and Tsai 2007). **In general, accidentally injured, developmentally normal, mobile individuals typically have a low number of small bruises on the front of the body (knees, shins, forehead, nose, lips, chin) on or near boney prominences** (Dunstan 2002; Chang and Tsai 2007; Sugar 1999).

Bruising and other cutaneous injuries manifest differently in physically abused versus accidentally injured children. Clustered and patterned bruising is classically found in abused children (Fig. 2.7). Patterned bruising is caused when an object leaves an imprint that reflects the outline of the object. Common examples of patterned bruises are loop marks from being struck with a ‘looped’ cord, parallel linear bruises and bite marks. Patterned bruising can be either a positive imprint (Fig. 2.8) or a negative imprint. Classically, a slap mark results in a negative imprint when blood is pushed away from the point of impact (Fig. 2.9).

The head, face, neck and mouth are injured in two thirds of physically abuse children less than age 4 years (Naidoo 2000). **Bruising on the torso, ear, neck (TEN) in a child age 4 year or less, and bruising anywhere on the body for infants less than age 4 months has a sensitivity of 97% and a specificity of 84% for predicting abuse** (Pierce et al. 2010) (Fig. 2.10). In this latter study that compared the bruising

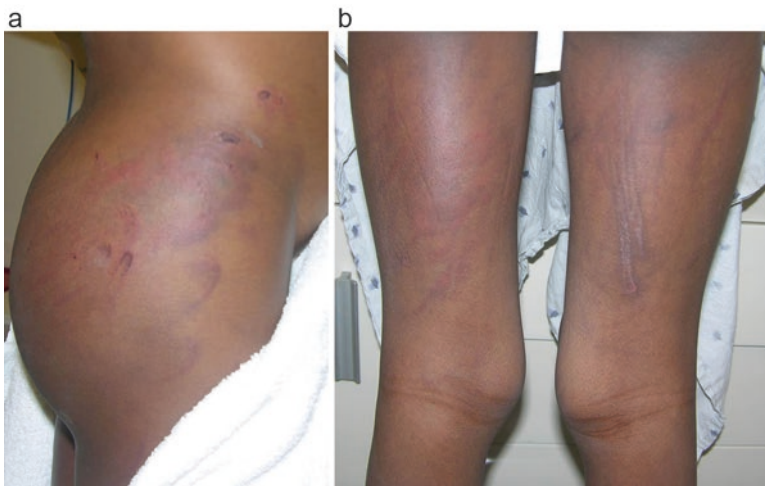


Fig. 2.7 (a, b) Clustered bruises including loop marks are noted in two verbal children who each disclosed being struck with a belt (Courtesy of Children’s National Health System)

Fig. 2.8 A 13 year old disclosed being struck with a belt. Investigators found a belt with round, raised studs in his mother's apartment that matched physical findings (Courtesy of Children's National Health System)



Fig. 2.9 A 14 month old with the negative imprint of a hand on her left face. Bruising to her left ear is also evident (Courtesy of Children's National Health System)



ing characteristics of children less than 4 years of age admitted to a Pediatric Intensive Care Unit because of either abusive or accidental injuries, no children who were accidentally injured had ear, neck, chest or buttocks bruising, or more than four bruises (Pierce et al. 2010). **Cheek, eyes, ear, neck, and genital bruising is also rare in infants and children with bleeding disorders** (Collins et al. 2016).

When skin lesions do not have characteristic features or patterns, the clinician must be alert to the possibility that vascular malformations, dermal melanosis (Mongolian spots), hypersensitivity syndromes, connective tissue disorders, bleeding and oncologic disorders, and phytophotodermatitis are among the many entities that can potentially be confused with bruising (Jenny

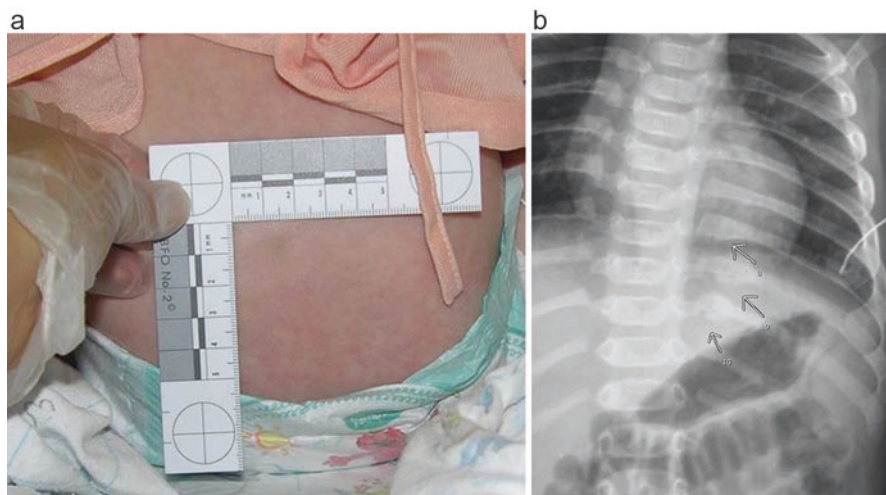


Fig. 2.10 (a, b) 4 month old with a small bruise near spine. Plain film revealed unexplained healing posteromedial rib fractures (Courtesy of Children's National Health System)

2010). Following the evolution of the lesion(s) and consultation with the appropriate specialists is often beneficial.

Although skin injuries are the most common manifestation of child physical abuse, bruising is not universally present in abused children including some children with serious or life-threatening injuries. **When present, small and seemingly clinically insignificant bruising may indicate the presence of significant occult intracranial injuries in infants** (Ingham et al. 2010; Greenes and Schutzman 1998; Sheets et al. 2013). Soft tissue injury to the scalp may be the only indicator of trauma among neurologically normal living infants with intracranial hemorrhaging, skull fracture and cerebral contusions (Greenes and Schutzman 1998). Among children who die, the presence of bruising anywhere on the body is significantly associated with the presence of injuries. Approximately 16% of infants at autopsy have bruising somewhere on the body; 81% of these infants with bruising have intracranial hemorrhaging, oral or anal lacerations, and/or acute or healed fractures (Ingham et al. 2010). The incidence of other injuries/lesions is significantly higher in bruised infants compared with the non-bruised group ($p < 0.001$) as is the ruling of death by homicide ($p = 0.003$) (Ingham et al. 2010).

Bruises do not heal in a uniform fashion and/or follow a predictable change in color with healing. Thus clinicians should be cautious about estimating the age of the bruise based solely on color. In addition, the presence of bruises of multiple colors on different parts of the body cannot, in isolation, be used to conclude that distinct episodes of trauma have occurred on different days (Fig. 2.11). Finally, outside of the classic patterned skin injuries (e.g. loop marks, slap marks, bites), clinicians should remain open to a wide variety of objects causing the bruising pattern seen at the time of examination (Fig. 2.12).

