



## SELECTED ISSUES FOR THE ADOLESCENT ATHLETE AND THE TEAM PHYSICIAN: A CONSENSUS STATEMENT

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**Definition** Team physicians may be called upon to treat adolescent athletes, defined in this document as those in the 12–18 age range. Many are involved in school-based, intramural, or specialized sports participation and/or training, potentially resulting in injury and/or illness. Specialized treatments may be necessary due to growth and development of the adolescent. Additionally, psychological factors are important in this age group and may play an important role in sports participation, emotional well-being, and injury rehabilitation. While many

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children younger than 12 are active in sports, their medical and musculoskeletal concerns are not included in the scope of this consensus statement.

### Goal

The goal of this document is to help the team physician improve the care of the adolescent athlete by understanding the medical, musculoskeletal, and psychological factors common in this age group. To accomplish this goal, the team physician should have knowledge of and be involved with:

- Musculoskeletal injuries of the adolescent athlete, specifically those to the shoulder, knee, elbow, and spine
- Medical conditions of the adolescent athlete, especially those pertaining to infectious diseases, concussion, and nutrition and supplementation
- Psychological issues related to sports specialization and overtraining.

### Summary

This document provides an overview of selected medical issues that are important to team physicians who are responsible for the care and treatment of athletes. It is not intended as a standard of care, and should not be interpreted as such. This document is only a guide, and as such, is of a general nature, consistent with the reasonable, objective practice of the health care profession. Adequate insurance should be in place to help protect the physician, the athlete, and the sponsoring organization.

This statement was developed by a collaboration of six major professional associations concerned about clinical sports medicine issues; they have committed to forming an ongoing project-based alliance to bring together sports medicine organizations to best serve active people and athletes. The organizations are: American Academy of Family Physicians, American Academy of Orthopaedic Surgeons, American College of Sports Medicine, American Medical Society for Sports Medicine, American Orthopaedic Society for Sports Medicine, and the American Osteopathic Academy of Sports Medicine.

## Musculoskeletal Issues

### The Adolescent Athlete and Shoulder

#### Traumatic Anterior Shoulder Instability

##### Pathophysiology

- Stability of the shoulder joint is from static (ligaments) and dynamic (muscular control) factors.
- Traumatic instability results from direct or indirect injury to the shoulder resulting in a subluxation/dislocation event.
- These injuries in the adolescent athlete are associated with a high rate of recurrence.
- The injury causing instability is either ligament tearing from bone or capsular injury.
- Dynamic muscular control is often lost with this injury and can magnify the instability.
- Bony injury to the glenoid and/or the humeral head may increase the severity of instability.

##### Evaluation

- History
  - The mechanism of injury may be a direct blow to the arm or an indirect injury from falling on an outstretched arm.
  - Confirm the direction of subluxation/dislocation.
  - Previous subluxation/dislocation episodes.
  - Determine the method of reduction: spontaneous or the need for manual manipulation.
  - Determine the associated presence of symptoms and signs such as numbness and weakness.
- Physical Exam
  - Active range of motion and strength.
  - Provocative maneuvers for instability, such as apprehension and relocation.
  - Neurologic exam for axillary and musculocutaneous nerve injury.
- Imaging
  - X-rays in two planes for physal and other associated bony injuries.
  - MRI with or without intra-articular contrast is the procedure of choice to better define the injury, but the indication and timing is controversial.

##### Treatment

- Initial treatment is reduction and immobilization.
- Early reduction on the field is desirable for pain relief and ease of reduction.
- Duration of immobilization and positioning in internal or external rotation is controversial.
- Operative versus non operative issues:
  - Early operative intervention with first time dislocation may be indicated. Timing of repair is controversial (immediate or at end of season).
  - Return to play with non operative treatment requires resolution of pain, normal range of motion, and normal strength and strength balance, as well as resolution of neurological signs and symptoms.
  - Braces that limit range of motion and rehabilitation may be helpful in allowing return to play for certain athletes, although recurrent instability may occur.

##### Prevention

- There are no specific programs proven to decrease the risk of first-time traumatic dislocations.
- Rehabilitation or bracing has not been proven to prevent recurrent dislocations.

##### *It is essential the team physician:*

- Recognize the high incidence of recurrence after initial traumatic subluxation/dislocation.
- Perform a history and a physical exam which can diagnose traumatic instability and associated injuries.
- Understand return-to-play issues with first-time traumatic dislocations of the shoulder.
- Understand initial treatment of traumatic subluxation/dislocation.

##### *It is desirable the team physician:*

- Be familiar with and perform reduction at the venue.
- Understand associated injuries, such as bony Bankart and Hill-Sachs lesions, and nerve injuries that may affect outcome of treatment.
- Understand primary factors responsible for shoulder stability.
- Work with the athletic care network to educate athletes, parents, and coaches regarding:

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- Risk of recurrent dislocation and the advantages and disadvantages of operative treatment at the time of first dislocation
- Individual and sport-specific issues that may affect recurrent dislocation.

### Non Traumatic Shoulder Injuries

#### Pathophysiology

- Sport-specific demands contribute to pathophysiology. Baseball data has shown:
  - Excessive throwing, measured by number of pitches per game or pitches per season, results in higher injury rates.
  - Better pitchers throw a higher number of pitches and have higher injury rates.
  - Year-round participation without rest results in higher injury rates.
  - Specialty pitches such as curve balls and sliders may play a role.
- Musculoskeletal deficits in range of motion and strength balance occur early in intensively training adolescent athletes.
- This may result in biomechanical problems such as gleno-humeral internal rotation deficit (GIRD), glenohumeral joint hyperangulation, and scapular dyskinesis.<sup>1,9</sup>
- Epiphyseal changes may occur due to traction and rotational stresses.
- Alterations in these musculoskeletal and biomechanical factors may lead to a decline in performance or injury.
- Most injuries are the result of overuse and can be successfully treated with relative rest and rehabilitation.
- Other injuries such as labral tears, instability, and rotator cuff injuries may require surgical treatment.
- Other sports such as swimming, tennis, and volleyball have similar musculoskeletal and biomechanical issues, but injury risk has not been clearly documented.

#### Evaluation

- History
  - Document throwing history or other overhead activity to determine exposure and possibility of overuse.
  - When in the overhead motion and where in the shoulder does pain occur.
  - Performance issues such as velocity, control, stamina, and change in mechanics.

- Physical Exam
  - Range of motion specifically internal and external rotation.
  - Exam for labral and rotator cuff pathology.
  - Exam for scapular motion and position.
  - Kinetic chain factors related to core stability and flexibility.<sup>9</sup>

#### Imaging

- X-rays in two planes to evaluate physcal changes of widening and fragmentation.
- MRI with intra-articular contrast for labral and rotator cuff injuries, if indicated.

#### Treatment

- Modification of sport-specific demands through relative rest and decreased participation.
- Address biomechanical and musculoskeletal deficits through rehabilitation and conditioning.
- Repair of labral and rotator cuff injuries that do not respond to rehabilitation and activity modification.
- NSAIDs may be used for short-term analgesic purposes; these medications are not recommended to substitute for activity modification, training, or rehabilitation.

#### Prevention

- Decreasing exposure to overuse and preservation of musculoskeletal and biomechanical factors has been shown to be the best preventative program.<sup>9</sup>
- Work with the athletic care network to educate athletes, parents, and coaches regarding overuse and overexposure.

#### *It is essential the team physician:*

- Conduct a history and physical exam for the injured athlete.
- Understand that these injuries are most often a process of overuse rather than an acute injury event.

#### *It is desirable the team physician:*

- Understand that the demands of throwing or other overhead activity and multiple musculoskeletal and biomechanical factors can contribute to decline in performance or injury.
- Understand pitch counts for individual age groups as a preventive measure.

