# Chapter 16
# The Preparticipation Physical Exam

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The preparticipation evaluation (PPE) is a necessary, yet controversial and regulated, function that serves several purposes for athletic participants. At its core, the PPE is a screening tool used to identify potentially life-threatening or debilitating conditions that may manifest as a result of athletic participation. However, there are many other objectives of the PPE that are of great importance and less controversial. This chapter will discuss the pertinent details in performing an adequate PPE with special attention to the most common life-threatening conditions. Examples of medical history questions, exam techniques, and clearance issues will be provided.

An adequate screening tool has several characteristics. It should identify readily prevalent life-threatening or disabling conditions. It should also be simple to interpret, be cost effective, and allow for very few false negatives [1]. Currently, data supporting the efficacy of the PPE to meet these requirements is lacking. Nonetheless, a PPE is required by virtually all states for participation in school-sponsored athletics. Virtually all college institutions require a full PPE upon entrance to the program. Thus, in addition to being a screening tool, the PPE is felt to serve other important objectives. These objectives include identifying predisposition to injury, determining general health, providing an entry point for adolescents into the healthcare system, and initiating discussion on topics relevant to adolescent health [2].

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Musculoskeletal assessment during the PPE is an important opportunity for the provider to become familiar with past, present, and potential future problems the athlete encounters. Up to 90 % of athletes in one survey believe the PPE can help prevent injury [3]. This indicates many athletes may have questions regarding injury prevention. The PPE provides a gateway to identify and discuss acute, recurrent, or improperly rehabilitated injuries that may predispose the athlete to other injuries. While the purpose of the PPE is not to diagnose individual conditions, further assessment can be coordinated in order to properly address the athlete's concerns. In addition to providing a comprehensive musculoskeletal assessment, the PPE can serve as an assessment of general health. In fact, the PPE may serve as an entry point for many adolescents into the healthcare system. While data is again lacking on the effectiveness of this model, multiple organizations advocate routine health exams and preventive counseling for adolescents [4]. The PPE is not designed to take the place of these visits. However, its importance in providing a platform for discussion and introduction to the concept of establishing a medical home should not be underestimated.

The setting, structure, and qualification of examiners can play a major role in the effectiveness of the PPE. Multiple settings are used ranging from an individual office visit with the athlete's primary care provider (PCP) to "gymnasium" exams where athletes are herded from station to station. Ideally, the athlete's PCP will perform the exam and coordinate further assessment if necessary. Unfortunately, this scenario is rarely feasible. The responsibility of coordinating the PPE should then fall to the team physician. The team physician may coordinate with other qualified providers. State regulations and governing bodies vary with respect to which healthcare providers are qualified to perform the PPE. However, it is recommended the history and exam be performed by the same provider to ensure all components are reviewed. Noisy gymnasium settings with multiple stations for physical exam are considered inappropriate. These settings lack privacy and fail to meet the primary objectives of the PPE [2].

The appropriate frequency of the PPE can be quite variable. There is no evidence that more frequent PPEs reduce the risk of injury or death associated with athletic participation [2]. In general, younger athletes should have more frequent evaluations. Many states in fact require yearly exams for high school-age athletes and younger. For college athletes, a comprehensive PPE is recommended any time a new athlete enters an institution. Following the comprehensive evaluation, an annual update consisting of history, height, weight, blood pressure, and problem-focused physical exam is adequate [2].

## Obtaining the Medical History

A thorough medical history is the most important portion of the PPE [2, 5]. Performing a complete history will identify 75 % of problems affecting athletes [2, 6, 19]. Ideally, parents and athletes will complete the history form together.

It is also imperative that the physician review the history with the athlete prior to the examination. Any abnormal response should prompt the physician to elicit further explanation.

An example PPE form is available for use at the American Medical Society for Sports Medicine website (www.amssm.org). It is important to know if the athlete has been previously disqualified. Any prior disqualification will require investigation including details of the diagnosis, review of medical records, and possible further subspecialty consultation before a clearance determination can be made.

Inquiring about medications, both prescription and over-the-counter, is imperative as it may provide the examiner information regarding medical conditions that the athlete failed to report. Assessment of the adequacy of prescription medications for control of chronic conditions is important. Specifically inquire about supplement use as many athletes do not report "natural" or ergogenic aids as medications. The PPE is an important time to counsel athletes on the use of such aids and possible performance expectations, as well as to assess the legality based on the sport's governing body [2].

