Acute and Non-Acute Lower Extremity Pain in the Pediatric Population: Part II

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Lower extremity pain is common in childhood, with etiologies ranging from benign muscular conditions to systemic disease. We are presenting a three-part series of evidence-based practice guidelines to aid the provider in efficiently determining the diagnosis and treatment of a child with lower extremity pain. Part I focused on the history, physical examination, and diagnostic workup (Duey-Holtz, Collins, Hunt, Husske, & Lange, 2012; Duey-Holtz, Collins, Hunt & Cromwell, 2012). Parts II and III have been divided to include comprehensive treatment guidelines, which are summarized in the Table. In general, the most common diagnoses for musculoskeletal pain can be categorized into the following etiologies:

- Trauma: strains/sprains, fractures, dislocations, foreign body, non-accidental trauma
- Infection: septic arthritis, osteomyelitis, diskitis
- Immune-mediated: toxic synovitis, juvenile idiopathic arthritis, Lyme disease, reactive arthritis
- Acquired/developmental: slipped capital femoral epiphysis, Legg-Calve-Perthes disease, Kohler disease, tarsal coalition, accessory navicular, osteochondritis desiccans
- Neoplastic: leukemia/lymphoma, Ewing sarcoma, osteosarcoma
- Referred: scoliosis, spondylolysis, spondylolisthesis
- Benign musculoskeletal: growing pains, tendonitis/apophysitis
- Neurologic: complex regional pain syndrome, restless leg syndrome
- Metabolic: rickets

The following non-painful conditions can present with a limp or abnormal lower extremity examination results:
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<th>Diagnosis</th>
<th>History, physical and test findings</th>
<th>Treatment and referral</th>
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| Accessory navicular             | Medial foot pain; + radiograph findings | ● Conservative treatment with NSAIDs  
● Activity modification  
● Possible immobilization or orthosis  
● Referral to orthopedics with no improvement  
● NSAIDs or naproxen twice a day  
● May consider short 1- to 2-wk immobilization or bracing  
● PT  
● Follow up in 6 wk, consider referral to orthopedics with no improvement |
| Apophysitis/                    | Tender to palpation over apophysis;  | Based on local referring pattern, refer to subspecialist who routinely cares for children with neuromuscular conditions (i.e., pediatric physical medicine and rehabilitation, pediatric neurology, and/or pediatric orthopedic surgery) |
| musculoskeletal conditions:     | ± radiograph findings               |                                                                                        |
| ○ Osgood-Schlatter disease      |                                     |                                                                                        |
| ○ Patella femoral pain          |                                     |                                                                                        |
| ○ Sinding-Larsen-Johansson      |                                     |                                                                                        |
|   syndrome                      |                                     |                                                                                        |
| ○ Sever disease                 |                                     |                                                                                        |
| Cerebral palsy                  | Neurology deficits with motor       | Based on local referring pattern:  
● NSAIDs or naproxen twice a day  
● Begin PT for desensitization  
● Discontinuation of any bracing  
● Refer to pediatric pain specialty |
| Complex regional pain           | Pain after an injury, lower limb    | Refer to pediatric orthopedics with positive examination findings or imaging studies (ultrasound or radiograph) |
| syndrome                        | most common; pain to light touch    |                                                                                        |
|                                 | that is disproportionate to        |                                                                                        |
|                                 | mechanism of injury; evaluate for  |                                                                                        |
|                                 | autonomic symptoms (skin temperature different; color changes; absence or increase of sweating) |                                                                                        |
| Developmental dysplasia of the  | Check history for female, first    | Based on the local referring pattern:  
● Treat with IV antibiotic therapy, typically with inpatient admission  
● Involvement of subspecialists who routinely care for bone/joint infections as necessary (i.e., infectious disease, orthopedic surgery, general pediatrics/hospitalists)  
● Consider immobilization for pain control  
● Remove foreign body  
● Antibiotic prophylaxis as needed  
● Referral to general surgery or orthopedics if bone involvement or surgical excision is required  
● Antibiotic treatment if septic joint (CDC, 2010)  
● Antibiotic treatment if aseptic joint and chlamydia likely plus pain management (Holmes et al., 2008)  
● Conservative management using symptomatic NSAIDs, massage, warmth, and other supportive measures until the syndrome resolves with time  
● May try a course of PT with muscle stretching and exercise |
| Hip Discitis                    | first born, breech, and family     |                                                                                        |
|                                 | history; + Ortalani and Barlow      |                                                                                        |
|                                 | signs, asymmetric thigh fold, +     |                                                                                        |
|                                 | Galeazzi sign, + Klisic sign        |                                                                                        |
| Foreign body                    | Possible history of foreign body,   |                                                                                        |
|                                 | red, swollen, ± radiograph findings |                                                                                        |
| Fracture                        | Swelling/pain with motion/palpation: + radiograph findings: if tender over physis, assume fracture | Split and refer to emergency department or orthopedics within a few days if physeal, displaced, or angulated |
| Gonococcal/chlamydial arthritis | + Sexual activity; arthritis of one or more joints; sometimes accompanying dermatitis and systemic signs and symptoms; ± positive nucleic acid amplification tests of synovial fluid, urine, vagina/cervix | ● Involvement of local subspecialists as needed (i.e., infectious disease and/or rheumatology), especially if septic joint  
● Antibiotic treatment if septic joint (CDC, 2010)  
● Antibiotic treatment if aseptic joint and chlamydia likely plus pain management (Holmes et al., 2008)  
● Conservative management using symptomatic NSAIDs, massage, warmth, and other supportive measures until the syndrome resolves with time  
● May try a course of PT with muscle stretching and exercise |
| Growing pains                   | Late evening or nighttime lower limb extremity pains, usually bilateral, resolve with pain reliever/massage, not typical during day; radiographs negative/laboratory results negative |                                                                                        |