- Understand rehabilitation, rest from overhead activity, maintaining range of motion (ROM), scapular control, and strength are the mainstays of treatment.
- Understand that labral lesions exist in this age group and should be considered.
- Work with the athletic care network to educate athletes, parents, and coaches regarding overuse and overexposure.

### The Adolescent Thrower's Elbow

#### Pathophysiology

- Valgus loads with rapid elbow extension produces:
  - Tensile stress along the medial compartment restraints.
  - Shear stress in the posterior compartment.
  - Compression stress on lateral structures.
- These loads can come from overuse, poor kinetic chain mechanics, weak shoulder or arm muscles, and a large number of pitches.

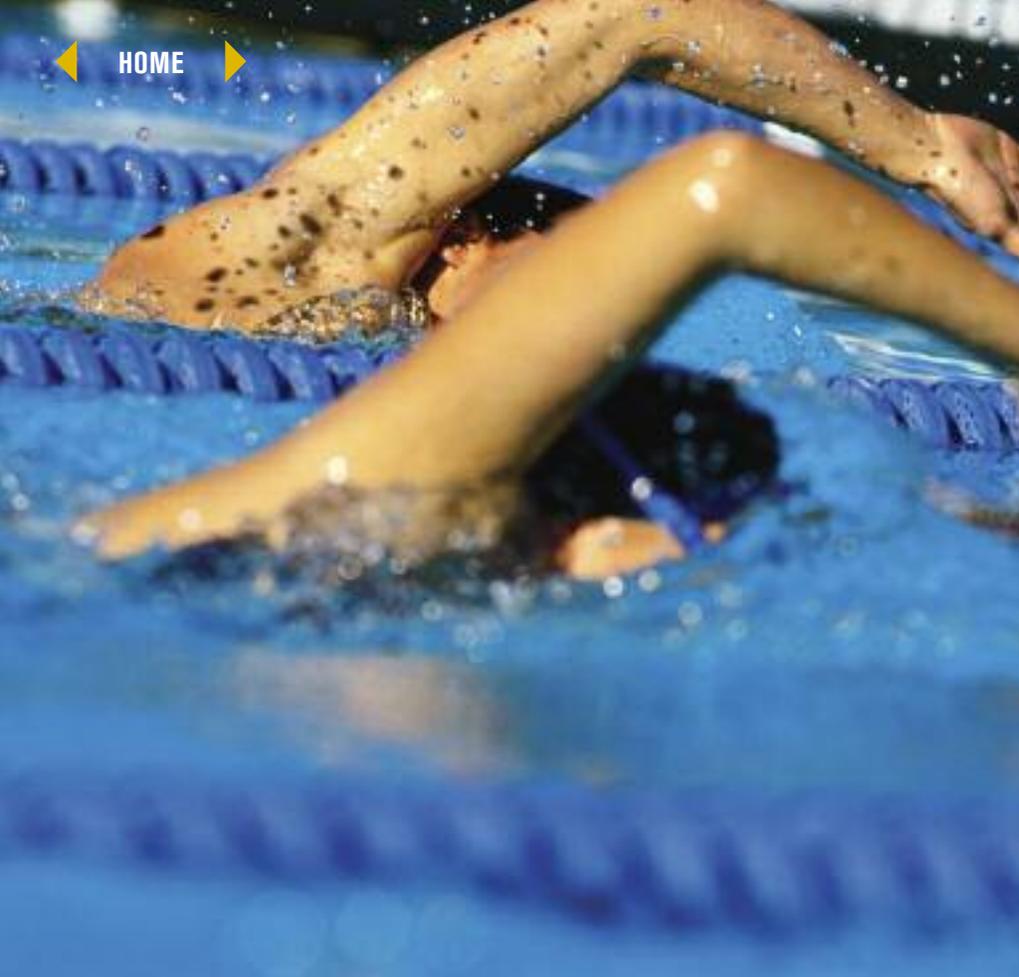
#### Evaluation

- History
  - Determine acute versus chronic injury, location of pain, mechanical symptoms, and decline in performance.
  - Identify injuries in the kinetic chain.
  - Measure excessive throwing by number of pitches per game or pitches per season.
- Physical exam
  - Perform elbow examination to include areas of tenderness, ROM, valgus stress testing, manual muscle testing, and ulnar nerve testing.
  - Evaluate kinetic chain to include core stability, scapular motion and position, and GIRD.
- Imaging
  - X-rays in two planes and consider comparison views with open growth plates.
  - MRI with intra-articular contrast is useful to better define injury, including ligamentous and osseous injuries, and articular cartilage lesions.

#### Treatment

- Most injuries are the result of overuse and can be successfully treated with relative rest, rehabilitation, and modification of throwing demands.<sup>4</sup>

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- Medial epicondylar avulsions need urgent evaluation for surgery.
- Elbow injuries that need evaluation for surgery may include ulnar collateral ligament injury unresponsive to conservative treatment or osteochondritis dissecans (OCD) lesions with mechanical symptoms.

#### Prevention

- Decreasing exposure to overuse and preservation of musculoskeletal and biomechanical factors has been shown to be the best preventative program.<sup>9</sup>
- Enforcement of pitch counts per game and per season, and limitation of specialty pitches in skeletally immature athletes.<sup>9</sup>
- Work with the athletic care network to educate athletes, parents, and coaches regarding overuse and overexposure.

#### *It is essential the team physician:*

- Conduct a history and physical exam.
- Understand that the demands of throwing can contribute to injuries to the elbow and rest from pitching is a mainstay of treatment.
- Identify medial epicondylar avulsions.

#### *It is desirable the team physician:*

- Understand pitch counts for individual age groups as a preventive measure and emphasize enforcement of pitch counts and limitations of specialty pitches.<sup>9</sup>
- Understand that multiple factors can create the injuries and musculoskeletal and biomechanical alterations that lead to elbow injury.
- Understand rehabilitation and maintaining ROM, scapular control, and strength are also main treatment strategies.
- Work with the athletic care network to educate athletes, parents, and coaches regarding overuse and overexposure.

### The Adolescent Athlete's Knee

#### Patellofemoral Pain and Instability

##### Pathophysiology

- Multiple musculoskeletal, biomechanical, and psychological factors are associated with patellofemoral pain; the exact source of the pain is often unknown.
- The six major structural sources of patellofemoral symptoms are subchondral bone, synovium, retinaculum, nerve, muscle, and skin.

- Articular cartilage damage is rarely a source of patellofemoral symptoms.
- The most common causes of patellofemoral symptoms are overuse, patellofemoral malalignment, muscle weakness or imbalance, and trauma.
- These symptoms are more frequently reported in female patients.
- Traumatic instability may occur from an injury to the otherwise normal knee.
- Atraumatic instability is associated with knee and patellar malalignment and/or abnormality of the extensor mechanism.

#### Evaluation

- History
  - Determine if there was a specific injury.
  - Establish if there is any instability associated with the symptoms.
  - Determine location and characterization of the pain (vague versus well localized, intermittent or constant, deep or superficial).
  - Recognize hip conditions may present as knee pain (e.g., slipped capital femoral epiphysis).
  - Determine if a history of prior lower-limb injury exists.
  - Determine the presence of systemic signs and symptoms.
  - Consider psychosocial factors (e.g., parental/coaching pressure, depression, anxiety, abuse).
- Physical Exam
  - Perform an examination of the knee to include patellar tracking and stability.
  - Examine the hip for strength, flexibility, and ROM.
  - Evaluate for musculoskeletal and biomechanical alterations (e.g., lower-extremity alignment, gait, muscle strength, balance, and ligamentous laxity).<sup>5,9</sup>
- Imaging
  - Standard four view X-rays: weight-bearing AP and tunnel; lateral with knee in extension; axial patellar view at 30° or 45° of knee flexion (merchant, sunrise).
  - Additional imaging studies may be useful in selected patients (radionuclide scan, CT, MRI).

