

Exertional Heat Illness (EHI) in Athletes

See also Heat Illness

See also Heat Related Illness (Peds)

Background

1. Definition

- Potentially fatal process where elevated core temperature, vital organ dysfunction and dehydration occur as a result of exercising in warm/hot conditions

2. General info

- Most likely to occur during late summer mos
 - Environmental conditions hot/humid
- Football especially prone
 - 2-a-day practices-usually in first 4 days of practice
 - Bulky equipment, decr heat dissipation
- Wrestling
 - Participants try to lose weight with sweat suits and plastic wraps
- Young healthy athletes can be treated aggressively
 - Use caution treating athletes at extremes of ages
- **Wet bulb globe temperature (WBGT)**
 - Developed in 1950's for military to help reduce heat casualties during training
 - Often used by occupational and athletic venues
 - $WBGT = 0.7(T)wb + 0.2(T)bg + 0.1(T)db$
 - (T)wb- temp measured by natural wet bulb for humidity
 - (T)bg- temp measured by black globe where a thermometer is placed into a black copper globe for radiant heat stress
 - (T)db-temp measured by ambient dry thermometer
 - Used to make recommendations for activity environmental conditions
 - Green <18°C (64.4°F)
 - Risk low but still exists
 - Yellow 18°-23°C (64.4-73.4°F)
 - Moderate risk incr as event progresses
 - Red 23°-28°C (73.4-82.4°F)
 - High risk be aware of injury potential
 - Individuals w/risk factors should not compete
 - Black >28°C (82.4°F)
 - Extreme risk reschedule or delay event
 - If event continues, must be on high alert for EHI
- ACSM Position Stand: Exertional Heat Illness During Training and Competition
 - <http://www.acsm-msse.org/pt/pt-core/template-journal/msse/media/0307.pdf>
- ACSM Position Stand: Exercise and Fluid Replacement
 - <http://www.acsm-msse.org/pt/pt-core/template-journal/msse/media/0207.pdf>

Pathophysiology

1. Pathology of dz

- Imbalance between heat generation and dissipation
 - During exercise body generates heat as by-product of energy utilization
 - Body dissipates heat from convection, radiation, conduction
 - Conduction (evaporation) most effective in humans
 - Body produces sweat which cools body as it evaporates
 - If evaporation is impaired, body has difficulty cooling
 - Any environment where sweat cannot evaporate places athlete at risk for EHI
 - Exercising in a hot, humid environment
 - Wearing heavy restrictive clothing
 - Dehydration (SOR:B)
- Unlike other heat related injuries, EHI pts
 - Sweat profusely
 - Respond rapidly to aggressive cooling measures

2. Incidence/ prevalence

- Most studies done in military athletes/settings
 - During 2002 the Army had 3.8/1000 person yrs for all heat related illnesses
- National Center for Catastrophic Sports Injury Research report from 1995 to 2005
 - 26 high school, collegiate and professional athletes died from exertional heat injuries
- Often seen in late summer when training begins
 - Football-single largest group of athletes at risk
 - Soccer
 - Cross country
 - Wrestling

3. Risk factors (SOR:B)

- Lack of fitness
- Obesity/elevated BMI
- Not acclimatized to heat
- Current illness
 - Diarrhea
 - Vomiting
- Inadequate fluid intake/dehydration
- Sweat gland dysfunction
- Sunburn
- Previous Hx of EHI
- Lack of sleep
- Medications/drugs
- Additional risks
 - Alcohol/caffeinated drink consumption
 - Predisposing medical conditions
 - Excessive clothing/equipment
 - Especially dark colored clothing
 - Plastic wraps/sweat suits
 - Overeager athlete

4. Morbidity/ mortality

- Related to length of time between collapse and initiation of cooling therapy
- If Tx w/in an hr of onset, most athletes recover fully

Diagnostics

1. History

- Early detection important
- Hx of strenuous exercise in hot environment
- Heat injury spectrum
 - Many athletes progress w/o recognizing S/S
 - From heat rash through heat cramps
 - Heat exhaustion to heat stroke
- Wet bulb globe temp trend starting 3 days prior places athletes at risk
- Absolute body core temp upon arrival is not critical for Dx especially if cooling began in field
- Presents with:
 - N/V
 - Not feeling "well"
 - Ataxia
 - Confusion
 - Delirium
 - Obtundation
 - Seizures
 - Death
- Children:
 - See Peds Heat Related Illness
- Older athletes
 - More susceptible to heat injury
 - Due to co-morbid conditions
 - Aging physiology cannot tolerate aggressive cooling methods
- Athletes with spinal cord injuries
 - Increased risk for heat injury-autonomic instability
 - Altered vascular tone leading to pooling in lower extremities
 - More difficult to cool these athletes

2. Physical exam

- Need RECTAL temp
 - Typically between 38.9-43.3°C (102-110°F)
 - If cooling has started enroute it may already be lower
 - Check w/EMS for initial temp
- VS
 - BP usually low 90/60
 - Tachycardia
 - Hyperventilation
- Mental status:
 - Normal to obtundation
- Skin:
 - Sweating

