On-field pediatric injuries

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Abstract: On-field pediatric injuries are unavoidable regardless of better equipment and rule changes geared towards safer play. Initial recognition of time-sensitive injuries is important for minimizing potential long-term consequences. With appropriate knowledge and training, first-responding orthopedic surgeons should be able to evaluate and manage sudden cardiac arrest, concussion, heat stroke, and eye injuries along with the more common musculoskeletal injuries.

Keywords: Heat stroke; concussion; eye injuries; sudden cardiac death (SCD)

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Introduction

Overall participation in youth sports is on the decline (1), however, the incidence of sports-related injury in young athletes has actually increased, particularly in growing sports like lacrosse (2). Even with preventative efforts geared towards injury reduction—such as rule changes to alter tackling techniques or reduce contact, better and more technologically-advanced equipment and helmets, and improved training methods—injuries are still increasing. Orthopedic surgeons may be some of the first responders on the field of play when an injury occurs. Timely recognition and management are critical, and it is essential to determine whether a young athlete can return to play, be held out, or should go immediately to a hospital. In the face of parental pressure for children to achieve potential recruitment and scholarships, combined with ever-increasing scrutiny about safety and a growing body of research about long-term consequences of youth injuries, the responding physician has a key role and responsibility. In this article, the evaluation and management of common acute, on-field pediatric injuries—including sudden cardiac death (SCD), concussion, heat stroke, and eye injuries—will be discussed.

Sudden cardiac death

SCD is the leading cause of in-play death in young athletes. It results from intrinsic cardiac conditions that are triggered by the physiologic demands of exercise. The most common of these conditions are hypertrophic cardiomyopathy or cardiac arrhythmias, which can be asymptomatic until a patient is dehydrated or physiologically stressed. Detecting such dangerous congenital cardiovascular diseases through electrocardiogram (ECG) screening may prevent SCD from occurring (3). Many studies have suggested the effectiveness of pre-season ECG or echocardiogram screening to determine cardiac abnormalities that might predispose a young athlete to SCD (4,5). However, the use of the 12-lead ECG in pre-participation screening in children is highly controversial (6,7). Concerns of ECG screening include low cost-effectiveness and lack of sufficient infrastructure to conduct screening. Currently, both the prevalence of ECG-positive SCD-related diseases in children and the specificity, sensitivity, and predictive values of the current pathological ECG criteria when applied to a younger population are unknown. Additionally, without appropriate infrastructure and training to use an ECG, false positives that lead to additional expensive testing could take place. Many feel that SCD prevention should take a multi-faceted approach by including other preventative, and perhaps more cost-effective, measures such as providing better access to automatic external defibrillators (AED), which could also benefit a larger community (3,6,7). Should an athlete collapse with no pulse and no signs of breathing in sudden cardiac arrest, physicians on the field should immediately perform cardiopulmonary resuscitation and use an AED (3).

Concussions

Studies have shown that the annual rate of concussions in youth participants is increasing significantly in popular sports such as football, lacrosse, and soccer (8). As recent high-profile instances in the National Football League have illustrated, single—and especially recurrent—concussions can have long-term mental health and cognitive consequences. The on-field diagnosis of concussions is currently based on a player's symptoms subsequent to impact to the head. Critically, one must ascertain if the patient had an episode of loss of consciousness or disorientation and amnesia. Other symptoms of concussions include somatic symptoms (nausea, dizziness, fatigue, light sensitivity, and noise sensitivity noise sensitivity should not be there twice), cognitive symptoms (slowed reaction time and feeling mentally impaired), and unusual emotional sensitivity as well as physical signs, such as difficulty with balance, behavioral changes, and sleep disturbances (9). Research has shown that these symptoms can be reduced or eliminated if proper treatment is started early (10).

Diagnostic tools that can be used for on-field assessment include the Standardized Assessment of Concussion (SAC), the Sport Concussion Assessment Tool—5th edition (SCAT5 for ages ≥13 and Child SCAT5 for ages 5–12), the King-Devick Test, and the Balance Error Scoring System (BESS) (11,12). The SAC provides immediate sideline mental status assessment of athletes who may have incurred a concussion, takes about 5 minutes to administer, and does not require a neuropsychologist to evaluate scores. The SCAT5 is a concussion evaluation tool that incorporates the SAC and can differentiate concussed from non-concussed athletes (13). The King-Devick test is designed to assess saccadic eye movements and rapid number naming with the goal of detecting impairments of eye movement, attention, and language that would indicate a concussion (14). It usually takes about 2 minutes to complete, and while it cannot definitively diagnose a concussion, it may add value to sideline cognitive and balance tests (15). The BESS measures postural stability and is a quantifiable version of 6 modified Romberg tests for balance (14).