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</table>
| Juvenile inflammatory arthritis | Morning pain, often multiple joint involvement, warmth and/or diminished range of motion, ± CBC, ESR, CRP, (consider ANA, AntiDNAse B, ASO, Lyme serology, if clinically indicated) | Based on local referring pattern: </li>
|                            |                                                                                                     | • Symptomatic relief can be obtained with NSAIDs </li>
|                            |                                                                                                     | • Referral to a pediatric rheumatologist </li>
| Kohler disease             | Pain/swelling mid foot, limp, + radiograph findings navicular bone                                  | Restrict weight bearing and refer to orthopedics </li>
| Legg-Calve-Perthes disease | White boys ages 4-10 y, hip and groin pain, decreased internal hip rotation, radiograph findings: flattening and fragmentation of femoral head | Restrict activities and refer to orthopedics </li>
| Limb length discrepancy    | ± Limp, not painful, + Galeazzi sign, + AP leg length films                                         | Refer to orthopedics </li>
| Lyme arthritis            | Exposure to endemic area, ± target rash, swelling/pain joints, + Lyme titer with + Western blot   | Based on local referring pattern: </li>
|                            |                                                                                                     | • Refer to cdc.gov for most recent treatment guidelines </li>
|                            |                                                                                                     | OR </li>
|                            |                                                                                                     | • Refer to Red Book: Report of the Committee on Infectious Disease (American Academy of Pediatrics [AAP], 2012) </li>
|                            |                                                                                                     | • Involvement of local subspecialists as needed (i.e., infectious disease and/or rheumatology) </li>
| Neoplasm                   | Progressive or intermittent, deep seated, gnawing pain, often worse at night, ± constitutional symptoms, ± elevated laboratory results, ± radiograph findings | Based on local referring pattern, expedited referral to pediatric tumor specialist or pediatric oncologist based on local referral pattern </li>
| Non-accidental trauma      | Injury doesn’t match story, child non-ambulatory with high suspicion fractures, + radiograph findings of affected area | Based on local referring pattern: </li>
|                            |                                                                                                     | • Treat injuries and begin further workup to evaluate for non-accidental trauma based on facility guidelines </li>
|                            |                                                                                                     | • Admit to hospital for safety of patient and further workup </li>
|                            |                                                                                                     | • Involvement of Child Protective Services and additional subspecialists as needed (i.e., social work, child advocacy teams, neurosurgery, general surgery or trauma teams) </li>
| Osteochondritis dissecans  | Pain ± swelling affected joint, increase with activity, ± catch/locking, + radiograph findings for older child/teen | Treat initially with activity restrictions, immobilization, and non-weight bearing to affected limb </li>
|                            |                                                                                                     | • NSAIDs </li>
|                            |                                                                                                     | • Refer to orthopedics </li>
| Osteomyelitis              | Local tenderness/swelling bone, limp, ± fever, elevated CBC, ESR, and CRP                           | Based on local referring pattern: </li>
|                            |                                                                                                     | • ± order MRI </li>
|                            |                                                                                                     | • Refer to orthopedics/emergency department/admission to local hospital </li>
| Restless leg syndrome      | Sleep disturbance, normal physical examination, no systemic symptoms, meet National Institutes of Health restless leg syndrome guidelines criteria | Based on local referring pattern, referral to pediatric sleep center </li>
| Rickets                    | No supplemental vitamin D, darker skin, genu varum and radiograph findings: widening/cupping of the metaphysis; abnormal laboratory findings | Based on local referring pattern: </li>
|                            |                                                                                                     | • Refer to orthopedics for treatment of genu varum </li>
|                            |                                                                                                     | • Treatment of rickets by primary care provider or endocrine team based upon provider </li>
| Scoliosis                  | Thoracic/lumbar prominence on Adams forward bend test; asymmetric shoulders/pelvis; radiograph shows scoliosis | Refer to orthopedics </li>
| Septic joint              | Pain with joint motion, redness, swelling, warmth, restricted joint motion, non-weight bearing, fever, elevated CBC, CRP, ESR ± blood cultures | Based on local referring pattern: </li>
|                            |                                                                                                     | • Ultrasound hip joint or proceed with joint aspiration of small joints (if comfortable) </li>
|                            |                                                                                                     | • May refer to orthopedics, emergency department, or admission to hospital for joint aspiration and continued follow-up with positive cultures |
### TRAUMATIC CONDITIONS