3. Dx testing

- Lab eval looking for evidence of end organ damage
 - CBC
 - Elevated WBCs may suggest infectious cause for elevated temp
 - Elevated H/H: hemoconcentration
 - Electrolytes
 - Low sodium: hyponatremia
 - Elevated BUN/ creatinine: acute renal failure
 - Liver enzymes
 - Elevated liver enzymes: liver injury
 - UA
 - Concentrated specific gravity: dehydration
 - Blood or protein
 - CPK
 - If elevated: consider rhabdomyolysis
- Dx imaging
 - Only if another dx is suspected

Differential Diagnosis

1. Illness

- Pneumonia
- Influenza
- Sepsis
- Meningitis
- Viral illness

2. Electrolyte abnormality

- Hyponatremia
- Hypoglycemia

3. Drugs/ toxins

4. CVA/ seizures

5. MI/ arrhythmia

6. Sickle cell crisis

Therapeutics

1. Acute treatment

- Early on-site mgmt
- Cooling athlete is most important
 - Start in the field w/removing clothing down to t-shirt and shorts
 - Ice packs to groin, axilla, neck
 - Transport for definitive cooling
 - Ice submersion (SOR:A)
 - Fastest cooling rate
 - Lowest morbidity/ mortality
 - Modified ice submersion:
 - Use sheets soaked in ice water placed over pt (SOR:C)
 - Incl massaging extremities to improve blood flow
- IVF 1-2L bolus, best if cool~18°C (~ 65°F)

- Athlete may need 3-4L
- Cool until rectal temp of 38.8°C (102°F) to avoid over cooling
- Maximum body temp not as important as duration of overheating
- 2. Further mgmt (24 hrs)
 - Should remain under supervision for 6 hrs
 - Repeat same lab eval at 6 hrs to ensure a trend towards or normalization of abnormalities
 - Follow urine output
 - Ideal is > 50 mL/hr
 - Can discharge home if <6 hrs
 - Labs return to normal
 - Mental status clears
 - If evidence of ongoing end organ damage; need continued Tx
 - Incr LFTs most common abnormality
 - May take up to a wk to return to normal
- 3. Long-term care
 - Usually not needed

Follow-Up

1. Return to play guidelines (SOR:C)
 - Recommendations
 - After discharge from medical care, no strenuous exercise for 7 days
 - Follow up exam and lab testing should be at 1 wk
 - Repeat lab testing or dx imaging as indicated
 - Once cleared for activity; gradually incr exercise and heat exposure based on athlete's tolerance
 - Incr duration, heat exposure and intensity over 2 wks
 - If return is difficult, consider a lab exercise heat tolerance test at one month
 - May take 2-4 wks to return to full activity
2. Refer to specialist
 - If continuing evidence of end organ damage
3. Admit to hospital
 - If mental status has not cleared after temp normalizes
 - Evidence of continuing end organ damage at > 6 hrs

Prognosis

1. Good if recognized and treated early
2. Can return to practice and competition when athlete has reestablished heat tolerance (SOR:B)

Prevention

1. Medical care available at practice/ events
 - Providers familiar w/treating heat illness
2. Limit intensity/ duration until acclimatized
3. Acclimatization
 - 10-14 days of exercise training in heat
 - Reduces risk of EHI (SOR:C)

4. Proper hydration
 - Fluid replacement recommendations
 - Urine color chart
 - <http://www.owl.net.rice.edu/~heal103/docs/Am%20I%20Hydrated%20-%20Urine%20Color%20Chart.pdf>
 - <2% body wt change
 - Weigh athlete before and after practice
 - If > 2% change they should drink fluids until at pre-practice weight
5. Increased salt consumption to 2 g per day
6. Limit amount of clothing/ equipment
 - Light colored clothing
7. Assure good physical condition if exercising in heat
8. Avoid alcohol consumption
9. Limit caffeine consumption
10. Exercise when cool or early morning
 - Avoid 10am - 5pm
11. Workout to rest cycles
 - Increase number and length of rest periods

References

1. Armstrong, LE PhD, et al; American College of Sports Medicine position stand. Exertional Heat Illness During Training and Competition. *Med Sci Sports Exerc.* 2007 Mar; 39(3):556-72. Review
2. Gaffin SL PhD, et al; Cooling Methods for Heat Stroke Victims, *Annals of Internal Medicine*, 2000 April; 132(8): 678
3. Sims ST, et al; Sodium Loading Aids Fluid Balance and Reduces Physiological Strain of Trained Men Exercising in the Heat; *Med Sci Sports Exerc.* 2007; 123-130
4. O'Connor FG MD; Guidelines for Return to Duty (Play) After Heat Illness: Military Perspective. *Journal of Sports Rehabilitation.* 2007, 16 227-237
5. Gardner JW MD Dr PH et al; Risk Factors Predicting Exertional Heat Illness in Male Marine Corps Recruits. *Med Sci Sports Exerc.* 1996, 939-944
6. Kark JA MD et al. Exertional Heat Illness in Marine Corps Recruit Training. *Aviation, Space and Environmental Medicine*, 1996, April; (67) 4; 354-360
7. Howe AS, Boden BP; Heat Related Illness in Athletes. *Am J of Sports Medicine.* 2007; November; (35); 1384-95.
8. