

Practical Guidelines for Identifying Non-Accidental Trauma in Children

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No care provider wants to miss non-accidental trauma and potentially expose a child to additional harm. However, mistakenly characterizing an injury as child abuse can have serious consequences for families. What follows is a guide to red flags, patterns of injury that may signal abuse, and differential diagnoses that may also account for trauma.

Non-accidental trauma (NAT) is an injury that is purposefully inflicted upon a child—in other words, child abuse. Often the injury is to the skin and soft tissue, but approximately a third of NATs are fractures. In 2011, 3.4 million instances of NAT were reported to child protection agencies in the U.S. Death from inflicted injury that year was estimated at 2.1 per 100,000 children. All physicians, nurses and other health care workers are required by law to report suspected abuse.

History May Reveal Red Flags

During the intake process, a caregiver's description of when and how an injury occurred may trigger concerns. Pay attention to:

- Delays in seeking treatment
- Inconsistent stories between historians (e.g., various caregivers give different explanations, or a caregiver's and a child's explanations differ). Some historians may provide one explanation to a nurse and a different one to a physician.
- Caregivers who have an inappropriate affect
- A pattern of injury that does not match what caregivers say happened
- A child with a history of injuries

KEY INSIGHTS

- Non-accidental trauma (NAT) is an injury that is purposefully inflicted upon a child, also called child abuse.
- Often NAT results in injuries to the skin and soft tissue, but fractures are also common.
- Symptoms that may indicate NAT include retinal hemorrhage, torn frenulum, bruises, burns, bite marks or multiple fractures.
- If the patient's history or a caregiver's description of the injury raises concerns, care providers should evaluate the patient for cutaneous, cranial, ocular, visceral and orthopedic injuries.
- Suspicious physical exam findings may point to NAT, but an underlying medical condition should also be considered.

Some Types of Injuries Are Associated With NAT

If the physical exam reveals any of these symptoms, care providers should be suspicious and conduct a very thorough exam:

- Retinal hemorrhage
- Torn frenulum
- Bruises
- Burns
- Bite marks
- Multiple fractures

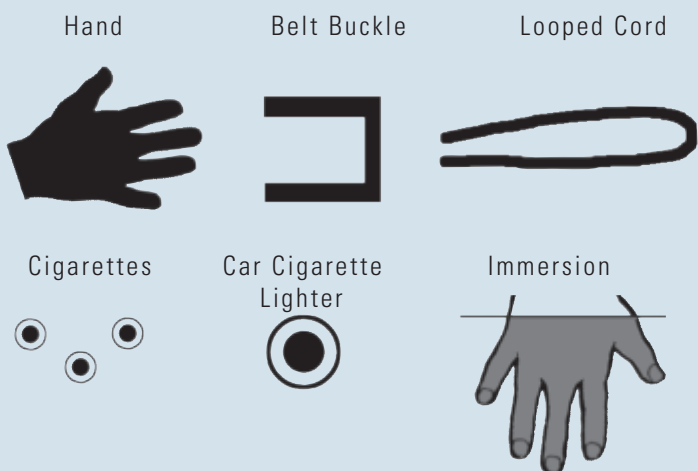
When NAT Is Suspected, Look for Patterns of Injury

If getting the patient's history raises concerns, or if any of the injuries listed above are noted, primary care providers should evaluate the patient for cutaneous, cranial, ocular, visceral and orthopedic injuries.

Cutaneous Injuries

Injuries to the skin or soft tissue often leave telltale marks. For example, a hand, belt buckle, looped cord or spatula can leave distinctive marks. Similarly, burns from cigarettes or car cigarette lighters are obvious. Immersion burns leave a clear demarcation line. See Fig. 1.

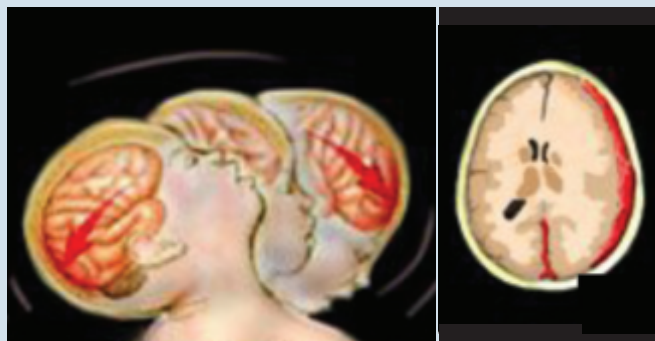
Fig. 1 Marks From Instruments and Burns



Cranial Injuries

Evidence of skull fractures, subdural hematomas, or coup-contracoup injuries such as retinal hemorrhage and detachment may signal NAT, especially if the circumstances of the injuries are suspicious. See Fig. 2.