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#### Treatment

- Rehabilitation remains the primary treatment for non traumatic patellofemoral symptoms.<sup>9</sup>
  - The major components include: vastus medialis obliquus muscle strengthening, stretching the lateral retinaculum and quadriceps, and kinetic chain balancing.
- Additional treatments may include orthotic devices, taping, and bracing.
- Surgery for patellofemoral pain and instability is not indicated unless specific lesions are identified and need to be addressed.
- Psychosocial factors should be addressed.

#### Prevention

- Implement sport/activity conditioning program with periodization,<sup>9</sup> emphasizing the proven interventions of quadriceps, strengthening, and increasing hamstring flexibility.
- Other interventions may include core and lower-extremity strengthening, hip abductor and external rotator strengthening, and improving motor control.

#### *It is essential the team physician:*

- Conducts a history and physical exam for the injured athlete.
- Differentiates between traumatic and non traumatic causes of patellofemoral pain and instability.
- Understands that rehabilitation is the primary focus of treatment.

#### *It is desirable the team physician:*

- Understands musculoskeletal and biomechanical factors create patellofemoral symptoms.
- Understands patellofemoral anatomy and biomechanics.
- Understands the role of psychosocial factors in the development and management of patellofemoral pain.
- Works with the athletic care network to educate athletes, parents, and coaches regarding the development and management of patellofemoral pain and instability.

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## Anterior Cruciate Ligament (ACL)

### Pathophysiology

- The mechanism of ACL injury in the skeletally immature is the same as in adults, with most being non contact.
- Females have a higher incidence of non contact ACL injury than their male counterparts.
- ACL injuries in this population may be tibial spine bony avulsions, as well as ligament tears.
- ACL injury has been reported in up to 65 percent of children with acute hemarthrosis.
- The presence of open growth plates requires special attention in determining ACL injury treatment.

### Evaluation

- History
  - Establish the mechanism of injury. Classical presentation is a sudden deceleration or twisting injury with a “pop,” immediate swelling, and inability to continue playing.
- Physical Exam
  - A positive Lachman test is sufficient to make the diagnosis.
  - Evaluate for other associated injuries, including ligamentous injury, patellofemoral instability, and meniscal injury.
- Imaging
  - Standard four view X-rays: weight-bearing AP and tunnel; lateral with knee in extension; axial patellar view at 30° or 45° of knee flexion (merchant, sunrise).
  - MRI is helpful in determining the extent of the ligamentous injury, as well as associated injuries such as meniscal tears and chondral lesions.

### Treatment

- Initial treatment involves ice, compression, and restoration of ROM, especially extension (not immobilization), and protected weight bearing.
- Tibial spine ACL avulsions need urgent evaluation for surgery.
- Concern exists regarding surgical management of intra-substance ACL injuries in adolescents with open growth plates.
- Non operative management has shown poor results as activity modification

in adolescents is difficult and bracing provides little or no protection.

- Postoperative rehabilitation and return-to-play criteria are the same as adults.

### Prevention

- Implement a sport-specific conditioning program with periodization<sup>3,4</sup> including these elements that have been shown to have efficacy in specific populations:
  - Motor control, including core and lower extremity strength, balance, and flexibility.
  - Technique training to include landing and sport-specific athletic skills programs.
  - Risk awareness education.
  - Proper care of playing surfaces and selection of shoe wear.
- Prophylactic bracing has not been shown to reduce ACL injury risk.

### *It is essential the team physician:*

- Understand the classic history and mechanism of ACL injury.
- Perform a Lachman test.
- Understand the poor prognosis of the ACL deficient knee, especially in the adolescent.
- Identify tibial spine ACL avulsions.

### *It is desirable the team physician:*

- Recognize risk of non contact ACL injury in adolescent female athletes, and implement risk reduction strategies through the athletic care network.
- Understand that current surgical procedures allow for reconstruction in the skeletally immature athlete.
- Understand the associated injuries that may accompany or result from ACL instability.

## Osteochondritis Dissecans (OCD)

### Pathophysiology

- OCD is an acquired, potentially reversible idiopathic lesion of subchondral bone resulting in delamination and sequestration with or without articular cartilage involvement and instability.
- Skeletally immature athletes with an OCD lesion and an intact articular surface have a potential for healing through cessation of repetitive impact loading.
- Skeletally mature athletes with an OCD lesion have a poorer prognosis.

- The presence of mechanical symptoms such as locking or catching may indicate unstable osteochondral fragments.

### Evaluation

- History
  - Presentation is generally non specific and includes poorly localized knee pain.
  - Establish the presence of mechanical symptoms.
- Physical Exam
  - There are no specific physical examination findings for OCD, although pain may be elicited with flexion, extension, internal and external rotation, and areas of tenderness may be palpated.
  - Observe for an antalgic gait.
- Imaging
  - Standard four view X-rays: weight-bearing AP and tunnel; lateral with knee in extension; axial patellar view at 30° or 45° of knee flexion (merchant, sunrise).
  - MRI provides useful information, including lesion size and stability, status of articular cartilage, and subchondral bone.

### Treatment

- Prognostic factors guide treatment and include status of the growth plate, articular cartilage and subchondral bone, and lesion size, location, and stability.
- Outcome of symptomatic OCD with stable lesions and open growth plates is favorable with rest from offending activities.
- Surgery should be considered in skeletally immature patients with unstable lesions and in those patients approaching growth plate closure whose symptoms persist despite non operative management.

### *It is essential the team physician:*

- Be able to diagnose OCD.

### *It is desirable the team physician:*

- Understands the natural history and prognostic factors of OCD in the knee.
- Understands non operative and operative treatments of OCD.
- Works with the athletic care network to educate athletes, parents, and coaches regarding OCD.

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## The Adolescent Athlete's Spine

### General Considerations

- Significantly higher rates of low back pain in athletes than in non athletes.
- Significantly higher rates of structural abnormalities on imaging studies (e.g., disc degeneration, Schmorl's nodes, and apophyseal injuries) in athletes than in non athletes.
  - Athletes have a higher incidence of spondylolysis of 8 to 14 percent, as compared to 4.4 to 5.2 percent in the general population. Incidence may be much higher in specific sports.
- Follow-up studies do not show any significant increased risk for low back pain in adulthood.
- A specific diagnosis in cases of low back pain is usually present. Etiologies to consider include musculoskeletal, infection, neoplasm, inflammatory conditions, and developmental disorders. There may be an association between depression and/or other emotional problems and low back pain in adolescents.
- Every evaluation should include a history, noting psychosocial factors and family history of spinal disorders, along with a physical examination with neurological assessment.
- There are no known primary prevention strategies, including all conditions profiled below.

### Spondylolysis/Spondylolisthesis

#### Epidemiology/Pathophysiology

- Spondylolysis is the most frequent diagnosis made in adolescent athletes presenting to a sports medicine clinic with low back pain.
- The pars interarticularis lesion is felt to represent a fatigue fracture; the great majority occurs at the L5 level.
- Sports that involve frequent flexion/extension motions combined with rotation are associated with the highest frequency of spondylolysis (e.g., gymnastics, weightlifting, football, diving), but can occur in any sport.
- The progression from spondylolysis to spondylolisthesis is uncommon, even with continuation of sporting activity. If progression occurs, it is often during the adolescent growth spurt and typically occurs without symptoms.



#### Evaluation

- Presents with axial low back pain of acute or more insidious onset.
- Pain is worsened by activity and better with rest and may have been present for several months.
- There are no pathognomonic findings on physical examination, including extension.
- Imaging
  - Spondylolysis is a radiographic diagnosis.
  - Standing AP and lateral X-rays of the lumbar spine can demonstrate spondylolysis/listhesis; oblique views do not improve diagnostic accuracy and increases radiation exposure.
  - Bone/SPECT scan assesses metabolic activity of fractures seen on X-ray or occult fractures.
  - CT can provide information as to the likelihood of bony healing in metabolically active lesions.
  - MRI is not as sensitive as bone scan/SPECT combined with CT for diagnosis of early or incomplete pars fractures.

