Caring for Wrestlers

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Abstract
Wrestling is a popular high school and college sport with an injury and illness rate second only to football. It is important that the physician providing medical care for wrestlers be familiar with the unique characteristics of wrestling and the associated common injuries and medical problems. Common orthopedic injuries include shoulder, elbow, and finger dislocation; prepatellar bursitis; knee medial collateral ligament sprains; and cervical strains. Skin infections are the most common cause of missed mat time for wrestlers. Physicians need to be able to identify and treat these infections, and know the rules regarding return to wrestling once an infection has been identified. Other conditions that are common include auricular hematomas, epistaxis, and brow lacerations. Physicians also need to be familiar with the medical issues involved with rapid weight loss and weight cycling, and understand the high school and college weight certification rules.

Introduction
Wrestling is considered by many to be the world's oldest sport. It is a hand-to-hand combat with the goal of pinning the opponent's back to the mat, with points awarded for changes in position that bring a wrestler closer to pinning his opponent. Currently, there are two main styles in international wrestling: Greco-Roman and Freestyle. The major difference between these styles is that wrestlers are not permitted to attack an opponent's legs in Greco-Roman wrestling. Freestyle wrestling has both men and women's divisions. Women's Freestyle wrestling was added to the Olympic Games in 2004 in Athens and has now grown from four weight classes to six for the upcoming 2016 games in Brazil.

In the United States, the most common style of wrestling is Folkstyle, which is contested in college, high school, and youth wrestling. The basic differences in the predominant styles influence the injuries that occur. Greco-Roman and Freestyle reward throws more than Folkstyle so these are attempted more often, which can result in more injuries where a wrestler is being returned to the mat forcefully. Folkstyle allows the wrestlers to be in the down position for longer periods, which increases the risk of defensive injuries such as shoulder strains and subluxations.

In 2013 to 2014, wrestling ranked sixth among boys in high school sports participation, with almost 270,000 boys wrestling, and there were 10,668 schools with a wrestling team, which was the eighth of 49 sports (8). According to 2013 to 2014 National Collegiate Athletic Association (NCAA) statistics, there were 77 wrestling programs in Division 1 with 2,544 participants, 58 programs in Division 2 with 1,856 participants, and 91 programs in Division 3 with 2,582 participants, for a total of 220 programs and 6,831 participants (22).

Injuries
Epidemiology
Injury rates for high school wrestling range from 2.33 to 2.50 per 1,000 athlete exposures (AE) (45,57). Wrestling has the second highest injury rate among high school boys sports, roughly equivalent to boys soccer, but considerably less than football (Table 1). For college wrestling, the NCAA Injury Surveillance System reported a wrestling injury rate of 7.25 injuries per AE (57). A review of the injury data from the 2008 Beijing Olympics found that 30 wrestlers (9.3%) experienced a total of 32 injuries during the tournament (50).

In all studies, the injury rate is higher in competition than in practice (2,40,45,57). In the NCAA, preseason practices had an injury rate of 8.3 per 1,000 AE compared with an in-season practice of 4.7 per 1,000 AE (2). Wrestling from the standing neutral position accounted for the highest percentage of injuries with 39.0% in high school and 41.9% in college. In high school wrestling, 6.4% of injuries resulted from illegal moves (57).

The shoulder is the most common site injured in high school wrestlers, with reports ranging from 18% to 24% of injuries (12). Among younger wrestlers, hand, wrist, and finger injuries appear to be the most common (35). Reports for college wrestlers indicate that the knee is the most common injury site, with 24.8% of injuries involving the...
Prepatellar bursitis and medial collateral ligament (MCL) occur in both the offensive and the defensive positions. Knee injuries requiring surgery (57). or more of college wrestling and the most common site of injury, followed by fractures of the hand, shoulder, and ankle. Knee injuries are more common in college wrestlers, not only in frequency, but also in severity. Knee injuries are the most common injury responsible for missing 3 wk or more of college wrestling and the most common site of injury requiring surgery (57).

Orthopedic Injuries

Knee Knee injuries are quite common in wrestling and can occur in both the offensive and the defensive positions. Prepatellar bursitis and medial collateral ligament (MCL) sprain are two specific knee injuries common in wrestlers (56).

Prepatellar bursitis

The prepatellar bursa lies directly anterior to the patella and can be easily injured due to direct trauma, most commonly from repeated striking of the knee on the mat. This action is repeated frequently especially during early season practices when takedowns are drilled heavily. Inflammatory changes and occasionally a hematoma are precipitated in the prepatellar bursa.

Prepatellar bursitis presents as a swollen and tender area just anterior to the patella. There may be associated erythema and warmth of the skin. Typically, the knee is tender but not painful. The range of motion is normal with pain only in full flexion because of stretching of the bursa.