Fig. 2.11 A 10 year old disclosed he was struck with a belt on his buttocks on a single day following a report of bad behavior at school. Multiple colors are evident 4 days after he was struck (Courtesy of Children's National Health System)



Fig. 2.12 Circular bruise on the anterolateral thigh of a pediatrician caused when she accidentally struck a solid rectangular bedpost. Six days after this single episode of blunt trauma multiple colors are present as the bruise heals with central clearing. This healing pattern could potentially create the false impression of blunt trauma with an item other than a solid rectangular bedpost (Courtesy of Children's National Health System)



Absence of Bruising in Children with Significant Injuries

The absence of visible bruising or other forms of cutaneous trauma does not imply absence of underlying soft tissue, skeletal, abdominal, or intracranial injuries. Absence of visible head and neck bruising in subsets of both living and deceased infants and toddlers with traumatic subdural hemorrhaging and fractures has been described by practicing physicians beginning decades ago (Guthkelch 1971; Caffey 1974). Approximately 8% of infants at autopsy have no visible bruises despite presence of subcutaneous face, neck and scalp bruising, intracranial hemorrhaging and rib fractures (Ingham et al. 2010). Significant abdominal trauma resulting in liver lacerations, pancreatic transections, duodenal perforation and other intraabdominal injuries may also occur without truncal bruising; abdominal bruising may only occur in 40% of children with abdominal injuries (Hilmes et al. 2010). Elasticity of the skin and abdominal wall vessels may contribute to the lack of visible bruising despite significant force and resultant intraabdominal organ injury (Goddard et al. 2014).

In children with both acute and healing fractures, a quarter or fewer fractures are associated with bruising or other cutaneous trauma. (Valvano et al. 2008; Peters et al. 2008; Mathew et al. 1998). Presence or absence of bruising does not appear to help differentiate accidental from abusive trauma (Valvano et al. 2008). Likelihood of visible injury appears to vary in part based upon on fracture type and location (Peters et al. 2008). Nearly half of skull fractures have associated visible soft tissue swelling or subgaleal hemorrhaging (Peters et al. 2008). Conversely, less than 10% of rib, humerus, radius, ulna, femur and tibia fractures have nearby bruising (Peters et al. 2008).

Absence of bruising does immediately imply presence of a non-traumatic reason for skeletal injury, or a metabolic bone disease. Bruising may not be associated with an acute fracture on presentation, but may become apparent within 1–7 days after presentation (Mathew et al. 1998). Delayed visualization of bruising in an adult, 2 days following strangulation, has also been reported (Strack et al. 2001). Conversely, a bruise may have healed by the time of presentation for medical care. Mechanism of injury has also been proposed to affect presence or absence of an associated bruise in children with known fractures (Peters et al. 2008). Indirect blunt trauma or torsion has been proposed as an explanation for lack of bruising in some fracture types; the site of traumatic contact may not be directly over the fracture site (Peters et al. 2008) (Fig. 2.13).

Bites

Bites are a form of inflicted injury that can be abusive in nature. A skin lesion that consists of two opposing concave arches with or without central bruising is suspicious for a human bite, according to the American Board of Forensic Odontology

Fig. 2.13 A 7 month old with an acute transverse right proximal humerus fracture. Mother confessed she was frustrated with siblings who were fighting near the infant as the infant rested on a rug on the floor. She described yanking the infant up by the right forearm without supporting the infant's body (Courtesy of Children's National Health System)

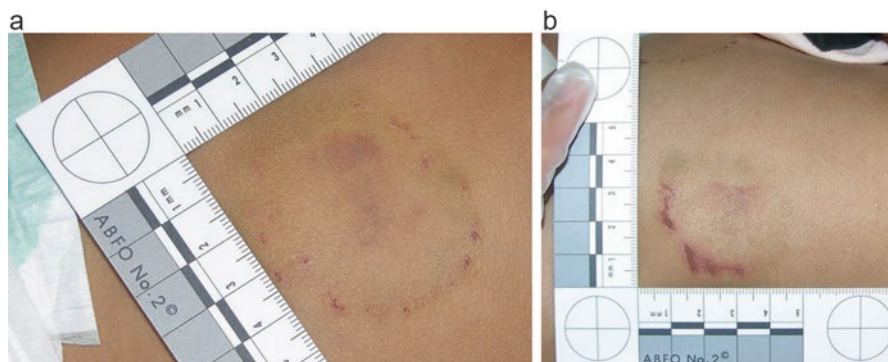


Fig. 2.14 (a, b) A ruler should be placed in the same plane as the suspected bite mark with the camera at a 90 angle to the ruler (<http://abfo.org/wp-content/uploads/2016/03/ABFO-Bitemark-Standards-03162016.pdf>) (Courtesy of Children's National Health System)

(ABFO) (<http://abfo.org/wp-content/uploads/2016/03/ABFO-Bitemark-Standards-03162016.pdf>) (Fig. 2.14). These concave round or oval arches are often separated at their bases by open spaces. The arches consists of abrasions, contusions or scars (<http://abfo.org/wp-content/uploads/2016/03/ABFO-Bitemark-Standards-03162016.pdf>). Human bites are often between 2 and 5 cm in diameter. Assessment of a bite mark is complex. Several factors affect the appearance of a bite mark including clothing, skin pigment, skin turgor and tissue distortion that occurs during the injury event. Input from a forensic odontologist (abfo.org) is ideal in order to distinguish adult versus child perpetrator(s) and other nuances. Many medical examiners offices also

have existing relationships with forensic odontologists. When a forensic odontologist is not readily available, clinicians may assist by carefully describing and photo documenting concerning skin findings for later analysis (Fig. 2.14). Forensic evidence collection may also be feasible; this possibility should be discussed with law enforcement.

Forensic Evidence Collection from Bites

Bite mark(s) should be swabbed for possible DNA extraction and blood typing evidence after photographing bites (<http://abfo.org/wp-content/uploads/2016/03/ABFO-Bitemark-Standards-03162016.pdf>). Swabbing should be attempted if finding(s) are acute. At first a single sterile swab is moistened with sterile distilled water. For approximately 7–10 s, the swab is moved over the affected site with systematic and circular motions utilizing medium pressure. A second dry swab is moved over the area in a similar fashion utilizing light pressure to collect the moisture left on the skin surface by the first swab. Both swabs should be allowed to air dry (e.g. for 30 min) or both placed into the same labeled swab drying box. Swabs should be submitted as soon as possible for analysis. The ABFO suggests swabs be kept at room temperature if submitted within 4–6 h. Swabs should be refrigerated (not frozen) if stored longer than 6 h (<http://abfo.org/wp-content/uploads/2016/03/ABFO-Bitemark-Standards-03162016.pdf>). This technique should be repeated if there are multiple bite marks. Each swab drying box should contain the wet and dry swab utilized on a single bite. Boxes or envelopes must be labeled with child's information, time of collection, and location of bite(s).