#### Treatment

- No randomized controlled trials have been performed to establish best treatment practices.
- After diagnosis, a period of activity modification is recommended.
- Bracing is controversial. Regardless of bracing, outcome studies have similar results regarding return to play and bony healing.
- Most symptomatic spondylolysis improves nonoperatively with or without radi-

ographic evidence of bony healing. Bony healing is a reasonable goal if incomplete or nonsclerotic fractures are present.

- Surgical intervention is considered for a slip of 50 percent or more, progressive spondylolisthesis, or spondylolysis/listhesis with intractable axial pain.

#### Prevention

- Limiting volume and intensity of training and participation in sports that involve frequent flexion, extension, and rotation motions, and early attention to lumbar spine pain in adolescent athletes may be beneficial.

### Lumbar Disc Herniations

#### Epidemiology/Pathophysiology

- Disc herniations are uncommon in adolescents; most occur at L4-5 and L5-S1.
- Most herniated discs in adolescents are central rather than posterolateral and radiculopathy is not as common as in adults.
- Radicular symptoms or radiculopathy are more common with large disc herniations and/or disc herniations in conjunction with congenital spinal stenosis.

#### Evaluation

- There are no pathognomonic signs and symptoms for disc herniation in adolescents. Central disc protrusions can present with band-like low back discomfort, worse with flexion and sitting, but can also be painful with extension.
- MRI examination is the imaging test of choice for diagnosing disc herniation. The findings on MRI examination should correlate with physical examination findings.

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### Treatment

- Almost all disc herniations in adolescent athletes are managed nonoperatively. The natural history of disc herniation is favorable.
- Treatment options include manual therapy, modalities, exercise therapy, and medications. There is limited evidence of effectiveness of these interventions.
- Fluoroscopically-guided epidural steroid injections can be considered as adjunctive care for disc herniations with radicular pain. In this population they should be used sparingly.
- Surgery is indicated for cauda equina syndrome, severe persistent radicular pain, significant spinal stenosis, and/or significant or progressive radiculopathy.

### Prevention

- Training and rehabilitation strategies addressing general conditioning and fitness, as well as core fitness may improve performance and may have value in recovering from spinal problems, including disc herniation.

### Scheuermann's Kyphosis

#### Epidemiology/Pathophysiology

- Scheuermann's Kyphosis is a deformity of the spine that develops before puberty and progresses and typically presents in adolescence. It is a radiographic diagnosis.
- The etiology has not been determined.
- It may be more frequent in males and there may be some correlation with increasing height.
- A radiographic definition is anterior wedging of at least 5° in three adjacent vertebrae, endplate irregularities, disc space narrowing, and the presence of Schmorl's nodes. These findings can affect the thoracic and/or thoracolumbar spine.

#### Evaluation

- Evaluate for thoracolumbar pain, fatigue, postural complaints, and deformity.
- Examine for increased kyphosis, lumbar hyperlordosis, and forward head position. The kyphosis is rigid.
- Advanced imaging is usually not indicated, as neurologic symptoms or signs are rare.

### Treatment

- The natural history is not well understood, and symptoms often diminish at the time of skeletal maturity.
- Sports participation is permitted as tolerated.
- Treatment is dependent upon the extent of symptoms and the degree of kyphosis.
  - For curves less than 50°, relative rest, judicious use of anti-inflammatory medications, and flexibility and posture exercises may be helpful.
  - For curves of 50° to 75°, bracing should be considered.
  - For curves greater than 75°, surgical consultation should be considered, as bracing may not be effective.

#### *It is essential the team physician:*

- Understands back pain is usually associated with a specific cause.
- Understands there are few pathognomonic signs that point to an exact diagnosis.
- Recognizes spondylolysis as the most frequent cause of back pain in the adolescent seeking treatment.

#### *It is desirable the team physician:*

- Understands the indications for and utilizations of radiologic imaging.
- Recognizes back pain can have physical and psychological components.
- Employs a treatment plan for treating spondylolysis.
- Works with the athletic care network to educate athletes, parents, and coaches regarding back pain, treatment, and management.

## Medical Issues

### The Adolescent Athlete and Infectious Diseases

#### Infectious Mononucleosis (IM)

##### Pathophysiology/Clinical Presentation

- IM is primarily caused by the Epstein-Barr Virus (EBV).
- Transmission is primarily through saliva and can occur through shedding of the virus by asymptomatic hosts.
- Classic triad of symptoms (70–80 percent of patients) is sore throat, lymphadenopathy (especially posterior cervical), and fever.
  - Exudative tonsillitis is the most common sign (more than 50 percent of patients).

- Other symptoms may include fatigue, headache, malaise, myalgia, and anorexia.
- Streptococcal pharyngitis can coexist and evaluation is necessary as treatment is different.
- Splenomegaly is almost universal, and the physical examination is unreliable in its detection.

#### Evaluation

- A complete blood count demonstrates an absolute and relative lymphocytosis with a high percentage of atypical lymphocytes.
- Confirmation is based on serologic testing for non specific heterophile antibodies (Monospot®) with a high false negative rate in the first week of the illness.
- A small minority of patients will never develop a seropositivity for heterophile antibodies.
- EBV-specific antibody testing should be considered in certain patients.
- In most cases, the assessment of splenomegaly by ultrasound is unnecessary, though if done serial measurements should be considered.

#### Treatment

- IM is generally a self-limited disease which is managed conservatively.
- Systemic corticosteroid use is controversial and without proven benefit unless treating tonsillar hypertrophy complications such as airway compromise.
- Antiviral therapy has not been shown to diminish severity or duration of symptoms.
- Coexisting streptococcal infection is treated with agents other than amoxicillin. A rash is commonly seen when amoxicillin is used in the presence of IM.
- Tonsillar hypertrophy or abscess may result in acute airway obstruction and/or dehydration.
- Hematologic complications include autoimmune hemolytic anemia and/or thrombocytopenia.
- Spontaneous and traumatic splenic rupture can occur in 0.1–0.5 percent of patients.
- Although ultrasound and computed tomography are more reliable in evaluating spleen size than physical examination, without baseline and serial measurements their role in management and RTP is limited.

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## Prevention

- Oropharyngeal secretions contain EBV and transmission can be decreased by avoiding contact, such as sharing food, water bottles, and kissing.
- Prevention of complications related to splenic rupture:
  - While splenic rupture may occur with trauma, most are atraumatic.
  - There is a lack of evidence-based return to play guidelines.
  - Once clinical symptoms have resolved, gradual return to activity after three weeks post-illness onset is reasonable while avoiding contact/collision sports until four weeks post-illness onset.

*It is essential the team physician understand:*

- The diagnosis of IM is based on clinical presentation and serological confirmation.
- Presentation is variable, including prolonged fatigue which may affect ability to return to sport and competition.
- In almost all cases of IM, splenomegaly is present.
- Once clinical symptoms have resolved, gradual return to activity after three weeks post-illness onset is reasonable while avoiding contact/collision sports until four weeks post-illness onset.

*It is desirable the team physician:*

- Understands specific complications may include splenic rupture (rare), tonsillar hypertrophy leading to airway obstruction and dehydration, and hemolytic anemia.
- Works with the athletic care network to educate athletes, parents, and coaches regarding IM management and treatment.

**Other Infectious Diseases:  
MRSA, Herpes Gladiatorum****Methicillin Resistant Staphylococcus Aureus (MRSA)**

## Pathophysiology/Clinical Presentation

- MRSA is a resistant variation of the common bacteria that does not respond to the traditional penicillin-based antibiotic.
- No longer limited to hospitalized patients, MRSA is commonly seen in the community, including athletic settings.
- Many individuals are asymptomatic and colonized with staphylococcus aureus, including MRSA.