<table>
<thead>
<tr>
<th>Condition</th>
<th>Definition</th>
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<tbody>
<tr>
<td>Foreign Body</td>
<td>A foreign object is found imbedded in soft tissue or bone</td>
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<tr>
<td>Tarsal coalition</td>
<td>Pain in foot with activity, often flat foot and restricted subtalar foot motion, ± radiograph findings</td>
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<tr>
<td>Toxic synovitis</td>
<td>Mild/moderate pain with hip motion, ± limp, afebrile, normal CBC and CRP, ± hip effusion on ultrasound</td>
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<tr>
<td>Slipped capital femoral epiphysis</td>
<td>Often seen in 10- to 14-year-old teens, boys more than girls, overweight, groin/knee pain, pain internal hip rotation, limp, + AP/frog lateral pelvis radiograph</td>
</tr>
<tr>
<td>Spondyloysis/spondylolisthesis</td>
<td>Pain with back extension, AP/lateral/oblique lumbar sacral spine films ± findings</td>
</tr>
<tr>
<td>Strain/sprain</td>
<td>Tender to palpation over soft tissue, ± laxity, swelling, no significant pain with weight bearing</td>
</tr>
</tbody>
</table>

#### Diagnostic Tests
- Anteroposterior, lateral, and potentially oblique radiographs of the affected site should be obtained.

#### Physical Examination
- The wound should be evaluated for signs of a foreign object, redness, swelling, or discharge.
- The musculoskeletal and neurovascular examination of the affected area should be performed.
- Signs of redness or swelling may be reported.
- Signs of tenderness, radiation, and pain should be evaluated.
- The amount of wound contamination should be evaluated.
- The patient should be evaluated for the type of foreign object involved in the accident, and preexisting medical conditions, including the nature, timing, any known foreign materials involved in the accident, and preceding medical conditions.

#### Treatment
- Most cases are treated successfully in the emergency department.
- Often both a physical examination and radiographs are needed to sufficiently exclude the presence of a foreign object.
- NSAIDs
- Follow up in 2 to 3 days
- Ambulation as tolerated
- Limit sports
- Refer to emergency department or orthopedics with increasing pain and/or fever

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**ANA, Antinuclear antibody; Anti-DNAase B, anti-deoxyribonuclease B; ASO, antistreptolysin; AP, Anteroposterior; CBC, complete blood cell count; CRP, C-reactive protein; ESR, erythrocyte sedimentation rate; IV, intravenous; MRI, magnetic resonance imaging; NSAIDs, non-steroidal anti-inflammatory drugs; ±, positive; PT, physical therapy.**

Adapted from Herring, 2008; Junnilla & Cartwright, 2006; Sawyer & Kapoor, 2009.
Antibiotics are sometimes prescribed. The patient may be referred to general surgery if the object is in soft tissue and is not easily visible and removable. The patient may be referred for orthopedic surgery if the injury involves bone (Bass & Levis, 2010; Levine, Gorman, Young, & Courtney, 2008).

**Fracture**

**Definition**

A fracture is an injury to the bone causing a break in the cortical surface. It can include both sides with disruption of alignment.

**Characteristics of pediatric fractures**

- Biomechanical considerations
  - Decreased mineralization and increased vascular channels
  - Decreased modulus of elasticity causing the same stress to result in increased strain
  - Plastic deformation can occur
- Anatomic considerations
  - Presence of growth plates
  - Apophysis
    - Secondary growth center
    - Site of tendon attachment
  - Thick periosteum
    - Assists with reduction and decreased angulation
    - May become interposed between fracture fragments
    - Potential for remodeling (Mathison & Agrawal, 2001)

**Common pediatric fractures**

- Fractures involving the physis (i.e., growth plate), Salter Harris (SH) classification: Pose risk of growth arrest
  - SH1: Involves only the zone of cartilage between the epiphysis and the metaphysis; separation may not be visible on radiographs
  - SH2: Transcends the metaphysis and physis
  - SH3: Transcends the epiphysis and physis
  - SH4: Transcends the epiphysis, physis, and metaphysis
  - SH5: Compression of physis
- Buckle (torus) fractures
- Plastic deformation
- Greenstick fractures

**History of present illness**

A fracture usually presents with a history of trauma. The patient may report pain over a bony prominence. Swelling and bruising may be visible. The patient may limp or be non–weight bearing.

**Physical examination**

- Point tenderness to palpation over the affected area
- Redness, swelling, or bruising may be visible
- The patient may be limping if the lower extremity is involved
- Perform a neurovascular examination
- Be aware of the possibility of compartment syndrome, especially in acute lower extremity fractures
• Pain out of proportion to injury, tight swollen tissue planes, and most specifically, significant pain with passive/active pain with toe motion
  — Requires emergent evaluation
  — Open fractures must be evaluated emergently (Morrissy & Weinstein, 2006)

Diagnostic tests
• Multiview radiographs of the affected area
• If no obvious fracture is found but point tenderness is present over the physis, consider an SH1 fracture if the child is skeletally immature

Treatment
• Splint the injury initially
• Refer to an orthopedic surgeon if you are not comfortable with casting and/or if the fracture involves physis, evidence of displacement, or angulation
• If the fracture involves physis or may require surgical intervention, refer within the first week (i.e., before the beginning of callous formation, which may make any treatment more complex) (Beaty & Kasser, 2001; Canale & Beaty, 2007; Mathison & Agrawal, 2001; Morrissy & Weinstein, 2006)

Non-Accidental Trauma

Definition
Non-accidental trauma (NAT) is a non-accidental injury to a minor younger than 18 years.

