An Evidence-Based Approach To Pediatric Orthopedic Emergencies

You are working the Friday night shift when the triage nurse tells you that a 4-year-old-boy has been brought in by his parents because he is refusing to walk. The nurse tells you that the boy looks “pale and sweaty” in his dad’s arms. On your examination you find an ill-appearing child who is very irritable, febrile, and complaining that his right hip hurts. You order acetaminophen, fluids, a CBC and a hip x-ray. Half an hour later, the child is resting more comfortably but still complaining of hip pain and refusing to move his leg. Although he looks better, you ask yourself, “Do I need to do anything more here?”

Your next patient is a 5-year-old girl who is holding her right forearm and refusing to use her hand. Her mother tells you that the patient and her 8-year-old brother were playing on the swings and jumped off, landing on outstretched hands. The 8-year-old notes pain to his left elbow. He is also hesitant to use the extremity. Neither has any other obvious trauma. Are x-rays needed? What common injury should be suspected for each sibling? What is the best treatment modality?

Your third patient is a 14-year-old football player who has significant left knee pain after falling on his flexed knee during a tackle. He is not able to walk due to the pain. What condition should you consider in addition to patellar fracture or dislocation? How is this diagnosed?

The fourth patient to present is a 15-year-old male noting increasing left knee pain over the last 1 to 2 months. His pain is increasing to the point that he has difficulty ambulating. What conditions should be considered in this case? What imaging should be performed? What is the prognosis for this condition?
Orthopedic injuries are a common presenting condition to emergency departments (EDs), with both pediatric and adult patients affected. Neurovascular status is of paramount concern in these injuries. However, structural differences between growing and mature bone (as well as tendons and ligaments) mandate that particular attention be paid to the pediatric patient to ensure that subtle age related injuries are not missed.

This issue of Pediatric Emergency Medicine Practice focuses on the challenge of evaluating and managing the pediatric orthopedic patient and highlights conditions with which the ED clinician may not have significant experience. Many of these injuries are of the simple “bumps and bruises” variety and require little more than ice, pain control, and education about the injury. However, there are some diagnoses that require truly emergent care in order to salvage a limb or prevent future loss of function. Differentiation between the urgent and emergent patient may not be overtly obvious. This article will focus on the available literature with the caveat that much of the information available is based on small case studies and retrospective reviews. By raising clinician awareness of these conditions and applying the available evidence, the ED clinician can work to ensure the best possible outcome for pediatric orthopedic patients.

Critical Appraisal Of The Literature

A literature review was launched with Ovid MEDLINE® and PubMed for articles on pediatric orthopedic emergencies published from 1966 to 2008. Keywords included SCFE, slipped capital femoral epiphysis, septic joint, toxic synovitis, limp, limping child, buckle fracture, radial buckle fracture, torus fracture, FOOSH, supracondylar fracture, elbow fracture, sleeve fracture, patellar avulsion, compartment syndrome, abuse, and non-accidental trauma. The resulting articles provided excellent background for further manual literature searches. Over 600 total articles were reviewed, and 88 of these are included here for the reader’s reference. A search of the Cochrane Database of Systematic Reviews did not produce any applicable reviews. Websites for the American College of Emergency Physicians (ACEP), the American Academy of Orthopedic Surgeons (AAOS), and the American Academy of Pediatrics (AAP) were searched for policy statements regarding pediatric orthopedic conditions; no entries were found. A search of http://www.guidelines.gov provided 2 results. The first was a review of the evaluation of the limping child: ages 0 to 5 (updated in 2007), and the second was a guideline from the AAP on the evaluation of suspected child abuse (updated 2007).

The literature on the diagnosis and treatment of common pediatric orthopedic conditions is based primarily on case reports and anecdotal evidence. Several retrospective studies have also been instrumental in developing the current decision models. However, there have been few prospective studies to validate long held beliefs. The most notable changes in the recent literature have resulted in changes in treatment paradigms, particularly the use of soft casts/splints and less invasive surgical techniques. These findings directly challenge previously held beliefs that longer term, more invasive therapies yield better functional and cosmetic outcomes. It is imperative that the ED clinician be familiar with these changes to minimize morbidity associated with these conditions.

Epidemiology, Etiology, And Pathophysiology

Injury is the most common cause of death in the pediatric population in children more than 1 year of age. Unintentional injury is also the leading non-fatal cause of visits to the ED in the pediatric age group. Orthopedic complaints and injuries are very common in the pediatric population. Analyzing data from the National Hospital Ambulatory Medical Care Survey (NHAMCS), Simon, Bublitz, and Hambridge reported that there were approximately 11 million injury-related visits to EDs in 1998. They found that the most common reasons for visits included open wounds, contusions, sprains/strains, and fractures/dislocations. More recently, Nawar, Niska, and Xu used data from the NHAMCS and found that there were approximately 25 million total ED visits by children under the age of 15 in the US in 2005. Chamberlain et al reported that orthopedic injuries account for about 12% of ED visits. Wilkins (1996) estimates that before the age of 16, boys have a 42% chance of sustaining a fracture, and girls have a 27% chance of the same, while the risk of a fracture severe enough to require hospitalization is about 7% before the age of 16. Upper extremity fractures are more common than those of the lower extremity, but lower extremity fractures are more likely to require surgical repair. Most fractures are sustained after a fall, but the incidence of injuries related to competitive sports increased.

There are significant anatomic, biomechanical, and physiological differences between the skeleton of a pediatric patient and a fully-grown adult. The long bones of children are less dense and more porous than those of adults. The increased compliance means that pediatric long bones have a greater tendency to bow or buckle rather than fracture when subjected to stress. The periosteum of a child’s bones is thicker than that of an adult; thus, children are less likely to have open fractures, and their fractures tend to be less displaced than comparable adult fractures. Children’s ligaments are often stronger than the bone to which they are attached, making ligamentous injuries relatively more rare.
Salter-Harris Classification Of Physeal Fractures

Salter-Harris classification also has important implications for treatment and prognosis of pediatric fractures. Type I fractures occur when the epiphysis separates from the physis, with the reproductive cells of the physis remaining attached to the epiphysis. Growth disturbances rarely result from Type I fractures. Abnormalities in plain films of Type I fractures are notoriously subtle and may only manifest as soft tissue swelling or joint effusion. Displacement of the epiphysis may be detected, but in the absence of radiographic findings, the diagnosis is a clinical one. Point tenderness over the physis may be the only clinical finding. Treatment consists of immobilization, ice, elevation, and timely referral to an orthopedic surgeon for further evaluation. The prognosis with proper treatment and referral is excellent.

Type II fractures are the most common type of Salter-Harris fracture encountered. This fracture is a break through the physis and metaphysis. A small piece of the metaphysis typically remains attached to the epiphysis (Thurston-Holland sign). Treatment and prognosis are similar to that of Type I fractures.

Type III fractures are intra-articular fractures. These fractures go through the epiphysis and into the physis. The prognosis of this type of fracture is directly related to achieving anatomical alignment of the fragments. This is usually done by open reduction to assure the best outcome. Closed reduction is also an option in some cases. Immediate treatment consists of pain control, immobilization, and consultation with an orthopedic surgeon. Depending on the setting, admission may be required. Additional imaging studies such as computed tomography (CT) may help to further delineate involvement of the articular surface.

Type IV fractures have a significant incidence of growth disturbance. These fractures originate in the articular surface and extend through the epiphysis, physis, and the metaphysis. To lessen the likelihood of growth disturbance, realignment of the fragments must be precise. Open reduction with internal fixation is the preferred method of repair. Orthopedics should be consulted while the patient is in the ED.