- Both staphylococcus aureus and MRSA infections present as pustules, abscess or cellulitis; 75 percent are localized to skin and soft tissue.
- MRSA infections may mimic a “spider bite.”
- More virulent strains of staphylococcus, including MRSA causes osteomyelitis, sepsis, toxic shock syndrome, and necrotizing pneumonia.

## Evaluation

- Evaluate size, depth, and extent of lesion(s).
- Determine evidence of systemic infection.

## Treatment

- Incision and drainage should be performed and provides adequate treatment in some cases of superficial infection.
- Cultures should be obtained to help direct specific antibiotic treatment.
- Antibiotic treatment
  - Initial empiric antibiotic treatment is based on community prevalence.
  - More definitive therapy is defined by sensitivities.
  - Topical [mupirocin (Bactroban®)] treatment is controversial.
- Fluoroquinolones should not be used.
  - Patients receiving fluoroquinolones are more likely to develop increased resistance.
  - Possible effect of fluoroquinolones on growth plates and tendons is also a contraindication for use in adolescent athletes.
- Individuals with active lesions (new, moist, weeping) should not be allowed to participate, as these are considered contagious.
- Once a lesion is not considered contagious, it should be covered.
- Evidence clearly defining contagiousness precautions is lacking and specific guidelines are variable. The CDC recommends a minimum of three days of oral antibiotic therapy prior to return to play for sports involving skin-to-skin contact for all staphylococcus infections, including MRSA.
- Some staphylococcus infections are more severe and invasive, which would warrant more urgent definitive treatment, including infectious disease consultation.

## Prevention

- Encourage good hygiene practices, including showering and washing with soap and hot water after all practices and competitions.
- Discourage sharing of towels, personal items, and equipment.
- Discourage body shaving.
- Routine cleaning of shared equipment and surfaces with a standard hospital disinfectant.
- Decolonization of asymptomatic carriers and teammates of the infected individual is controversial.
- Work with the athletic care network to recognize lesions and seek early evaluation.

**Herpes Gladiatorum (HG)**

## Pathophysiology/Clinical Presentation

- Extremely contagious, especially with primary infections, caused by herpes simplex virus (HSV-1)
- Prevalence in wrestling teams of up to 29 percent
- Transmission occurs by skin-to-skin contact.
- Incubation period is within two weeks (8 day average).
- Clinical presentation includes vesicles on an erythematous base.
- Risk of recurrence includes re-exposure, autoinoculation, reactivation secondary to triggers such as fatigue, stress, poor nutrition, and coexisting infection.

## Evaluation

- Recognize characteristic skin lesions.
- Order further tests if diagnosis is unclear.
  - Test of choice is viral isolation in tissue culture.
  - Blood test for presence of antibodies to HSV-1.

## Treatment

- Prescribe oral anti-viral therapy if seen within the first 48 hours of any lesion.
- For primary (first episode) HG, athletes with skin-to-skin exposure should be treated and not allowed to compete for a minimum of 10 days.

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#### Prevention

- Daily skin checks
- Consider prophylactic treatment for wrestlers with a history of herpes, or if an outbreak has occurred among teammates, daily dosing of an antiviral agent throughout the season.
- Do not allow athletes with active lesions to participate.
- Avoid practice/competition (contact) during widespread outbreaks.

#### *It is essential the team physician:*

- Recognizes signs, symptoms, and community prevalence of MRSA in order to provide appropriate treatment.
- Recognizes HG in order to provide appropriate treatment and precautions to decrease spread of infection.
- Knows the rules of sports governing bodies with regard to these infectious diseases.

#### *It is desirable the team physician:*

- Understands prevention measures as it pertains to MRSA and herpes for contact sports.

- Implements cleaning procedures for wrestling mats and other surfaces to help prevent staphylococcus, including MRSA. While HG is not primarily prevented by this method, there are other infections that may be prevented.
- Works with the athletic care network to educate athletes, parents, and coaches regarding prevention of infectious disease in sport.

#### **The Adolescent Athlete and Asthma**

##### Epidemiology

- Asthma is a chronic inflammatory disease of the airways.
- For some patients, the only trigger is exercise.
- Ninety percent of subjects with a previous diagnosis of asthma will experience exercise-induced asthma (EIA).
- EIA is more prevalent in endurance and winter sport athletes, but can occur in any sport.

##### Pathophysiology

- Multi-factorial
  - Dry air causes histamine release and bronchoconstriction.
  - Cold air causes hyperemia and airway edema.
  - Inflammation.
- Triggers include URI, NSAIDs, hyperventilation, cold air, pollens/allergens, and pollutants (e.g., bromine/chlorine vapors in swimming pools, vehicle exhaust).

##### Evaluation

- Evaluate for symptoms of cough, chest tightness, and/or exertional dyspnea with cough more likely to occur after exercise.
- Determine history or family history of asthma, seasonal allergies, or atopic dermatitis, which makes EIA more likely.
- Physical exam is usually normal between episodes. During episodes, expiratory wheezing may be auscultated.
- Self-reported symptoms (and lack of symptoms) are poor predictors of EIA.

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- Bronchoprovocation testing should be performed to establish the diagnosis.
- Vocal cord dysfunction may mimic EIA, and must be distinguished.
  - Symptoms include shortness of breath with exercise, difficulty with inspiration, noisy breathing (stridor).

**Treatment**

- Beta-agonists are the rescue medication of choice for symptomatic patients, and are used prophylactically prior to exercise.
  - Short acting beta agonists given 15–30 minutes prior to exercise protect from EIA symptoms for at least 3 hours.
  - Long acting beta agonists are effective with longer onset of action.
  - Overuse of either short-acting or long-acting beta-agonists may make these medications less effective (tachyphylaxis).
- Medications to treat airway inflammation include inhaled corticosteroids, mast cell stabilizers and leukotriene antagonists.
- Adequate warm-up may induce a refractory period in some athletes preventing symptoms for approximately 2–3 hours independent of medication use.
- For the elite adolescent athlete, the U.S. Anti-Doping Agency (USADA) and the specific sport governing bodies have strict rules regarding the use of asthma medications.

**Prevention**

- Prophylactic asthma medication use.
- Reduce environmental triggers, including allergy treatment.
- Warming inspired air (e.g., face-mask, nose breathing).
- Induce refractory period with adequate warm-up.

*It is essential the team physician:*

- Recognizes EIA and be prepared to treat asthmatic emergencies on the sideline.<sup>2</sup>

*It is desirable the team physician:*

- Manages EIA.
- Understands the utility of bronchoprovocation testing.
- Understands restricted medications for elite athletes.

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- Recognizes vocal cord dysfunction and be able to educate the athlete as to this condition and treatment recommendations.
- Works with the athletic care network including athletes, parents, and coaches on recognition and management of EIA.

## The Adolescent Athlete and Nutrition and Supplements

### Weight Loss

#### Patient Populations

- The obese adolescent (body mass index greater than 95th percentile)
  - Prevalence of obesity stands at approximately 15–20 percent for 12–18 year olds.
  - Complications of obesity include hypertension, insulin resistance, type 2 diabetes, hypercholesterolemia, orthopedic problems (e.g., Slipped Capital Femoral Epiphysis, Blount's disease).
  - Multi-factorial etiology (e.g., sedentary lifestyle, poor nutrition, genetics, psychosocial factors).
- Adolescents in weight-restricted sports: wrestling, light-weight rowing.
- Adolescents in sports favoring leanness: gymnastics, figure skating, distance runners.

