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**Abstract:**

Bruises and burns are often early signs of child physical abuse that, if unrecognized and/or unreported, can lead to additional injuries and, ultimately, poor outcomes. The emergency physician is in the position to recognize signs of abuse, diagnose, treat, and intervene on behalf of the child to help ensure protection from further harm. In children with bruising and burns suspicious for physical abuse, concomitant occult injuries such as fractures, abdominal injury, and brain injury are common and therefore must be considered. This article uses cases to illustrate the approach to cutaneous injury in children and emphasizes the importance of including physical abuse as part of the differential diagnosis in young children with injuries.

**Keywords:**

bruises; burns; physical abuse; inflicted injury; non-accidental trauma, children

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# Bruises, Burns, and Other Blemishes: Diagnostic Considerations of Physical Abuse

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**C**hildren with cutaneous injuries commonly present to the emergency department (ED). The emergency physician is presented with the challenge of identifying which cases are suspicious for child physical abuse. Injuries to the skin are the most common presentation of physical abuse.<sup>1</sup> Bruises are the most common and often the earliest sign of physical abuse. It is estimated that up to 25% of pediatric burns requiring hospitalization are the result of abuse or neglect.<sup>1-4</sup>

## CASE 1

A 3-month-old boy presents with his mother to an urgent care with 1- to 2-day history of increased fussiness and intermittent vomiting. Before presenting to urgent care, the mother calls 911 for concerns of abnormal breathing and vomiting. Emergency medical services reassures the mother that his breathing is normal and does not recommend evaluation in the ED at this time. The mother becomes increasingly concerned over the next 12 hours because the patient continues to be fussy and is refusing to eat. At this time, she takes the patient to a local urgent care and is subsequently referred to the ED for further evaluation of abdominal pain.

On physical examination, the emergency physician astutely notes bruising to the abdomen (Figure 1) and a healing frenulum tear (Figure 2), which initiates evaluation for nonaccidental trauma. Head computed tomography (CT) is significant for acute subdural hemorrhage along the right cerebral hemisphere, cerebellum, and tentorium. Complete blood count (CBC) and coagulation studies (prothrombin time [PT]/partial thromboplastin time [PTT]) are normal. Liver transaminases (aspartate aminotransferase [AST]/alanine transaminase [ALT]), lipase, and an abdominal CT to screen for occult abdominal injury are normal. Typically, when screening for occult abdominal injury in the setting of suspected physical abuse, an abdominal CT is performed if liver transaminases and/or lipase are elevated. However, in this case, because the patient also presented with abdominal bruising, the emergency physician had a higher suspicion for abdominal injury and performed an abdominal CT with the head CT. A skeletal survey demonstrates multiple acute anterior rib fractures. The only accidental injury reported by the patient's father is that his child scooted across a toy causing bruising to his abdomen. The mother reports that she has never seen the patient demonstrate this developmental skill. A report is made to child protective services (CPS) for suspected physical abuse, and the patient was admitted to the hospital for further management. Ophthalmology consultation reveals numerous multilayered hemorrhages bilaterally in all 4 quadrants and extending into the periphery. The child abuse pediatrician makes a diagnosis of physical abuse based on the constellation of injuries (subdural hemorrhage, rib fractures, abdominal bruising, frenula injury, and retinal hemorrhages). The patient is discharged to foster care.

This case raises several pertinent clinical questions:

1. What historical information is important to obtain in the ED when evaluating seemingly minor trauma such as bruising?



**Figure 1.** Bruising of the abdomen.



**Figure 2.** The white plaque on the gum is a healing upper labial frenulum tear.

2. What should I look for on examination if I suspect physical abuse?
3. Is the history provided (infant scooting across a toy) a plausible mechanism of injury for the abdominal bruising?

According to the patient's mother, she had not witnessed a developmental motor skill that was the alleged history to explain the injury; a conflicting history and/or unlikely developmental history should raise concern for inflicted injury. Bruising in young, nonambulatory infants is rare and does not occur in well-protected areas of the body such as the abdomen (to be discussed in more detail in the section "Is the History Provided a Plausible Mechanism of Injury for the Abdominal Bruising"). Therefore, this infant's abdominal bruising should engender a high concern for physical abuse and requires additional diagnostic evaluation, including a comprehensive physical examination. In this case, the physician's physical examination not only identified the abdominal bruising but also identified the frenulum tear. Identifying other injuries when conducting a detailed examination increases the medical provider's certainty of abuse as the most likely explanation for the traumatic injuries.