If it is determined that the athlete has a concussion, it is important that he or she be removed from play immediately to mitigate prolonged concussion recovery (16). The expected duration of sports-related concussion symptoms is less than 4 weeks. Prolonged recovery is defined as symptomatic for over 4 weeks (17), and patients who may be at a higher risk of prolonged recovery are those with on-field amnesia or on-field dizziness (18,19), or those who are identified with a salivary miRNA swab (20). The young athlete should rest cognitively and physically for 24–48 hours after the injury and then gradually return to school and noncontact physical activity that does not significantly exacerbate the concussion symptoms (13). They should also avoid vigorous movement while they are recovering.

There are stepwise, gradual return-to-learn and return-to-play (RTP) models for young athletes that can be personalized for each individual (21). Each of the 6 steps should take at least 1–2 days with advancement to the next level if there are improvements (13). This typically takes 1 week or more to fully complete. Early symptom-limited physical activity is encouraged; however, children and adolescents should not return fully to their sports until they have successfully returned to school (21). Management should include short-term, achievable goals that allow providers and patients to highlight gradual symptom improvement as they progress through the RTP protocol.

Heat stroke

Exertional heat stroke (EHS) has become one of the leading indirect causes of death in high school athletes and is arguably the most common cause of preventable death in young athletes (22). EHS is a life-threatening condition defined as an elevated rectal temperature greater than 40 deg C that is associated with a systemic inflammatory response leading to a syndrome of multi-organ dysfunction (23,24). EHS occurs when the body cannot lose enough heat through conduction, convection, and evaporation to offset the heat gained from the environment and metabolism. This thermoregulation is done through increasing blood flow to the skin and sweating (25). Elevated environmental temperatures, humidity, and dehydration hinder the body's ability to dissipate heat (26). Risk factors for EHS include history of heat illness or exertional cramping, poor physical conditioning, dehydration, lack of sleep, skin conditions that inhibit sweating, and medications/supplements in the bloodstream (e.g., antihistamines, anticholinergics, calcium channel blockers, beta blockers, diuretics, capsaicin, oral contraceptive, illicit drugs, and alcohol) (27,28).

The best treatment for EHS is prevention, which is geared towards slowing the progression of hyperthermia. Preventative efforts can begin with mitigating risk factors prior to preseason and into the early part of the season, when athletes are at the highest risk of developing EHS (29). These could entail educating players of the importance of physical conditioning prior to preseason; providing them conditioning guidelines; and educating them about the importance of adequate hydration, dietary salt intake, and sleep to maintain their ability to produce sweat and pump enough blood through their bodies (30). Additionally, coaches could be educated about scheduling preseason practices in the morning to avoid high temperatures and humidity; planning for practices without the use of excessive protective clothing and pads so as to keep the athletes cool; keeping cooling garments and cooling packs around during practice and game times; and the importance of gradually increasing exercise intensity and duration over the course of the preseason so that the athletes can adjust to higher temperatures in a process called heat acclimatization (29).

Rapid identification and treatment of EHS is effective at reducing its morbidity and risk of mortality (31). If an athlete exhibits disorientation, confusion, dizziness, strange behavior, irritability, headache, loss of coordination, delirium, collapse, or seizures; he or she should be taken out of play immediately, and a rectal temperature should be taken (31,32). If the rectal temperature is normal, the athlete may have exercise-associated hyponatremia (EAH) (33). EAH is when the blood sodium level is too low and can be caused by too much fluid intake. In this case, foods or drinks that are high in sodium should be given. However, if the rectal temperature is elevated, rapid whole-body cooling should be administered immediately. The athlete should be quickly placed in a tub of ice water with water continuously circulated to facilitate cold-water immersion therapy. Torso immersion should be prioritized over extremities if only partial immersion can be achieved (34). The goal is to achieve a rectal temperature less than 38.9 deg C within 30 minutes of diagnosis (35). IV saline should also be given as the resuscitative fluid.