Notation of environmental allergies may be important if the athlete is participating in an outdoor sport. Anaphylaxis to hymenoptera (e.g., bee, wasp, yellow jacket, and fire ant) envenomation should be noted and communicated with appropriate staff and coaches. The athlete with a history of anaphylaxis should be required to carry injectable epinephrine.

A primary objective of the PPE is to screen for life-threatening conditions. The estimated incidence of sudden cardiac death in high school and college athletes in the United States ranges from 1 in 83,000 (collegiate athletes only [2, 7]) to 1 in 200,000 (combine high school and college athletes; [2, 8]) per academic year. Any history of syncope or near syncope requires further, detailed, investigation. The actual historic details are the primary vehicle for separation of benign (neurocardiogenic) from malignant (ion channelopathies, structural heart disease) pathologies, with any history of exercise-induced syncope generally warranting subspecialty evaluation. Syncope after exercise is more likely related to exercise-associated collapse and carries a less ominous prognosis; however, further inquiry and potential cardiovascular evaluation may be required.

The pathology of chest pain in an athlete should be approached in an age-centered fashion. In younger athletes (ages 12–25 years), complaints of chest pain are often noncardiac in nature and may represent symptoms of exercise-induced asthma (EIA) or other noncardiac conditions. In athletes age 35–40 years, atherosclerotic disease becomes the most likely etiology [9]. Regardless of age, any athlete with complaints of chest pain in concert with syncope should undergo subspecialty evaluation.

Palpitations in athletes are often indicative of arrhythmias [2]. A history detailing the timing of the onset, heart rate, and frequency of episodes should be obtained. Use of caffeine, tobacco, illicit drugs, and supplements should also be investigated. Palpitations may be associated with syncope or presyncope. If they occur in association with exercise intolerance, lightheadedness, or chest discomfort, the athlete should be evaluated for a primary cardiac disorder.

The most common cardiac condition seen in participants of competitive athletics is hypertension. Correlating age, sex, height, and blood pressure to established percentiles is necessary to diagnose and establish severity of hypertension. Any athlete with a known or suspected history of hypertension requires further monitoring and counseling beyond the PPE to determine the safety of athletic participation.

Up to 50 % of children athletes will be diagnosed with an "innocent" murmur. Innocent murmurs are often of low grade (grade 1–2/6) and occur early in the cardiac cycle (early–mid systole). Pathologic auscultatory findings, i.e., third and fourth heart sounds (S3, S4), abnormal splitting of the 2nd heart sound, prominent (≥3/6) systolic murmurs, diastolic murmurs, etc., may be harbingers for underlying heart disease. Ejection murmurs may be accompanied by a click and are typically abnormal in any age athlete.

Eliciting a history of cardiac testing may reveal a suspected cardiac disorder that the athlete had not revealed. The examiner should obtain these medical records for review and documentation.

A detailed family cardiac history is very important. Identification of a first-degree relative that suffered sudden death prior to age 50 may place the athlete at increased risk for sudden death. It is imperative to inquire about the circumstances surrounding the relatives' death. If this history is present, the athlete should be considered for a basic workup, including EKG, echocardiogram, and lipid panel. Genetic causes of sudden cardiac death include connective tissue disorders (Marfan syndrome), ion channelopathies (long QT), and structural heart disease (hypertrophic cardiomyopathy, arrythmogenic right ventricular cardiomyopathy, anomalous coronary anatomy, and familial dilated cardiomyopathy) [2].

Controversy exists regarding the use of routine noninvasive cardiovascular screening such as ECG or echocardiography in athletes. Previously, the American Heart Association (AHA) recommended against cardiovascular screening of asymptomatic athletes with ECG or echocardiography due to the size of the athlete cohort, low prevalence of disease, limited resources, absence of a physician cadre to interpret the ECG, and the potential to create anxiety in athletes with false-positive test results [2, 9]. In a recent Scientific Statement, however, the American Heart Association recognized (with a class IIb recommendation, level of evidence C) that 12-lead ECG screening (or echocardiograms) in association with comprehensive history-taking and physical examination may be considered in relatively small cohorts of young people 12–25 years of age to identify or raise suspicion of genetic/congenital or other cardiovascular abnormalities, emphasizing *close physician involvement* and *sufficient quality control* [10]. Additionally, recognizing this need to advance integration of the cardiovascular specialist into the athlete healthcare team, the American College of Cardiology formed the Section of Sports and Exercise Cardiology in 2011, with over 4,000 current members [11].