Burns

Burns that result from neglect (errors of omission) are approximately 10 times more common than burns due to physical abuse (Chester et al. 2006). In Western countries, liquid scald burns are the most common form of accidental burning (Chester et al. 2006, Thombs 2008). Accidental scald burns are usually of varying depth with irregular lines of demarcation between affected and unaffected skin. The majority of an accidental, self-inflicted household burns occur when a child is unsupervised in the vicinity of a hot beverage or food. A resultant 'pull down' burn scald affects the head, face, neck, trunk and upper extremity in an asymmetric fashion (Fig. 2.15). In such a case, in addition to a careful history, the developmental/motor abilities, height and reach of the child, and presence or absence of additional non-burn wound injuries are considered prior to a diagnosis of physical/supervision neglect, physical abuse or accidental injury. **In cases when child abuse by burning is not diagnosed, children with accidental burns at a young age remain an "at risk" population. Among children accidentally burned at age less than 3 years, one-third are referred to social-services for new physical injury, sex**

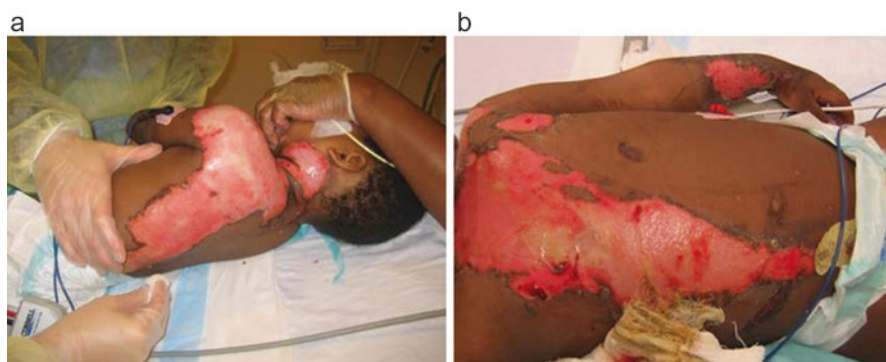


Fig. 2.15 (a, b) Post debridement photographs of a sedated toddler believed to have pulled a hot bowl of soup onto himself while he was left unsupervised in the kitchen (Courtesy of Children's National Health System)



Fig. 2.16 This was an unwitnessed household burn caused by an unknown liquid until investigators noted a discarded garment with bleach splatter. Child's mom admitted she left a bowl of bleach on a table which child overturned. Mother's initial focus had been a burn near the child's lips and concern he drank the bleach; only hours later did she remove his diaper revealing a chemical burn and penile swelling (Courtesy of Children's National Health System).

abuse concerns or neglect in the 3 years following their accidental burn injury (James-Ellison et al. 2009).

Approximately 6% of burns in children less than 12 year of age are due to abuse (Thombs 2008). Child abuse by burning by immersion must be excluded when burns have clear upper margins and/or involve large surface areas (Fig. 2.16) (Thombs 2008). Liquid scald burns involving the anogenital area and lower extremities, or isolated to the lower extremities, are the most commonly diagnosed abusive burns (Thombs 2008). Occasionally, facial immersion scald burns due to abuse are described (Daria et al. 2004). Children with abusive scald burns are typically younger and have larger total body surface area involvement (Thombs 2008). Other forms of burning due to physical

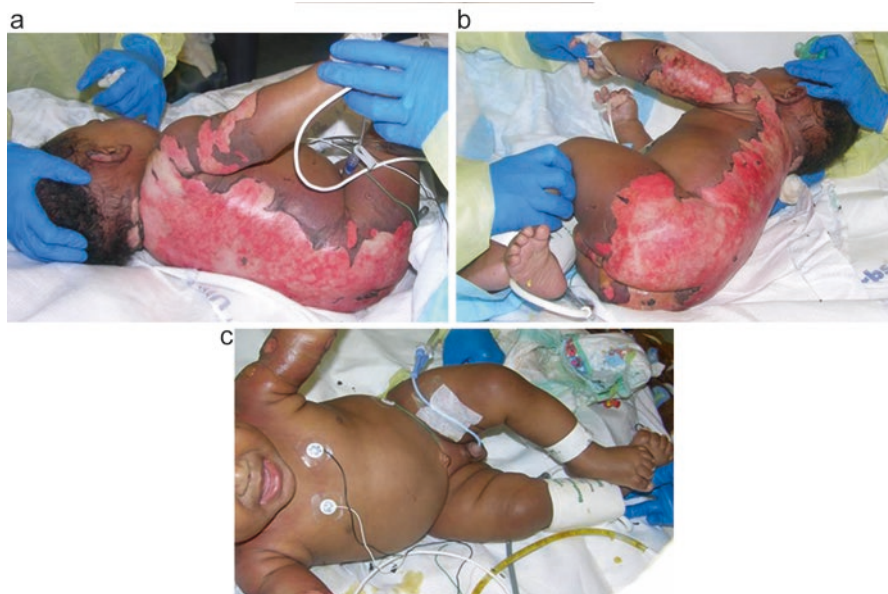


Fig. 2.17 (a, b) Burn pattern is consistent with immersion when infant is supine with flexed extremities. (c) Attention to unburned skin will often provide clues to the position of the child's body at time of scalding (Courtesy of Children's National Health System)

Fig. 2.18 Iron burn inflicted on a toddler by his mother with unmedicated schizophrenia (Courtesy of Children's National Health System)



abuse or supervisory neglect have been described including flame burns, chemical burns and electric burns. It is sometimes difficult to distinguish the cause of burns (e.g. hot liquid versus liquid chemical) solely on appearance (Fig. 2.16). Burn wounds must be interpreted in the context of caretaker(s) history, child's motor development, and scene investigation done by law enforcement and/or social services (Figs. 2.16 and



Fig. 2.19 Deep partial and full thickness burns to the right palm caused by forced, prolonged contact with a naked light bulb. Child had been seen a year earlier with a superficial partial thickness burn to his left palm in the identical distribution; at that time his mother's history of accidental contact with an iron was not challenged (Courtesy of Children's National Health System)

Fig. 2.20 This newborn was not capable of rolling onto a space heater as alleged by father. (Courtesy of Children's National Health System)



2.17). Contact burns with the clear outline of an object should prompt consideration of physical abuse (See Figs. 2.18, 2.19, 2.20 and 2.21) Finally, children with suspicious burns have similar rates of co-incident skeletal injuries and liver enzyme (transaminases) elevations when compared to similar aged children evaluated for other forms of suspicious injuries (Pawlik et al. 2016). A third of skeletal surveys in infants and toddlers with suspicious burn wounds reveal acute or healing fractures (Fagen et al. 2014).