Once the goal temperature is reached, the athlete should be transferred to the hospital for evaluation of sequelae like rhabdomyolysis and other forms of end-organ failure (29) and further fluid replacement. The urgent need to cool first cannot be overstated as individuals with EHS who present to the ED with a persisting rectal temperature greater than 41 deg C may carry an 80% mortality rate (36). Death from EHS is due to multi-organ failure including encephalopathy, rhabdomyolysis, septic shock, and hepatic and renal failure (37) caused by heat cytotoxicity, coagulopathies, and an endotoxin-mediated systemic inflammatory cytokine response (38). Studies have shown that survival nears 100% when aggressive cooling starts within 5 minutes of collapse or identification of EHS (24,33).

Eye injuries

Eye injuries comprise approximately 1.5% of all sports injuries. Sports with a high risk of eye injuries include baseball/softball, basketball, racquetball, squash, lacrosse, wrestling, hockey, and fencing (39). Baseball and basketball are associated with the most eye injuries in 5- to 24-year-old (40). Although eye injuries are relatively rare, they are clinically important because they are one of the most common causes of permanent visual impairment (41). Symptoms of eye injuries include pain, diminished vision, diplopia, spots and lights in the visual field, bleeding, swelling, foreign body sensation, and discoloration of the sclera. The majority of sport-related eye injuries are due to blunt trauma, which can result in hyphema (rupturing of the blood vessels of the iris), retrobulbar hemorrhage (which can lead to orbital compartment syndrome and permanent visual loss due to raised intraocular pressures), retinal tear or detachment, and globe rupture (42). Other serious eye injuries include orbital fractures and penetrating eye trauma. With these injuries, the athlete should not return to competition and cannot return until clearance by an ophthalmologist. For corneal abrasion, corneal foreign body, eyelid laceration, burns, and radiation exposure, the athlete may return to play if bleeding is controlled, and there is no functional or binocular loss of vision (42).

Initial management of the eye injury should begin with questioning about the mechanism of injury, the force and direction of impact, and whether the athlete was wearing contact lens at the time of injury. Past medical and surgical history relating to the eye should be inquired as well since high myopia, previous eye injury or infection, or previous eye surgery predisposes for globe rupture (43). On physical exam, evaluation of visual acuity with a Snellen chart should be done first to assess if vision has changed. The visual fields should also be checked to evaluate for retinal, optic nerve, or central nervous system injury. The pupils can be tested for reaction to light, accommodation, and constriction with a penlight or phone light to assess for retinal and optic nerve injury. Additionally, extra-ocular movements and facial sensation should be assessed. Eyelids, conjunctiva, and sclera should be inspected for a change in color, edema, and visual sensitivity, and the cornea and the lens should be inspected for opacities. An ophthalmoscope or fundoscope can be used to check the optic disc and retina for hemorrhage or detachment.

For serious eye injuries like a globe rupture, retinal detachment, penetrating eye trauma, or hemorrhage, the patient should be prepared for a potential emergency surgery and should be withheld from oral intake of food and fluids (43). If globe rupture is likely, a specific eye shield or a plastic or Styrofoam cup should be applied as protection over the eye. The athlete should be kept sitting and given analgesics and antiemetics in order to avoid any Valsalva maneuver that could increase intraocular pressure. Hyphema can be managed acutely with an eye shield, lying down with the head elevated, cycloplegic drops, and avoidance of any aspirin-containing products (42,43) until the ophthalmologist is seen. For less serious injuries like corneal abrasions and foreign bodies, the on-field sports medicine physician can do more to return the athlete to play. Small corneal abrasions may be examined with fluorescein dye and treated with a topical antibiotic like chloramphenicol and cycloplegic drops. Athletes with contact lenses may want to be seen by an ophthalmologist afterwards as they are more likely to develop infection, and they should discontinue their lenses use until healing and drops are stopped. For corneal foreign bodies, irrigation of the eye should be done including under the upper and lower lid (lids should be inverted). A moistened cotton swab can also be used to remove the object. Use of topical antibiotics is not necessary but is recommended in an athletic setting where hygiene may be less optimal (42).

Conclusions

On-field pediatric injuries can happen regardless of better equipment and rule changes geared towards safer play. First responders on the field of play must be able to recognize and manage injuries when they occur. Every second counts for EHS and sudden cardiac arrest, and even with non-life threatening injuries like concussions and eye injuries, a timely recovery back to full function depends on initial recognition and management of symptoms. With appropriate knowledge and training, first-responding orthopedic surgeons should be able to manage and stabilize sudden cardiac arrest, concussion, heat stroke, and eye injuries along with the more common musculoskeletal injuries.

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