Infectious bursitis must be distinguished from traumatic bursitis. The bursa can become inflamed from a primary infection, or a traumatic bursitis can become secondarily infected. Traumatic bursitis should not be routinely aspirated because of the risk of introducing infection, but the bursal fluid should be aspirated and sent for Gram staining, culturing, and cell counting if infection is suspected. Signs and symptoms of infection include fever and other accompanying systemic symptoms and/or an excessively warm and tender bursa (10).

Treatment of traumatic prepatellar bursitis focuses on reducing the irritation of the bursitis through suspension of activity and/or wearing a knee pad. Typical neoprene knee pads used often in wrestling will likely not provide enough padding once a traumatic bursitis has developed, so a large, volleyball-style knee pad is usually required. Off the mat, an elastic bandage or a simple neoprene or elastic knee sleeve will maintain compression and reduce the swelling and pain of bursitis. A week or two of immobilization and avoidance of direct trauma has been recommended to shorten the course of the injury (36), but many wrestlers will choose to practice and compete. Wrestlers with prepatellar bursitis need to be closely monitored for the development of a secondarily infected bursa. Once the swelling of the bursa has been resolved, it is recommended that the wrestler continue to wear a knee pad to prevent recurrence. Surgical bursectomy may be required for wrestlers who develop chronic bursitis (36).

Table 1.
Injury rates of five common sports in U.S. high schools (45)

<table>
<thead>
<tr>
<th>Rank</th>
<th>Sport</th>
<th>Injuries per 1,000 AE</th>
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<tbody>
<tr>
<td>1</td>
<td>Football</td>
<td>4.36</td>
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<tr>
<td>2</td>
<td>Wrestling</td>
<td>2.50</td>
</tr>
<tr>
<td>3</td>
<td>Soccer</td>
<td>2.43</td>
</tr>
<tr>
<td>4</td>
<td>Basketball</td>
<td>1.89</td>
</tr>
<tr>
<td>5</td>
<td>Baseball</td>
<td>1.19</td>
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MCL sprain

The MCL of the knee is the major stabilizer against valgus force and is frequently placed under great stress in the sport of wrestling. To evaluate the MCL, the knee exam should include valgus stress in full extension and at 30° of knee flexion to eliminate secondary restraints (30,34,54). Traditional grading of MCL sprains is based on the amount of medial joint line opening with valgus stress with the knee flexed to 30°. Some physicians rely more on the quality of the end point rather than the amount of opening with valgus stress. This is described as the degree of injury, with a firm end point as a first-degree sprain and a soft end point as a third-degree sprain (35). Joint line opening with valgus stress with the knee fully extended indicates tears to both the MCL and the posterior oblique ligament, and possibly a posterior cruciate or anterior cruciate tear (30,34).

Treatment protocols for MCL injuries that emphasize early controlled motion and protected weight bearing have been found to be successful in returning athletes to full function (34,54). A hinged brace can be used to protect against valgus stress and external rotation. Even for grade III injuries, nonoperative protocols that include a functional rehabilitation program and 6 wk in a hinged brace have been found to have favorable outcomes compared with surgery (54). Operative repair or reconstruction is reserved for severe acute or chronic valgus instability in athletes with a poor response to nonoperative rehabilitation (34,54). Return to athletics is based on a functional assessment of the athlete more than a specific time frame. Generally, wrestlers with grade II sprains return to wrestling in 3 to 6 wk, whereas grade III sprains may require 3 to 9 months to heal and return to full function (34). When a hinged knee brace has been used after a sprain, it may be used in wrestling competition if properly padded and must be approved by the referee before a match.

Shoulder subluxation/dislocation Shoulder injuries are quite common in wrestling and are often precipitated by extreme anterior flexion, abduction, and external rotation that occur frequently in wrestling. These positions may lead to subluxation or dislocation. Subluxation is often associated with a rotator cuff muscle strain or a glenoid labral tear during the initial event. These increase the risk of a recurrent injury due to the weakened rotator cuff muscles, tear of the stabilizing glenoid labrum, and stretching of the joint capsule (53).
Shoulder joint stiffness may actually increase the risk of injury in wrestlers. Pasque and Hewett (40) found that wrestlers with generalized ligamentous laxity had half the number of injuries as those with no signs of shoulder laxity.

More than 97% of acute shoulder dislocations are anterior, with the injury occurring with forced abduction and external rotation as described earlier. The wrestler will present in acute pain with the arm typically held in a fixed position in slight internal rotation and abduction (58). The ease of reduction is related to the amount of spasm of the surrounding shoulder musculature, which is often directly related to the amount of time since the injury. Therefore, prompt reduction has the advantage of avoiding muscular spasm and decreasing neurovascular compromise (58). However, reduction attempts should only be done after a full neurologic examination of the arm and after the shoulder has been palpated and found to be nontender. Evaluation for an axillary nerve injury is tested by checking the sensation of the lateral aspect of the shoulder. In addition, sensation and strength in the hand should be checked to ensure there has not been a brachial plexus injury (53). If tenderness is found, a radiograph will be needed before reduction to rule out a fracture dislocation. Radiographs should always include an axillary view. Anteroposterior (AP) views alone can be misleading, and a posterior dislocation can be missed (58).