### **What Historical Information Is Important to Obtain in the ED When Evaluating Seemingly Minor Trauma Such as Bruising?**

The history of present illness is a critical component of the ED evaluation and provides key details to determine injury plausibility. Particular attention should focus on the reported explanations for bruising and/or other injuries. Clear, accurate

detailed documentation of the history is important both for medical diagnosis and treatment and for investigative purposes. Essential elements to include are as follows: what occurred, when, where, and who was present. How the child acted before and after the reported injury occurred is also important and should include development of any associated symptoms as part of the review of systems. In addition, any recent accidental injuries should be documented, even if they may seem unrelated or irrelevant because they may become important during the course of the investigation. Paying attention to these historical details helps establish a timeline of events, identify any inconsistencies in the history, and assist with injury plausibility.<sup>5</sup> If no trauma history is provided (accidental or inflicted), this should also be recorded in the medical record. In verbal children, any statements made directly by the child should be documented, ideally as exact quotations.

Medical history including birth history, chronic medical conditions, hospitalizations, surgical procedures, prior injuries/ingestions, medications, and diet should be included. Birth history is particularly important in young infants when trying to differentiate between birth trauma and physical abuse. In addition, certain medical conditions and medications may predispose a child to bruising and/or be included as diagnostic possibilities along with bruising from physical abuse and therefore should be part of a thoughtful differential diagnosis (see [Table 1](#)).

### What Should I Look for on Examination When Suspecting Physical Abuse?

A thorough physical examination is indicated in any child presenting with bruising. The child should be completely undressed and examined in a hospital gown to allow for inspection of the entire skin surface. In this case, the urgent care provider did not document bruising or the frenula tear and thus missed the clues to the diagnosis of physical abuse. Examination of the mouth and oropharynx should include inspection of all 3 frenula (upper labial, lower labial, and lingual). Frenula injuries, particularly in nonambulatory children such as this case, are concerning for abusive injury and should prompt additional diagnostic evaluation. Common abusive injury mechanisms for frenula tears are direct blows to the mouth and forced feeding with a bottle or spoon. Thackeray<sup>7</sup> described 3 infants who initially presented to the ED with frenula injuries and were sent home without concern for physical abuse. All 3 children later presented to the hospital with severe abusive head trauma. In addition to the frenula, careful attention should be paid to the anterior-

**TABLE 1. Differential diagnosis of bruises and burns.<sup>6</sup>**

Bruises	Burns
Allergic contact dermatitis	Blistering dactylitis
Coagulation disorders	Contact dermatitis
Cultural practices	Cupping
Dermal melanosis (previously known as "Mongolian spots")	Eczema
Ehlers-Danlos syndrome	Ecthyma
Erythema multiforme	Epidermolysis bullosa
Erythema nodosa	Erysipelas
Hemangiomas	Erythema multiforme
Hemolytic uremic syndrome	Fixed drug eruption
Hemorrhagic edema of infancy	Impetigo
Henoch-Schönlein purpura	Laxative dermatitis
Hypersensitivity vasculitis	Millipede burn
Incontinentia pigmenti	Moxibustion
Ink/Dye staining	Phytophotodermatitis
Maculae ceruleae	Ringworm
Nevus of Ito	Staphylococcal scalded skin syndrome
Nevus of Ota	Stevens-Johnson syndrome
Oncologic disorders	
Panniculitis	
Pemiosis (chilblains)	
Phytophotodermatitis	
Urticaria pigmentosa	

posterior aspects of the pinna, scalp, mandible/neck region, trunk, and buttocks because these locations are unlikely to be bruised accidentally.<sup>8-10</sup> Bruising can be subtle in these locations and is highly

concerning in nonambulatory children. The physical examination should also include an anogenital examination because a child may be physically injured while being sexually abused, or the anogenital area may be a target of the physical abuse.

On skin examination, physicians should be alert for pattern injuries that may provide clues to distinct injury mechanisms. Children who have been slapped may have characteristic parallel linear bruises with sparing between bruises.<sup>11</sup> Other pattern injuries result from a child being struck with an object, leaving a bruised imprint of the object on the child's skin. Belts, electrical cords, and kitchen utensils (eg, spatula and wooden spoon) are common instruments used, and when patterned injury is identified, can be diagnostic of physical abuse. Paying attention to the contour of the injury along the skin's surface may provide additional clues to the type of implement used, that is, flexible vs inflexible object. For example, if a child is struck on the thigh with a flexible object such as a belt, it would be expected for the injury to wrap around the curvature of the thigh. In contrast, a nonflexible object such as a wooden spoon would not be expected to create a pattern injury that wraps around the contour of the thigh.

Bite marks are also pattern injuries seen in physical abuse and appear as a series of small bruises arranged in an arch-like pattern. There is a significant variability in the curvilinearity of the imprint, as well as demarcation of the specific teeth involved, based on the pressure exerted during the bite episode, body location involved, and age (adult vs child) of the offender. Bite marks should be photodocumented from various angles and should include a measuring device. Forensic dentists can assist in matching bite mark patterns to alleged perpetrator dental impressions. In addition, given the possibility that saliva may be present, swabbing of the bite mark for forensic testing should be considered and completed as per local evidence collection protocols.