Type V fractures are often difficult to appreciate radiographically. The injury typically occurs in the knee or ankle where compressive force is transmitted to the physis, resulting in a crush injury of the proliferating chondrocytes. There may be only minimal displacement of the epiphysis despite the serious nature of this injury. The injury may initially be misdiagnosed as a Type I fracture or even a sprain or strain. The diagnosis is often made in retrospect after limb shortening has become evident. A high degree of suspicion should be maintained if there is sufficient mechanism to cause injury and the radiographs appear normal or if radiographs show epiphyseal injuries.

Figure 1. The Salter-Harris Classification Of Pediatric Fractures

Reprinted from the National Institutes of Health, Department of Health and Human Services website: http://www.niams.nih.gov/Health_Info/Growth_Plate_Injuries/#box_2.
displacement or a joint effusion. Immobilization and timely orthopedic followup are required for casting and monitoring of the limb for any sign of growth length discrepancies.

Complications Of Fractures

In addition to the pain caused by a broken bone, there are a number of conditions that may accompany a pediatric fracture. Open fractures, fractures with dislocations or subluxations, and fractures with neurovascular compromise all deserve special mention as they may all be classified as orthopedic emergencies.

Open Fractures

Open fractures are fractures that allow communication of the fracture site with the outside environment due to disruption of the overlying soft tissue. These open wounds may be quite obvious or they may present subtly. Open fractures can be caused by the sharp ends of the broken bone protruding through the skin and then returning beneath the skin. Any wound overlying a fracture should be considered to be a potential open fracture. In cases of open fracture, antibiotics have been shown to reduce the risk of infection. A recent Cochrane Systematic Review demonstrated a 59% reduction in the risk of infection. However, this review was not limited to the pediatric population.

While administration of antibiotics is generally accepted as beneficial, there is still controversy regarding the optimal regimen. A first generation cephalosporin such as cefazolin is typically administered following an open fracture. Gentamicin is often added for more severe injuries or for those obviously contaminated. Clindamycin and other anaerobes can be covered by the addition of penicillin. Clindamycin is generally used if the patient is allergic to penicillins or cephalosporins. There is considerable disagreement as to the optimal length of treatment for open fractures, but this will not affect initial management of these fractures in the ED.

Fractures, Dislocations, And Neurovascular Compromise

Fractures accompanied by dislocations present a special set of challenges to the ED clinician. The need for urgent reduction is generally dictated by the presence of neurovascular compromise. Vessels and nerves may be disrupted or distorted by the abnormal anatomy caused by the dislocation. Prolonged distortion may lead to permanent sequelae; thus, it may be necessary for the ED clinician to attempt reduction without orthopedic back up in some cases. Simple longitudinal traction may serve to temporarily alleviate the problem in some cases. Other cases may require open reduction due to fracture fragments interfering with the normal anatomy. If an orthopedic consultant is not readily available in this situation, seek consultation by telephone before attempting to reduce any fracture with an associated dislocation.

Special Fractures And Conditions

Torus or buckle fractures are typically seen only in children. These injuries often result from a fall onto an outstretched hand (FOOSH). Due to the plastic nature of growing bone, subtle fractures involving one cortex often result as compared to the typical distal radius fractures (Colles and Smith) seen in the adult population. The dorsal cortex is typically disrupted while the volar surface remains intact. Although, many buckle fractures include both cortices. The fracture usually occurs at the distal metaphysis, approximately 3 to 4 mm proximal to the open physis. This fracture accounts for 2% of all pediatric fractures.

Supracondylar (Humerus) Fractures

Supracondylar (humerus) fractures are the most common pediatric elbow fracture, accounting for approximately 60% of these injuries. Although all pediatric patients are prone to this fracture, it is particularly common between ages 3 to 7. The typical mechanism for this injury is the FOOSH with the arm extended behind the patient. Forces are typically transmitted proximally and result in the supracondylar fracture. Current research suggests that children with baseline ligamentous laxity are more prone to this injury.

Patellar Fractures

Patellar fractures are relatively rare in the pediatric population and account for approximately 1% of all fractures. Only 2% of these actually occur in skeletally immature individuals. However, more than half of these fractures in skeletally immature patients are sleeve fractures not true fractures. Sleeve fractures result from a force applied to the flexed knee. The applied force results in avulsion of the cartilage from the patella rather than fracture of the patella or patellar tendon rupture that would be seen in the adult patient. The majority of these sleeve injuries involve the inferior pole of the patella, but several case reports have recently been published documenting sleeve injuries of the superior pole. There has been one small case series reporting partial sleeve fractures.

Slipped Capital Femoral Epiphysis (SCFE)

Slipped capital femoral epiphysis (SCFE) is a common condition in adolescence. The incidence in the United States is estimated to be 10.8 cases/100,000 children. African American children (3.94 times more likely) and Hispanic children (2.53 times more likely) are affected more than Caucasian children. However, incidence is increasing worldwide, with a 5-fold increase reported in Japan. Increases are believed to be related to increasing rates of childhood
Compartment Syndromes

Any fracture or blunt trauma to a limb may cause a rise in compartment pressures as tissues within the compartment are inadequately perfused, causing a compartment syndrome. Tissue perfusion is dependent on the difference between the arterial and venous pressures. The resultant tissue hypoxia is especially deleterious to nerves and muscles. Early recognition of elevated compartment pressures is necessary to prevent permanent tissue damage and post-ischemic changes such as Volkmann’s contracture, a permanent flexion contracture of the hand at the wrist that results in a claw-like deformity of the hand and fingers. The compartments of the forearm and lower leg are the most susceptible to compartment syndromes due to the relatively inelastic borders of the compartments, but any compartment can be affected. Many authors have concluded that irreversible ischemia begins to occur after about 6 to 8 hours of increased pressure.

Normal compartment pressures are near 0 mm Hg. There is debate as to the absolute pressure required to cause a compartment syndrome; however, it is generally agreed that any pressure greater than 30 mm Hg requires intervention. In the adult orthopedic literature, some authors recommend following the perfusion pressure (AP) of the compartment as a means of assessing for a compartment syndrome. Compartment pressures may be measured by means of a commercial pressure monitor. Shadgan et al stated that clinical assessment is “still the diagnostic cornerstone” of acute compartment syndrome diagnosis. Measurement of intracompartmental pressures can confirm the diagnosis and may have a role in the diagnosis of the condition in unconscious patients or those unable to cooperate.

The clinical signs of a compartment syndrome are classically described as the “5 Ps.”

1. Pain out of proportion to the physical findings
2. Pallor
3. Poikilothermia
4. Parasthesia
5. Pulseless

Numerous studies warn that pain and parasthesias may be the only reliable indicators of increased intracompartmental pressures. Pain with passive stretch of the muscles and loss of sensation are frequently cited as the earliest and most reliable indicators of compartment syndrome. In an extensive review, Ullmer found that presence of the various signs had a low sensitivity for diagnosis of compartment syndrome, but the absence of these signs was more useful in ruling out the possibility of a compartment syndrome.

The Limping Child

The child presenting to the ED with a limp represents a diagnostic challenge. There are a variety of traumatic versus non-traumatic causes of limp (See Table 1.) History and physical examination will often suffice to differentiate between traumatic and atraumatic causes. Plain films are a good first-line diagnostic study. If the hip examination is abnormal, obtain bilateral AP and frog leg views. Consider films of the knee if it is not clear if the pain is coming from the hip.