There are several reduction techniques described in the literature (14,58). The choice of the technique should be based on the familiarity and comfort level of the physician. However, some of the older techniques, such as the Kocher and Hippocrates methods, have been associated with more postreduction complications and should be avoided (14).

Once reduced, the patient should be placed in a sling and sent for x-rays to verify reduction and identify any bone injury. After a first-time dislocation, some authors recommend 3 wk of immobilization in the sling followed by physical therapy, whereas others recommend earlier therapy (14,53,58). Because subluxation and dislocation are on a continuum of the same process, the physical therapy for both should focus on rotator cuff strengthening with special attention paid to the subscapularis muscle, as well as neuromuscular training (23). Some orthopedic surgeons recommend arthroscopy after a first-time dislocation and surgery after an acute dislocation has been shown to decrease the risk of recurrence (14,53). Although not all athletes who experience an acute shoulder dislocation require surgery, the potential benefits and risks of surgery should be discussed with the athlete so they can make an informed decision.

Cervical strain/sprain The techniques and counter-techniques used in wrestling can often lead to cervical injury. Cervical strains and sprains are the most common. Cervical strains are technically injuries to the cervical muscles, whereas sprains are injuries to the ligaments of the cervical spine, but they are often difficult to distinguish. Fortunately, they are managed similarly. Cervical injuries can occur when the wrestler tries to resist a force placed on his/her neck by the opponent or can occur while being returned to the mat during a throw by the opponent.

The wrestler may recall the exact instant that pain began or may simply notice pain after a match. Many times, wrestlers who compete in several matches in 1 d in a tournament will complain of neck pain by the end of the day due to overuse and fatigue in addition to the typical trauma. It is important to ask if the patient has midline pain over the spinous processes or if it is paraspinal over the musculature. Numbness, tingling, paresthesia, and radicular pain should be investigated because these findings indicate irritation or injury of nerve roots and will require close physical exam and possibly further testing such as imaging of the spine (18).

Imaging studies are necessary only after significant trauma or when there is an associated neurologic finding. Two helpful tools that aid in the decision to use imaging are the NEXUS criteria (20) and the Canadian C-Spine Rules (9). These screening tools can be used to decide if a patient is at high enough risk to warrant an imaging study after cervical trauma. Both can be found on numerous web sites. For detection of clinically significant C-spine injuries, the sensitivity values for the NEXUS criteria and the Canadian C-Spine Rule are 99.6% and 99% to 100%, respectively (9,20).

If there is any concern for cervical spine injury occurring with nerve injury, the patient should undergo cervical immobilization with a hard cervical collar. Spinal immobilization with a spine board is of uncertain benefit and actually may be detrimental to patient outcomes. Although still debated, most now believe that backboard immobilization is not required when a patient has been ambulatory. If nonambulatory or with lower extremity neurologic signs or symptoms, a backboard can assist in moving a patient onto an emergency medical service’s (EMS) cart, but its role in spinal immobilization is still unknown (15).

Once more, significant injuries have been ruled out either clinically or with imaging; treatment of cervical sprains and strains focuses on pain control with nonsteroidal anti-inflammatory drugs, massage, stretching of the neck and upper back, therapeutic ultrasound when physical therapy is used, and early return to activities. For mild injuries, a return to wrestling may occur after only a day or two as tolerated, but this may be difficult with ongoing pain and a decreased range of motion. More severe injuries will take several days to weeks to resolve to a point that wrestling is possible. Wrestlers should not be allowed to return to wrestling until there is a painless full range of neck motion and full strength on resisted neck muscle testing.

Elbow dislocation Most elbow injuries in wrestling occur when a wrestler has been lifted off his feet then attempts to catch himself with an outstretched arm when returning to the mat. An elbow dislocation is a significant injury that can end a wrestler’s season. About 80% of elbow dislocations are posterior and have significant disruptions of the supporting ligaments. There is also a high association with fractures (29).

On exam, the elbow appears swollen with a disruption of the normal bony landmarks. The hand should be examined for vascular or neural compromise by testing the pulses of the radial and ulnar arteries; capillary refill in the fingers; and sensation and motor functions of the radial, ulnar, and median nerves.

Imaging of the elbow with radiographs should be performed as soon as possible and before attempts at reduction due to the likelihood of associated fractures. Reduction
may be attempted before imaging if there is any sign of neurovascular compromise. The reader is referred to a recent review that describes techniques for elbow dislocation reduction and subsequent treatment (29).

**Finger dislocation** One of the most common dislocations in wrestling is the finger dislocation. For those fingers that dislocate in the medial-to-lateral plane, one or both of the collateral ligaments of the finger are damaged, but for those that dislocate in the volar-to-dorsal plane, the volar capsular ligament is injured. The proximal interphalangeal joint is the most common dislocated joint in the finger (11).