History of present injury
• Description of injury
• Detailed description including timing of injury, witnesses, caregivers present, and the mechanism of injury
• The following details of the history are a cause for concern:
  — An explanation inconsistent with child’s developmental level
  — An explanation inconsistent with the level of injury severity
  — No history of trauma or a vague explanation for significant trauma
  — A description inconsistent with the pattern, age, or severity of the injury or injuries
  — Variable explanations among witnesses regarding the injury
  — A previous referral to child protective services
  — A history of abuse in any family member (Kellog & The Committee on Child Abuse and Neglect, 2007)

Detailed medical history
• Prior injuries, hospitalizations, and chronic illnesses
• Family history of bony syndromes, fragile bones, bleeding disorders, and genetic syndromes
• Pregnancy (including complications, expected/unexpected, postpartum pregnancy) (Kellog & The Committee on Child Abuse and Neglect, 2007)

Child development
• Gross/fine motor and language milestones (Kellog & The Committee on Child Abuse and Neglect, 2007)

Social history
• Caregivers involved in the child’s care
• Family beliefs regarding discipline
• The child’s temperament
• Stressors in the home (e.g., financial or social)
• Family support and resources available to them
• Violence among family members (Kellog & The Committee on Child Abuse and Neglect, 2007)

Physical examination

General assessment
• Height/weight/head circumference
• Overall temperament
• Nutritional state
• Overall appearance, paying attention to signs of neglect

Skin evaluation
• Identify the location/size/shape of marking/bruising/bites of various ages/“pattern” injuries
• Evaluate the entire body including the mouth, extremities, buttocks, and torso
• Identify any unusual locations for accidental injuries
• Photograph skin injuries

Skeletal evaluation
• Test the range of motion of all extremities
• Palpate and inspect all long bones, the spine, and ribs for pain to palpation, deformity, erythema, and bruising

Neurologic
• Evaluate for any cranial injuries
• Perform an ophthalmic evaluation for retinal hemorrhage
• Evaluate deep tendon reflexes, muscle tone, Babinski sign, and clonus

Thoracoabdominal
• Perform an abdominal examination to evaluate for acute intraabdominal injuries
Perform a cardiopulmonary examination (Kellogg & The Committee on Child Abuse and Neglect, 2007)

Diagnostic tests
- Perform a skeletal survey, especially in children younger than 5 years
  - “Bucket handle” or corner metaphyseal fractures are considered specific for NAT given the significant shearing, pulling force required to cause these injuries
  - Long bone spiral fractures, especially in a non-ambulatory child, are a concern for NAT; but the mechanism of injury must be evaluated (lower extremity spiral fractures occasionally can occur from exersaucers, cribs, etc.)
  - Multiple fractures of various ages and rib and skull fractures are a concern for NAT (Di Pietro et al., 2009)
- Order aspartate aminotransferase, alanine aminotransferase, amylase, lipase, and urinalysis tests
- Order a computed tomography (CT) scan of the head and consider a CT scan of the abdomen, especially with abnormal laboratory results (Di Pietro et al., 2009)
- Perform an ophthalmology examination

Treatment
- All acute/non-acute injuries should be treated with involvement of subspecialists as needed
- Specific state laws are provided by the Children's Bureau: www.childwelfare.gov/systemwide/laws_policies/search/index.cfm (Child Welfare Information Gateway, 2007, 2008)
- Involvement of local community child abuse team(s) who have expertise in evaluation of suspected child abuse may be required; if they are not available, identify local resources with pediatric experience in the evaluation of suspected child abuse case(s), such as a social worker or pediatric health care provider (Kellogg & The Committee on Child Abuse and Neglect, 2007; Stoodley, 2002; Sugar, Taylor, Feldman, 1999)
- Referral to Child Protective Services
- Notify the child’s primary care provider
- Admission to a local hospital experienced in caring for and evaluating children in cases of suspected child abuse (Child Welfare Information Gateway, 2007, 2008; Di Pietro et al., 2009; Stoodley, 2002; Sugar, Taylor, Feldman, 1999)

Strain/Sprain

Definition
A strain or sprain is an injury to the muscle (strain) or ligaments (sprain); most commonly affects the ankle and is caused by a plantar flexion and inversion injury where the lateral ligaments are affected, including the anterior talofibular ligament, calcaneofibular ligament, and posterior talofibular ligament. A strain or sprain is caused when the ligaments or muscles are stretched beyond their normal limits and tearing of the fibers occurs.