Fig. 2 Cranial Manifestations



Ocular Injuries

Accidental retinal hemorrhage may be present in 45 to 100 percent of children who have experienced NAT, compared with a 0 to 10 percent rate for children who have accidental trauma. The number of hemorrhages correlates with the severity of the trauma. Detached retina, hyphema or an optic nerve sheath hemorrhage may also indicate abuse.

Visceral Injuries

If imaging shows liver or pancreatic lacerations, NAT should be considered.

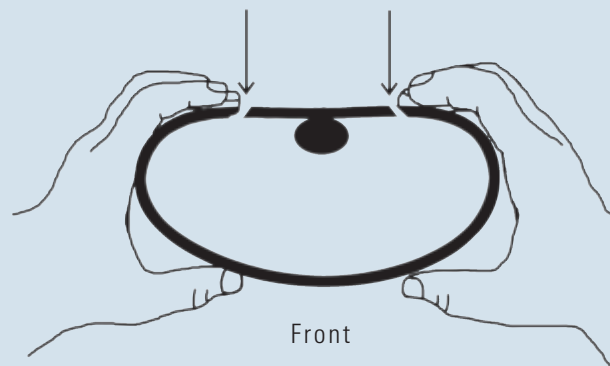
Orthopedic Injuries

The following fractures should be red flags:

- Long bone fractures in a child who is not walking yet
- Fractures of ribs, skull, scapulae or sternum
- Metaphyseal corner fractures
- Multiple fractures at different stages of healing

Shaken babies may have rib fractures on either side of the spine and close to the sternum. See Fig. 3.

Fig. 3 Shaken Baby Rib Fractures



Metaphyseal corner fractures can result when a small child is handled roughly (e.g., by shaking, when a child is jerked hard when being picked up, or a leg is yanked). Metaphyseal corner fractures occur in 40-50 percent of abused babies who are under 18 months. See Fig. 4.

Imaging may show evidence of older fractures that are healing and can be dated as follows: Signs of periosteal healing will be visible one week after a fracture, metaphyseal corner fractures will be visible at four weeks or under, and signs of skull fractures can be seen within two weeks.

Fig. 4 Metaphyseal Corner Fracture



Consider Differential Diagnoses

Suspicious physical exam findings may point to NAT or an unrelated underlying condition. The following conditions could account for injuries resembling NAT and should be considered in cases of suspected NAT:

- Osteogenesis imperfecta
- Osteopenia of prematurity (during the first 6 months of life)
- Rickets (vitamin D deficiency)
- Hypervitaminosis A
- Caffey's disease
- Scurvy (vitamin C deficiency)
- Osteomyelitis
- Disuse osteopenia (paralysis or palsy)

Osteogenesis imperfecta (OI) is rare, occurring in approximately one in 20,000 births. Children who have OI often have multiple fractures that are in different stages of healing.

The incident that caused the fracture may raise suspicions because it seems too low-energy to account for the break. These symptoms point to a diagnosis of osteogenesis imperfecta: blue sclera, documented family history of brittle bones, osteopenia or bowing bones.

Osteopenia of prematurity may be seen in infants who are premature (less than 34 weeks) and have a low birth weight (under 1,500 grams). Infants who are born at under 28 weeks have 30 percent chance of having osteopenia of prematurity. The condition can be a side effect of medication used to treat complications of preterm birth. Elevated alkaline phosphatase, decreased phosphorus, decreased bone density, cupping and irregularity of the metaphyses, and fracture are markers for osteopenia of prematurity.

Rickets is more prevalent in dark-skinned children who are breastfed and have inadequate sun exposure. Symptoms include vitamin D insufficiency, elevated alkaline phosphatase and low serum D2. The child's bones may show signs of bowing deformities and very wide growth plates.