Plain radiographs should be obtained to rule out associated fractures of the finger. Acute treatment should focus on reduction of the fracture and some form of immobilization or support of the joint. If there is no tenderness or if definitive care will be delayed, finger dislocations may be reduced onsite before obtaining radiographs. If there is bony tenderness or notable deformity of a phalanx, then reduction should be delayed until after radiographs. If there is an open fracture, the wrestler should be withheld from further competition and taken directly to the nearest emergency department (11).

After the reduction is performed, the finger should be “buddy taped” to the next larger finger by using two strips of tape to connect the middle phalanx and proximal phalanx of the two fingers. Additional support can be added by winding tape around the fingers to connect the two original strips of tape. The wrestler may continue to wrestle if there is no significant fracture or neurovascular injury. If there is an associated fracture, pain will typically limit the wrestler’s ability to continue. Once the competition day is finished, a splint can be used to give support and protection for the finger.

**Soft Tissue Injuries**

**Brow laceration** Lacerations are common in all combat sports, and wrestling is no exception. Eyebrow lacerations make up the largest proportion of lacerations and are typically the result of the two wrestlers striking heads together. A knee or elbow to the brow is also a common cause of lacerations. The lateral brow ridge is close to the surface of the skin and is the most likely site of laceration. Fortunately, the extensive blood supply to the face hastens the healing process.

Evaluation of the injury should include assessment for concussion and facial fracture. On exam, the depth and length of the wound should be noted as well as the presence of arterial bleeding and neurologic function around the laceration (47).

If the wrestler is otherwise cleared to continue in the match, the best treatment method to protect the laceration and control the bleeding is to place gauze over the wound and tightly wrap the head with elastic tape and athletic tape. Some athletic trainers advocate using ferric subsulfate (Monsel) solution and/or skin glue, but in the author’s experience, these substances can complicate subsequent repair and healing. Ferric subsulfate solution creates necrotic subcutaneous tissue that potentially increases the risk of infection if sutured over. Skin glue is often not strong enough to hold during wrestling and is difficult to remove when formal closure is attempted later. Once there is sufficient time, suturing the wound will allow the wrestler to continue wrestling and minimize subsequent bleeding.

**Auricular hematoma** Auricular hematomas due to trauma to the ear are common in wrestling and other martial arts and combat sports. Both the National Federation of State High School Associations (NFHS) and the NCAA mandate the wearing of headgear while wrestling to reduce auricular trauma, but this rule is generally only enforced during official matches. Many wrestlers choose not to wear headgear during practices and private work-outs. For many in the wrestling community, the auricular hematoma is seen as a sign of toughness and is even sought after by young wrestlers. Because of this, the potential development of a cauliflower ear does not necessarily motivate wrestlers to wear headgear while wrestling.

Blunt trauma to the ear can cause accumulation of blood in the subperichondrial space between the perichondrium and the auricular cartilage, resulting in a hematoma. The perichondrium carries the blood supply to the auricular cartilage. The formation of a hematoma separates the perichondrium from the cartilage, thereby interrupting the blood supply. If persistent, an auricular hematoma can result in cartilage death. Over time, new abnormal cartilage with fibrosis will form, resulting in the characteristic deformity known as a cauliflower ear (17).

The goals of treating an auricular hematoma are to remove the blood and prevent reaccumulation. If done soon enough, the blood can be drained by aspiration through an 18-gauge needle after local anesthesia. However, if the blood has started to clot, it may be difficult to aspirate, and incision and evacuation of the hematoma should be done.

Removal of the blood leaves a potential space into which blood will rapidly reaccumulate with even minimal trauma. Many techniques have been described to close the space, including use of hard and soft compression bolsters, Alumafoam, and nonbolster techniques (17,24). Recent reports describing the use of absorbable mattress sutures to close the space have been very favorable. This technique also has the advantage of allowing wrestlers to immediately return to wrestling (24).

**Epistaxis** The most common cause of bleeding in wrestling is epistaxis. Nasal trauma is the most common cause of epistaxis in wrestlers, and it is usually unilateral and anterior. Kiesselebach’s plexus is the most common location of bleeding. Dry winter air during wrestling season makes the nasal mucosa more friable and prone to bleeding.

During a match, epistaxis should be stopped as quickly as possible to minimize delays in the match and to avoid disqualification for using too much time in high school matches. The wrestler should first blow his nose to remove any clots then a cotton roll can be inserted into the nose to apply compression to the bleeding septum. The medical provider should be careful to leave enough of the cotton roll exposed so it can be easily retrieved after the match.

