Practical Guidelines for Identifying Non-Accidental Trauma in Children

Libby Weber, M.D., pediatric orthopedic surgeon

No case 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 purposely inflicted upon a child—in other words, child abuse. Often the injury is to the skin and soft tissues, but approximately one-third of NATs are fractures. In 2011, 3.4 million instances of NAT were reported to child protection agencies in the U.S. Deaths from inflicted injury that year was estimated at 2.1 per 100,000 children. 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.

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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 at least 75 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 sooner, and signs of skull fractures can be seen within two weeks.

When NAT Is Suspected, Look for Patterns of Injury

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

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

Cranial Injuries

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

Cutaneous Injuries

Injuries to the skin or soft tissue often leave telltale marks. Similarly, burns from cigarettes or car cigarette lighters are obvious. Immersion burns leave a clear demarcation line. See Fig. 1.

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.

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
- Osteomyelitis
- Rickets (vitamin D-deficiency)
- Hyperparathyroidism
- Caffey’s disease
- Scurvy (vitamin C deficiency)
- Osteomyelitis
- Divus osteopetrosis (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 cause suspicious fractures because it seems to low-energy to account for the break. These symptoms point to a diagnosis of osteogenesis imperfecta: blue sclera, documented family history of brittle bones, osteoporosis or bowing bones.

Osteoporosis 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 prematurity birth. Elevated alkaline phosphatase, decreased phosphorus, decreased bone density, cupping and irregularity of the metaphyses, and fractures 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 D3. 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 hyper-vitaminosis A, and cortical thickening may be seen in the bones.

Caffey’s disease, also called infantile cortical hyperostosis, affects babies under 6 months old as it tends to be self-limiting. Soft tissue swelling and irritability are symptoms, and they will be accompanied by exasma, 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 force and weight bearing.

The pediatric orthopedic surgeons at Gillette Children’s Specialty Healthcare welcome your consultations or referrals.
Injuries to the skin or soft tissue often leave telltale marks.

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

Cranial 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.

Orthopedic Injuries
- Metaphyseal corner fractures
- Multiple 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 at least 50 percent of abused babies who are under 18 months. See Fig. 4.

Oral injuries
Accidental retinal hemorrhage may be present in 40 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 hematomas correlates with the severity of the trauma. Detached retina, hyphema or an optic nerve sheath hemorrhage may also indicate abuse.

Ocular Injuries
If imaging shows liver or pancreatic lesions, NAT should be considered.

Orthopedic Injuries
The following findings should be red flags:
- Long bone fractures in a child who is not walking yet
- Fractures of ribs, skull, scapulae or sternum
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Shaken babies may have rib fractures on either side of the spine and close to the sternum. See Fig. 3.

Consider Differential Diagnoses
Suspected 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
- Rickets (vitamin D deficiency)
- Hypervitaminosis A
- Caffey’s disease
- Scurvy (vitamin C deficiency)
- Osteomyelitis
- Divorced osteopenia (paraprotein or parathyroidism)

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 cause the child to appear very young, especially if the child is very small. The baby may have difficulty breathing or feeding. The child may have a decrease in appetite and be listless. The child may also have pain, swelling and redness.

Consider a bone scan to detect occult fractures.

Document current fractures and evidence of previous fractures.

Consider a bone scan to detect occult fractures.

Osteomyelitis
Osteomyelitis is a bone infection that can occur in children. Osteomyelitis is caused by bacteria or fungi that enter the bone through a break in the skin, a surgical wound, or an injury. Osteomyelitis can be a serious condition if not treated promptly.

Cranial Injuries
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- Long bone fractures in a child who is not walking yet
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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.

Dissease osteopenia may occur secondary to parasympathetic nerve damage due to bone and tissue integrity and may require timely muscle force and weight bearing. The X-rays of an affected child may show buckled 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.

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- 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.
**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
- Tom 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 tissues 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.

**Ocular Injuries**

Shaken babies may have rib fractures on either side of the spine and close to the sternum. See Fig. 3. The following fractures should be red flags:
- Multiple fractures at different stages of healing
- Fractures of ribs, skull, scapulae or sternum
- Metaphyseal corner fractures
- Multiple fractures at different stages of healing

Occlusal 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

**Cranial Injuries**

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

**Consider Differential Diagnoses**

Suspicous 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
- Osteopetrosis of prematurity (during the first 6 months of life)
- Rickets (vitamin D deficiency)
- Hypervitaminosis A
- Coffeey’s disease
- Scurvy (vitamin C deficiency)
- Osteomalacia
- Divus osteopetra (paronychia or palsy)

**Osteogenesis imperfecta**

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, erythocyte sedimentation rate and C-reactive protein.

**Dissected osteopetrosis**

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

**For Suspected Cases of NAT, Follow the Treatment Algorithm**

- Intervene observers and caregivers separately and repeatedly.
- Document the 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 surgeon at Gillette Children’s Specialty Healthcare welcomes your consultations or referrals.**

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**Fig. 1 Marks From Instruments and Burns**

[Image of marks from instruments and burns]

**Fig. 2 Cranial Manifestations**

[Image of cranial manifestations]

**Fig. 3 Shaken Baby Rib Fractures**

[Image of shaken baby rib fractures]

**Fig. 4 Metaphyseal Corner Fracture**

[Image of metaphyseal corner fracture]

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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 45-50 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.

The incident that caused the fracture may cause 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 26 weeks have 30 percent chance of having osteopenia of prematurity. The condition can be a side effect of medication used to treat complications of prematurity birth. Elevated alkaline phosphatase, decreased phosphorous, 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 D. This 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 hypophosphatemia. Symptoms include bony tenderness, weakness, stiffness, pain, irritability, nausea and vomiting. Elevated liver enzymes and serum A are associated with hyper-vitaminosis A, and cortical thickening may be seen in the bones.

Coffeey’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, erythocyte 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.
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 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.

Practical Guidelines for Identifying Non-Accidental Trauma in Children

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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 tissues, 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, vascular and orthopedic injuries. Suspicious physical exam findings may point to NAT, but an underlying medical condition should also be considered.

No case 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.

Symptoms that may indicate NAT

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

Symptoms that may indicate NAT

- A pattern of injury that does not match what caregivers say happened
- Caregivers who have an inappropriate affect
- A child with a history of injuries
- Inconsistent stories between historians (e.g., various caregivers give different explanations, or a caregiver’s and a child’s explanations differ)

Symptoms that may indicate NAT

- Delays in seeking treatment
- A child with a history of injuries
- Inconsistent stories between historians (e.g., various caregivers give different explanations, or a caregiver’s and a child’s explanations differ)

Symptoms that may indicate NAT

- A pattern of injury that does not match what caregivers say happened
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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 tissues, 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.

Suspicions physical exam findings may point to NAT, but an underlying medical condition should also be considered.

Libby Weber, M.D., pediatric orthopedic surgeon

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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 tissues, but approximately one-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.

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New Therapy Pool to Open in St. Paul

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