### Is the History Provided a Plausible Mechanism of Injury for the Abdominal Bruising?

When trying to differentiate between accidental and nonaccidental injury, consideration of the child's developmental status is an important part of the ED evaluation. Sugar et al<sup>8</sup> described bruising patterns in nearly 1000 children younger than 36 months presenting for well child care and who were not felt to be cases of child abuse. Among 366 children younger than 6 months, only 2 (0.6%) had bruises, and only 8 (1.7%) of 473 children

younger than 9 months had bruises. The incidence of bruising increased as the children became ambulatory, with bruising seen in 17.8% of children who were cruising and in 51.9% of children who were walking. The location of bruises is also important to consider. For the overall study population, 93% of bruises were located over bony prominences such as the knees, anterior shins, and forehead. No child in the study had bruises to the buttocks, hands, or chin.<sup>8</sup> Similarly, Carpenter<sup>9</sup> studied bruising prevalence and distribution in infants aged 6 to 12 months presenting for well child care and found comparable results to Sugar et al. A total of 12% of children had any bruising, and all bruising was located over bony prominences.<sup>9</sup> A systematic review by Maguire et al<sup>10</sup> examined 23 studies to systematically review whether specific bruising patterns are diagnostic or suggestive of physical abuse. Results confirmed the conclusions of previous studies. In accidental injury, the prevalence and location of bruises are associated with the child's developmental status. For example, bruising in nonambulatory infants is rare (<1%) compared with an increased frequency of bruising in ambulatory children (17% of those beginning to walk, 53% of those walking independently).<sup>10</sup> Accidental bruises were more likely to be located on the anterior surface of the body and occur over bony prominences in almost all cases. No accidental bruising was seen on the hands, feet, or ears.<sup>10</sup> Although abusive bruises can occur anywhere on the body, bruising to the head (especially the face), neck, buttock, trunk, arms, and posterior legs is more commonly seen in abusive injury and is rarely seen in accidental injury.<sup>10</sup> Therefore, in the evaluation of bruising, age, developmental status, and location of bruising should be considered, and any bruising in children younger than 6 months and/or in uncommon locations for accidental bruising (ie, not over bony prominences) should alert the physician to possible physical abuse and prompt further diagnostic evaluation (see Table 2).

### Case 1 Take-Home Points

- A thorough physical examination is critical to identify injuries that may prompt evaluation for additional occult injuries, and ultimately, the diagnosis of physical abuse.
- Frenula tears are rare in nonambulatory infants and are concerning for physical abuse.
- Developmental history is a key component when considering plausibility of injury mechanisms.

**TABLE 2. Diagnostic evaluation of bruising concerning for physical abuse.**<sup>12</sup>

Injury	Diagnostic Test
Intracranial	Head CT strongly recommended if: <ul style="list-style-type: none"> <li>· Age &lt;12 month</li> <li>· Abnormal neurologic examination</li> <li>· Injury to the head/neck/face region(s)</li> <li>· Rib fractures or classic metaphyseal lesions (bucket handle or corner fractures)</li> </ul>
Skeletal	Skeletal survey for all children aged <2 y <ul style="list-style-type: none"> <li>· May be indicated in older children depending on developmental status and/or severity of injuries</li> </ul>
Abdominal	Liver transaminases (AST/ALT), amylase, lipase <ul style="list-style-type: none"> <li>· Consider abdominal CT if abnormal laboratory values</li> </ul>
Eye	Ophthalmology consultation if: <ul style="list-style-type: none"> <li>· Intracranial injury</li> <li>· Injury to the head/face/neck region</li> <li>· Altered mental status</li> </ul>
Bleeding disorder	Testing to screen for hematologic disorders should, at a minimum, include the following: <ul style="list-style-type: none"> <li>· CBC with platelets</li> <li>· PT/PTT</li> <li>· Additional studies may be indicated depending on laboratory results, patient's history, and family history.</li> </ul>

Data from Kellogg and the American Academy of Pediatrics Committee on Child Abuse and Neglect.<sup>12</sup>

- Bruising in nonambulatory infants is rare and should prompt concern for physical abuse.
- Bruising of the face, ears, upper arm, hands, trunk, posterior legs, feet, and buttocks is highly concerning for abusive injury and necessitates further evaluation.