History of present illness
- Swelling
- May have significant pain or refuse to bear weight

Physical examination
- Tender to palpation over soft tissue, but no tenderness over bony areas or growth plates
- May have laxity on the anterior/posterior drawer test
- Tender over the anterior talofibular ligament, calcaneofibular ligament, or posterior talofibular ligament

Diagnostic tests
- Negative radiographs of ankle if obtained (anteroposterior, lateral, and mortise views)

Treatment
- Conservative treatment initially: non-steroidal anti-inflammatory drugs (NSAIDs) as needed
- R.I.C.E.:
  - Rest the injury by not using it
  - Ice should be immediately applied to reduce swelling; it can be used for 20 to 30 minutes, three or four times daily; combine ice with wrapping to decrease swelling, pain, and dysfunction
  - Compression dressings, bandages, or Ace wraps immobilize and support the injured joint
  - Elevate the injured joint above heart level for 48 hours
- Consider immobilizing in a brace if the patient has pain with ambulation and increase weight bearing as tolerated
- Physical therapy, including proprioception therapy
- If no resolution occurs with conservative treatment, or if the patient has recurrent sprains, consider referring him or her to an orthopedic surgeon

Prevention
- The best way to prevent ankle sprains is to maintain good strength, muscle balance, and flexibility
- Warm up before doing exercises and vigorous activities
- Pay attention to walking, running, or working surfaces
- Wear good shoes
- Pay attention to your body’s warning signs and slow down when you feel pain or fatigue
BENIGN MUSCULOSKELETAL CONDITIONS
Apophysitis/Musculoskeletal Conditions

Definition
Apophysitis is a condition caused by repetitive strain and chronic irritation at the site of various apophyseal (growth area) structures. Examples include the distal pole patella, tibia tubercle, and calcaneus.

History of present illness
History includes pain over an apophysis associated with physical activity.

Physical examination
- Tenderness to palpation over the apophysis
- May present swelling or bony prominence

Diagnostic tests
- Initial radiographs should be performed to rule out any other etiology of pain at the location
  - May show bony fragmentation around the apophysis when significant

Diagnosis
- Specific to anatomic location:
  - Sinding-Larsen-Johansson disease (distal pole patella): most commonly seen in children ages 8 to 13 years
  - Osgood-Schlatter disease (tibial tubercle): most commonly seen in patients ages 10 to 15 years
  - Sever disease (calcaneus): most commonly seen in children ages 9 to 13 years (Cramer & Scherl, 2004)

Treatment
- Rest, ice applied alternating with heat, and NSAIDs as needed
- Physical therapy
- Recurrence of symptoms is common until growth is completed; may reinitiate treatment as needed (Cramer & Scherl, 2004; Gholve, Scher, Khakharia, Widmann, & Green, 2007; Hergenroeder, 2010; Sullivan & Anderson, 2000)

Growing Pains

Definition
- No definitive definition
- Exemplifies a type of non-inflammatory pain syndrome

History of present illness
- Nocturnal symptoms, occasionally in the later evening
- Symptoms range from minutes to hours
- Episodic with pain-free periods
- Non-articular
- Bilateral
- Affects the shins/calves/thighs
- The patient often is pain free the next day and does not remember symptoms from the prior evening

Physical examination
The physical examination is normal when the patient is symptom free.

Diagnostic tests
- Diagnosis of exclusion; all results from laboratory and radiographic workups will be normal
- Evaluation is required with atypical symptoms: unilateral, daytime, limp, joint swelling, weight loss, persistent symptoms
- A complete blood cell count (CBC) with manual differential, erythrocyte sedimentation rate (ESR), and C-reactive protein (CRP) may be performed
- Anteroposterior/lateral lower extremity radiographs may be ordered
- Consider a bone scan if symptoms are persistent in young patients and pain cannot be localized and if ESR and/or CRP levels are elevated

Treatment
- NSAIDs
- Massage
- If symptoms are severe and all workup findings are negative, consider evaluation for restless leg syndrome (Armstrong, Kohler, & Lilly, 2009; Asadipooya & Bordbar, 2007; Evans & Scutter, 2011; Morrissy & Weinstein, 2006; Ondo, 2009; Skaggs & Flynn, 2005; Thorpy & National Heart, Lung, and Blood Institute Working Group on Restless Legs Syndrome, 2004; Uziel & Hashkes, 2007)

NON-PAINFUL ETIOLOGIES (MAY PRESENT AS ABNORMAL GAIT)
Cerebral Palsy (Static Encephalopathy)

Definition
Cerebral palsy is an upper motor neuron central nervous system disorder with multiple etiologies that
causes postural and movement disorders with onset at infancy or early childhood. It is classified as non-progressive, but the musculoskeletal pathology is often progressive. In addition to motor disorders, associated issues with perception, communication, cognition, or seizure disorder often are seen (Staheli, 2006).

**History of present illness/condition**
Consider a history of prematurity, use of supplemental oxygen therapy, infections, and perinatal trauma.