Photodocumentation of Cutaneous Findings

Photodocumentation of examination finding(s) is a powerful adjunct to carefully written documentation. In many cases, consent for photographs is addressed in the general consent form signed at the beginning of a medical evaluation. Prior to obtaining photographs, it is nevertheless good practice to understand an institution's



Fig. 2.21 Mother of this infant placed infant on the flat top of an electric stove recently used by her roommate (Courtesy of Children's National Health System)

policies regarding photodocumentation, storage, transmission and sharing of images with other clinicians, social-services, and law enforcement. Young children often have multiple questions about who will see their photographs. Many children also want to see and discuss their photographs. This can be a teaching and rapport building opportunity.

Photography should occur as soon as concerning skin findings are discovered. The clinician should begin and end photodocumentation with a child's identifying information. When bite marks are present, photography should occur prior to swabbing or otherwise manipulating the affected skin. Photography should also occur prior to and after debridement of burn wounds. Contrasting pre- and post-debridement images can inform a medical assessment.

Both orienting shots that show the location of the finding(s) and then closer images should be obtained. Closer shots should be obtained with and without a scale. An ideal scale, especially important for bite mark analysis, is the L shaped American Board of Forensic Odontology (ABFO) No.2 scale (Fig. 2.14). However, an object with a known diameter such a coin or a flexible measuring tape can also be used if the ABFO scale is not available. The scale, tape or coin should be placed as close as possible to finding(s) without obscuring findings(s).

Some images, with a scale, should be taken with the lens plane parallel to the plane of the finding(s) to minimize image and measurement distortions. When photographing bite marks on a curved surface, each plane should be photographed separately to minimize distortions. Additional photographs can be taken from multiple angles and in multiple positions at the discretion of the clinician.

Overall, photodocumentation is highly recommended to facilitate peer review and/or expert consultation in cases of suspected maltreatment. There are multiple

benefits to the child and clinician when finding(s) are photodocumented. Photographs can be used to objectively compare findings between initial and follow-up examinations. This is particularly helpful when numerous and or complex injuries are present. For instance, characteristics of teeth may be more clear once swelling around a suspicious bite has resolved. In other instances, photographs may allow the child to be spared repeated examinations when a second opinion is requested by a less experienced examiner. Photographs also facilitate a richer understanding of relevant findings for trainees who were not directly involved in a child's care, but anticipate seeing children with similar concerns in the future.

Fractures

Musculoskeletal injury is typically suspected when a history of an injury event is accompanied by a change or decline in activity or use of a body part which may also be bruised or swollen. The majority of accidental fractures, approximately 85%, occur in children who are 5 years of age and older (Worlock et al. 1986). Epidemiologically, common accidental fractures in mobile children are mid- and distal clavicular fractures, supracondylar fractures, fractures of the distal radius and ulna, spiral femur fractures, and toddler fractures (Wood et al. 2014). These fractures are typically deemed accidental if and when they occur in ambulatory children, are not associated with other injuries, and are associated with specific, plausible injury events. Supracondylar fractures, femur and toddler fractures also present acutely following accidental trauma because of obvious symptoms after the injury event. However, a diagnosis of accident or abuse is not made based on epidemiologic data. When these low-specificity fractures are identified in mobile children, it is still the responsibility of the clinician to listen for a plausible mechanism of injury, do a careful examination, and consider additional imaging, particularly in children less than age 24 months.

Discrepancies among identified skeletal injuries, historical information and/or a child's age or development should prompt suspicion of physical abuse or supervisory neglect (Fig. 2.22). Approximately 80% of abusive fractures occur in children less than age 18 months (Worlock et al. 1986). Abusive fractures are most likely to be seen in children less than 12 months of age (Leventhal et al. 2008). Among hospitalized children, the incidence of abusive fractures is approximately 7 times higher in children <12 months of age compared with 12–23 month old children (Leventhal et al. 2008). Abused children are also significantly more likely to have multiple fractures (Leventhal et al. 2008, Worlock et al. 1986). Seventy two percent of abused children with fractures have bruising of the head and neck (Worlock et al. 1986). Neuropsychiatric and behavioral disorders may predispose to the minority of abusive fractures in older children (Loder and Feinberg 2007).

Multiple rib fractures, classic metaphyseal fractures (CMLs), fractures of the scapula, sternum, spinous processes, hands and feet carry a moderate to high specificity for abuse in infants and young children (Flaherty et al. 2014; Servaes et al.

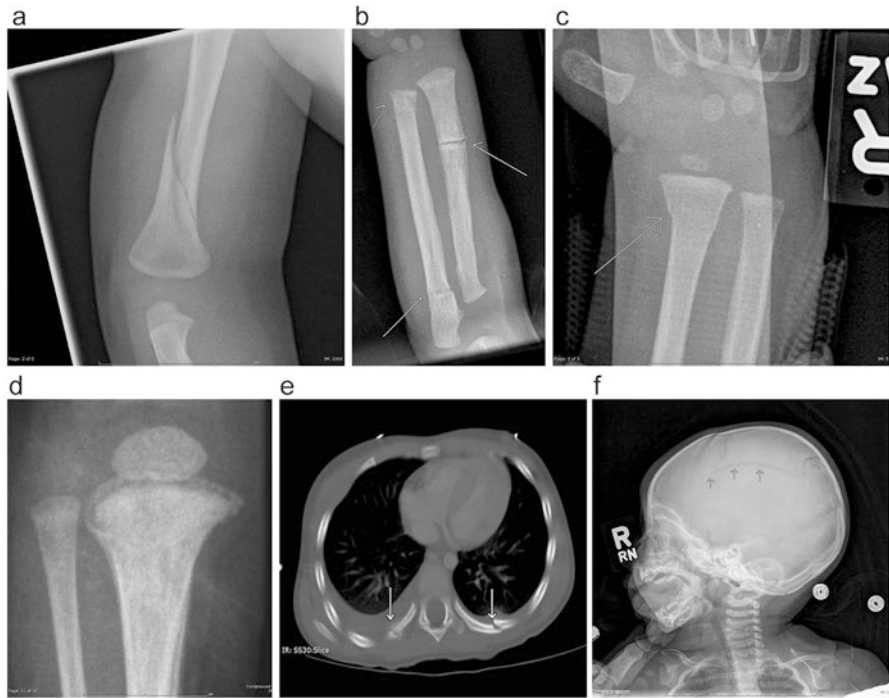


Fig. 2.22 (a) Spiral/long oblique fracture: torsional load (Courtesy of Children's National Health System); (b) Transverse fractures: bending load(s). These fractures may be in different stages of healing (Courtesy of Children's National Health System); (c) Buckle/impaction fracture: compressive load (Courtesy of Children's National Health System); (d) Classic metaphyseal lesion: tension and/or shear load (Courtesy of Children's National Health System); (e) Rib fractures: chest compression and/or squeezing (Courtesy of Children's National Health System); (f) Skull fracture: impact trauma (Courtesy of Children's National Health System)

2016). These fracture types are often clinically asymptomatic and/or not detected on physical examination. Multiple rib fractures, in the absence of a history of major chest trauma is strongly suggestive of child abuse (Worlock et al. 1986; Barsness et al. 2003). When children with accidental trauma and/or disease are excluded, the positive predictive value of rib fracture(s) for the diagnosis of abuse exceeds 95% (Barsness et al. 2003). CMLs are rare in healthy infants who are not believed to have been abused (Kleinman et al. 2011). CMLs are also unlikely to occur with a fall, including falls that result in skull fractures (Kleinman et al. 2011). One or more classic metaphyseal fractures can be noted in infants suspected to have been abused, usually in combination with other significant or fatal injuries (Kleinman et al. 2011). Rare case reports of CMLs that are iatrogenic are a reminder of the importance of a holistic approach to diagnosis (Burrell et al. 2015).