#### Evaluation

- Review dietary intake and training program
- Obese athletes:
  - Determine body mass index (BMI) and body composition.
  - Evaluate for medical causes (e.g., polycystic ovary syndrome, hypothyroidism, genetic syndromes).
  - Evaluate for medical (e.g., insulin resistance, cholesterol abnormalities and liver disease) and orthopedic (e.g., Blount's disease, SCFE) complications.
- Athletes in weight-restricted sports should have measurement of percent body fat and hydration status.
  - In wrestling, males must be at least 7 percent body fat; 12 percent for females.
- Athletes in sports favoring leanness should be screened for the Female Athlete Triad.<sup>5</sup>

### Treatment

- Determine if weight loss is needed and/or appropriate.
- Set a goal for weight loss; athletes should lose no more than 1.5 percent of their body weight per week.
- Provide individualized nutrition and exercise recommendations.
- Counsel against weight-loss medication use (e.g., stimulants, laxatives, diuretics), excessive fluid/food restrictions, purging, vapor impermeable suits, and other pathogenic weight-control behaviors.
- For the obese athlete, provide behavioral and family counseling, as needed.
- For the female athlete at-risk of developing the Triad, consider multi-disciplinary intervention.<sup>5</sup>

### Prevention

- Monitor BMI to aid in primary and secondary prevention strategies.
- Primary prevention of obesity should be initiated in early childhood.
- See selected reading five for additional considerations regarding weight loss issues specific to female athletes.
- Work with the athletic care network to educate athletes, parents, and coaches regarding weight loss issues at the time of the pre-participation physical examination (PPE) and during other visits.

### Weight Gain

#### Patient Populations

- Adolescents who desire weight gain related to strength and performance.
- Adolescents who desire weight gain related to appearance and body image.

#### Evaluation

- Review dietary intake and training program.
- Determine BMI and body composition.
- Screen by history for performance-enhancing agent use.
- Assess reasons for desiring weight gain (i.e., performance versus body image).

### Treatment

- Determine if weight gain is needed and/or appropriate.
- Set a goal for weight gain; athletes should gain no more than 1.5 percent of their body weight per week.

- Provide individualized nutrition and exercise recommendations.
- Counsel regarding weight gain medication and supplements.

### Prevention

- Monitor BMI and body composition.
- Work with the athletic care network to educate athletes, parents, and coaches regarding weight gain issues at the time of the PPE and during other visits.

### Supplements

#### Epidemiology

- Prevalence in adolescent athletes
  - Ergogenic supplement use is estimated at 24–29 percent, and is higher in athletes than non athletes.
  - Common supplements used in this age group include protein powders, creatine, and caffeine and other stimulants.
  - Rate of creatine use significantly increases between 9th and 12th grade.
  - Over half of all anabolic steroid use begins in high school.
  - Athletes who report legal supplement use are significantly more likely to report anabolic steroid use.
  - The most common sources of information regarding supplement use are friends and coaches.
- Iron supplementation may be considered for athletes at risk of iron deficiency, including females, vegetarians, and endurance athletes.

#### Evaluation

- Inquire about use of supplements during pre-participation physical examination (PPE) and other opportunities.
  - Higher risk if adolescent is using other illicit substances (e.g., alcohol, marijuana).
  - Develop a strategy to discuss supplement use, including questions about sports participation and performance, body image, and peer pressure, building from indirect to direct questioning.
- Screen for iron deficiency in at-risk athletes.

### Treatment

- No evidence supports nutritional supplement use for performance enhancement in adolescent athletes.

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- Provide alternatives for performance-enhancement, including nutrition, training and sports psychology techniques.<sup>2,8</sup>
- Counsel regarding the risks of supplements and performance-enhancing substances.
- Create awareness about banned and illegal supplements.
- Discuss issues related to fair play and ethics.
- Prescribe iron supplementation for iron-deficient athletes.
- Work with the athletic care network to educate athletes, parents, and coaches regarding supplement use at the time of the PPE and during other visits.

#### Prevention

- Consider prophylactic iron supplementation in at-risk female athletes.
- Counseling on the risk of supplement use should be initiated early in sports involvement.
- Work with the athletic care network to educate athletes, parents, and coaches regarding supplement use at the time of the PPE and during other visits.

#### *It is essential the team physician:*

- Identifies the obese athlete and makes recommendations related to nutrition and exercise.
- Understands that rapid weight loss has significant adverse consequences that may affect competitive performance, physical health, and normal growth and development.
- Is aware of the Female Athlete Triad.<sup>5</sup>

#### *It is desirable the team physician:*

- Emphasizes health and performance over weight loss and gain.
- Counsels the athlete regarding the risks of supplements and performance-enhancing substances.
- Makes nutrition recommendations and guidance related to strength training for the athlete who desires strength and weight gains.
- Makes recommendations related to minimum weight, nutrition and exercise for weight-restricted sports.
- Understands minimum weight recommendations related to weight-restricted sports.



- Understands the impact of pathogenic weight behaviors on normal growth and development.
- Understands the impact on the timing of weigh-ins on excessive weight behaviors.

### **The Adolescent Athlete and Overtraining/Sports Specialization**

Overtraining and sport specialization is a frequently discussed topic in the adolescent. The amount of published data is limited and a complete discussion is beyond the scope of this paper. For the team physician, the following discussion points are included:

- There has been an increase in the number of surgical procedures and complex medical problems seen in the adolescent athlete throughout the past decade.
- Many overuse injuries can be related to an excessive increase in the intensity, volume, or frequency of practice and game participation in the adolescent.
- Adolescent athletes have the same risks for overtraining as their mature counterparts, but may not be as able to recognize when they are doing too much.
- Specific limits for number of pitches per game, games per season, and pitch types are recommended for youth baseball (USA Baseball).
- Specific limits for the amount of activity in other sports are unknown.
- Participating in multiple sports, multiple teams, and early sports specialization with year-round activities contributes to the risk of sustaining overuse injuries.
- Rest and recovery are important in preventing overuse injury. Recommendations to consider are taking off one month out of every six, or two months out of every 12. Cross-training and participating in different sports or activities should be considered.

- The effect of an increase in volume, intensity, and frequency of training and competition on the mental health of the adolescent is unclear.
- Review of training logs can be useful in evaluation for overtraining.

#### *It is essential the team physician understands:*

- The potential effects of overtraining on the adolescent athlete.
- The differences between adolescent athletes and their mature counterparts as it relates to overtraining.

#### *It is desirable the team physician:*

- Understands the role of rest and recovery in preventing overuse injury.
- Understands the role of psychological stressors as a response to injury (reference TPCC), even though all the mental health issues remain unclear.
- Educates athletes, parents, and coaches regarding the importance of appropriate rest and recovery.
- Knows the limits set forth for pitching in youth baseball.

### **Concussion in the Adolescent Athlete**

This section will highlight issues unique to the adolescent athlete. For additional information and details related to concussion, please refer to selected reading seven.

#### Epidemiology

- Concussion/mild traumatic brain injury (mTBI) can be defined as a brief and usually short lived neurological impairment which occurs after a direct or indirect blow to the head or body. The impairment is often immediate, and symptoms typically resolve spontaneously. Acute clinical symptoms represent a functional disturbance rather than structural injury, and as such

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neuroimaging studies are typically normal. The clinical symptoms that occur may or may not include loss of consciousness (LOC).

- Concussion is underreported.<sup>7</sup>
- Concussion is common in all contact/collision sports, both helmeted and unhelmeted.
- Concussion has been reported to account for approximately 4–5 percent of all injuries in high school sports. Football is the most common sport for reported concussion.

#### Pathophysiology

- Natural history of concussion in adolescents is not well understood.
- The cognitive deficits and behavioral problems seen are similar to those seen in adults.
- High school athletes require a longer period of time to become asymptomatic and for their cognitive function to return to normal than both collegiate and professional athletes.
- “Second impact syndrome,” though controversial, has only been described in athletes younger than 20 years old (except in boxers).
- Due to cognitive dysfunction, there may be a negative impact even after one concussion on the ability to learn new information or social and educational development.