The American College of Preventive Medicine (ACPM) position statement supports using a standardized history and physical exam (i.e., using standardized items as developed by the AHA [9, 20] to ensure uniformity and consistency in risk assessment); see Table 16.1 [11, 20]. ACPM recommends against routine screening for potential sudden cardiac death with ECG, echocardiography, and genetic testing in individuals without personal risk factors [11, 20].

**Table 16.1** Standardized history and physical

| |
|---|
| *Medical history* |
| Personal history |
| 1. Exertional chest pain/discomfort |
| 2. Unexplained syncope/near-syncope |
| 3. Excessive exertional and unexplained dyspnea/fatigue associated with exercise |
| 4. Prior recognition of a heart murmur |
| 5. Elevated systemic blood pressure |
| 6. Prior restriction from participation in sports |
| 7. Prior testing for the heart, ordered by a physician |
| Family history |
| 8. Premature death (sudden and unexpected or otherwise) before age 50 years due to heart disease, in ≥1 relative |
| 9. Disability from heart disease in a close relative aged <50 years |
| 10. Specific knowledge of certain cardiac conditions in family member: hypertrophic or diluted cardiomyopathy, long QT syndrome or other ion channelopathies, Marfan syndrome, or clinically important arrhythmias |
| *Physical examination* |
| 11. Heart murmur |
| 12. Femoral pulses to exclude aortic coarctation |
| 13. Physical stigmata or Marfan syndrome |
| 14. Brachial artery blood pressure (sitting position) |

*Source*: Adapted from Ref. [11]

Athletes with a significant neurological history, such as a seizure disorder, head injuries, concussions, stingers or burners, pinched nerves, or recurrent headaches will need a thorough history and will likely need further evaluation not possible at the PPE [2]. Preexistence of any of these conditions may indicate that the athlete is at risk for a future catastrophic neurologic injury [2]. Assessing for a history of concussions or prior head trauma allows the physician to discuss preventative strategies with the athlete as well as to counsel the athlete on the risk involved with collision sports and recurrent brain trauma.

A straightforward and easily understandable definition of concussion is "a traumatically induced transient disturbance of central neurologic function" [2]. It is important to remember that the loss of consciousness is not required to make the diagnosis of concussion, and in about 90 % of concussions, there will be no loss of consciousness [2]. Essentially, there are three main issues to consider when deciding whether it is reasonable to clear someone or return them to play after a concussion: second impact syndrome, postconcussion syndrome, and persistent neurologic deficit [2].

Stingers and burners are a common occurrence in collision sport athletes. Annually, 52 % of football athletes experience a stinger and, overall, 65 % will report at least one stinger in their career [2]. Evaluation of episodes of cervical cord neuropraxia (CCN) is also important. Athletes with CCN or recurrent stingers may benefit from a formal neurologic evaluation.

A thorough musculoskeletal history provides the examiner insight into an athlete's prior injury history and training methods. If the athlete has a history of stress fracture, further inquiry into training methods may be indicated to prevent recurrence of such injuries. Any workup that has been done on previous injuries also gives the examiner insight into the severity of the injury.

EIA is one of the most common encountered conditions of the PPE with a prevalence of 10–50 % in adolescents. In athletes who have been diagnosed with EIA, the PPE allows the physician to discuss timing and use of short-acting inhalers, avoidance of possible triggers, use of rescue inhalers during competition, and response to treatment. The physician must also maintain a high level of suspicion when the athlete complains of subtle symptoms, such as fatigue, being "out of shape," muscle cramps, and decreased stamina. Workup in such cases may be aided by performing spirometry in an exercise setting.

Heat edema, heat cramps, heat-related syncope, heat exhaustion, and heat stroke make up the spectrum of heat-related illnesses. Exertional hyperthermia is the leading cause of nontraumatic, noncardiac-related sports deaths [5]. Assessment of circumstances around the occurrence of heat illness in an athlete is important. Factors such as acclimatization, equipment, fluid intake, weight changes, medications and supplements, and history of heat illness are all important factors. Previous occurrence of heat illness does not prevent the athlete from being able to participate in sports. The importance of the PPE in these cases is to discuss prevention and treatment strategies.