After the match, continued bleeding should be controlled by first having the wrestler blow his nose to clear all clots.
Then, vasoconstriction will be aided by use of 0.05% oxymetazoline nasal spray. This can be sprayed into the nose and used to soak a cotton roll or cotton pledget that is placed in the nose for 4 to 5 min. When this is removed, the septum should be inspected for continued bleeding. If bleeding is found, gentle cautery with silver nitrate may be performed by lightly dabbing a silver nitrate stick on the bleeding area. Alternatively, or in addition, triple antibiotic ointment or petroleum jelly can be spread on the septum to help stop active bleeding and prevent new bleeding (47).

Weight Management in Wrestlers

Wrestlers have traditionally wrestled in the lowest weight class possible in the belief that this gives them a competitive advantage. Wrestling at a weight class significantly lower than the normal weight requires considerable weight loss. Surveys have shown that high school wrestlers lose an average of 3% to 5% of body weight during the season (25,38). The majority of the weight lost by wrestlers during the season is lost and regained in frequent weight cycles involving rapid weight loss in the days before a competition weigh-in. Studies have found that weight cycling is common in both high school and college wrestlers, and can occur 10 to 30 times over the course of a season (32,44). Wrestlers lose an average of 2.5 to 3.5 kg in the week before a match (32,51). The most common techniques for rapid weight loss are sweating and fluid and caloric restriction (25,38,51). Sweating is induced by exercise, often in hot environments with excessive clothing or impermeable suits. Diuretics, laxatives, and vomiting are the less commonly used methods (25,38,51).

In the fall of 1997, three collegiate wrestlers died within a 5-wk period from complications of rapid weight loss (46). All three wrestlers were attempting to rapidly lose significant weight by induction of severe dehydration using the traditional techniques of wrestlers (exercise and heat-induced sweating and fluid deprivation). In response to these tragedies, the NCAA implemented five-rule changes for the 1998 to 1999 season, including a minimum wrestling weight based on 5% body fat, moving weigh-ins to at most 1 h before competition, and a prohibition of using saunas, steam rooms, and impermeable suits to lose weight. The NFHS also called for each individual state high school association to “develop and use a specified weight-control program which will discourage excessive weight reduction and/or wide variations in weight . . . .” The NFHS transformed this weight certification program recommendation into a nationally mandated rule for the 2006/2007 season.

It is important that physicians who care for wrestlers know the college and high school regulations regarding weight certification. The NCAA requires the establishment of a minimum weight classification based on a preseason lean body mass assessment by skinfold measurements, hydrostatic weighing, or air displacement plethysmography (BOD POD). Wrestlers’ minimum weight class cannot be below a calculated weight of 5% body fat. Wrestlers can lose a maximum of 1.5% of their body mass per week to get to a weight class at or above their minimum certified weight. Weigh-ins must occur within 1 h of the start of the wrestling competition. Both the National Junior College Athletic Association and the National Association of Intercollegiate Athletics specifically mandate that their member institutions adhere to the NCAA Weight Management Program for wrestlers.

The NFHS mandates a similar weight certification program to the NCAA Weight Management Program, with the minimum weight set at 7% body fat. Body composition assessment must be accompanied by measurement of urine specific gravity to ensure adequate hydration for the testing. Low weight due to dehydration decreases the precision of the calculations. Wrestlers must have a urine specific gravity less than 1.025 to proceed to body composition assessment and calculation of a minimum wrestling weight. A weight loss descent plan for each wrestler also is calculated based on a maximum of 1.5% weight loss per week to a minimum of 7% body fat. Wrestlers cannot wrestle at a weight lower than the weight indicated for each week during the season. However, despite the declaration of a “mandate,” the NFHS is an advisory organization. Official rules are set by each individual state athletic association and plans vary by state. Physicians should check with their particular state high school athletic association for the specifics of their state’s weight certification requirements.

Both the NCAA and the NFHS weight management programs allow for an exception for the minimum body fat weight certification for athletes who have less than 5% body fat (NCAA) or 7% body fat (NFHS) at the preseason body composition assessment. These athletes are allowed to wrestle at their preseason weight with a statement from a physician that this weight represents their “normal” healthy weight. Physicians should be aware that it is very unusual for mature high school and college athletes to be less than 7% body fat. Assessments done at the NCAA wrestling championships from 1999 to 2004 found an average percent body fat of 9.5% (excluding heavyweights). No wrestler had a percent body fat of less than 5%, and fewer than 5% had a percent body fat less than 7% (39). At the high school level, it is usually only the physically immature athletes in the lowest weight classes who have a “normal” percent body fat less than 7% (Uyl, M., Michigan High School Athletic Association, personal communication, 2014).