**Physical examination**

**Signs/symptoms**
- Presence of spasticity (may not develop until after age 2 years), contractures, loss of motor control, perceptual deficits, increased reflexes, abnormal gait, poor balance, and limb weakness: upper versus lower; left versus right
- Often first diagnosed in children who fail to meet developmental milestones
- Diagnosis may become evident upon serial examinations

**Classification by tone**
- Rigidity: Demonstrated by resistance to passive stretch
- Spasticity: Increasing tone with passive stretch, especially if applied quickly (the most common form)
- Ataxia: loss of balance and coordination
- Athetosis: Involuntary movement
- Dystonia: Sporadic distorted posturing
- Ballismus: Uncontrollable involuntary motion (Staheli, 2006)

**Classification by distribution of involvement**
- Spastic diplegia
  - Bilateral lower extremity involvement
  - Hypertonia in lower limbs
  - Signs of spastic hip adduction at 6 months
  - Delayed functional maturation
- Spastic hemiplegia
  - Unilateral upper and lower extremity involvement
  - Motor asymmetry
  - Finger flexion/adduction thumb
  - Decreased hip abduction and increased plantar flexion of ankle
  - Flexion/pronation of upper limbs
  - Posturing
- Spastic quadriplegia
  - Bilateral upper and lower extremity involvement
  - Moderate/severe psychomotor delay
  - Poor head control
  - Leg scissoring
  - Unable to flex legs and poor trunk balance at 9 months (Miller, 2011)
- Athetoid
  - Involuntary, random, purposeless movements at rest
  - Almost constant motion
  - Muscle tone can be affected by emotional state
  - Scoliosis often present

**Diagnostic tests**
- No one test is confirmatory; the diagnosis typically is made on the basis of history and physical examination
- If a prenatal infectious etiology is suspected, such as those in the TORCH category (toxoplasmosis, rubella, cytomegalic inclusion disease, and herpes virus), consider performing laboratory tests
- If no etiology has been established and/or a progressive etiology is suspected, neuroimaging should be obtained
- Magnetic resonance imaging (MRI) is preferred over a CT scan because it offers a better chance of obtaining the etiology and history of the illness
- Obtain an electroencephalograph if signs of seizures are seen
- If the diagnosis of cerebral palsy is confirmed, screen for associated conditions (ophthalmologic, hearing, speech, and language disorders and mental disabilities)

**Developmental Dysplasia of the Hip**

**Definition**
Developmental dysplasia of the hip is an abnormal anatomic relationship between the acetabulum and the femoral head resulting in a continuum of disorders. Although it sometimes can be seen at birth, it also can present later in development and can change or progress with growth.

**Classification**
- Typical: Dysplasia of the hip with essentially normal anatomy
  - Acetabular dysplasia: shallow acetabulum
  - Subluxed: the femoral head is not fully reduced or covered by the acetabulum
- Dislocatable: The femoral head is located but it can be dislocated with gentle manipulation
- Dislocated: The femoral head is dislocated or not covered by the acetabulum
- Teratologic: Dysplasia due to anatomic malformation of the acetabulum and/or femoral head (Cramer & Scherl, 2004)
History of present illness
The history may include increased incidence, breech presentation, being female, being firstborn, and/or having a family history of the condition.

Physical examination
- Asymmetric thigh folds
- Asymmetric hip abduction or decreased hip abduction (less than 60 degrees)
- Positive Galeazzi sign
  - With the patient in the supine position with knees flexed and feet in plantigrade position, the Galeazzi sign is positive if one knee is higher than the other (Figure 2)
- Laxity noted on the Ortalani and/or Barlow maneuver with subluxation
- Positive Ortalani sign (dislocated but reducible)
  - When the patient’s hips are abducted, a palpable clunk is felt, indicating that the hip was dislocated and is now reduced by the maneuver
- Positive Barlow sign (located but dislocatable)
  - When the hips are adducted, a palpable clunk is felt, indicating that the hip was located and is now dislocated

Diagnostic tests
- Prior to 6 months of age
  - Obtain a bilateral dynamic hip ultrasound when results of a physical examination are abnormal
  - Obtain a bilateral dynamic hip ultrasound when results of a physical examination are normal but history reveals risk factor(s); it should not be ordered before 4 to 6 weeks of age because false-positive results can be obtained
- After 6 months of age, an anteroposterior and frog lateral pelvis radiograph can be ordered first because the ossific nuclei usually can be seen by that age
  - A break in Shenton’s line determines the position of the femoral head on radiographs; it is an imaginary arch formed by the arch of the inferior border of the superior ramus of the pubis and the arch of the medial femoral trochanter (Figure 3)
  - An intact Shenton’s line/arch indicates a located hip
  - A broken Shenton’s line/arch indicates a subluxed or dislocated hip
  - An acetabular index greater than 30 degrees is dysplasia
  - Visible subluxation of the femoral head—not in the lower inner quadrant

Treatment
- Refer the patient to a pediatric orthopedic surgeon
- Common initial treatments are based on category
— Hip subluxation at < 6 months: Pavlik harness for 6 to 12 weeks with repeat ultrasounds to monitor resolution
— Dislocation at < 6 months: Pavlik harness initially; if the dislocation doesn’t reduce, surgical reduction and spica casting will be required
— Dislocation at > 6 months: surgical reduction and spica casting (Cramer & Scherl, 2004; Sewell, Rosendahl, & Eastwood, 2009; Skaggs & Storer, 2006; Staheli, 2006)

Limb Length Discrepancy

Definition
A discrepancy in limb length occurs when the length of one lower extremity is longer than the other.