Individuals with sickle cell disease should avoid highly strenuous activity and all contact and collision sports. Sudden death in athletes has been associated with sickle cell trait while doing strenuous activity in high environmental heat or altitude. Universal screening for sickle cell trait has been recommended [2]. Recommendations include asking the athlete if they have been screened for sickle cell trait. If positive for sickle cell trait, the athlete should acclimatize gradually and engage in year round training to maintain physical conditioning [2]. Education of the staff, coaches, and athletes concerning the condition and prevention of possible complications is the most important aspect [2]. The remainder of the PPE may focus on issues that are specific to the athlete. Questions concerning weight issues, menstrual history, and immunizations may be indicated based on concerns or observations of a specific athlete. Any affirmative responses on the history form should be an indicator to the examiner to obtain further information.

## Performing the Physical Exam

The purpose of the physical exam portion of the PE is to identify athletes that may be at an increased risk of disability or death during athletic participation. Essential to the exam is a thorough cardiovascular assessment as well as evaluation of the musculoskeletal system. A focused exam should be performed based on findings from the history. Table 16.2 lists the components that should be included on the physical exam.

Measurement of height and weight allows the examiner to determine the athlete's body mass index (BMI). If an athlete is underweight, it may prompt further questioning by the examiner to assess for an eating disorder.

**Table 16.2** Components of PPE

| |
|---|
| Height |
| Weight |
| Eyes |
| Visual acuity |
| Differences in pupil size |
| Oral cavity |
| Ears |
| Nose |
| Lungs |
| Cardiovascular system |
| Blood pressure |
| Pulses (radial, femoral) |
| Heart (rate, rhythm, murmurs) |
| Abdomen |
| Masses |
| Tenderness |
| Organomegaly |
| Genitalia (males only) |
| Single or undescended testicle |
| Testicular mass |
| Hernia |
| Skin |
| Rashes |
| Lesions |
| Musculoskeletal system |
| Contour, range of motion, stability |
| Symmetry of neck, back, shoulders/arms |
| Elbow/forearm, wrist/hand, hip/thigh |
| Knee, leg/ankle, foot |

Evaluation of the head, eyes, ears, nose, and throat (HEENT) begins with visual acuity measurement using a Snellen eye chart. Visual acuity should be 20/40 or better in each eye with or without corrective lenses [2]. If best corrected vision is less than 20/40, the athlete has one eye missing, or a history of a significant eye injury, they should wear protective eye wear when participating in high-risk sports.

The remainder of the HEENT exam should focus on the general well-being. The examiner should note any oral ulcers or decreased enamel that may be evidence of an eating disorder. A high-arched palate is a minor diagnostic criterion for Marfan syndrome. Athletes with braces or other oral hardware may need a mouth guard to protect from laceration. Assessment of tympanic membranes for perforation is important in water sports athletes and may necessitate use of ear plugs [2].

When evaluating the lungs of an athlete, it is important to note wheezes, rub, prolonged expiratory phase, or significant cough with a forced expiration. These conditions may need further workup or may need referral to the appropriate specialist. It is important to note that athletes with EIA may have a normal exam during the PPE.

The cardiovascular exam should focus on the four major areas outlined in the 14-element American Heart Association Recommendations for Preparticipation Cardiovascular Screening of Competitive Athletes [9]. These include generalized inspection (with specific attention to the stigmata of Marfan syndrome [12]), blood pressure measurement, femoral artery palpation (palpation of radial and femoral pulses), and cardiovascular auscultation [9].

During generalized inspection, aside from casual assessment of carotid and venous wave forms, the examiner should pay particular attention to the thoracic anatomy. Pectus deformities, scoliosis, kyphosis, and increased arm/height ratio with reduced upper torso/lower torso dimension should all raise suspicion of potential Marfan syndrome [12]. At the discretion of the examiner, a more comprehensive assessment of the revised Ghent nosology should subsequently follow (with subspecialist referral as indicated) [9, 12].

Blood pressure should be taken using an appropriate-sized cuff for the athlete. Blood pressure elevation should be interpreted using charts based on the athlete's age, sex, and height. If the initial measurement is elevated, repeat the blood pressure measurement after the athlete has sat quietly for 5 min or reclined supine for 10–15 min [2].

Palpation should begin with characterization of the radial pulse, rate, and rhythm, progressing thereafter to simultaneous assessment of the radial and femoral arteries. Findings indicative of an arrhythmia or radial/femoral artery discrepancy should be further investigated. Thereafter, precordial palpation is completed with specific attention to the anterior precordium and the point of maximal impulse. A heave or thrill in the anterior precordium, as well as a displaced, sustained, or bifid apical impulse, should alert the examiner to potential nonphysiologic pathology and subsequently be correlated with auscultatory findings.