Several studies have reported a decrease in the magnitude of rapid weight loss after the implementation of minimal weight certification programs at the high school and collegiate level. The average weight gain the day after weigh-ins the NCAA championships in 1991 (before minimum weight certification) was 3.7 kg (49). In the seasons after the rule change, the average rapid weight gain after weigh-ins was 1.7 kg (39). Ransone and Hughes (44) reported similar results in their study of successful NCAA wrestlers after the 1998 rule changes, with an average weight loss of 1.4 kg in the 24 h before weigh-ins and a weight gain of 1.12 kg in the 24 h after weigh-in for competitions. The weight loss patterns and behaviors of Wisconsin and Michigan high school wrestlers were both studied before and after the implementation of their respective weight certification and monitoring programs. In both states, average weekly weight loss, frequency of weight loss cycles, and use of potentially harmful weight loss methods significantly decreased after their respective weight certification programs became mandatory (26,38).
International style wrestling tournaments in the United States are governed by USA Wrestling for all age groups. USA Wrestling prohibits many of the rapid dehydration methods, such as saunas and other “hot boxes,” as well as vapor-impermeable suits, at their non-Senior level sanctioned events. However, there are no other weight loss rules and no minimal weight certification requirement. In addition, weigh-ins usually occur the day before the competition. Alderman et al. (3) studied the weight loss pattern and behaviors of teenage wrestlers at a national championship international style tournament. They found that rapid weight gain after weigh-in was 3.4 kg, which is remarkably similar to what was reported for NCAA wrestlers before the implementation of the weight certification rules and moving the weigh-in time to 1 h before wrestling. In addition, the use of rapid dehydration methods also was similar to what was found before the NCAA and high school rule changes. This study indicates that the NCAA and high school weight certification and weight monitoring programs have only been effective in decreasing rapid weight loss patterns and behaviors during the college or high school seasons. Many wrestlers still believe that wrestling at the lowest possible weight class is necessary for success (41), and the Alderman study suggests that they will revert to previous weight loss patterns when given the opportunity.

There is a growing body of literature challenging the assumption that wrestling in the lowest possible weight class confers a competitive advantage. It appears that several factors influence the effect of weight loss on wrestling performance, including level of dehydration, time for replenishment, and number of matches. Studies of 3 to 4 d of gradual weight loss of 3% to 6% body weight without dehydration found significant reduction in the average work produced in a 6-min wrestling specific performance test (43). Dehydration of 2% to 3% appears to have little effect on muscle strength and anaerobic power. However, in a glycogen-depleted state, wrestlers will reach a performance limiting level of glycogen within 7 min of wrestling (31). This may not have much effect on a single match but can have a profound effect on performance in tournaments that involve several matches in 1 d, because even with refeeding, replenishment of glycogen stores can take 24 to 48 h (21). The “advantage” of wrestling lighter opponents may be more than offset by the deleterious effects of rapid weight loss on performance, particularly when multiple matches are wrestled in a day (28).

Skin Infections

Skin infection is the most common condition for which wrestlers seek medical attention, and it is the single condition that accounts for the most time loss from practices and matches (2). Wrestling intrinsically contains the two primary risk factors for skin infections: a localized breakdown in the natural skin barrier to infection by repetitive trauma to specific sites and exposure to skin pathogens. More than 70% of herpes simplex virus (HSV) skin infections in wrestlers occur on the head, neck, and face, with a predilection for the right side, which are the primary areas of skin-to-skin contact between wrestlers (5). This distinct localization of infection indicates that the primary vector for skin pathogens is other wrestlers, and not the mat or other environmental sources of possible infectious agents.

Among NCAA wrestlers between 1993 and 2004, herpetic infections accounted for approximately 45% of skin infections that resulted in lost practice or game time (2). Bacterial skin infections, including impetigo and methicillin-resistant Staphylococcus aureus (MRSA), comprised 25% of skin infections, whereas 22% of skin infections that resulted in lost mat time were caused by fungus (2).

Infectious skin lesions in wrestlers can be viral, bacterial, or fungal. Herpes gladiatorum (HG) is a term used to describe a cutaneous infection in athletes caused by HSV1. Primary HG infections are more extensive than recurrent infections, often presenting as multiple clusters of vesicles that spread over several dermatomes, occasionally affecting both sides of the body (7). The athlete can have mild systemic symptoms, and facial lesions are often associated with cervical adenopathy. After the primary infection, the virus lives in a latent state in the trigeminal ganglion for facial lesions or the dorsal root ganglion for other areas of the body. Secondary or recurrent infections are localized to a specific dermatome. Reactivation of the virus can be induced by stress, trauma, temperature extremes, and/or immunosuppression (16). Primary infections generally resolve within 10 to 14 d in healthy hosts, although viral shedding can last longer (16).

The most serious consequence of HSV infection occurs with ocular involvement. Potential complications include blepharitis, follicular conjunctivitis, keratitis, scleritis, and uveitis. Dendritic keratitis can cause corneal scarring and subsequent corneal blindness (16). Athletes with ocular involvement should be referred immediately to ophthalmology.

Viral shedding occurs before the appearance of vesicles, so it also is important to educate wrestlers about the early signs and symptoms of an HG outbreak. Patients with a history of HG will usually experience burning or itching at the site a few days before the appearance of vesicles. Primary infection characteristically produces systemic symptoms (e.g., fever, fatigue, and myalgia) for 1 to 2 d before vesicular outbreak (6). In the setting of a team outbreak, athletes need to be monitored closely for these nonspecific symptoms and excluded from wrestling until symptoms resolve and no lesions appear.