A child with a limp or refusal to walk who presents with a fever or history of recent injury is a special case requiring careful investigation. Two of the most common conditions are septic arthritis and transient synovitis. Assume that any child with a fever who presents with refusal to walk or with a limp has septic arthritis or osteomyelitis until proven otherwise. These are emergencies as they may result in rapid bone and joint destruction unless treated immediately. Septic arthritis and transient synovitis present similarly but are treated differently and have very different potentials for long-term problems.

Prediction rules for differentiation of septic arthritis from transient synovitis have been developed. However, there is disagreement between reports as to the sensitivity of the algorithm. Kocher et al found that if all 4 independent predictors of septic arthritis of the hip (history of fever, non-weight bearing, ESR > 40 mm/hr and serum SBC >12,000 cells) were present, the probability of septic arthritis was 99.6%. This paper validated the results of the original clinical prediction algorithm published by this group.

Luhman et al attempted to validate the Kocher criteria and their own prediction rule at their facility. They found that presence of the 4 Kocher criteria had

Table 1. Differential Diagnosis For The Limping Child

- Septic arthritis
- Osteomyelitis
- Toxic synovitis
- Juvenile rheumatoid arthritis (JRA)
- Rheumatic fever
- Fracture
- Tumor
- Legg calve perthes (LCP)
- Slipped capital femoral epiphysis (SCFE)
a positive probability of only 59% for septic arthritis, compared to the 99.6% reported by the original authors. Luhman et al also found that their best model for predicting septic arthritis was only correct 71% of the time when their 3 variables (history of fever, serum total WBC >12,000 cells/mm³, and previous health-care visit) were present.42 Luhman et al advocated ordering plain films and laboratory studies including complete blood count (CBC), C-reactive protein (CRP), erythrocyte sedimentation rate (ESR), and blood cultures.42 Frick recommended an approach using “thresholds” for observation, testing and treatment based on presentation and examination, imaging, laboratory testing, and clinical judgement.44 More recently, Caird et al found that fever (> 38.5°C) was the best predictor of septic arthritis, followed by an elevated C-reactive protein level and an elevated erythrocyte sedimentation rate.45 These factors were followed by refusal to bear weight and an elevated serum white blood-cell count. A C-reactive protein level of >2.0 mg/dL was a strong independent risk factor for assessing and diagnosing children with septic hip arthritis. Children with all 5 variables had a 98% likelihood of having septic arthritis.

**Differential Diagnosis**

The differential diagnosis of fracture in the pediatric population is fairly straightforward (See Tables 2-5). There are a number of conditions causing limb pain in the pediatric population that are atraumatic. For the most part, these will not be discussed in this review. A thorough history should allow for the initial differentiation of traumatic versus atraumatic mechanism. This may be somewhat more difficult in the pre-verbal infant/toddler population, but the combination of history and a careful and complete physical examination should suffice to make this distinction.

Making the diagnosis is important; however, disposition of the patient is often just as critical. In general, immobilization, non-weight bearing status, elevation, and pain control with prompt orthopedic referral are sufficient for the majority of the conditions encountered in the ED. When in doubt, speak with a consultant while the child is in the ED. This often helps relieve the anxiety of the parents by assuring them that the specialist is already aware of the child’s injury and will be expecting them for followup care.

Initial examination should assure normal neurovascular status; neurovascular deficit warrants immediate orthopedic consultation and maneuvers to attempt to reestablish normal function/anatomy. Radiographic imaging in addition to physical examination is the primary diagnostic modality used to evaluate traumatic injuries. A common approach is to image a joint above and a joint below the affected area in an effort to rule out associated injuries as well as referred pain. In the event of a diagnostic dilemma, it is wise to obtain x-rays of the unaffected extremity to provide a point of anatomic comparison. This is particularly relevant to the pediatric population, as the presence of open physes not only complicates fracture diagnosis but is also responsible for injury patterns seen in this patient group. Contralateral films provide the physician with a patient specific developmental age and can help delineate fractures from normal bone. It is essential to consider these developmental concerns and unique conditions when evaluating pediatric orthopedic patients.

**Prehospital Care**

The overriding goal of the prehospital management of pediatric orthopedic patients is stabilization of the affected extremity in an attempt to limit discomfort and neurovascular deficits. Any suspected fracture encountered by prehospital personnel should be splinted. Splinting improves patient comfort, reduces the likelihood of converting a closed fracture to an open fracture, and reduces the likelihood of damage to neurovascular structures near the site of the fracture. Neurovascular status of any limb should be assessed before any movement of the injured extremity. Lack of a distal pulse may be an indic-

| Table 2. Differential Diagnosis Of Limb Pain In The Pediatric Population |
|-----------------------------|-----------------------------|
| **Traumatic**               | **Non-Traumatic**            |
| Fracture                    | Orthopedic                  |
| Soft tissue injury          | • Legg Calve Perthes disease|
| Non-accidental trauma       | • Osgood-Schlatter disease  |
|                            | • SCFE                      |
|                            | **Rheumatologic**           |
|                            | • Enthesitis                |
|                            | • Juvenile rheumatoid arthritis (JRA) |
|                            | • Spondylarthropathy malignancy |
|                            | • Systemic lupus erythematous |
|                            | • Henoch-Schonlein purpura  |
|                            | **Infectious**              |
|                            | • Lyme arthritis            |
|                            | • Toxic synovitis           |
|                            | • Septic arthritis          |
|                            | • Post-Streptococcal reactive arthritis |
|                            | • Osteomyelitis             |
|                            | **Malignancies**            |
|                            | • Leukemia                  |
|                            | • Bone tumors               |
|                            | **Hematologic**             |
|                            | • Sickle cell disease       |
|                            | • Hemophilia                |
tion to apply longitudinal traction to a fractured extremity. This should be done only in accordance with established protocols or ideally, after real-time communication with a medical command physician. Frequent reassessment of neurovascular status is also recommended.

There are a variety of methods for splinting of extremity fractures. Padded board splints, air splints, slings, and traction splints are all available for stabilization of specific fractures. Immobilize any suspected fracture according to the principle of immobilizing one joint above and one joint below the suspected fracture. Elevate the fractured extremity if possible and apply ice or a cold pack if possible. Provide analgesia in accordance with local protocols. Administer adequate analgesia, particularly when long transport times are anticipated. If possible, transport pediatric orthopedic patients to a facility that has the necessary specialists. However, the presence of significant concomitant trauma necessitates transport to the closest appropriate facility.

**ED Evaluation**

Question patients, parents, and paramedics regarding the mechanism of the current injury. Key details include the position of the extremity at the time of injury, the direction of the applied force, the item applying the force, and the presence of any protective equipment on the affected extremity. It is also important to inquire about previous injuries to the affected area; this may explain certain examination findings. It is also helpful to know if the patient was given any analgesics, either over the counter preparation or more potent agents by EMS. It is helpful to review the EMS examination and any procedures performed en route as changes in the examination should heighten physician suspicion for a significant neurovascular injury.