Cardiovascular auscultation allows the examiner to integrate observations from inspection and palpation and arrive at a unified opinion of the athlete's overall cardiovascular health. Auscultation should be completed in the supine, seated, and standing positions, with integration of the Valsalva maneuver when indicated. Careful notation of the intensity of the first and second heart sounds, as well as respiratory variation (i.e., splitting) of each heart sound, should be made. Diminished auscultatory intensity of the first heart sound, end-expiratory splitting of the second heart sound, and/or paradoxical splitting of the second heart sound all suggest pathology. The presence of additional heart sounds, i.e., third (S3) and fourth (S4) heart sounds, systolic clicks, and systolic/diastolic murmurs, requires additional diagnostic diligence on the part of the examiner.

Although an S3 may be physiologic in an athlete, it should occur in isolation of other cardiovascular abnormalities. An S4, on the other hand, is always pathologic. While provocative maneuvers may be performed to help clarify cardiac murmurs (Table 16.3), (1) any mid-peaking systolic murmur grade 3/6 or higher, (2) any holosystolic or late systolic murmur, (3) any diastolic or continuous murmur, and (4) any murmur associated with a systolic click or (5) radiating to the neck or back warrant echocardiographic evaluation [13]. Particular attention should be paid to the early–mid systolic murmur that accentuates with either the strain phase of Valsalva or when rising from a swatting position (i.e., dynamic outflow tract obstruction). Grade 1–2/6, early–mid systolic murmurs in an asymptomatic athlete with an otherwise normal examination, do not warrant further evaluation [13]. Abnormal noninvasive testing should be referred for subspecialty evaluation [9].

**Table 16.3** Effects of physiologic maneuvers on auscultatory events

| Maneuver | Major physiologic effects | Useful auscultatory changes |
|---|---|---|
| Respiration | ↑Venous return with inspiration | ↑Right heart murmurs (except PS) and gallops with inspiration, splitting of S2 |
| Valsalva maneuver | ↓BP, venous return, LV size | ↑HCM (dynamic obstruction)<br>↓AS, MR<br>MVP click earlier in systole, murmur prolongs |
| Standing | ↓Venous return | ↑HCM (dynamic obstruction); ↓AS, MR<br>MVP click earlier in systole, murmur prolongs |
| Squatting | ↑Venous return, systemic vascular resistance, LV size | ↑AS, MR, AI; ↓HCM (dynamic obstruction)<br>MVP click delayed, murmur shortens |
| Isometric exercise | ↑Arterial pressure, cardiac output | ↑MR, AI, MS, PS<br>↓AS, HCM (dynamic obstruction) |

*Source*: Ref. [2, 13]

The abdominal exam should be performed with the athlete supine and the abdomen exposed to allow for sufficient inspection. Palpation of all four quadrants should be performed. Palpation of the liver and spleen should include an assessment of size. If there is any enlargement of the organs or any abdominal masses, these should be evaluated prior to clearance. In the female athlete, palpation of the lower abdomen to assess for any enlargement of the uterus may be indicated. A pelvic exam should be deferred to the athlete's primary care doctor.

Prior to performing a male genitourinary exam, the examiner should provide a brief description of and reasoning for the exam. This will help in establishing rapport with the athlete. The important aspects of this exam include presence of both testicles, testicular masses or irregularities, and inguinal hernias [2]. In an athlete with a single testicle or undescended testicle, the examiner should counsel the athlete on participation in collision sports.

Examination of the skin should include notation of acne, evidence of sun damage, rashes, infections, infestations, or evidence of intravenous drug use. Special attention should be paid to evidence of eczema, impetigo, furuncles, carbuncles, herpes simplex lesions, molluscum contagiosum, fungal infections, scabies, and louse infestations [2]. If an athlete appears to have a contagious rash or infection, clearance may be withheld until the infection clears, especially in sports that require close contact with other athletes.

The evaluation of the musculoskeletal system should focus on any areas of previous injury based on the history and on areas that may be at an increased risk of injury based on the sports. In athletes without a history of injury, the yield of a thorough musculoskeletal exam is low [2]. In these athletes, a screening exam may be performed.

Finally, assessment of the neurologic system should be performed. In general, a normal musculoskeletal exam implies normal motor function [2]. Athletes who indicate a history of recurrent stingers or burners should have an evaluation of their cervical spine as well as assessment of upper extremity strength. If a history of concussions is reported, evaluation of cranial nerves and motor, cerebellar, and cognitive function is indicated [2]. If any impairment is found on these examinations, referral for detailed neurologic testing is indicated.