Bacterial skin infections are classified by the depth of the infection and the association with systemic symptoms (fever, myalgia, and fatigue). Impetigo is a superficial infection characterized by honey-colored crusting of the overlying skin. It can have associated bullae. Impetigo that penetrates deeper into the skin is called ecthyma. Nonbullous impetigo is usually caused by S. aureus and less commonly by Streptococcus pyogenes (group A strep, S. pyogenes). Bullous impetigo is always caused by S. aureus (19).

 Folliculitis is an infection of the hair follicle that remains superficial and localized to the epidermis. It is most commonly caused by S. aureus but can also be due to Pseudomonas aeruginosa (commonly associated with whirlpools and hot tubs) and, rarely, Enterobacter (52). A furuncle is an infection that starts in the hair follicle but then spreads deeper into the dermis and subcutaneous tissue, forming a perifollicular abscess. It is almost always caused by S. aureus. A carbuncle occurs when a group of furuncles interconnect. Carbuncles can cause systemic symptoms such as low-grade fever, myalgias, and fatigue (37).
A cellulitis is a diffuse infection of connective tissue with inflammation of the dermal and subcutaneous layers of the skin. It is characterized by the triad of erythema, edema, and warmth with the absence of a discrete focus of infection. It can be due to *S. aureus* or *S. pyogenes*. Erysipelas is a superficial infection of the dermis that produces intracutaneous edema that produces palpable margins of the skin. It is usually caused by *S. pyogenes* (52).

Some *S. aureus* species have the mecA gene that produces a penicillin-binding protein that confers resistance to most beta-lactam antibiotics. These staph species are called MRSA and are the causative agent in an increasing number of skin infections in athletes (13,27). The typical presentation of an MRSA skin infection is a pustular lesion with central necrosis. The athlete will often complain of pain out of proportion to the appearance of the lesion and may attribute the lesion to a “spider bite” (13).

Fungal skin infections are ubiquitous in wrestlers and are often referred to as “tinea gladiatorum” (1). Dermatophytes infect the outer layers of the epidermis, and arthrospores with extended survival time shed in skin scales. Transmission in wrestlers is primarily by skin-to-skin contact. A survey of wrestlers found that 60% of college wrestlers and 52% of high school wrestlers developed a fungal skin infection during the season (1). The typical appearance of tinea corpora is an erythematous annular plaque with central clearing and surface scale at the periphery of the lesion. However, tinea gladiatorum can have an atypical appearance with irregular borders and less central clearing. Diagnosis is usually made clinically, but a KOH preparation test from the periphery of the lesion can confirm the diagnosis. Fungal cultures are more sensitive and specific, but can take 1 to 2 wk to grow and are rarely needed. Wrestlers’ scalps also should be inspected for *tinea capitis*, because the scalp can be an asymptomatic reservoir of fungus in wrestlers (55).

**Approach to Skin Lesions in Wrestlers**

Wrestlers should be inspected before every practice for skin lesions. Wrestlers also should be instructed on self-inspection and to report new lesions immediately to their coach or trainer. Wrestlers need to be aware that early detection and treatment of skin infections will minimize time lost from wrestling, as well as prevent the spread of the lesions to other wrestlers. The most important intervention when a new lesion is identified is to take the athlete out of wrestling. Lesions that are excoriated can be difficult to identify, so physicians should have a high index of suspicion for herpes gladiatorum. If there is uncertainty about the etiology, viral cultures should be sent. However, treatment should be started empirically with acyclovir or valacyclovir (7).

Fluctuant skin lesions should be incised and drained with a purulent material sent for culture to identify antibiotic resistance, although generally, antibiotics are not necessary after incision and drainage (42,48). Nonfluctuant lesions should be treated empirically with a cephalosporin or amoxicillin-clavulanate (Augmentin) (33). Athletes should be monitored daily to ensure improvement. If the lesions are enlarging or spreading, an oral antibiotic with activity against MRSA based on local resistance patterns should be started. The U.S. Centers for Disease Control and Prevention has published guidelines for the treatment of MRSA skin infections in athletes (Table 2). Athletes that develop systemic symptoms (fever, rigors, myalgias, and hypotension) should be hospitalized (33).

Lesions consistent with *tinea corpora* should be treated with topical antifungal cream. The fungicidal allylamines are considered more effective than the fungistatic imidazoles (55). Treatment should continue for at least 14 d or for a week after the lesion has faded to prevent recurrence (1). Oral antifungal agents are used if there are a large number of lesions or there is a failure to respond to topical treatment (1,55). *Tinea capitis* is best treated with 2 wk of oral antifungal (e.g., terbinafine, 250 mg d−1) (55).