## CASE 2

A 5-month-old girl presents to her primary care clinic for routine care. On examination, the physician notes red-purple lesions on the infant's neck and right forearm. The physician is uncertain as to the etiology of the lesions and decides to have the patient return in 1 week for follow-up to assess for resolution. His differential diagnosis at this time is hemangioma versus bruising. When the child returns the following week, the lesions are resolved, confirming bruising. The physician discusses the case with the on-call child abuse pediatrician who

recommends filing a report of suspected physical abuse to child protective services (CPS) and refers the patient directly to the ED for screening for additional injuries. In the ED, the patient has a normal head CT, normal AST/ALT/lipase, and a positive skeletal survey. Her skeletal survey reveals a subacute transverse left fibula fracture. The emergency physician and social worker make a report of suspected physical abuse to the local child protective services agency and law enforcement. Both agencies respond to the suspected abuse report and meet with the family in the ED. No trauma history is provided by the caregivers to account for the resolved bruising and newly identified fibula fracture. A safety plan was established by child protective services before the patient was discharged home with the parents. Before discharge, the emergency physician confirmed with child protective services that they would follow up with the family once discharged.

A week later, the child abuse pediatrician receives a call from a child protective service caseworker who reports that during her home visit, she notices bruising to the infant's face. At this time, the child is again referred to the ED to screen for additional injuries. On this second visit to the ED, the patient is noted to have facial bruising (Figure 3). Head CT, AST, ALT, lipase, CBC, and PT/PTT are normal. Skeletal survey redemonstrates the known fibula fracture and does not identify any additional fractures. The patient is admitted to the hospital, pending a safe discharge plan from child protective services. The mother reports that the facial bruising is from the child sleeping on her pacifier. She states that she sleeps on her back with her head turned to the side on the pacifier. The parents do not provide a history to account for the fibula fracture.



**Figure 3.** Bruising of the face arranged in a triangular pattern with the most inferior bruise under the mandible.

This history raises several questions:

1. Is the history of sleeping on the pacifier a plausible mechanism of injury to explain the facial bruising?
2. Can you accurately estimate the age of the bruising?
3. What occurred in the ED on the initial visit that did not assure a safe discharge plan for the infant?

### **Is the History of Sleeping on the Pacifier a Plausible Mechanism of Injury to Explain the Facial Bruising?**

As discussed in case 1, bruising in young, nonambulatory infants is rare. It would not be expected that just lying on an object would cause bruising to this infant. The facial bruising is not consistent with the history provided and is therefore highly concerning for physical abuse and must be reported to child protective services.

### **Can You Accurately Estimate the Age of the Bruising?**

Bruising is the result of blunt force trauma significant enough to cause a disruption of blood vessels. Bruising appears at different rates and is dependent on a number of factors including skin color, injury force, depth of tissue injury, location of injury, amount of bleeding, and type/amount of underlying tissue(s).<sup>13</sup> Historically, textbooks have described the age of a bruise based on a defined course of color changes; however, no consistent predictable order has been established.

Several studies have examined the question of dating bruising based on color and appearance.<sup>14–17</sup> Stephenson and Bialas<sup>15</sup> photographed accidental bruises in children of known ages and asked blinded observers to describe bruise color and age. Age estimations were correct in only 55% of cases, not much better than chance.<sup>15</sup> This study also described that multiple colors can be present in the same bruise, and the rate of color change varies. Therefore, 2 bruises occurring at the same time can have different colors noted and change colors at different times. In a similar study, Barciak et al<sup>16</sup> enrolled 50 pediatric patients in a children's hospital ED with accidental bruises of known age and mechanism. Physicians blinded to the history were asked to estimate the age of the bruising. Emergency pediatricians were 47.6% accurate in estimating bruise age within 24 hours, while other physicians and trainees (fellows, residents, and medical students) were 29.4% and

36.8% accurate within 24 hours, respectively. For all groups, interobserver and intraobserver reliability was poor. Therefore, this study concluded that dating the age of bruises within 24 hours is highly inaccurate and is not related to level of training or experience.<sup>16</sup>

A systematic review by Maguire et al<sup>18</sup> confirms the inaccuracy in clinically dating bruises. Accurate color discrimination within bruises is poor, and current evidence does not support the practice of dating bruises based on color.<sup>18</sup> Given the high stakes involved in child physical abuse cases, inaccurate, non-evidence-based practice can be detrimental to both the child and the investigation, potentially leaving a child in an unsafe home environment and/or leading to identification of an incorrect perpetrator. Therefore, commenting on ages of bruises is not supported by the literature and should be avoided.