#### Evaluation

- Assess the adolescent athlete in the same fashion as other athletes.<sup>7</sup>
- Recognize the usual and subtle signs and symptoms of concussion, including confusion, headache, and amnesia. More subtle problems may include difficulties with concentration and attention, behavioral changes, and ataxia.
- Computerized neuropsychological (NP) testing is being used more frequently as a clinical assessment tool, and provides objective measurement of cognitive function. Cognitive function may be impaired despite resolution of symptoms.
  - NP testing is difficult given normal changes in cognitive function with growth and development.
  - Ideally, NP testing would be compared with pre-injury baseline testing.

#### Disposition

- An Emergency Action Plan (EAP) needs to be in place for all practices and competitions where concussion may occur.
- Athletes with concussion must be supervised. Decisions for return to play, observation, or transport need to be made.

#### Return to Play (RTP)

- Same-day RTP
  - Use added caution in allowing the adolescent athlete to RTP.
  - The athlete must be asymptomatic at rest and with exertion to RTP.
  - RTP in the adolescent should not be considered unless asymptomatic, with initial symptoms being minimal (not involving memory function) and of short duration. Other risk factors such as younger age and previous concussion history must be considered.
  - The safest course of action is to keep the athlete out of play.
- Post-game
  - All symptoms must resolve completely before considering RTP.
  - Consider a variety of other factors when making RTP decision, including age of athlete, sport, concussion history (number, severity, proximity), duration and severity of symptoms, mismatch in force and injury, and learning disabilities.
  - Younger athletes warrant a longer period of rest.
  - For the athlete to RTP, they must remain asymptomatic with limited cardiovascular exertion, unlimited cardiovascular activities, sport-specific activities without risk for contact, practice activities with limited risk for contact, full practice activities with unlimited risk for contact, and then full play.
  - NP testing may be considered, if available and understanding limitations, to help guide RTP decision.

#### Prevention

- Equipment
  - Helmets can prevent skull fracture, should be well maintained and custom fit for the individual athlete.

- Helmets and headbands do not prevent, and may potentially increase, risk for concussion.
- Mouthguards decrease risk for facial and teeth injury, but their role in concussion prevention is unclear.
- Rule Enforcement
  - Potentially the most important intervention in preventing concussion, as well as other injuries. While rules may exist, advocating for compliance is important.

#### *It is essential the team physician:*

- Evaluates the athlete, including obvious and subtle signs of concussion along with some evaluation for cognitive function.
- Does not allow athletes with any signs or symptoms of concussion to return to participation.
- Understands the differences between the adolescent and mature brain are not fully elucidated.
- Understands the adolescent brain requires a longer time to recover than the fully matured brain.
- Treats concussion in adolescents on an individual basis.

#### *It is desirable the team physician:*

- Has a game day and practice day medical plan for evaluation and management of concussion that is discussed with athletic trainers, coaches, parents, and athletes. This is especially important in situations where no medical personnel are available at games or practice.
- Communicates with other members of the athletic care network in regard to the assessment, management, and return-to-play decisions for the concussed athlete.
- Works with the athletic care network to educate athletes, parents, and coaches regarding:
  - The importance of proper rule enforcement, reporting concussion injuries, and why these injuries are unique in the younger athlete.
  - The risk of single head injury, repetitive injury, and risk of cumulative injury.
  - Post injury education, including avoiding alcohol, aspirin, NSAIDs or other medications, and exercise until evaluation occurs.

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## Selected Readings

1. Team Physician Consensus Statement. *Medicine & Science in Sports & Exercise*. 32(4):877, April 2000.
2. Sideline Preparedness for the Team Physician: A Consensus Statement. *Medicine & Science in Sports & Exercise*. 33(5):846-849, May 2001.
3. The Team Physician and Conditioning of Athletes for Sports: A Consensus Statement. *Medicine & Science in Sports & Exercise*. 33(10):1789-1793, October 2001.
4. The Team Physician and Return-To-Play Issues: A Consensus Statement. *Medicine & Science in Sports & Exercise*. 34(7):1212-1214, July 2002.
5. Female Athlete Issues for the Team Physician: A Consensus Statement. *Medicine & Science in Sports & Exercise*. 35(10):1785-1793, October 2003.
6. Mass Participation Event Management for the Team Physician: A Consensus Statement. *Medicine & Science in Sports & Exercise*. 36(11):2004-2008, November 2004.
7. Concussion (Mild Traumatic Brain Injury) and the Team Physician: A Consensus Statement. *Medicine & Science in Sports & Exercise*. 38(2):395-399, February 2006.
8. Psychological Issues Related to Injury in Athletes and the Team Physician: A Consensus Statement. *Medicine & Science in Sports & Exercise*. 38(11): 2030-2034, November 2006.
9. Selected Issues in Injury and Illness Prevention and the Team Physician: A Consensus Statement. *Medicine & Science in Sports & Exercise*. 39(11): 2058-2068, November 2007.

### Infectious Disease

#### MRSA

Gorwitz RJ, Jernigan DB, Powers JH, Jernigan JA, and Participants in the Centers for Disease Control-Convended Experts' Meeting on Management of MRSA in the Community. Strategies for Clinical Management of MRSA in the Community: Summary of an Experts' Meeting Convened by the Centers for Disease Control and Prevention. 2006. Available at: [http://www.cdc.gov/ncidod/dhqp/ar\\_mrsa\\_ca.html](http://www.cdc.gov/ncidod/dhqp/ar_mrsa_ca.html).

National Collegiate Athletic Association. National Collegiate Athletic Association Web site. Available at: <http://www2.ncaa.org/index/php>. Accessed January 2008.

National Federation of High Schools. National Federation of High Schools Web site. Available at: <http://www.nfhs.org>. Accessed January 2008.

Turbeville SD, Cowan LD, Greenfield RA. Infectious Disease Outbreaks in Competitive Sports: A Review of the Literature. *Am. J. Sports Med.* 34:1860-1865, 2006.

#### Mononucleosis

Asgari MM, Begos DG. Spontaneous Splenic Rupture in Infectious Mononucleosis: A Review. *Yale J. Biol. Med.* 70:175-182, 1997.

Auwaerter PG. Infectious Mononucleosis in Active Patients. *Physician and Sportsmed.* 30(11):43-50, 2002.

Barkun AN, Camus M, Green L, et al. The Bedside Assessment of Splenic Enlargement. *American Journal of Medicine.* 91:512-518, 1991.

Hoagland, RJ. Infectious Mononucleosis. *Prim. Care.* 96:505-508, 1975.

Hosey RG, Mattacola CG, Kriss V, Armsey TD, et al. Ultrasound Assessment of Spleen Size in Collegiate Athletes. *Br. J. Sports Med.* 40(3):251-254, 2006.

Putukian M, O'Conner FG, Stricker P, McGrew C, Hosey RG, Gordon SM, Kinderknecht J, Kriss V, Landry G. Mononucleosis and Athletic Participation: An Evidence-Based Subject Review. *American Medical Society for Sports Medicine.* 2008.

### Nutrition and Supplementation

American Academy of Pediatrics Committee on Sports Medicine and Fitness. Adolescents and Anabolic Steroids: A Subject Review. *Pediatrics.* 99(6):904-908, 1997.

American Academy of Pediatrics Policy Statement: Promotion of Healthy Weight-Control Practices in Young Athletes. *Pediatrics.* 116:1557-1564, 2005.

Loucks AB, Manore MM, Sanborn CF, Sundgot-Borgen J, Warren MP. American College of Sports Medicine Position Stand: The Female Athlete Triad. *Med. Sci. Sports Exerc.* 39(10):1867-1882, 2007.

Oppliger RA, Case HS, Horswill CA, Landry GL, Shelter AC. American College of Sports Medicine Position Stand: Weight Loss in Wrestlers. *Med. Sci. Sports Exerc.* 28(2):ix-xii, 1996.

American College of Sports Medicine Roundtable: The Physiological and Health Effects of Oral Creatine Supplementation. *Med. Sci. Sports Exerc.* 32(3):706-717, 2000.

Gregory, AJ, Fitch, RW. Sports Medicine: Performance-Enhancing Drugs. *Pediatr. Clin. North Am.* 54(4):797-806, 2007.