It is critical that wrestlers diagnosed with infectious skin lesions are prohibited from all wrestling activities until the lesions have been treated and are no longer contagious. The NCAA and NFHS have established strict guidelines for the minimum time to return to wrestling after the diagnosis of a skin infection (Table 2). However, it is important for physicians to realize that these are the *minimum* times to

**Table 2.**

<table>
<thead>
<tr>
<th>Document Title</th>
<th>Web Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>NFHS Medical Release Form for Wrestler to Participate with Skin Lesions</td>
<td><a href="http://www.nfhs.org/media/882323/2015-16-wrestling-skin-lesion-form-april-2015-final.pdf">www.nfhs.org/media/882323/2015-16-wrestling-skin-lesion-form-april-2015-final.pdf</a></td>
</tr>
<tr>
<td>Meticillin-Resistant <em>Staphylococcus aureus</em> (MRSA) infections</td>
<td><a href="http://www.cdc.gov/mrsa/community/team-hc-providers">www.cdc.gov/mrsa/community/team-hc-providers</a></td>
</tr>
<tr>
<td>Treating Meticillin-Resistant <em>Staphylococcus aureus</em> (MRSA) infections</td>
<td><a href="http://www.cdc.gov/mrsa/community/clinicians/index.html">www.cdc.gov/mrsa/community/clinicians/index.html</a></td>
</tr>
</tbody>
</table>
return — not all lesions respond to treatment in a predictable time course. Wrestlers need to be reinspected frequently for the emergence of new lesions.

Prevention
Skin infections in wrestlers are transmitted primarily from wrestling to wrestler (1,5), so preventive measures should focus on the personal hygiene of wrestlers and early identification of wrestlers with infectious lesions (Table 2).

Prophylaxis with oral valacyclovir (1 g d\(^{-1}\)) has proven to be effective in decreasing outbreaks of HG in wrestlers with a history of outbreaks (4). Consideration also should be given to prophylaxis in wrestlers exposed to wrestlers with a recent outbreak. Oral valacyclovir has been well tolerated and is not associated with substantial adverse effects (6).

There are several protocols for eradication of MRSA in carriers (28). Indications for their use are controversial. The effectiveness of MRSA eradication protocols on decreasing subsequent MRSA infections has not been studied in wrestlers. Widespread or prolonged antibiotic treatment may induce resistant species of \(S.\) \textit{aureus} and other pathogens (27). For these reasons, MRSA eradication in possible carriers is best done in consultation with a local infectious disease specialist with knowledge of the local \(S.\) \textit{aureus} resistance patterns.

Prophylaxis with oral antifungal agents has been studied for the prevention of tinea corporis outbreaks. Oral itraconazole and fluconazole have both been studied and found to be effective in preventing tinea corpora outbreaks. However, the benefit of prophylaxis against an essentially benign condition (tinea corpora) must be weighed against the potential liver toxicity of these agents. It is the opinion of the authors that antifungal prophylaxis is indicated only in wrestlers with an extensive history of difficulty in eradicating tinea corpora or capitis.

Event Coverage
All wrestlers are inspected during the prematch weigh-in for skin lesions. At dual meets, an athletic trainer or the official for the match often conduct the prematch inspection. However, the meet or tournament physician has the final authority in determining medical eligibility for wrestling. Both the NCAA and the NFHS have Communicable Disease forms to assist the physician in determining eligibility (Table 2). It is important to note that even if a wrestler has been on the appropriate medication for the minimal time indicated on the form, the meet physician can exclude the wrestler if in their judgment the wrestler is still contagious.

In large tournaments, wrestling occurs simultaneously on multiple mats. It is important to have an athletic trainer or comparable personnel assigned to each mat because of the limited time allowed for injury assessment. High school rules allow for a total of 2 min of injury time and 5 min of “blood time” to stop bleeding. The collegiate rules allow for 90 s of injury time, and “blood time” is at the discretion of the referee. In Freestyle and Greco-Roman wrestling, both injury time and “blood time” are at the discretion of the head physician at the competition. The tournament physician should be available to assist in the on-mat assessment of injuries. Once off the mat, it is the responsibility of the meet physician to determine whether the wrestler is fit enough to wrestle in any subsequent matches.

An emergency medical plan needs to be established before the competition. This includes the location and accessibility of an automatic defibrillator and a protocol for managing C-spine injuries and summoning EMS. A procedure for handling dental injuries and avulsed teeth should also be established. A quiet, private area should be reserved for more in-depth injury assessment (including possible concussion) and wound repair.

Conclusions
It is important for physicians providing medical care to wrestlers to be familiar with the common orthopedic problems and medical conditions found in wrestlers. The physician should be up-to-date on the rules regarding weight certification and management, as well as treatment and return-to-play decisions for wrestlers with skin infections. Physicians covering wrestling competitions need to be particularly prepared for common joint dislocations, neck and spine injuries, epistaxis, and lacerations. Event physicians also should be aware of the specific rules regarding skin lesions, blood time, injury time, and return to competition.

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References

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