### **What Occurred in the ED on the Initial Visit That Did Not Assure a Safe Discharge Plan for the Infant?**

In this case, unfortunately, the child sustained additional injury despite being reported to child protective services. In subsequent discussions, child protective services expressed concern that they felt that the initial ED documentation did not contain enough detail regarding suspicion for physical abuse that would allow them to seek emergency custody. Although the emergency physician communicated directly with the child protective services caseworker and expressed concerns for abuse, child protective services also needed detailed medical records to support the allegations of abuse. In a busy ED, complex social circumstances can be challenging to navigate and balance with other emergent needs. Understanding the various roles of team members can help alleviate some of the stress and allow for improved teamwork. Law enforcement is tasked with the criminal investigation, including interviewing alleged perpetrators and gathering evidence for potential prosecution. Child protective services is responsible for investigating reports of suspected child maltreatment, and along with the courts, works with families to keep children safe from additional harm.

The emergency physician's role includes identification, diagnosis, and treatment of injuries associated with physical abuse as well as reporting suspected physical abuse to the appropriate agencies (see section on "Reporting"). Accurate and detailed medical documentation must be sufficient for investigative agencies to understand the injuries

and the concern for physical abuse. Social workers can assist with the reporting and communication with the investigative agencies, and their role can include interviewing the family/patient to obtain details surrounding the injuries as well as a thorough psychosocial assessment. The psychosocial assessment should include who lives at home, risk of intimate partner violence exposure, risk of caregiver impairment (mental health, substance use), and past involvement with child protective services and/or law enforcement. Communication with investigative agencies is of the utmost importance for the child to remain safe and for the initiation of appropriate investigative action.

### Case Resolution

The child is discharged to foster care. The father later confesses to police that he squeezed the child's face with his fingers because he was frustrated. This is a consistent mechanism of injury for the facial bruising. No explanation is provided to account for the fibula fracture.

### Case 2 Take-Home Points

- Identification of bruising in young infants is critical, and suspicion for physical abuse must be high and acted upon.
- Estimating the age of bruises is unreliable and should not be attempted.
- Clear communication with child protective service about a defined safety plan for the child is imperative for the ongoing protection of a child from additional abusive injuries.

## CASE 3

A babysitter brings a 16-month-old boy into the ED due to a scald burn to the chin, chest, and arms (Figure 4). The history reported is that the child climbed onto a chair at the kitchen table and was attempting to drink hot broth-like soup that had been left to cool. When lifting the bowl, he accidentally poured the soup down the front of his unclothed chest.

## CASE 4

A mom brings her 20-month-old daughter to the ED due to feet/ankle burns (Figures 5 and 6). The history reported was that the mom was heating water (though not yet boiling) on the stove to prepare dinner while the patient was standing several feet away at a snack drawer. The pan of hot water fell off the stove, and the hot water flowed to where the patient was standing. Because the patient was wearing socks at the time, the



**Figure 4.** Chest and arm burns with undulating borders and pattern consistent with the flow of hot liquid down the trunk.

mom postulated that the socks must have soaked up the hot water, causing the bilateral, uniform, circumferential burn pattern.

These 2 cases raise several questions an emergency physician may face:

- Is the burn distribution consistent with the history provided?
- What exposure is necessary to cause the severity of burns sustained by these patients?

### Is the Burn Distribution Consistent With the History Provided?

Scald burns are the most common type of accidental and inflicted burn injury. As such, it is useful to identify specific burn patterns in distinguishing between accidental and nonaccidental



**Figure 5.** Partial thickness burns of bilateral distal lower extremities in a classic stocking distribution. Note the linear demarcation between burned and unaffected skin.



**Figure 6.** Uniform burn depth of bilateral distal lower extremities in a classic stocking distribution.

mechanisms.<sup>19–21</sup> The pattern of injury noted in case 3 (Figure 4) is typical of accidental scald burns and is consistent with the history reported by the caregiver. This is a classic flow pattern, reflecting how the hot liquid cools as it flows away from the initial point of contact.<sup>22</sup> Borders are often undulating.

The pattern of injury demonstrated in case 4 (Figures 5 and 6) is typical of abusive immersion burns; specifically, in this case, the distribution would be described as a stocking pattern. Features frequently associated with abusive burns include uniform burn depth, sparing of flexor creases, linear contour between burned and unaffected skin, and sparing in areas where the skin was in contact with cooler surfaces (such as the sink or tub).<sup>20</sup> Absence of splash marks can also be indicative of inflicted burns. However, if water temperature is less than 140°F, there will not be instantaneous burn with contact; therefore, splash marks may not be seen, even if the mechanism was accidental.<sup>22</sup> These characteristics of abusive scald burns are the result of children being forcibly immobilized while in contact with hot liquid.

In case 4, the burn is a well-demarcated bilateral stocking distribution, of uniform depth. The opinion of the child abuse pediatricians involved in this case was that the history provided was inadequate to explain this severity of burns. Upon further investigation by law enforcement, the mother's boyfriend confessed to inflicting the burns and pleaded guilty to the associated criminal charges. He admitted that he was angry with the mother for leaving him alone to care for the patient. He ran hot water in the

bathroom sink, took the patient out of her crib, and forcibly immersed her lower extremities in the water with her socks on her feet for what he estimated was 2 minutes. Afterward, when he took her socks off, the underlying skin sloughed off with them, at which time he realized the gravity of what he had done. He did not immediately seek medical attention for the burns; rather, he waited for the patient's mother to return home.