Lattavo A, Kopperud A, Rogers PD. Creatine and Other Supplements. *Pediatr. Clin. North Am.* 54(4):735-60, 2007.

POLICY STATEMENT: Use of Performance-Enhancing Substances. Committee on Sports Medicine and Fitness. *Pediatrics.* 115(4):1103-1106, 2005.

### Asthma

Allen TW. Return to Play Following Exercise-Induced Bronchoconstriction. *Clin. J. Sport Med.* 15:421-425, 2005.

Laine C, Goldmann D. In the Clinic-Asthma. *American College of Physicians.* ITC6:1-16, 2007.

McKenzie DC, Stewart IB, Fitch KD. The Asthmatic Athlete, Inhaled Beta Agonists, and Performance. *Clin. J. Sport Med.* 12:225-228, 2002.

Wilson JJ, Wilson EM. Practical Management: Vocal Cord Dysfunction in Athletes. *Clin. J. Sport Med.* 16:357-360, 2006.

### Overtraining

Brenner JS. Council on Sports Medicine and Fitness. Overuse Injuries, Overtraining, and Burnout in Child and Adolescent Athletes. *Pediatrics.* 119:1242-1245, 2007.

Dalton SE. Overuse Injuries in Adolescent Athletes. *Sports Med.* 13:58-70, 1992.

Continued on page 17

Kenttä G, Hassmén P, Raglin JS. Training Practices and Overtraining Syndrome in Swedish Age Group Athletes. *Int. J. Sports Med.* 22(6):460-165, 2001.

Teeple E, Shalvoy RM, Feller ER. Overtraining in Young Athletes. *Med. Health R.I.* 89(7):236-238, 2006.

### Concussion

Cantu RC. Post Traumatic (Retrograde/Anterograde) Amnesia: Pathophysiology and Implications in Grading and Safe Return to Play. *J. Athletic Training.* 36(3):244-8. 2001.

Collins M, Lovell MR, Iverson GL, Ide T, Maroon J. Examining Concussion Rates and Return to Play in High School Football Players Wearing Newer Helmet Technology: A Three-Year Prospective Cohort Study. *Neurosurgery.* Feb;58(2):275-86; discussion 275-86. 2006.

Field M, Collins MW, Lovell MR, Maroon J. "Does age play a role in recovery from sports-related concussion? A comparison of high school and collegiate athletes." *J. Pediatr.* 2003 May;142(5):546-53.

Lovell MR, Fazio V. Concussion Management in the Child and Adolescent Athlete. *Current Sports Medicine Reports.* 7(1): pgs. 12-15, January/February. 2008.

Lovell MR. The Neurophysiology and Assessment of Sports-Related Head Injuries. *Neurol. Clin.* Feb;26(1):45-62; viii. 2008.

Standaert CJ, Herring SA, Cantu RC. Expert Opinion and Controversies in Sports and Musculoskeletal Medicine: Concussion in the Young Athlete. *Arch. Phys. Med. Rehabil.* 88:1077-9. 2007.

### Spine

Bono, CM. Low-back Pain in Athletes. *J.B.J.S. Am.* 86:382-396, 2004.

Shah SWA, Takemitsu M, Westerlund LE, et al. Khyphosis Scheuermann's Disease and Congenital Stenosis. *Pediatric.* 5:565-585. 2006.

Standaert CJ, Herring SA. Expert Opinion and Controversies in Sports and Musculoskeletal Medicine: The Diagnosis and Treatment of Spondylolysis in Adolescent Athletes. *Physical Medicine and Rehabilitation.* 88:537-540, 2007.

Standaert CJ. Low Back Pain in the Adolescent Athlete. *Phy. Med. Rehabil. Clin. N. Am.* 19: 287 304, 2008.

### Shoulder

Lyman S, Fleisig GS, Waterbor JW, et al. Longitudinal Study of Elbow and Shoulder Pain in Youth Baseball Pitchers. *Med. Sci. Sports Exerc.* 1803-10. 2001.

Olsen SJ, Fleisig GS, Dun S, et al. Risk Factors for Shoulder and Elbow Injuries in Adolescent Baseball Pitchers. *Am. J. Sports Med.* 905-12.2006.

Hutchinson MR, Ireland ML. Overuse and Throwing Injuries in the Skeletally Immature Athlete. In: Ferlic DC, ed. *Instructional Course Lectures.* Rosemont: American Academy of Orthopaedic Surgeons. 25-36.2003.

Burkhart SS, Morgan CD, Kibler WB. Shoulder Injuries in Overhead Athletes: The Dead Arm Revisited. *Clin. Sports Med.* 125-59. 2000.

Burkhar SS, Morgan CD, Kibler WB. The Disabled Throwing Shoulder: Spectrum of Pathology Part I: Pathoanatomy and Biomechanics. *Arthroscopy.* 404-20.2003.

Myers JB, Laudner KG, Pasquale MR, et al. Scapular Position and Orientation in Throwing Athletes. *Am. J. Sports Med.* 263-71.2005.

Kibler WB, Chandler TJ. Range of Motion in Junior Tennis Players Participating in an Injury Risk Modification Program. *J. Sci. Med. Sport.* 51-62.2003.

### Knee

Bales CP, Guettler JH, Moorman CT. Anterior Cruciate Ligament Injuries in Children With Open Physes: Evolving Strategies of Treatment. *American Journal of Sports Medicine.* 32:1978. 2004.

Fulkerson JP. Diagnosis and Treatment of Patients with Patellofemoral Pain. *American Journal of Sports Medicine.* 30:447. 2002.

Guzzanti V, Falciglia F, Stanitski CL. Preoperative Evaluation and Anterior Cruciate Ligament Reconstruction Technique for Skeletally Immature Patients in Tanner Stages 2 and 3. *American Journal of Sports Medicine.* 31:941. 2003.

Kocher MS, DiCanzio J, Zurakowski D, Micheli LJ. Diagnostic Performance of Clinical Examination and Selective Magnetic Resonance Imaging in the Evaluation of Intra-articular Knee Disorders in Children and Adolescents. *American Journal of Sports Medicine.* 29:292. 2001.

Kocher MS, Micheli LJ, Zurakowski D, Luke A. Partial Tears of the Anterior Cruciate Ligament in Children and Adolescents. *American Journal of Sports Medicine.* 30:697. 2002.

Kocher MS, Tucker R, Ganle TJ. Management of Osteochondritis Dissecans of the Knee: Current Concepts Review. *American Journal of Sports Medicine.* 34:1181.2006.

Shelbourne KD, Gray T, Wiley BV. Results of Transphyseal Anterior Cruciate Ligament Reconstruction Using Patellar Tendon Autograft in Tanner Stage 3 or 4 Adolescents With Clearly Open Growth Plates. *American Journal of Sports Medicine.* 32:1218.2004.

### Elbow

Little League Implements New Rule to Protect Pitchers' Arms. 2007. Available at: [www.littleleague.org/media/pitch\\_count\\_08-25-06.asp](http://www.littleleague.org/media/pitch_count_08-25-06.asp)

Bradley JP, Petrie RS. Elbow Injuries in Children and Adolescents. In DeLee JC, Drez D, Miller MD (eds): *DeLee & Drez's Orthopaedic Sports Medicine: Principles and Practice, 2nd ed.* 1249-1264.2002.

DeFelice GS, Meunier MJ, Paletta GA. Elbow Injuries in Children and Adolescents. In Altchek DW, Andrews JR (eds): *The Athlete's Elbow.* 99 231-248.2001.

Pappas AM. Elbow Problems Associated with Baseball During Childhood and Adolescence. *Clin. Orthop.* 164:30-41.1982.

Rudzki JR, Paletta GA. Juvenile and Adolescent Elbow Injuries in Sports. *Clin. Sports Med.* 23:581-608.2004.