**Important Physical Findings**

Perform a brief neurovascular check and examine the affected extremity in detail. Assess range of motion at all joints (shoulder, elbow, wrist, and all metacarpophalangeal joints [MCP], proximal interphalangeal joints [PIP], and distal interphalangeal joints [DIP] of all fingers) in patients who have sustained an upper extremity injury. Children who have torus fractures should have full range of motion at all joints. A small hematoma may be seen in the area of the fracture. Include snuff box evaluation in the wrist examination, as scaphoid fractures are often based on clinical examination. Distal nerve function is typically preserved with torus fractures. Supracondylar fractures usually limit elbow range of motion in all planes (flexion, extension, pronation, and supination). Antecubital ecchymosis should also heighten clinician suspicion for a supracondylar fracture. Nerve injuries are commonly seen with supracondylar fractures; as many as 12% of patients experience nerve deficits. The incidence of nerve injury increases with increasing amounts of fracture fragment displacement. Median nerve motor deficits may be seen with this injury (loss of wrist flexion and inability to flex and oppose thumb). This is best illustrated by the patient’s inability to oppose the thumb and the index finger in the ‘ok’ sign. Sensory deficits are not commonly seen; the presence of sensory loss should raise concern for compartment syndrome associated with the fracture.

In patients with a suspected patellar sleeve fracture, begin the examination with an assessment of hip range of motion. Examine all planes of motion (flexion, extension, internal, and external rotation) for arc of motion and the presence or absence of pain with motion. Then complete a standard knee examination taking care to assess the stability of the anterior cruciate ligament (ACL), posterior cruciate ligament (PCL), medial collateral ligament (MCL), lateral collateral ligament (LCL), menisci, posterolateral corner, and patellar motion/stability. Evaluate the integrity of the extensor mechanism; deficits of this function should heighten clinician suspicion for a patellar injury.

Patients with SCFEs often present to the ED not-

### Table 3. Differential Diagnosis for Traumatic Pediatric Elbow Pain

- Supracondylar fracture
- Medial condyle fracture
- Lateral condyle fracture
- Radial head fracture
- Galeazzi fracture
- Monteggia fracture

### Table 4. Differential Diagnosis for Traumatic Pediatric Wrist Pain

- Buckle fracture
- Colles fracture
- Smith fracture
- Ligamentous injury
- Scaphoid fracture

### Table 5. Differential Diagnosis For Traumatic Pediatric Knee Pain

- ACL injury
- MCL/LCL injury
- Meniscus injury
- Patellar fracture
- Sleeve fracture
- Referred hip pain
  - SCFE
  - Hip fracture
  - Avulsion injury
ing knee or thigh pain. Pay careful attention to this patient population to ensure that a complete examination is performed; here the mantra of examining a joint above and a joint below the area of concern becomes relevant. Several retrospective studies show that patients with SCFE presenting with knee pain may have diagnostic delays as long as 2.5 months. In fact, more than 50% of SCFEs can be missed when the chief concern is knee pain. Focus attention on the range of motion at the hip and the presence or absence of pain with motion. Internal rotation is the most commonly limited motion.

Perform serial examinations of neurovascular status in all children with a suspected fracture. Fractures are dynamic and compartment pressures may change over time. An initially uncomfortable fracture may slowly become excruciating and require increasing dosages of pain medication. Any change in the examination of the limb immediately prompts consideration of neurovascular compromise by direct injury or increasing compartmental pressures.

Non-Accidental Trauma

Unfortunately, mistreatment of children is not a rare occurrence. The majority of the time, it is the youngest children at risk. Two-thirds of victims of physical abuse are less than 3 years old and one-third are less than 6 months old. A 1999 article in JAMA reported that one-third of the young victims of abusive head trauma had been to the ED previously (mean time 7 days) and that the diagnosis of abuse was not made. ED clinicians and other primary care providers may often be the first line of detection of physical abuse.

A complete history is often a crucial component of the diagnosis. The 2007 AAP guideline for the evaluation of suspected child physical abuse lists 5 circumstances that are concerning for intentional trauma. These include the following:

1. No or vague explanations for significant injury.
2. Change in an important detail.
3. Explanation inconsistent with the pattern, age, or severity of the injury.
4. Explanation inconsistent with the child’s physical/developmental capabilities.
5. Discrepancies among the stories of witnesses.

Traditionally, spiral fractures, metaphyseal chip fractures, and posterior rib fractures in children have been associated with abuse. However, any fracture may be the result of abuse. A recent review by Kemp et al found a lack of high quality data to definitively assign particular types of fractures as indicative of abuse. They concluded that “no fracture on its own can be used to diagnose child abuse.” They advocated an approach that includes assessment of the age and developmental stage of the child and the type and location of the fracture to determine if abuse has occurred.

All 50 states have mandatory reporting statutes for child abuse. The physician is not responsible for proving abuse before reporting. All steps must be taken to ensure that the child is removed from possible harm and that the proper authorities are notified about the concerns for abuse or neglect.

Diagnostic Studies

Imaging

It is important to understand the mechanism of injury and likely injury patterns before ordering diagnostic imaging. Focused studies are more cost-effective and time-effective; however, focusing too tightly may result in missed injuries. Depending on the type of injury, plain films may not be the best initial imaging study of choice. CT may provide greater detail and prevent the performance of redundant studies.

Any patient who has suffered a FOOSH mechanism and has pain or tenderness should undergo radiographic evaluation. The specific anatomy to be studied should be dictated by physical examination findings. In all cases, it is imperative to obtain additional views as necessary; however, minimally required views will be discussed here. For patients with possible torus fractures, perform the standard wrist series (AP, lateral, and oblique views). Scahoffdoid views may be helpful if there is snuff box tenderness. When reviewing films, it is imperative to carefully inspect all contours, including the radius, ulna, carpal rows, metacarpals, and phalanges. Take care to ensure that there are no subtle dislocations of the carpal bones, particularly involving the lunate and perilunate structures.

In cases of suspected supracondylar fractures, obtain AP, lateral, and oblique views of the elbow. On the lateral elbow view, examine the images for the presence of a posterior fat pad, which is thought to be pathognomonic for fracture. An elevated anterior fat pad is also abnormal. Draw the anterior humeral line and radiocapitellar lines on all lateral films to exclude the possibility of subtle supracondylar fractures. (See Figures 1-3.) Extension-type injuries account for approximately 95% of all supracondylar fractures and are described using the Gartland classification:

Type 1: Non-displaced fracture
Type 2: Displaced with maintenance of posterior cortex
Type 3: Displaced with complete cortical disruption

Obtain plain x-rays (AP, lateral, and sunrise views) for the patient with an injured knee. Lack of an obvious patellar fracture does not rule out the sleeve injury; in fact, this is a hallmark of the diagnosis. A high riding patella may be associated with the injury. The combination of negative x-rays or a high riding patella, loss of extensor mechanism, and appropriate

Gartland classification:
mechanism are concerning for a sleeve fracture.55 If available, perform MRI to confirm the diagnosis.56 If it is not possible to obtain an MRI on the day of injury, arrange immediate orthopedic followup to ensure that the diagnosis is made in a timely fashion.

For patients with a suspected SCFE, initial imaging should consist of AP and frog leg views of both hips. The key examination point on AP film is the Klein’s line.57 This is a line drawn along the superior aspect of the femoral neck. A portion of the femoral head should transect this line; lack of this intersection is indicative of SCFE as the femoral head typically dislocates in a posteromedial direction.58 A CT scan has been shown to be equivalent to plain films in diagnosing SCFE but does subject the patient to significantly more radiation.59 In cases of chronic slippage where there is concern for early avascular necrosis of the femoral head, perform MRI to assess vascular integrity and assist in operative planning.60

Children with refusal to walk due to septic arthritis should also undergo imaging studies. Plain radiographs of the hip are not sensitive enough to exclude septic arthritis in early cases.61 Ultrasound has been used to detect the presence of fluid in the hip joint; however, it cannot assess the cause of the effusion. It may also be used to guide needle aspiration of the hip. MRI is time-consuming and may require sedation of small children to obtain quality images, but it is the most sensitive and specific imaging modality for evaluation of septic arthritis and does not use ionizing radiation. Still, no imaging study can replace aspiration of fluid from the joint.