**Table 16.4** Classification of sports by contact level

| Contact/collision sports | Limited contact sports | Noncontact sports |
|---|---|---|
| Basketball | Baseball | Archery |
| Boxing | Bicycling | Badminton |
| Diving | Cheerleading | Canoeing/kayaking (flat water) |
| Field hockey | Canoeing/kayaking (white water) | Crew/rowing |
| Football (flag or tackle) | Fencing | Curling |
| Ice hockey | Field events (high jump, pole vault) | Dancing |
| Lacrosse | Floor hockey | Golf |
| Martial arts | Gymnastics | Race walking |
| Rodeo | Handball | Riflery |
| Rugby | Horseback riding | Rope jumping |
| Ski jumping | Racquetball | Running |
| Soccer | Skating (ice, inline, roller) | Sailing |
| Team handball | Skiing (cross-country, downhill, water) | Scuba diving |
| Water polo | Softball | Swimming |
| Wrestling | Squash | Table tennis |
| | Ultimate frisbee | Tennis |
| | Volleyball | Track and field |
| | Windsurfing/surfing | Weight lifting |

Adapted from Ref. [9]

## Clearance Determination

The act of determining clearance for sports participation must take several questions into account. The examiner must consider if the problem places the athlete – or other athletes – at risk for injury or health problems. In addition, the examiner must consider if there are viable treatment options or other participation options for the athlete. Sports can be classified on the basis of contact or intensity (static and dynamic activity; see Tables 16.4 and 16.5). Should an issue arise as part of the PPE, the examiner has several options for clearance ranging from cleared without restrictions, cleared with follow-up, not cleared pending further evaluation, and not cleared for certain activities.

As recognized in the 2007 American Heart Association Scientific Statement on Preparticipation [11], it is not possible to achieve a "zero-risk" circumstance in competitive sports [9]. In all clearance determination issues, communication with the athlete and family regarding potential workup, treatment, and participation consequences is paramount. Communication with the athletic training staff, coaching staff, and school officials is also critical. However, patient confidentiality must be respected at all times. A release of information waiver may be signed by the athlete (or parents) allowing communication with other school personnel regarding the athlete's condition. The remainder of this section will discuss specific clearance determination issues by system.

**Table 16.5** Classification of sports by intensity level

| High-moderate dynamic | High-moderate dynamic | Low dynamic |
|---|---|---|
| High-moderate static | Low static | High-moderate static |
| Boxing | Badminton | Archery |
| Crew/rowing | Baseball | Auto racing |
| Cross-country skiing | Basketball | Diving |
| Cycling | Field hockey | Equestrian |
| Downhill skiing | Lacrosse | Field events |
| Fencing | Orienteering | Gymnastics |
| Football | Table tennis | Karate or judo |
| Ice hockey | Race walking | Motorcycling |
| Rugby | Racquetball | Rodeo |
| Running (sprinting) | Soccer | Sailing |
| Speed skating | Squash | Ski jumping |
| Water polo | Swimming | Water skiing |
| Wrestling | Tennis<br>Volleyball | Weight lifting |

Adapted from Ref. [9]

## *Cardiovascular*

Clearance for cardiovascular conditions has been established by the guidelines set forth by the 36th Bethesda Conference [9]. Any physician determining preparticipation clearance for an athlete should be familiar with these guidelines. A positive response or finding in any 1 or more of the 14 items in the recommended AHA Preparticipation Cardiovascular Screening potentially warrants a formal cardiovascular consultation [9]. An athlete should not be cleared for participation until that evaluation is completed. Refer to the Bethesda guidelines for clearance issues regarding specific cardiovascular diagnoses.

Elevated blood pressure is one of the most common abnormalities found during the PPE. The use of appropriate-sized cuffs and maintaining a quiet environment for accurate measurement are a must in all settings. For those athletes younger than 18, established blood pressure values based on height, weight, age, and gender should be used for comparison. Values between the 90th and 99th percentile are classified as stage 1 hypertension, while values greater than the 99th percentile are classified as stage 2 hypertension [10]. Athletes 18 years and older can be classified according to JNC8 guidelines [14]. An athlete with stage 1 hypertension and no evidence of end-organ damage is free to participate in all sports categories provided a physician is supervising their condition. Athletes with stage 2 hypertension or who have findings of end-organ damage require further evaluation and treatment prior to full clearance. These situations require assessment on an individual basis with respect to participation risk, severity of disease, and sport [2].