History of present illness
Limb length discrepancy typically is an asymptomatic condition; any pain should be further evaluated.

Physical examination
• Assess for pelvic obliquity (overall pelvic crest height) when standing posterior to the patient
• Perform Adam’s forward bend test to determine if the pelvic obliquity is from scoliosis or a difference in leg length
• To identify femur symmetry, perform the Galeazzi test (knees flexed to 90 degrees with the patient lying supine)
• Evaluate tibial symmetry (the patient is prone with the knees and ankles flexed)
• Perform a neuromuscular examination to rule out a neuromuscular condition causing the discrepancy in leg length
• Look for asymmetry in muscular bulk and/or muscle wasting in all extremities
• Evaluate for shin and/or foot deformities such as clawing of the toes or missing rays or toes

Diagnostic tests
Order anteroposterior standing lower extremity radiographs to evaluate overall leg heights. This procedure also will help rule out hip dislocation, hemimelia, or bony dysplasia.

Treatment
• Refer the patient to an orthopedist
• Rule out etiologies causing the leg length discrepancy
• Perform a further workup if the patient has associated pain
• If hemi-hypertrophy is present, obtain an abdominal ultrasound (including the kidneys) to rule out an abdominal mass
• About 40% of the adult population has up to a 2.0- to 2.5-cm leg length difference; adult leg lengths less than 2.0- to 2.5-cm do not increase the risk of adult musculoskeletal bony degenerative or arthritic problems (Herring, 2008; Staheli, 2007; Staheli & Song, 2007)

REFERRED SPINE CONDITIONS
Scoliosis

Definition
Scoliosis is a lateral curvature of the spine with torsion of the spine and chest, as well as a disturbance of the sagittal profile. Measurement on radiographs is greater than 10 degrees.

History of present illness
• Curvature of the spine or positive Adam’s forward bend test
  — Posterior examination of the trunk with the patient bending forward at the waist, touching the toes, with the knees in extension (Figure 4)
• May present with leg length discrepancy

Classification
• Idiopathic scoliosis: accounts for nearly 80% of scoliosis
  — Infantile idiopathic scoliosis: normally occurs in first year of life, but always in patients younger than 3 years
  — Juvenile idiopathic scoliosis: occurs in patients between 3 and 10 years of age
  — Adolescent idiopathic scoliosis: the deformity is recognized after the child has reached 10 years of age and typically before the onset of puberty but is always noted before skeletal maturity; the most common type of idiopathic scoliosis in an otherwise healthy child; a cause has not been found
  — Other less common types are neuromuscular, congenital, syndrome, paralytic, and mesenchymal scoliosis

Physical examination
• Thoracic/lumbar prominence on Adams forward bend test
• Asymmetry of shoulders or pelvis height
• Scapular and/or flank asymmetry
• Neuromuscular examination

Diagnosis
• Posteroanterior/lateral scoliosis: Any curve greater than 10 degrees
• If the patient has an abnormal neuromuscular examination and/or significant pain, especially night waking pain, consider a further workup, including MRI of the base of the skull to the sacrum
Treatment

- Typically scoliosis is not a painful condition; pain with scoliosis requires further workup
- Refer to orthopedics as needed based on local referral patterns; in the context of significant pain, an abnormal neuromuscular examination, and/or night waking pain, refer to orthopedics acutely

Spondylolysis

Definition
Spondylolysis is an isolated defect in the posterior vertebra, specifically the interarticularis vertebra, that is most common at the fifth lumbar vertebra (L5). In pediatric and adolescent patients, it can lead to spondylolisthesis.

History of present illness
The most common symptom is back and/or leg pain that limits a patient’s activity level.

Physical Examination
- Pain with palpation
- Pain with back extension

Diagnostic tests
Anteroposterior/lateral/oblique lumbar sacral spine films may have diagnostic findings.

Treatment
- NSAIDS as needed for pain
- Physical therapy
- Consider activity limitations until the patient is evaluated by a subspecialist (Herring, 2008; Scoliosis Research Society, 2011a)

Spondylolisthesis

Definition
Spondylolisthesis is the forward slip or movement of one vertebra in association with the adjacent vertebra. Most commonly, it affects the L5 vertebra on the first sacral (S1) vertebra.

History of present illness
The most common symptom is back and/or leg pain that limits a patient’s activity level.

Physical examination
- Pain with palpation
- Pain with back extension

Classification
- Developmental
- Acquired

Diagnostic tests
Anteroposterior/lateral/oblique lumbar sacral spine films may provide diagnostic findings.
Treatment

- Refer the patient to orthopedics
- NSAIDs as needed for pain
- Physical therapy
- Consider activity limitations until the patient is evaluated by a subspecialist (Herring, 2008; Scoliosis Research Society, 2011b; Watters et al., 2008)

OTHER NEUROLOGIC CONDITIONS

Complex Regional Pain Syndrome

Definition

Complex regional pain syndrome is a condition experienced by a patient who has pain in a single limb out of proportion to the history or injury and is associated with one or more signs of autonomic nervous system dysfunction in that extremity. Subcategories of the syndrome include type I—no definite nerve lesion is present (seen in most children), and type II—a definite nerve lesion is present.