In suspected cases of non-accidental trauma, a dedicated skeletal survey is recommended.62 This includes films of all long bones, hands, feet, skull, cervical spine, chest (with oblique views), lumbar spine, and pelvis. Whole body films are unacceptable as they do not provide the necessary detail to detect subtle bony abnormalities.

**Laboratory Studies**

Routine laboratory studies are not indicated during the evaluation of torus fractures. Pre-operative planning/clearance is the only indication for laboratory studies in patients with supracondylar fractures or sleeve fractures. Patients with SCFE may require additional laboratory evaluation to determine if there is an endocrinologic cause for the slippage.62-64

In children being evaluated for septic arthritis, draw blood for laboratory analysis. Numerous recent papers have attempted to construct prediction rules for the detection of septic arthritis and its differentiation from transient synovitis. At a minimum, draw a complete blood count with differential, erythrocyte sedimentation rate, and C-reactive protein. Order blood cultures if considering an infectious etiology.

---

**Figure 2. AP Elbow X-Ray**

Image is courtesy of Moira Davenport, MD.

**Figure 3. Lateral Elbow X-Ray**

Image is courtesy of Moira Davenport, MD.

---

**Treatment**

Treatment of torus fractures has recently changed based on several prospective studies.45-48 Immobilization is still the cornerstone of therapy; however, it is now recommended that patients be discharged in removable splints rather than in casts. The splint should be worn for 3 to 4 weeks and can be removed by the parents. Studies have shown no significant difference in radiographic appearance or functional outcome at 3 weeks with splint therapy versus casting. Furthermore, there is a more rapid return to regular activities (both school and athletic functions) with splinting. Lastly, treatment with splinting decreases the number of required visits to orthopedic surgeons, thus decreasing the overall cost of treatment.

Treatment of supracondylar fractures varies based on the type of injury. Assuming a normal neurovascular examination, Type 1 injuries only require immobilization. Once immediate orthopedic followup (within
Perform PALS/ATLS and/or ABCs. Have the patient evaluated by a trauma surgeon. Transfer patient if needed. (Class I)

Perform a complete history and physical. Does patient show signs of trauma or significant mechanism of injury?

Order appropriate imaging studies. (Class I)

Is a fracture present?

Does the patient have a functional deficit?

Order an emergent orthopedic consult. (Class I)

Is the injury non-weight bearing? (Class II)

Clear patient for activity as tolerated. Follow up with PRN. (Class III)

Examine for Kocher predictors and Luhman signs. Make a clinical judgment. (Class III)

Order laboratory studies: CBC, ESR, CRP, and films. (Class II)

Is septic arthritis likely?

Order an emergent orthopedic consult. (Class I)

Are films abnormal or is SCFE or LCP present?

Admit for observation. Consider pediatric and rheumatology consults. (Class II)

Do serial examinations show worsening symptoms?

If signs and predictors are not apparent, discharge patient with followup in 24 hours. (Class III)

If signs and predictors are apparent, admit patient for observation and serial exams. (Class III)

This clinical pathway is intended to supplement, rather than substitute for, professional judgment and may be changed depending upon a patient’s individual needs. Failure to comply with this pathway does not represent a breach of the standard of care.

Copyright © 2009 EB Practice, LLC. 1-800-249-5770. No part of this publication may be reproduced in any format without written consent of EB Practice, LLC.
24-48 hours) has been established, patients may be safely discharged with the extremity in a posterior long arm splint. The elbow should be placed in 90° of flexion.52,65 Type 2 and 3 injuries should be evaluated immediately by a pediatric orthopedic specialist. Timing of treatment is critical. A retrospective study by Walmsley showed that Gartland types 2 and 3 injuries treated after 8 hours from the time of injury were significantly more likely to require open fixation.66 Closed reduction may be attempted in the ED; however, many of these fractures, particularly those that are unstable, require operative intervention of some type. Literature regarding casting and traction is somewhat controversial. Several retrospective studies63,52 have reported excellent or good outcomes with casting while similarly designed studies65-69 showed less robust outcomes, often requiring delayed surgical intervention. One retrospective study showed that children with Gartland types 2 and 3 fractures had significantly better outcomes with percutaneous pinning compared with casting.70 While open fixation has long been the mainstay of treatment, this technique is now reserved for cases that cannot be reduced either in a closed fashion or by percutaneous pinning.27,40 Multiple studies have shown excellent or good functional outcomes with few neurovascular complications following percutaneous pinning.61-67 One prospective study followed 60 children with Gartland type 3 fractures a mean of 28 months after percutaneous pinning. All had excellent or good outcomes and no neurovascular compromise.71 If immediate pediatric orthopedic consultation is not available and a neurovascular deficit is present, attempt reduction. Perform the reduction by placing the hand in a c-shape and using the fingers to direct the displaced fragment into place while using the thumb to stabilize the humerus. Use the other hand to gently flex the elbow while the reduction is being performed. The ideal elbow position is 90° flexion; however, if neurovascular deficits develop in this position, the elbow should be extended until the deficits resolve.22,72 Procedural sedation will likely be necessary. Patients awaiting surgery should be splinted in a similar position; however, such extremes of flexion are not required.

The patient with a sleeve fracture requires minimal treatment in the ED. It is critical to provide adequate analgesia, consult orthopedic surgery, and place the injured leg in a knee immobilizer. Definitive treatment is usually operative, particularly if there is any displacement of the fragments.73 Patients found to have SCFE should be seen and evaluated by pediatric orthopedic surgeons as quickly as possible as the likelihood of avascular necrosis (AVN) decreases with the rapidity of reduction.74 Patients should be nonambulatory until repaired. Closed reduction alone is rarely adequate, and current orthopedic theory recommends single screw fixation of the slipped epiphysis.72,75 Single screw fixation has been found to be superior to multiple screw fixation as functional outcome is similar and there are fewer associated complications.75,76 Given the high incidence of bilateral SCFE, prophylactic pinning of the unaffected hip is now recommended.78-81 This preventive measure is felt to be particularly important in girls younger than age 10 and boys younger than 12 at the time of initial diagnosis.77

Treatment of compartment syndrome consists of immediate and complete fasciotomy of all involved compartments.39 The compartments are left open for a minimum of 48 hours or until the pressure has normalized. Once the pressure has normalized, direct closure may be attempted, but this may not be successful and closure using plastics techniques may be necessary. Institute steps in the ED to minimize further damage while awaiting definitive surgical treatment. Remove any splints, casts, or other circumferential dressings. Do not elevate the extremity as this will decrease the mean arterial perfusion pressure.78

Children who have been diagnosed with septic arthritis require admission to the hospital. Joints must be drained by percutaneous aspiration or open surgical techniques. Antibiotic coverage should be based on the results of the gram stain and tailored once sensitivities are known. The child’s age and risk factors as well as Gram stain results should all influence initial antibiotic coverage, which in normal circumstances, should be directed against S. aureus. Oxacillin and gentamicin are reasonable choices for neonates, with oxacillin alone likely adequate for older children vaccinated against H. influenzae. Given the recent outbreaks of H. influenzae infections in children previously vaccinated against the disease, it is important to review that third-generation cephalosporins (ceftriaxone or cefotaxime in particular) are the preferred treatment for the organism. Community prevalence of MRSA should also be considered when choosing antibiotic coverage.79

Special Circumstances

Children may have inherited disorders making them more susceptible to skeletal trauma and infection. Conditions such as osteogenesis imperfecta (OI) and inherited disorders of immunity are not infrequently seen in children, and their presentation to the ED with an orthopedic problem may be the initial manifestation of their disease.