The history provided in the confession from case 4 is consistent with the burn distribution noted on physical examination.

### What Exposure Is Necessary to Cause the Severity of Burns Sustained by These Patients?

There are several factors that determine the degree of burn injury.<sup>23</sup> The most obvious of these factors is the temperature of the exposure. It seems intuitive that exposure to boiling water (212°F) would produce more injury than the same amount of time of exposure to hot tap water at a lower temperature. The next determinant is the time of exposure.<sup>24</sup> Imagine the brief amount of contact that occurs when one is attempting to wash his/her hands, but immediately assesses that the temperature of running tap water is too hot. This is likely to produce less injury than if one's hands were forcefully being held under the same temperature of running water for a longer duration.

Another determinant of degree of burn injury is the type of exposure. Liquids with higher viscosity (ie, oil versus water) can prolong contact to the skin and reach higher temperatures, which can result in a more significant thermal injury to the skin.<sup>25</sup> Lastly, burn severity can be impacted by the skin thickness and vascularity of the body part affected. Infant skin is thinner than adult skin and thus is likely to sustain greater burn injury when exposed to a given hot object or substance.<sup>23</sup> When skin comes into contact with a heat source, the heat is most effectively removed from the tissue via vascular perfusion. If perfusion is compromised, the heat does not dissipate as quickly and can result in more significant injury.

Investigators frequently want to know how long an exposure must have been in order for a child to sustain the burn injury. After taking into account the history provided and the above factors, temperature of the exposure is often the most important data point, and the investigators can often gather this information. There are few data available to predict the amount of injury expected from a given time/temperature of exposure in a child. However, extrapolation from adult studies on the degree of



injury resulting from exposure to various temperatures of water has been useful.<sup>26</sup> For instance, deep partial thickness burns would be expected to occur in a child after a 10-minute exposure to water at 120°F, 10 seconds at 130°F, 4 seconds at 135°F, and 1 second at 140°F.<sup>24,26,27</sup>

In case 4, the investigators' scene investigation found the tap water in the home reached a maximum temperature of 140°F. Although the perpetrator estimated that he held the patient in this water for 2 minutes, it was likely much less time to achieve the severity of injury that this patient sustained.

### CASE 5

A father brings his 14-month-old daughter to the ED due to a scald burn obtained in the bathtub in their home. The father reports that the tap water often takes "a while to get hot," so he turned on the tub water before going downstairs to get the patient and her 4-year-old sister for a bath. He then asked them to wait at the bottom of the stairs while he went to the basement to get towels. When he returned from getting towels, neither child remained on the first floor. The patient's sister was standing on the second floor, pointing to the bathroom with the running bathwater, saying "the water is hot." When he got to the bathroom, the father found the patient lying in the tub, partially full of water, where she was prone, propped up on her elbows, with her legs splayed in a frog-like position. She was still wearing her diaper. Father reports that the patient was quiet but moving such that he thought she was playing, until he noticed steam coming from the running water. He grabbed the patient out of the water by her arms, and her skin "sloughed off like gloves." The patient immediately started crying, and as he wrapped her in a towel, the father noted that her skin was sloughing off her legs and abdomen. The child's grandmother, also in the home at the time, called 911, and the patient was transported to the ED. In the ED, the patient was diagnosed as having deep and superficial partial thickness burns of nearly 40% total body surface area, in the distribution as depicted in [Figure 7](#).

This case raises several questions an emergency physician may face:

- Is the pattern of the burn consistent with the history provided by the patient's father?
- How did the 14-month-old climb upstairs and into the tub in the time it took her father to grab towels from the basement?



**Figure 7.** Burns of varying depth over abdomen and upper and lower extremities, with sparing of flexural creases and relative sparing of the area that was covered by a diaper.

- Is the tap water hot enough to cause this severity of injury?
- Could the patient have sustained this sort of injury without screaming upon touching the water?
- Were there any other potential witnesses to corroborate this incident, in addition to the patient's sister?

### Role of the Scene Investigation in Determining Likelihood of Abuse

This case highlights the importance of scene investigation in determining the likelihood of abuse when evaluating childhood burn injuries. Scene investigations can be performed by law enforcement or child protective services; however, almost universally, a report of suspected abuse or neglect is required to facilitate this investigative process.