History of present illness

- Often associated with trauma to that limb, including fracture; it also may be associated with other surgical or medical conditions and certain drugs
- Female predominance
- Most common in children 5 to 17 years of age with a mean age of 13 years
- Occurs more commonly in the lower extremity

Symptoms

- Pain disproportionate to the initial traumatic or noxious event
- Can be elicited and/or exacerbated by mechanical or thermal stimuli and aggravated by touch or dependency
- Pain often is elicited with a light touch and continues even after the stimuli is removed
- The comorbid presence of psychological stress or disorders can be seen

Physical examination

- Pain often is elicited with a light touch and continues even after the stimuli is removed
- An early finding is edema of the involved area
- Changes in skin color and temperature occur compared with the normal side
- Weakness, dystonia, reduced movement, and/or tremor can be seen
- Trophic changes can be seen in hair, nails, and muscle size
- Increased sweating is present

Diagnostic tests

- Diagnosis of exclusion; all laboratory findings and the radiographic workup will be normal
- No specific laboratory studies confirm the diagnosis; a CBC, ESR, and CRP can be performed to rule out other etiologies
- Consider radiographs or a bone scan to exclude other etiologies of pain

Treatment

- No proven definitive treatment
- The disease course is varied
- The prognosis for most children is full resolution
- Consider referral to a pain specialist as an adjunct to mainstay treatment
- Current mainstay treatment:
  - Physical therapy/occupational therapy to focus on desensitization modalities
  - Referral to a pain specialist
  - No agreed upon pharmacotherapy treatment exists (Baron & Janig, 2004; Morrissy & Weinstein, 2006; Sherry, 2011; Stanton-Hicks et al., 1998; Wilder, 2006)

Restless Leg Syndrome

Definition

Restless leg syndrome is a movement disorder that is characterized by the urge to move legs and other parts of the body. This movement is accompanied by discomfort in the leg(s) or body part(s) affected.

Physical examination

- Normal physical examination
- Essential features of restless leg syndrome:
  - Urge to move legs accompanied by discomfort or uncomfortable sensations
  - Urge to move or uncomfortable sensations begin and worsen during periods of inactivity
  - Stretching and movement improves the discomfort
  - Symptoms typically occur in the evening or only during night (Thorpy & National Heart, Lung, and Blood Institute Working Group on Restless Legs Syndrome, 2004)
- Supportive clinical features:
  - Periodic limb movements
  - Family history of restless leg syndrome
  - Response to dopaminergic therapy in adults (Thorpy & National Heart, Lung, and Blood Institute Working Group on Restless Legs Syndrome, 2004)
- Associated clinical features:
  - Clinical course has identifiable patterns
  - Sleep disturbance
Normal physical examination and diagnostic test workup (Thorpy & National Heart, Lung, and Blood Institute Working Group on Restless Legs Syndrome, 2004)

Diagnostic tests
- Diagnosis of exclusion; all results of all laboratory tests and the radiographic workup will be normal
- No specific laboratory studies confirm the diagnosis; a CBC, ESR, and CRP can be performed to rule out other etiologies
- Consider radiographs or a bone scan to exclude other etiologies of pain
- Sleep diary

Treatment
- No known cure exists for restless leg syndrome; the incidence in children is unknown, although it is believed that some children with attention deficit hyperactivity disorder and/or growing pains actually meet the diagnostic criteria for restless leg syndrome (Thorpy & National Heart, Lung, and Blood Institute Working Group on Restless Legs Syndrome, 2004)
- Treatment is aimed at reducing stress and helping the muscles relax, including warm baths, gentle stretching exercises, and massage
- Patients should be referred to a sleep disturbance subspecialist for further treatment (Armstrong et al., 2009; Ondo, 2009; Thorpy & National Heart, Lung, and Blood Institute Working Group on Restless Legs Syndrome, 2004; Walters, Picchietti, Ehrenberg, & Wagner, 1994)

CONCLUSION
Providers commonly see children and adolescents with lower extremity pain. Although some causes of the pain can be obvious, the diagnosis often can be challenging. The goal of the three-part practice guidelines is to help the provider make the correct diagnosis and implement the most appropriate treatment in a timely manner. Part I of the series provides an evidence-based guideline for evaluating the patient to elicit a diagnosis. Parts II and III of the guidelines include the definition, history and physical examination findings, recommended diagnostic tests, and treatment recommendations. Part II addresses traumatic, benign musculoskeletal, referred, developmental, non-painful, and neurologic etiologies that present with the symptoms of lower extremity pain. Part III will focus upon infectious, immune-mediated, acquired, neoplastic, and metabolic conditions that cause lower extremity pain. The overall intent of these guidelines is to offer providers a detailed, concise resource that can be used easily when these patients are seen in clinical practice.

REFERENCES