A skeletal survey is recommended for all children less than 24 months of age when an unexplained fracture is detected and/or child physical abuse is suspected because of other suspicious finding(s). A skeletal survey helps identify fractures that are not suspected based on history and or physical examination. It consists of frontal and lateral views of the skull, lateral views of the cervical, thoracic and lumbosacral spine, chest (frontal, right and left obliques), and single frontal views of the long bones, hands, feet, abdomen and pelvis (Wootton-Gorges et al. 2017).

A limited follow-up survey 2 weeks after an initial survey is recommended (Flaherty et al. 2014; Wootton-Gorges et al. 2017). Views of the skull, spine and pelvis are eliminated on follow-up imaging (limited follow-up survey) with little effect on diagnostic accuracy (Hansen et al. 2014). A limited follow-up survey can identify previously occult fractures, most commonly non-displaced rib fractures, long bone fractures, and CMLs; this may increase the likelihood of an abuse diagnosis in 15% of children (Harper et al. 2013) (Fig. 2.23 CML a CML b). The limited follow-up survey increases diagnostic accuracy by detecting fractures, excluding potential mimics of trauma that remain unchanged between imaging, and clarifying equivocal findings (Harper et al. 2013, Hansen et al. 2014). In the hands of an experienced pediatric radiologist, a limited follow-up survey will also assist with the dating of fractures when a comparison is done between the initial and follow-up surveys.

A differential is also considered based on presence or absence of dysmorphic physical examination features, non-fracture abnormalities on a skeletal survey, and factors in the child's birth, medical, family and dietary data (Bishop et al. 2007;

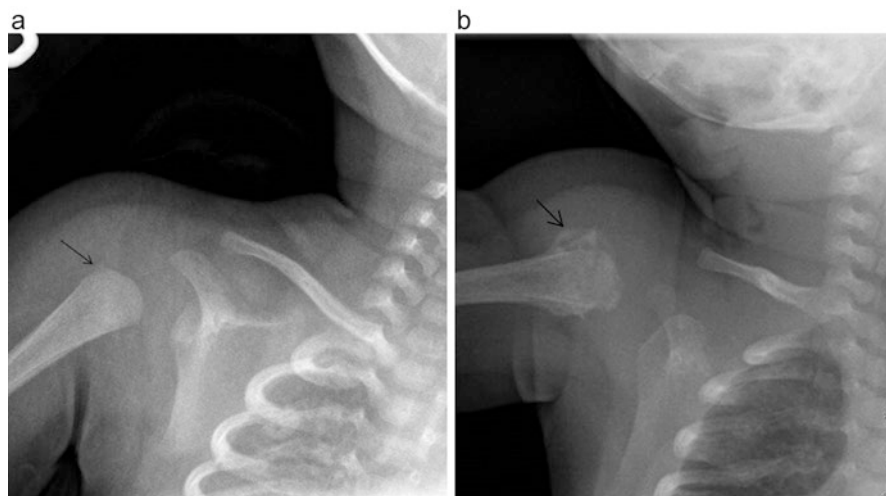


Fig. 2.23 (a) Initial survey with very subtle CML of proximal right humerus (b) 2 week follow-up survey with CML now healing with subperiosteal hemorrhaging was confirmatory (Courtesy of Children's National Health System)

Flaherty et al. 2014; Servaes et al. 2016). It is important to distinguish between a laboratory abnormality and a radiologically apparent disease that predisposes to fracture (Servaes et al. 2016). A Vitamin D level may be suboptimal relative to its multiple physiologic functions. However, Vitamin D insufficiency, in the absence of rickets, has not been shown to increase fracture risk in peer reviewed medical literature (Schilling et al. 2011; Flaherty et al. 2014; Servaes et al. 2016). Legitimate factors that can potentially compromise bone health and integrity include metabolic bone disease of prematurity, nutritional deficiencies, rickets, osteogenesis imperfecta, and other rare genetic conditions (Bishop et al. 2007; Flaherty et al. 2014; Servaes et al. 2016).

The rate of fractures (nearly 12%) in siblings who share the households of physically abused children is high enough to warrant that skeletal surveys also be obtained on all siblings aged 2 years or younger (Lindberg et al. 2012). None of these fractures was associated with bruising, swelling or tenderness (Lindberg et al. 2012). Nevertheless, a physical examination should also be completed, even in asymptomatic sibling(s) of the index child. An exam may reveal undiagnosed and/or untreated conditions including dental caries, respiratory illnesses and rashes. Finally, the suspected or confirmed perpetrator of abusive trauma is often not specified in medical records. When a perpetrator is specified among children hospitalized with abusive fractures, a quarter of perpetrators were the father or stepfather of the child, or boyfriend of the child's mother (Loder and Feinberg 2007).

Visceral Injuries

Among children less than 10 years old who were evaluated for physical abuse, 2.8% have an intraabdominal injury (Lindberg et al. 2013). Abdominal injury is less common than intracranial, skeletal and cutaneous injuries, but is a relatively lethal form of abuse. **Abdominal trauma is the second most common cause of death due to child physical abuse** (Lane et al. 2009). Abusive abdominal injury represents more than one quarter of all abdominal trauma hospitalizations among children less than 1 year of age, although toddlers are believed to be at highest risk for abusive abdominal trauma (Lane et al. 2009).

Motor vehicular accidents are the most common cause of severe accidental abdominal injuries, along with falls onto protruding objects (Pena and Medovy 1973; Hilmes et al. 2010; Trokel et al. 2006). Duodenal and other intraabdominal injuries should not be readily attributed to unobstructed falls down stairs and short household falls (Huntimer et al. 2000). **Young children with abdominal injuries should be evaluated for physical abuse in the absence of motor vehicular accidents or other significant accidental intrusive trauma, particularly if they have co-incident brain injuries or failure to thrive** (Trokel et al. 2006; Hilmes et al. 2010) (Fig. 2.24). The liver is the most common site of abdominal injury following accidental or abusive abdominal trauma (Hilmes et al. 2010;

Fig. 2.24 A 2 month old with intracranial hemorrhage and altered mental status. No abdominal bruising. Liver enzymes were 10 times upper limit of normal when CT revealed large right liver laceration (Courtesy of Children's National Health System)



Lane et al. 2009). However, duodenal, proximal jejunum and pancreatic injuries, along with multiple abdominal injuries in the setting of low energy trauma have the greatest predictive value for abuse (Hilmes et al. 2010). Major abdominal injuries have been reported with bilaterally costochondral rib fractures, a relatively rare fracture type that is associated with significant, high energy intrathoracic trauma (Ng and Hall 1998).