Controversies/Cutting Edge

As mentioned in the treatment section of this article, definitive treatment of supracondylar fractures is somewhat controversial. However, ED management of these injuries remains clear. It is imperative that neurovascular deficits be addressed immediately. Stabilization of the extremity in a posterior long arm splint with the elbow in 90° flexion is the standard of care.
Controversy regarding the role of osteotomy in the treatment of SCFE has recently developed.\textsuperscript{80,81} Research is currently underway to attempt to address this issue. However, initial treatment in the ED remains the same.

There remains considerable disagreement on the utility of prediction rules for differentiating septic arthritis from transient synovitis. This is likely to generate future studies. Abnormal laboratory values in a febrile child who refuses to walk should certainly prompt serious consideration of the diagnosis of septic arthritis. Admission for observation and discussion with an orthopedic consultant are prudent management steps.

**Disposition**

Discharge children with isolated torus fractures from the ED in a functional splint. Provide information regarding basic splint care and basic analgesic principles to the parents. Orthopedic followup should be available but is not routinely required with this injury. Patients with supracondylar fractures who are discharged from the ED MUST have orthopedic followup within 24 to 48 hours. This allows for resolution of some of the edema/effusion and permits operative planning. Thoroughly review the signs and symptoms of compartment syndrome with the parents before the child with a Gartland type 1 or 2 supracondylar fracture is allowed to go home. Children with Gartland type 3 injuries are typically admitted for frequent neurovascular checks and more immediate operative therapy.

Patients with a sleeve fracture may be safely discharged from the ED if orthopedic followup is available within 24 to 48 hours. Immediate surgical repair is preferred as longer repair times increase the likelihood that the fragment will retract significantly, thus increasing the technical difficulty of

---

**Risk Management Pitfalls In The Treatment Of Pediatric Orthopedic Emergencies**

1. “I didn’t see a fracture on the forearm x-ray.” Radiographic findings may be subtle in patients with torus (or Salter-Harris I) fractures. In cases with a mechanism consistent with the injury, tenderness at the distal metaphysis (or over the physis) on examination, and no obvious fracture on x-ray, patients should be considered to have a torus (or Salter-Harris I) fracture and should be treated as such.

2. “I thought this patient had a typical torus fracture, but this x-ray doesn’t look like a torus fracture.” Patients who sustain torus fractures may present with persistent pain for 2 main reasons. Angulated buckle fractures may be misdiagnosed initially, resulting in prolonged healing and persistent pain.\textsuperscript{82} Secondly, bony cysts may develop at the initial fracture site, serving as a nidus for pain and prompting return to the ED.\textsuperscript{83,84}

3. “My patient with a supracondylar fracture has no signs of elevated compartment pressure in the ED, so it is unlikely to develop after discharge.” Compartment pressure may continue to elevate after discharge as edema continues to increase. Take care to properly immobilize the extremity and to review warning signs with patients and their parents.\textsuperscript{85,86}

4. “I can’t fully reduce the supracondylar fracture. Is close enough acceptable?” The inability to fully reduce a supracondylar fracture should prompt pediatric orthopedic consultation, including transfer if necessary, as incomplete reduction has been associated with long-term limitations in range of motion.\textsuperscript{72}

5. “The patient didn’t look sick. I didn’t think that he could have a septic joint.” Clinical prediction algorithms may only predict a subset of patients with septic arthritis. Even with 3 positive predictors, the variables developed by Luhman et al only predicted 70% of the cases of septic arthritis.\textsuperscript{42}

6. “The mechanism simply wasn’t there for a fracture so I didn’t splint the injury.” If the child indicates that a joint hurts and there is evidence of trauma, it is better to be overly conservative and splint rather than miss a subtle Salter-Harris type fracture.

7. “I was distracted by the open tib/fib fracture and completely missed the chest contusions.” Evaluate all victims of multiple trauma using ATLS protocols with attention to the ABCs and primary survey followed by a thorough secondary survey. Do not be distracted by the most obvious injury.

8. “There was just a small wound over the fracture. I didn’t think that it could be an open fracture.” Bone ends may pull back through the skin after causing an open fracture. Assume that any wound in proximity to a fracture communicates with the fracture until it is proven not to.
the procedure. Children should be placed in a knee immobilizer and be fully non-weight bearing. It is imperative that proper crutch training is provided to ensure that no further trauma results from crutch use. Adequate analgesics should be provided.

Patients found to have SCFE may be discharged home while operative planning occurs as most cases are scheduled on an urgent but elective basis. Some institutions admit all patients with SCFE for pinning since there is concern that delay may result in more slippage. If a patient is discharged, she or he should be placed on crutches and made fully non-weight bearing on the affected extremity. Again, proper crutch training should be performed and adequate analgesia prescribed.

Admit children who are likely to have septic arthritis. Closely follow those who are less likely based on clinical suspicion, laboratory data, and physical examination as outpatients, provided that the parents are reliable and are given explicit instructions for followup and indications for bringing the child back to the ED for reevaluation.

Admit all children who are the victims of suspected non-accidental trauma to the hospital or place them in the care of the appropriate child protective authorities. Failure to do so exposes the child to further potential for injury and death.

Summary

Normal function of the upper extremities is paramount for activities of daily living and for advanced activities enjoyed by most. Torus fractures, when properly treated, have excellent prognosis for rapid return to regular activity. However, supracondylar fractures must be properly and rapidly diagnosed to minimize morbidity. As this article emphasizes, ED clinicians should pay particular attention to the elbow contours on the lateral x-ray to ensure that this diagnosis is made in a timely fashion. Significant cortical disruption warrants immediate orthopedic consultation for operative intervention while less impressive fractures can be stabilized with a posterior long arm splint with the elbow in 90° flexion.

The ability to walk and run normally is dependent on a normal extensor mechanism at the knee. The inability to ambulate can be devastating to the pediatric patient. As this article illustrates, the ED clinician must consider the sleeve fracture in the differential diagnosis of knee trauma. Clinical suspicion is the cornerstone of the diagnosis, and the clinician must pay attention to ensure that timely imaging and follow up are arranged.

This article also emphasizes the need to consider that the hip is often the true etiology of knee pain; the clinician should perform a thorough hip examination to ensure that SCFE is diagnosed in a timely fashion.

Diagnosis of septic arthritis of the hip is challenging. Generally, the child looks ill and refuses to bear weight on the infected joint. Despite clinical prediction algorithms, it may be difficult to determine who should undergo advanced imaging and perhaps invasive diagnostic procedures.

Any case of injury where the mechanism does not explain the injury or the injury does not fit with the procedure is changing for the worse, something needs to be done. Failure to act in a timely fashion is one of the most common causes of litigation in the orthopedic literature.

Cost-Effective Strategies

- Limit x-rays to areas with abnormalities on physical examination. Limiting radiographic studies will not only save money but will save time in the diagnostic process and limit the amount of radiation to which the patient is exposed. Risk Management Caveat: Be sure that all patients being sent home have followup care with a pediatric orthopedic specialist. Ensure that thorough discharge instructions have been provided, particularly relating to signs and symptoms of compartment syndrome.