Hypervitaminosis A can be caused by accidental ingestion of vitamin A or in cases of Munchausen's by Proxy. It may also be seen in children who have hydrocephalus. Symptoms include bulging fontanel, drowsiness, irritability, nausea and vomiting. Elevated liver enzymes and serum A are associated with hypervitaminosis A, and cortical thickening may be seen in the bones.

Caffey's disease, also called infantile cortical hyperostosis, affects babies under 6 months old so it tends to be self-limiting. Soft tissue swelling and irritability are symptoms, and they will be accompanied by anemia, an elevated white blood count, erythrocyte sedimentation rate and alkaline phosphatase value.

Scurvy, though uncommon, may occur in babies whose diet consists solely of unsupplemented milk. Consequently, the infant lacks an adequate supply of vitamin C. Scurvy may affect a child's bones as follows: subperiosteal hemorrhage, periosteal new bone, and/or a broad metaphysis with a spur.

Osteomyelitis can cause a child's bones to appear abnormal in X-rays. Specifically, bones may have lytic lesions. Additionally, the child will have a fever and elevated white blood count, erythrocyte sedimentation rate and C-reactive protein.

Disuse osteopenia may occur secondary to paralysis because bone structure and integrity require typical muscle forces and weight bearing. The X-rays of an affected child may show buckle fractures in the long bone metaphyses.

For Suspected Cases of NAT, Follow the Treatment Algorithm

- Interview observers and caregivers separately and repeatedly.
- Document their recollection of the injury each time.
- Do a thorough exam of the child's skin and a skeletal survey. This will require removing all of the child's clothes, as injuries to the genitals or buttocks won't be seen if clothes are not removed.
- Document current fractures and evidence of previous fractures.
- Consider a bone scan to detect occult fractures.
- Request any lab work needed to confirm or rule out NAT.
- Report the case to the police and the child protection agency in the county where the child lives.
- To protect the child, admit him or her to the hospital.

The pediatric orthopedic surgeons at Gillette Children's Specialty Healthcare welcome your consultations or referrals.

Author PROFILES



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Libby Weber, M.D., is a board-certified orthopedic surgeon who has a special interest in orthopedic trauma and limb reconstruction. She received her medical degree from Indiana University School of Medicine in Indianapolis, and completed her residency at Dartmouth Medical School.

Subsequently, she completed a limb reconstruction and pediatric fellowship at the Royal Children's Hospital in Melbourne, Australia, and a pediatric orthopedic fellowship at Brown Medical School/Hasbro Children's Hospital in Providence, Rhode Island. She is a member of the American Academy of Orthopaedic Surgeons, the Limb Lengthening and Reconstruction Society, and the Pediatric Orthopaedic Society of North America.

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NEWS & NOTES

Gillette Offers Comprehensive Care for Traumatic Brain Injuries (Concussions)

With winter sports and activities ramping up, concussions seem to be in the news on a weekly basis. While all concussions are serious, injuries that children and teens sustain to their still-developing brains can bring additional complications. The pediatric specialists at Gillette's Neurotrauma Clinic can assess and treat all types of traumatic brain injuries—from milder injuries like concussions to serious brain injuries that require hospitalization. When children sustain a concussion, our experts help them achieve a full recovery and eliminate the risk of recurrent or permanent injury.

New Therapy Pool to Open in St. Paul

A new therapy pool will open at Gillette's St. Paul campus in January. The new pool includes several features specifically designed to meet the needs of children who have disabilities, including adjustable depth settings, an underwater treadmill and cameras, and adjustable jets that allow therapists to control water resistance levels. Pool therapy provides an ideal environment for patients to practice skills such as strength building and balance. If you have a patient that would benefit from pool therapy, call 651-325-2200 or 855-325-2200 (toll-free).

Gillette Welcomes New Pediatric Orthopedic Surgeon

Andrew Georgiadis, M.D., a pediatric orthopedist, will join Gillette in January. After graduating from Ohio State University College of Medicine, Georgiadis did his orthopedic residency at Henry Ford Hospital in Detroit, Michigan. He then completed his fellowship in pediatric orthopedic surgery at Children's Hospital of Philadelphia. Georgiadis is a member of the Pediatric Orthopaedic Society of North America, the American Academy of Orthopaedic Surgeons and the Scoliosis Research Society. Georgiadis will provide care at Gillette's St. Paul (main campus) and Burnsville clinics.