The presence of a murmur found during the PPE does not necessarily preclude clearance. The physical exam section aids in delineating potential causes – both benign

and pathologic – of such murmurs. A positive response or finding, however, in any 1 or more of the 14 items in the recommended AHA Preparticipation Cardiovascular Screening may be sufficient to warrant a formal cardiovascular referral [9]. An athlete should not be cleared for participation until that evaluation is completed. Refer to the Bethesda guidelines for clearance issues regarding specific cardiovascular diagnoses.

Another common cardiovascular condition encountered during the PPE includes arrhythmias. The presence of symptoms such as syncope and chest pain as outlined in the physical exam section should prompt further workup of a potential arrhythmia or other cardiovascular disorder. Again, reference to the Bethesda guidelines and cardiology consultation is required prior to the clearance in any athlete presenting with an arrhythmia.

## *Neurologic*

Several neurologic issues may present as part of the PPE. One of the most common involves a history of concussion. Any athlete with recent history of concussion should be fully evaluated to assess resolution of symptoms prior to return to activity. A remote history of concussion in an otherwise asymptomatic athlete should not preclude participation [2]. Utilization of baseline neuropsych testing remains a controversial subject in regard to its role in the PPE. At this time, neuropsych testing is not necessary, but may be considered as part of the PPE.

An athlete presenting for PPE clearance with a history or transient quadriplegia or CCN requires evaluation and ultimate clearance from a specialist familiar with such issues, usually a neurologist or neurosurgeon. Return-to-play issues for athletes with this history and no identifiable structural or pathological abnormalities are controversial and require assessment on an individual basis [11]. Any athlete with identified instability or progressive lesions presenting with such a history should be excluded from contact sports.

"Burners" or "stingers" on the other hand would not preclude an athlete from participation providing a detailed examination at the time of PPE is normal. Athletes with a history of recurrent episodes or prolonged symptoms, however, require diagnostic imaging to rule out a pathologic cause. Such cases would then require individual assessment and specialist evaluation prior to clearance for contact sports.

Athletes with a history of seizure disorder that is stable and well controlled can participate in virtually all sports. If the seizure disorder is new or poorly controlled, clearance should be deferred for the majority of sports. Conditioning and limited participation that do not pose increased risk to the athlete or others may be considered until the process is considered stable.

## *Musculoskeletal*

Clearance determination for athletes with musculoskeletal injuries can have many facets. Obviously review of every musculoskeletal injury is beyond the scope of this chapter. The situation surrounding the injury and the athlete's clearance will

determine how best to proceed. These factors can include whether the athlete is new or returning, the acuity of the injury, current rehabilitation status, fracture care, and postsurgical care.

Acute injuries should be evaluated for the presence of joint effusion, loss of range of motion, strength deficit, and inability to perform sports-specific skills. Full clearance will depend upon resolution of these issues. The athlete may, however, have limited participation that does not pose increased injury risk while they continue to rehabilitate. Fracture clearance and postsurgical clearance should be deferred to the treating physician.

Chronic injuries and developmental conditions must be addressed on an individual basis. The deficit, sport, and risk of injury must all be factored into the decision. Ideally, the patient's primary care physician and/or treating physician are involved in the decision-making process for clearance determination. If questions or controversy exists regarding the clearance determination, consultation with a sports medicine specialist familiar with the athlete's condition is suggested.

## *Pulmonary*

The most prevalent pulmonary disorder encountered as part of the PPE is exercise-induced bronchoconstriction. Accurate diagnosis of this disorder, however, can be quite challenging. Rarely will a complaint of exercise-induced bronchoconstriction or asthma result in a restriction of participation at the time of PPE. The physician's objective at the time of PPE should be to assess accuracy of diagnosis, severity of disease, and adequacy of treatment. Based upon these historical, clinical, and physical factors, the physician and athlete can develop a plan for further workup and intervention if needed.

## *Abnormal Vision and Eye Disorders*

One of the most common abnormalities encountered as part of the PPE is poor vision. The visual acuity test functions as the "vital sign" of the eyes. An athlete with best corrected vision of less than 20/40 in one eye is considered monocular or a functionally one-eyed athlete. The importance of this classification stems from the fact that loss of vision in the athlete's adequate eye would result in significant impairment for the athlete. Because of this, functionally one-eyed athletes are contraindicated from participation in very high-risk sports or sports where no adequate eye protection can be provided [12]. Participation in other sports is dependent upon the use of adequate eye protection during all participation including practice. Table 16.6 classifies sports based upon risk of eye injury.