- Plain x-rays are usually sufficient to diagnose SCFE. Studies have shown that x-rays are as effective as CT scan at detecting SCFE. Given the significantly higher amount of radiation associated with CT scan, the fact that the radiation is directed at sensitive reproductive organs, and the fact that little additional information is gleaned, CT scan should be avoided in the SCFE diagnostic process.

- Conduct serial examinations of the patient yourself. There is considerable debate about the exact compartment pressure needed to cause tissue injury and the relationship of the signs and symptoms to the pressure. Don’t rely on interpreting another provider’s examination. If your examination of the patient is changing for the worse, something needs to be done. Failure to diagnose a compartment syndrome is one of the most common causes of litigation in the orthopedic literature.

- Conduct simple studies first. If the patient has focal pain, start with plain films instead of the CT. Consider whether CT or MRI will give you the information that you are seeking in order to reduce testing. Consult with your radiology colleagues for their opinions regarding the best test to answer the question you are posing.
the developmental or motor abilities of the child should prompt consideration of non-accidental trauma. No one injury is pathognomonic for abuse. Multiple factors must be considered.

Case Conclusions

The 4-year-old with the fever who refused to walk did look better, but he still refused to put weight onto his hip. His CBC, ESR and CRP were all elevated. Your orthopedic colleague agreed to do an aspiration of the joint. The joint fluid was cloudy with 80,000 white cell per mm³. Antibiotics were started and after the joint was washed out in the operating room, the child improved greatly over the next 24 hours.

The 5-year-old girl and her 8-year-old brother both had upper extremity x-rays performed. She was found to have a right radius torus fracture, placed in a functional splint, and discharged. Her brother was found to have a Garland type 3 fracture without neurovascular deficits. He was placed in a posterior long arm splint with a sugar tong component and admitted for neurovascular checks. He underwent operative fixation approximately 10 hours after the injury and at his 8-week followup had no significant deficits.

The 14-year-old football player was found to have a disrupted extensor mechanism and unremarkable knee x-rays. He was seen and evaluated by orthopedics. He was placed in a knee immobilizer and MRI was performed, confirming the diagnosis of sleeve fracture. He was admitted to the orthopedic service and taken to the operating room the next morning. The operative fixation was successful and the patient was discharged home. He is expected to make a full recovery by next football season.

The 15-year-old male with left knee pain was found to have a normal knee examination. However, he had significant pain with internal rotation of the hip and had limited internal rotation. Plain x-rays of the hip showed a SCFE. He subsequently underwent bilateral pinning of his femoral heads and has now returned to pain free ambulation.

References

Evidence-based medicine requires a critical appraisal of the literature based upon study methodology and number of subjects. Not all references are equally robust. The findings of a large, prospective, and randomized, and blinded trial should carry more weight than a case report.

To help the reader judge the strength of each reference, pertinent information about the study, such as the type of study and the number of patients in the study, will be included in bold type following the reference, where available. In addition, the most informative references cited in this paper, as determined by the authors, will be noted by an asterisk (*) next to the number of the reference.

3. What is the preferred method of definitive treatment for SCFE?
   a. Hip replacement
   b. Single screw fixation
   c. Double screw fixation
   d. Non-weight bearing status

4. What is the most common organism causing septic arthritis?
   a. S. pneumoniae
   b. S. aureus
   c. Salmonella
   d. H. influenza
   e. N. gonorrhoea

CME Questions

Physician CME Information


Accreditation: This activity has been planned and implemented in accordance with the Essentials and Standards of the Accreditation Council for Continuing Medical Education (ACCME) through the sponsorship of EB Medicine. EB Medicine is accredited by the ACCME to provide continuing medical education for physicians.

Credit Designation: EB Medicine designates this educational activity for a maximum of 48 AMA PRA Category 1 Credit(s)™ per year. Physicians should only claim credit commensurate with the extent of their participation in the activity.

ACEP Accreditation: Pediatric Emergency Medicine Practice is also approved by the American College of Emergency Physicians for 48 hours of ACEP Category 1 credit per annual subscription.

AAP Accreditation: This continuing medical education activity has been reviewed by the American Academy of Pediatrics and is acceptable for up to 48 AAP credits. These credits can be applied toward the AAP CME/CPD Award available to Fellows and Candidate Fellows of the American Academy of Pediatrics.

Needs Assessment: The need for this educational activity was determined by a survey of medical staff, including the editorial board of this publication; review of morbidity and mortality data from the CDC, AHA, NCHS, and ACEP; and evaluation of prior activities for emergency physicians.

Target Audience: This enduring material is designed for emergency medicine physicians, physician assistants, nurse practitioners, and residents.

Goals & Objectives: Upon reading Pediatric Emergency Medicine Practice, you should be able to: (1) demonstrate medical decision-making based on the strongest clinical evidence; (2) cost-effectively diagnose and treat the most critical ED presentations; and (3) describe the most common medicolegal pitfalls for each topic covered.

Discussion of Investigational Information: As part of the newsletter, faculty may be presenting investigational information about pharmaceutical products that is outside Food and Drug Administration approved labeling. Information presented as part of this activity is intended solely as continuing medical education and is not intended to promote off-label use of any pharmaceutical product. Disclosure of Off-Label Usage: This article discusses the off-label use of procainamide, bromocriptine, dantrolene, and cimetidine.

Faculty Disclosure: It is the policy of EB Medicine to ensure objectivity, balance, independence, transparency, and scientific rigor in all CME-sponsored educational activities. All faculty participating in the planning or implementation of a sponsored activity are expected to disclose to the audience any relevant financial relationships and to assist in resolving any conflict of interest that may arise from the relationship. Presenters must also make a meaningful disclosure to the audience of their discussions of unlabeled or unapproved drugs or devices. In compliance with all ACCME Essentials, Standards, and Guidelines, all faculty for this CME activity were asked to complete a full disclosure statement. The information received is as follows: Drs. Davenport, Dr. Nesbitt, Dr. Whitman, Dr. McCready, and their related parties report no significant financial interest or other relationship with the manufacturer(s) of any commercial product(s) discussed in this educational presentation.

Method of Participation:

Print Subscription Semester Program: Paid subscribers who read all CME articles during each Pediatric Emergency Medicine Practice six-month testing period, complete the post-test and the CME Evaluation Form distributed with the June and December issues, and return it according to the published instructions. Participants are eligible for up to 4 hours of CME credit for each issue. You must complete both the post test and the CME Evaluation Form to receive credit. Results will be kept confidential. CME certificates will be delivered to each participant scoring higher than 70%.

Online Single-Issue Program: Current, paid subscribers who read this Pediatric Emergency Medicine Practice CME article and complete the online post-test and CME Evaluation Form at EBMedicine.net are eligible for up to 4 hours of CME credit for each issue. You must complete both the post test and CME Evaluation Form to receive credit. Results will be kept confidential. CME certificates will be printed directly from the website to each participant scoring higher than 70%.

Hardware/Software Requirements: You will need a Macintosh or PC with internet capabilities to access the website. Adobe Reader is required to download archived articles.