In case 5, the law enforcement investigation revealed several important facts. Through mobile phone records, it was determined that there was a 10-minute time lapse where he was not supervising the children. Although his recollection was that he got towels from the basement and returned directly to the bathroom, there was a significantly longer duration of time for our unsupervised patient to climb the flight of stairs. It was also determined that the maximum tap water temperature was 148°F, although it is unknown how long it took for the water to reach maximum temperature. At this temperature, it is estimated that a child (<5 years old) would sustain a full-thickness burn in less than 1 second. As the water was running at a cooler temperature for some time before patient exposure, there was likely a dilution to a relatively lower temperature than the

maximum, which likely lessened the potential severity of her injury.

The tub wall height was measured to be nearly 12 inches from the bathroom floor. Allasio and Fischer<sup>28</sup> demonstrated that approximately 40% of 14-month-old children (mostly male) were able to climb into a bathtub independently. Of all “successful climbers,” approximately 75% entered the tub leg first and 25% entered head first, usually with both arms entering the tub first.

At the time of the incident, the patient and her brother were in the home with father, grandmother, teenage aunt, and adult uncle who were all in various rooms in the home. None of these relatives reported hearing the patient cry until immediately before the father brought the patient out of the bathroom, wrapped in a towel, to ask grandmother for help. Although the severity and extent of burn injury were concerning to the treatment team, the information gathered from scene investigation was able to corroborate the accidental mechanism provided by the patient's father. This corroboration was entirely attributable to the scene investigation, which occurred as a direct result of the initial report to child protective services by medical personnel. This case highlights the fact that mandated reporting is based solely on *suspicion* of abuse, and the resultant investigation by outside agencies can often provide vital information in determining the etiology of injuries.

### Case 5 Take-Home Points

- Several factors determine the degree of burn injury: temperature of exposure, time of exposure, type of exposure, and thickness of skin and tissue perfusion.
- The distribution of a scald burn is important in determining the likelihood of it being abusive or accidental in origin.
- Scene investigation can provide crucial data in determining the etiology of burn injuries. Mandated reporting may be necessary to facilitate appropriate scene investigation.

### ADDITIONAL DIAGNOSTIC EVALUATION

In cases of bruises that are suspicious for abuse, refer to [Table 2](#) for the suggested diagnostic evaluation. In children younger than 2 years with suspicious burn injury, a skeletal survey is recommended to evaluate for occult bony injury.<sup>29,30</sup> Further diagnostic workup in patients with burn should be guided by additional findings on physical examination or history.

## PHOTODOCUMENTATION

Comprehensive documentation of all injuries is crucial in cases of suspected physical abuse. Bruises and burns should be documented as descriptively as possible in the medical record and should include photodocumentation, whenever possible. High-resolution images are helpful to clearly document the injury and for peer review and court proceedings. When taking photographs of injuries, the first photograph should be of the child's face for identification purposes. Additional images should document all cutaneous injuries in a systematic approach, beginning at the head and proceeding to the feet. The following steps are important in the photodocumentation of specific injuries:

- The camera should be aligned perpendicular to the injury.
- Photograph 1: it should be a zoomed-out orientation photograph of the injury to demonstrate the injury in context with the body region.
- Photograph 2: it should be a closer, zoomed-in photograph of the injury.
- Photograph 3: a measuring ruler or scale should be added next to the injury to help document size.

## REPORTING

In all 50 states, physicians are mandated reporters and are therefore required by law to report cases in which child abuse is suspected. The physician must have *reasonable suspicion* to believe that a child has been abused and is not required to know with certainty or be able to prove that abuse occurred to report. Reports should be made to the local child protective services agency and/or law enforcement agency. Specific reporting information by state is available from the Children's Bureau (<http://www.childwelfare.gov/responding/reporting.cfm>). It is important that reports are made in a timely manner and that a safe discharge plan is established by the investigating agency before discharge from the ED to assure protection of the child from ongoing abuse.

## SUMMARY

Cutaneous injuries in children are common, and differentiating between accidental and abusive etiologies is critical. As discussed previously, there are approaches the emergency physician can take to aid in making this distinction. The first step in this process is completion of a thorough history and

physical examination. When doing so, the ED physician must be aware of injuries that are suspicious for physical abuse, including any bruising in a nonambulatory child; bruising to the ear, buttocks, genitals, or abdomen; frenula tears; any patterned bruises or burns; and burn distribution inconsistent with the history. Additional diagnostic evaluation to screen for occult injuries is often indicated in these circumstances. When abuse is suspected, ED staff are mandated to report to child protective services and/or law enforcement to facilitate appropriate investigations and to ensure the safety of the children. ☒