When present, abdominal distension and bruising are significantly associated with abdominal injuries (Hilmes et al. 2010; Lindberg et al. 2013). However, abdominal bruising is uncommon even in the setting of serious intra-abdominal injuries which can be clinically occult. Elevated liver enzymes and liver lacerations have been noted in up to 8% of children without abdominal distention, bruising or other signs of abdominal trauma (Lindberg et al. 2009; Coant et al. 1992). Children with transaminase levels greater than 80 IU/L should undergo definitive testing for abdominal injury (Lindberg et al. 2013). Contrast enhanced abdominal CT is the preferred imaging modality when hepatic enzymes, amylase and lipase are abnormal (Hilmes et al. 2010; Lindberg et al. 2013). Abdominal ultrasound has a low sensitivity compared with CT for both solid organ and hollow viscous injury; it is generally not recommended as the sole imaging modality. There are no serologic screening tests for splenic and adrenal injuries.

Children present in a similar fashion irrespective of accidental or abusive abdominal trauma; declines in mental status, changes in activity and appetite (Hilmes et al. 2010; Trokel et al. 2006). A delay in seeking care has been documented after accidental and abusive abdominal injuries; in isolation, a delay in seeking care cannot be the

sole factor used to suspect abusive abdominal, including pancreatic, injuries (Klin et al. 2011).

Neurological Injuries

Children may present with neurologic changes due to toxic ingestions that are either forced and intentional, or due to a lack of supervision. Prescription medications in the home (most commonly sedatives), over the counter cough and cold preparations, alcohol and illicit drugs have the potential to cause life threatening altered mental status. In the absence of clear medical reasons for altered mental status (such as intracranial injury or pre-existing seizure disorder), serum and urine toxicology screens should be considered. Targeted testing based on the child's symptoms should be an initial approach. Prompt testing should also be considered in relatively asymptomatic children removed from adverse environments. Forty-six percent of asymptomatic children, mean age 5 years, removed from clandestine methamphetamine labs tested positive for methamphetamine (Grant et al. 2010). Additional children tested positive for precursor chemicals pseudoephedrine (7%) and ephedrine (7%). Mean time from removal to testing was 2.7 h. (Grant et al. 2010).

A positive immunoassay for cocaine, marijuana, benzodiazepines, amphetamines, opiates, barbiturates, tricyclic antidepressants, phencyclidine, methamphetamine or their metabolites is usually followed by confirmatory testing via gas chromatography-mass spectrometry (GC-MS). It is important to remember that multiple prescriptions and over-the-counter drugs as well as ever changing synthetic "street" drugs are not usually detected by rapid drug screens available in many Emergency Rooms. A local toxicologist with knowledge of locally preferred drugs of abuse or toxicologists at the United States based National Capital Poison Center (1-800-222-222; poison.org) can be contacted to guide either more comprehensive or drug specific toxicology testing. Comprehensive toxicology testing identified clinically significant toxins (most commonly over-the-counter cold medications) in 8% of children undergoing an Acute Life Threatening Event (ALTE) evaluation (Pitetti et al. 2008).

Neurologic changes, temperature instability and cardiorespiratory compromise can also be caused by Abusive Head Trauma (AHT). **AHT, colloquially Shaken Baby Syndrome, is the most common cause of serious or fatal brain injuries in children aged 2 years and younger** (Keenan 2004). Children less than 1 year of age have the highest incidence of AHT; however, a quarter of AHT is diagnosed in children older than 1 year of age (Scribano et al. 2013). AHT mortality can be 19% or higher (Scribano et al. 2013). AHT often occurs in the presence of a single usually male caregiver in the home of the infant (Scribano et al. 2013).

With rare exceptions, non-motor vehicular caused accidental head trauma, falls in supervised environments (hospitals and large licensed multi-provider daycare centers), and falls witnessed by at least two adults, result in minor or no brain injuries (Chadwick et al. 2008). However, in a small number of cases, there can be overlap with both moderate to severe accidental and AHT presenting with non-specific respiratory or neurologic symptoms, intracranial hemorrhaging and retinal hemorrhaging. Fortunately, the history that accompanies accidental trauma versus AHT is often strikingly different. In the setting of significant finding(s), more than 80% of infants and toddlers ultimately diagnosed with AHT have no history of trauma or had a history of trivial trauma such as a short fall (<3 feet) (Feldman et al. 2001; Keenan 2004). Children with AHT present with symptoms and/or unexplained injuries; in contrast, 45% of caregivers of children with non-motor vehicular (MVC) caused accidental head injuries seek care after the injury event and before symptoms (Keenan 2004).

A third of children diagnosed with AHT have no external signs of trauma such as bruising on examination (Keenan 2004). No physical evidence of trauma may mean trauma is not considered during the diagnostic process. A third of children who have sustained AHT will be misdiagnosed at initial presentation with viral gastroenteritis or influenza, accidental head injury, ruled out sepsis, idiopathic increasing head size, otitis media or seizure disorder (Jenny 1999). At the time of AHT diagnosis, 30–45% of children have clinical or radiologic evidence of prior injuries (Ewing-Cobbs et al. 1998; Keenan 2004).

In an otherwise healthy child who is outside of the neonatal period, characteristics of intracranial and retinal hemorrhaging help distinguish between accidental and AHT. While epidural and subarachnoid hemorrhaging can be caused by AHT in a minority of cases, SDH is the most common injury associated with AHT. At autopsy, SDH is noted in 83% of children diagnosed with AHT (Brennan et al. 2009). Interhemispheric, multifocal, convexity and posterior fossa SDH are significantly associated with AHT (Kemp et al. 2011). As previously noted (see section on Ocular Injuries), the severity of retinal hemorrhaging is significantly higher in AHT compared with accidental trauma (Binenbaum et al. 2009).

There is no substitute for diagnostic brain imaging with CT or MRI once head injury is suspected (Wootton-Gorges et al. 2017). If either the presence of retinal hemorrhaging or an abnormal skeletal survey is used as a criterion to order neuroimaging with CT or MRI, traumatic intracranial injury will not be detected in 10–26% of children (Rubin et al. 2003, Keenan 2004). **Radiologically apparent spinal soft tissue injuries may also result from AHT. These spinal soft tissue injuries, particular in infants with AHT, are generally clinically occult.** In one study, 63% of children diagnosed with AHT have spinal SDH (cervical, thoracolumbar) on MRI compared with 1% of accidentally injured children (Choudhary et al. 2012). As many as 78% of children diagnosed with AHT have cervical ligamentous injury compared with 46% of accidental and 1% of non-traumatically injured children (Choudhary et al. 2014). Children with AHT are also significantly

more likely to have rib fractures, long-bone fractures, and metaphyseal fractures compared to children with non-motor vehicular accidental injury (Keenan 2004).