CME Questions

1. What is a normal compartment pressure?
   a. 0 mm Hg
   b. 5 mm Hg
   c. 10 mm Hg
   d. 20 mm Hg

2. Torus fractures should be treated in which fashion?
   a. No treatment is needed
   b. Operative reduction and fixation
   c. Casting
   d. Functional splint

3. What is the preferred method of definitive treatment for SCFE?
   a. Hip replacement
   b. Single screw fixation
   c. Double screw fixation
   d. Non-weight bearing status

4. What is the most common organism causing septic arthritis?
   a. S. pneumoniae
   b. S. aureus
   c. Salmonella
   d. H. influenza
   e. N. gonorrhoea

Childhood Fractures

Torus fractures are frequently missed in pediatrics due to their subtle presentation, common in the mandible and skull, and are often asymptomatic. Dental and neurosurgical consultation are needed in cases of severe maxillary and cranial fractures. Isolated maxillary fractures may have anhidrosis (dry mouth) due to injury to the chorda tympani nerve. A ‘dry mouth’ is unlikely to be a result of dehydration, shock, or decreased oral intake. Patient assessment reveals no findings to indicate dehydration or shock. Further investigation with the patient and owner to determine normal, baseline neurosensory function, as well as any contributing factors to diminished clinical assessable neurosensory function should be performed.

References

83. Wass A, Sloan J. Cortical bone cyst following a greenstick rdial frac
An Evidence-Based Approach To Pediatric Orthopedic Emergencies
Davenport M, Nesbit, C. May 2009; Volume 6 Number 5

This issue of Pediatric Emergency Medicine Practice focuses on the challenge of evaluating and managing the pediatric orthopedic patient and highlights conditions with which the ED clinician may not have significant experience. For a more detailed and systematic look at the latest evidence on pediatric orthopedic emergencies as well as other considerations such as the physical examination, clinical pathways, and other laboratory tests not noted here, see the full text article at www.ebmedicine.net.

### EVIDENCE-BASED CLINICAL RECOMMENDATIONS FOR PRACTICE

<table>
<thead>
<tr>
<th>Key Points</th>
<th>References*</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>A thorough neurovascular check should be performed at the beginning of each evaluation of the pediatric orthopedic emergency patient.</td>
<td></td>
<td>Assess range of motion at all joints (shoulder, elbow, wrist, and all metacarpophalangeal joints [MCP], proximal interphalangeal joints [PIP], and distal interphalangeal joints [DIP] of all fingers) in patients who have sustained an upper extremity injury.</td>
</tr>
<tr>
<td>Appropriate x-ray views performed to technical standards are key to making the proper diagnosis.</td>
<td></td>
<td>It is important to understand the mechanism of injury and likely injury patterns before ordering diagnostic imaging. Depending on the type of injury, plain films may not be the best initial imaging study of choice. CT may provide greater detail and prevent the performance of redundant studies.</td>
</tr>
<tr>
<td>Torus fractures can easily be treated with a functional splint; this modality results in rapid return to normal function while limiting repeat physician visits.</td>
<td>45-48</td>
<td>Treatment of torus fractures has recently changed based on several prospective studies. Studies have shown no significant difference in radiographic appearance or functional outcome at 3 weeks with splint therapy versus casting.</td>
</tr>
<tr>
<td>Lateral elbow x-rays should be carefully reviewed for the presence of a supracondylar fractures; the anterior humeral line and radiocapitellar lines should be drawn on all films.</td>
<td>54</td>
<td>Extension-type injuries account for approximately 95% of all supracondylar fractures and are described using the Gartland classification.</td>
</tr>
<tr>
<td>Assuming no neurovascular deficit is present, patients with Gartland type 1 injuries can be sent home in a posterior long arm splint once immediate orthopedic follow up has been arranged.</td>
<td>22,65</td>
<td>The elbow should be placed in 90° of flexion.</td>
</tr>
<tr>
<td>Gartland type 3 fractures are at high risk for neurovascular complications and are frequently admitted for serial examinations prior to operative fixation.</td>
<td>66</td>
<td>A retrospective study by Walmsley showed that Gartland types 2 and 3 injuries treated after 8 hours from the time of injury were significantly more likely to require open fixation.</td>
</tr>
<tr>
<td>The Klein’s line should be drawn on AP hip x-rays to diagnose SCFE. Findings can often be confirmed on the frog-leg view.</td>
<td>57,58</td>
<td>This is a line drawn along the superior aspect of the femoral neck. A portion of the femoral head should transect this line; lack of this intersection is indicative of SCFE as the femoral head typically dislocates in a posteromedial direction.</td>
</tr>
<tr>
<td>Consider non-accidental trauma when the history does not fully explain the resultant injury.</td>
<td>52</td>
<td>In suspected cases of non-accidental trauma, a dedicated skeletal survey is recommended.</td>
</tr>
<tr>
<td>All patients with open fractures should receive antibiotics.</td>
<td>10</td>
<td>A recent Cochrane Systematic Review demonstrated a 59% reduction in the risk of infection. NOTE: This review was not limited to the pediatric population.</td>
</tr>
<tr>
<td>Normal compartment pressures may become abnormal. Frequent neurovascular checks of the patient are necessary.</td>
<td>37</td>
<td>Normal compartment pressures are near 0 mm Hg. There is debate as to the absolute pressure required to cause a compartment syndrome; however, it is generally agreed that any pressure greater than 30 mm Hg requires intervention.</td>
</tr>
</tbody>
</table>

* See reverse side for reference citations.
REFERENCES

These references are excerpted from the original manuscript. For additional references and information on this topic, see the full text article at ebmedicine.net.


CLINICAL RECOMMENDATIONS

Use The Evidence-Based Clinical Recommendations On The Reverse Side For:

• Discussions with colleagues
• Preparing for the boards
• Developing hospital guidelines
• Storing in your hospital’s library
• Posting on your bulletin board
• Teaching residents and medical students

Emergency Medicine Practice subscribers:
Are you taking advantage of all your subscription benefits? Visit your free online account at ebmedicine.net to search archives, browse clinical resources, take free CME tests, and more.

Not a subscriber to Emergency Medicine Practice?
As a subscriber, you’ll benefit from evidence-based, clinically relevant, eminently useable diagnostic and treatment recommendations for every-day practice. Plus, you’ll receive up to 192 AMA/ACEP Category 1 credits and full online access to our one-of-a-kind online database. Visit ebmedicine.net/subscribe or call 1-800-249-5770 to learn more today.

Pediatric Emergency Medicine Practice is not affiliated with any pharmaceutical firm or medical device manufacturer.

CEO: Robert Williford President & Publisher: Stephanie Ivy Associate Editor & CME Director: Jennifer Pai Director of Member Services: Liz Alvarez

Direct all questions to:
EB Medicine
1-800-249-5770
Outside the U.S.: 1-678-366-7933
Fax: 1-770-500-1316
5550 Triangle Parkway, Suite 150
Norcross, GA 30092
E-mail: ebm@ebmedicine.net
Web Site: EBMedicine.net
To write a letter to the editor, please email: jagodamd@ebmedicine.net

Subscription Information:
1 year (12 issues) including evidence-based print issues, 48 AMA/ACEP Category 1, AAP Prescribed CME credits, and full online access to searchable archives and additional CME: $299
1 year institutional/hospital/library rate: $899
Individual issues, including 4 CME credits: $30
(Call 1-800-249-5770 or go to www.ebmedicine.net to order)

Pediatric Emergency Medicine Practice (ISSN Print: 1549-9650, ISSN Online: 1549-9669) is published monthly (12 times per year) by EB Practice, LLC. 5550 Triangle Parkway, Suite 150, Norcross, GA 30092. Opinions expressed are not necessarily those of this publication. Mention of products or services does not constitute endorsement. This publication is intended as a general guide and is intended to supplement, rather than substitute, professional judgment. It covers a highly technical and complex subject and should not be used for making specific medical decisions. The materials contained herein are not intended to establish policy, procedure, or standard of care. Pediatric Emergency Medicine Practice is a trademark of EB Practice, LLC. Copyright © 2009 EB Practice, LLC. All rights reserved.