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## REFERENCES

- Jenny C, Reece RM. Cutaneous manifestations of child abuse. In: Reece RM, Christian CW, editors. *Child abuse: medical diagnosis and management*. 3rd Ed. Elk Grove Village (Ill): American Academy of Pediatrics; 2009. p. 19-51.
- Ellerstein N. The cutaneous manifestations of child abuse and neglect. *Am J Dis Child* 1979;133:906-9.
- Andronicus M, Oates RK, Peat J, et al. Non-accidental burns in children. *Burns* 1998;24:552-8.
- Deitch E, Staats M. Child abuse through burning. *J Burn Care Rehabil* 1982;3:89-92.
- Harris TL, Flaherty EG. Bruises and skin lesions. In: Jenny C, editor. *Child abuse and neglect: diagnosis, treatment, and evidence*. 1st Ed. St. Louis (Mo): Elsevier Saunders; 2011. p. 239-51.
- Makoroff KL, McGraw ML. Skin conditions confused with child abuse. In: Jenny C, editor. *Child abuse and neglect: diagnosis, treatment, and evidence*. St. Louis (Mo): Elsevier; 2011. p. 252-9.
- Thackeray JD. Frenula tears and abusive head injury: a cautionary tale. *Pediatr Emerg Care* 2007;23:735-7.
- Sugar NF, Taylor JA, Feldman KW. Bruises in infants and toddlers: those who don't bruise rarely bruise. *Arch Pediatr Adolesc Med* 1999;153:399-403.
- Carpenter RF. The prevalence and distribution of bruising in babies. *Arch Dis Child* 1999;80:363-6.
- Maguire S, Mann MK, Sibert J, et al. Are there patterns of bruising in childhood which are diagnostic or suggestive of abuse? A systematic review. *Arch Dis Child* 2005;90:162-86.
- Kaczor K, Pierce MC, Makoroff K, et al. Bruising and physical child abuse. *Clin Pediatr Emerg Med* 2006;7:153-60.
- Kellogg ND, American Academy of Pediatrics Committee on Child Abuse and Neglect. Evaluation of suspected physical abuse. *Pediatrics* 2007;119:1232-41.
- Schwartz AJ, Ricci LR. How accurately can bruises be aged in abused children? Literature review and synthesis. *Pediatrics* 1996;97:254-7.
- Langlois NE, Gresham GA. The aging of bruises: a review and study of the colour changes with time. *Forensic Sci Int* 1991; 50:227-38.
- Stephenson T, Bialas Y. Estimation of the age of bruising. *Arch Dis Child* 1996;74:53-5.
- Barciak ED, Plint AC, Gaboury I, et al. Dating of bruises in children. *Pediatrics* 2003;112:804-7.
- Munang LA, Leonard PA, Mok JY. Lack of agreement on colour description between clinicians examining childhood bruising. *J Clin Forensic Med* 2002;9:171-4.
- Maguire S, Mann MK, Sibert J, et al. Can you age bruises accurately in children? A systematic review. *Arch Dis Child* 2005;90:187-9.
- Maguire S, Moynihan S, Mann M, et al. A systematic review of the features that indicate intentional scalds in children. *Burns* 2008;34:1072-81.
- Daria S, Sugar NF, Feldman KW, et al. Into hot water head first: distribution of intentional and unintentional immersion burns. *Pediatr Emerg Care* 2004;20:302-10.
- Yeoh C, Nixon JW, Dickson W, et al. Patterns of scald injuries. *Arch Dis Child* 1994;71:156-8.
- Knox BP, Starling SL. Abusive burns. In: Jenny C, editor. *Child abuse and neglect: diagnosis, treatment, and evidence*. 1st Ed. St. Louis (Mo): Elsevier Saunders; 2011. p. 222-38.
- Henriques FC, Moritz AR. Studies of thermal injury: I. The conduction of heat to and through skin and the temperatures attained therein. A theoretical and an experimental investigation. *Am J Pathol* 1947;23:530-49.
- Moritz AR. Studies of thermal injury: III. The pathology and pathogenesis of cutaneous burns. An experimental study. *Am J Pathol* 1947;23:915-41.
- Chiu TW, Ng DC, Burd A. Properties of matter matter in assessment of scald injuries. *Burns* 2007;33:185-8.
- Feldman KW. Help needed on hot water burns. *Pediatrics* 1983;71:145-6.
- Moritz AR, Henriques FC. Studies of thermal injury: II. The relative importance of time and surface temperature in the causation of cutaneous burns. *Am J Pathol* 1947;23: 695-720.
- Allasio D, Fischer H. Immersion scald burns and the ability of young children to climb into the bathtub. *Pediatrics* 2005; 115:1419-21.
- Hicks RA, Stolfi A. Skeletal surveys in children with burns caused by child abuse. *Pediatr Emerg Care* 2007;23: 308-13.
- Degraw M, Hicks RA, Lindberg D, et al. Incidence of fractures among children with burns with concern regarding abuse. *Pediatrics* 2010;125:e295-9.