Occult Head Injuries

Young children with significant intracranial injuries, particularly those less than 12 months of age, may not present with clinically overt signs and symptoms; their neurological examinations may be normal (Greenes and Schutzman 1998; Laskey et al. 2004; Rubin et al. 2003). This appears to be a phenomenon based on age rather than etiology of traumatic brain injury. This phenomenon is demonstrated in a retrospective study of children less than age 2 years with a discharge diagnosis of head trauma and known acute intracranial hemorrhage, cerebral contusion or brain swelling on CT (Greenes and Schutzman 1998). Twenty-seven percent (14 of 52) of infants less than age 6 months, and 19% (19 of 101) of the overall population (mean age 7.1 months) were asymptomatic at the time of ED presentation. These 19 children, all less than 12 months of age, did not have a loss of consciousness, behavioral changes, vomiting, seizures, depressed mental status, irritability, focal neurologically deficits, pupillary abnormalities, bulging fontanelles or retinal hemorrhaging. Eighteen of these asymptomatic 19 infants had skull fractures, scalp contusions or abrasions at time of ED evaluation; these were the physical examination findings that were likely to have prompted brain imaging. A single infant with a small cerebral contusion had a brief generalized seizure 48 h after the ED evaluation. Some children were prescribed prophylactic anticonvulsants. None of the infants required surgical intervention for, or medical management of, increased intracranial pressure. No previously asymptomatic infant deteriorated and died after admission.

Neuroimaging with CT or MRI should be performed in infants 12 months of age or less, even when infants appear to be neurologically intact. Some consideration should also be given to children who are older (i.e. between 12 and 24 months of age). Twenty-nine percent (11 of 38) of neurologically normal children (mean age 14.7 months, median age 8.7 months) evaluated for abuse have subdural hemorrhage, epidural hemorrhage or cerebral edema on CT or MRI (Laskey et al. 2004) (Fig. 2.25a, b). Thirty-seven percent (19 of 51) of neurologically normal children (median age 2.5 months) with suspicious non-skull fractures or facial injury have scalp injury (not identified on physical exam), skull fracture, subdural hemorrhage or parenchymal brain injury on CT or MRI; 18 of 19 children in this study were less than 1 year old and the remaining child was 23.9 months old (Rubin et al. 2003).

Table 2.4 Diagnostic testing of patients with suspected maltreatment

Screening for bleeding disorders (Anderst et al. 2013)	CBC, von Willebrand panel, PT, PTT, Factor VIII, Factor IX (if bruising or intracranial hemorrhaging) <i>Discuss testing with Hematologist.</i>
Screening for genetic or metabolic diseases (Flaherty et al. 2014; Christian 2015)	Calcium, Phosphorus, intact Parathyroid Hormone, Alkaline Phosphatase, 25-hydroxyvitamin D, DNA sequencing of COL1A1 and COL1A2 (if fractures) Urine Organic Acids (if subdural hemorrhaging) <i>Discuss testing with subspecialists.</i>
Screening for occult fractures: skeletal survey (Wood et al. 2014; Borg and Hodes 2015; Wootton-Gorges et al. 2017)	<i>Newborn to 11 months old with</i> All fracture types EXCEPT Distal radius and/or ulna buckle fracture in a cruising child with a history of a fall Toddler fracture of the tibia and/or fibula in a cruising child with a history of a fall Linear, unilateral skull fracture if greater than age 6 months with a significant fall Clavicular fracture that is likely to be birth related
Screening for occult fractures: skeletal survey (Wood et al. 2014; Borg and Hodes 2015; Wootton-Gorges et al. 2017; Christian 2015)	<i>Newborn to 23 months old with</i> History inconsistent with one or more injuries History of trivial impact (e.g. young sibling wielding toy) to explain significant injury Skin and /or oral injury in a non-ambulatory child Unexplained cutaneous, skeletal or intraabdominal trauma Intracranial hemorrhage and/or Hypoxic-ischemic brain injury of unclear etiology Sudden unexplained or unexpected infant death Sibling(s) or household contact(s) with abused child Injury during domestic violence Confessed abuse
Screening for occult fractures: skeletal survey (Wood et al. 2014; Borg and Hodes 2015; Wootton-Gorges et al. 2017)	<i>12–23 months old with</i> Rib fracture(s) Classic Metaphyseal Lesions/Corner fractures Humeral fracture with epiphyseal separation attributed to a 3 feet or shorter fall Femoral diaphyseal fracture attributed to a fall from any height Delay in presentation of more than 24 h with obvious signs of distress
Screening for occult abdominal trauma (Christian et al. 2015)	Transaminases (AST, ALT), amylase, lipase, urinalysis Abdominal CT if transaminases greater than 80 IU/L (Lindberg et al. 2013)
Screening for occult intracranial hemorrhaging (Wootton-Gorges et al. 2017; Christian 2015)	Non contrast CT and/or MRI of brain <i>Discuss utility of contrast enhanced MRI, spinal MRI and specific MRI sequences with Neuroradiologist.</i> <i>Ultrasonography is not sensitive for identifying small and/or thin SDH and is not recommended.</i>
Screening for retinal hemorrhaging (Christian 2015)	Dilated eye examination by ophthalmologist when intracranial hemorrhage or eye injuries <i>Examination should occur as soon as clinically possible.</i>

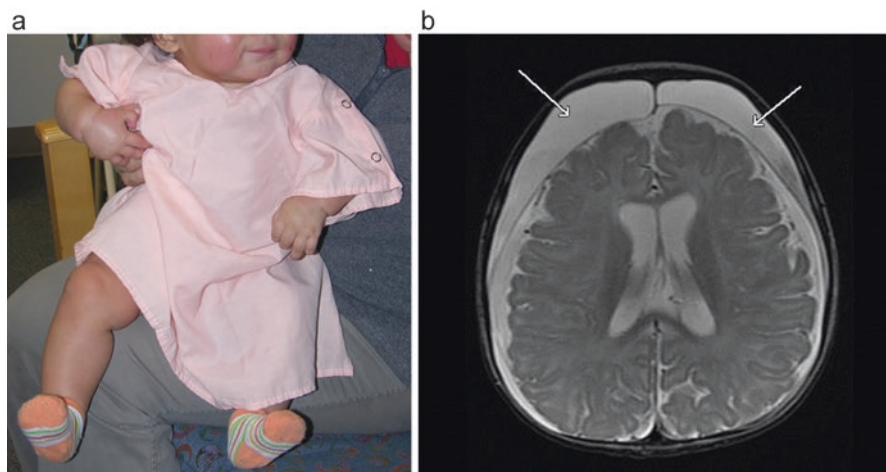


Fig. 2.25 (a, b) Neurologically normal 9 month old with chronic subdural hemorrhage. She was screened for occult head injury after older sibling presented with severe brain injury. Child looked so well clinician opted to wait 36 h to get MRI instead of immediate head CT (Courtesy of Children's National Health System)

Mimics of Abuse

Medical conditions can mimic trauma. As highlighted, the diagnosis of child maltreatment, accidental trauma, or a medical condition that mimics trauma utilizes the traditional diagnostic process. Familiarity with legitimate medical mimics is critical given the ramifications of either the (mis)diagnosis of abuse or the failure to identify a rare and/or potentially serious medical concern.

If a potential medical mimic is less likely than a traumatic lesion and there is suspicion the traumatic lesion was caused by maltreatment, then a report must be made to CPS. A medical evaluation ([Table 2.4 Diagnostic testing of Patients with Suspected Maltreatment](#)) does not have to be complete prior to a CPS report. The appropriate caveats and plans for additional diagnostic testing should be shared at the time of the report. For instance, in a young, otherwise healthy hospitalized child with fracture(s), CPS needs to understand why there is clinical concern for maltreatment, (ii) what diagnostic tests are planned and why, and the likelihood that fracture(s) is/are caused by a medical entity, i.e. a clinician may share that only approximately 1% of fractures among hospitalized children less than age 3 years are due to bone (0.85%) or metabolic abnormalities (0.12%) (Leventhal et al. 2008). This gives CPS appropriate context and allows both the work of CPS and the clinician to proceed with the least possible detriment to the child.

A CPS report must often occur prior to the completion of all of the diagnostic testing related to suspicious subdural and/or retinal hemorrhaging. In particular,

there is a lengthy differential when a child is noted to have subdural and/or retinal hemorrhaging. Differential includes (AHT, accidental trauma, birth trauma), medical interventions, bleeding disorders, Vitamin K Deficiency, malignancies (brain tumors, leukemia, hemophagocytic lymphohistiocytosis), infectious diseases (meningitis, encephalitis), metabolic and genetic diseases (Menkes Disease, Glutaric Aciduria Type 1, Osteogenesis Imperfecta), and anatomical malformations (enlarged subarachnoid spaces, aneurysms, and arteriovenous malformations) (Hymel et al. 2002). In spite of a lengthy differential, maintaining a balanced perspective is important. In a study of 186 children aged less than 2 years, **AHT is the most common cause of SDH: abuse (n = 106; 57%) followed by medical conditions (16%), birth trauma (14%), undetermined etiology (9%), and accident (n = 7; 4%)** (Hobbs 2005). When AHT is being considered, the clinician has the added responsibility to the patient to make an appropriate distinction between legitimate medical mimics of AHT, and ‘court room only’ diagnoses that utilize unproven and ‘unique’ theories of causation that do not have an evidence base in mainstream, peer reviewed medicine (Jenny 2014). For instance, purely hypoxic events (asphyxia, suffocation, drowning) do not have radiologically apparent SDH (Byard et al. 2007). Hypoxia is thus not a medically plausible reason for radiologically apparent SDH in a child being evaluated for AHT in hospitals or in the courts.

Multidisciplinary Collaboration

When child maltreatment is suspected, there needs to be collaboration among pre-hospital providers, primary care clinicians and subspecialists. The American Academy of Pediatrics reminds us that it is “...helpful to consult subspecialist[s] ... child abuse pediatrics...radiology, ophthalmology, neurosurgery, neurology and other fields...to ensure a complete and accurate evaluation...” (Christian and Block 2009). It is important that clinicians remember the medical evaluation can occur at the same time as an investigation (Table 2.4, 2.5, and 2.6). Multidisciplinary collaboration must also include clinicians working with social-services and law enforcement in cases of suspected maltreatment. As noted by the American Academy of Pediatrics, “....When child protective services or law enforcement is involved in an investigation, the pediatrician is required to interpret medical information for nonmedical professionals in an understandable manner that accurately reflects the medical data.” (Christian and Block 2009).

Outcomes

“Please make it go away. I want to wear short sleeved shirts. I don’t want them [friends at school] to see it.” A 7 year old spoke only of two bite marks inflicted by his father. He refused to speak about suspected chronic physical and sexual abuse.

Table 2.5a Suggested guidelines for an urgent medical evaluation

Difficulty breathing, change in mental status, and/or level of consciousness
Suicidal ideation and/or gesture, or other significant mental health issues
Infants and non-mobile child with bruising in any region
Possible abdominal injury, including complaints of pain in the absence of bruising
Unwitnessed or inadequately explained genital or extragenital pain, bleeding or injury
Subtle signs of possible head trauma, e.g. minor skin findings on head, face or ears of infants
Oral bleeding and/or oral injuries in infants
Ear, neck, torso, genital and/or buttocks bruising in preschool age or younger children
Acute large surface area burns, circumferential burns, and/or symmetric burns
Burns involving the face, genitals, hands and/or feet
Suspected ingestion of a toxic, illicit or unknown substance or object
Child with serious flight or safety concerns, including suspected human trafficking
Child who is unlikely to follow-through with a scheduled visit

Table 2.5b Suggested criteria for a scheduled medical evaluation.

No urgent medical, mental health or safety concerns
Equivocal findings on initial evaluation
Need to document changes or resolution of previously documented findings
History of oral injuries or suspicious bruising in an infant without prior radiologic imaging
Healing cutaneous injuries in older developmentally normal preschool and older children
Limited follow-up skeletal survey needed
Additional information from social-services or law enforcement since initial medical evaluation that may inform or alter medical opinion
Sibling of 'index' patient who has not been screened for abuse

Table 2.6 Practice suggestions for the general practitioner

Be alert to signs and symptoms, and historical information that may indicate maltreatment
Begin an objective medical evaluation with a detailed and comprehensive history
Regard subtle oral and cutaneous injuries as 'sentinel' findings that may indicate presence of occult trauma
Screen for occult brain injury with a non-contrast head CT, particularly in children less than 1 year of age
Obtain a dilated eye exam when intracranial hemorrhaging is identified
Obtain a skeletal survey in young children, particularly those less than 2 years
Screen for occult abdominal trauma
Consult subspecialists including child abuse pediatricians, radiologists, ophthalmologists, surgeons
Consider medical mimics
Report suspected child maltreatment
Consider a limited follow-up survey
Offer to examine sibling(s) of the index child

Adverse Childhood Experiences (ACEs) and toxic stress can impair brain development and increase one's risk of medical and behavioral problems (Fig. 1.11). Five percent of children in the United States experience physical violence instigated by an adult in a given year (Finkelhor et al. 2015). A quarter of all adults surveyed by the World Health Organization report having been physically abused as children (WHO 2016). The goal of clinicians, social-services and law enforcement must be prevention and early identification of child maltreatment.

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