Many other eye disorders may present as part of the PPE. These may include but are not limited to retinal detachment, severe myopia, history of infection, and history of surgery. When such conditions are present, consultation with the ophthalmologist is necessary to determine the level of safe participation.

**Table 16.6** Eye risk classification

| High risk | Moderate risk | Low risk |
|---|---|---|
| Shooting sports | Badminton | Bicycling |
| Boxing | Fishing | Diving |
| Full-contact martial arts | Football | Noncontact martial arts |
| Baseball/softball | Golf | Skiing |
| Basketball | Soccer | Swimming |
| Cricket | Tennis | Wrestling |
| Fencing | Volleyball | Gymnastics |
| Hockey<br>Lacrosse<br>Racquetball<br>Squash | Water polo | Track and field |

Adapted from Ref. [2], Table 24 page 70

## *Abnormalities of Abdominal Organs*

There are various conditions involving abdominal organs (i.e., liver, kidney, spleen) that may place the athlete at increased risk. Review of all such conditions is outside the scope of this chapter. The presence of hepatomegaly or splenomegaly identified on PPE should prompt further evaluation and clearance should be deferred pending evaluation. Splenomegaly is most commonly associated with acute mononucleosis. Established guidelines for participation should be strictly followed for any athlete diagnosed with mononucleosis [13]. Athletes presenting with kidney abnormalities should be cleared by a nephrologist for safe levels of participation.

An athlete with a solitary kidney has been the subject of controversy over recent years. Injury to a solitary functioning kidney would produce a dramatic change in lifestyle for any athlete. For this reason, these athletes are occasionally not cleared to participate in high-risk collision sports. These disqualifications seem to be unwarranted based on research analyzing the risk of kidney injury in sports [14, 15]. Nevertheless, the athlete, parents/guardians, and coaches should all be informed of the potential consequences of kidney injury in these athletes.

## *Gender-Specific Issues*

Female athletes with menstrual abnormalities should be evaluated by a physician familiar with the unique characteristics of the female athlete triad. If continued sports participation is determined to place the athlete at an unnecessary health risk, clearance may be denied pending further evaluation and treatment. Otherwise, most athletes with menstrual irregularities can be cleared pending further workup. Female athletes with a solitary ovary may participate without restrictions [2].

The presence of a solitary or undescended testicle in males should not disqualify the athlete from participation provided they are willing to wear protective equipment such as a protective cup [15]. An undescended testicle that has not been treated should be referred to urology for evaluation.

## *Diabetes*

The diabetic athlete poses unique challenges given the increased risk of complications including coronary artery disease, retinopathy, nephropathy, neuropathy, and gastroparesis. Athletes with such complications will need individual assessment depending upon the severity of disease and sports-specific risks. The diabetic athlete with excellent glucose control and no complications may be allowed participation without restriction. Activities such as rock climbing, skydiving, scuba diving, endurance activities, and motor sports may be considered high risk for such athletes [2].

## *Heat Illness*

The athlete with a history of heat illness or severe cramping requires special monitoring and should be identified during the course of the PPE. Detailed review of the circumstances surrounding prior issues with heat illness can help both the physician and athletic training staff to prevent future occurrences. A special consideration is the athlete with sickle cell trait. These athletes are believed to be at increased risk for exertional rhabdomyolysis and sudden death [16]. Factors such as altitude, dehydration, and heat may predispose sickle cell trait athletes to such events. Recent publications from organizations including the NCAA recommend screening for sickle cell trait if the athlete's status is not already known [2].

## *Transmissible Illness*

The risk of transmitting a blood-borne pathogen such as HIV, hepatitis B, and hepatitis C has been difficult to quantify. Given the likelihood of transmission during sports activity – while not impossible – appears incredibly remote, the presence of such illness does not warrant disqualification from participation. The health of the infected athlete, however, must be considered when determining clearance, and regular monitoring of disease progression is recommended as it would be for any member of the general population [2].

CA-MRSA poses a greater challenge due to its nearly ubiquitous presence, high degree of transmissibility with skin-to-skin contact, virulence, and potential morbidity and mortality. A history of such infection should be noted during the

history portion of the PPE. Concerning lesions or open wounds found during the exam should be covered and treated appropriately. An athlete with active infection at the time of PPE may have clearance deferred pending resolution of the infection. NCAA guidelines exist regarding participation for athletes in high-risk sports such as wrestling [18]. Return-to-activity decisions following treatment should be made by the treating physician and/or team physician based upon risk to the infected athlete as well as other competing athletes.

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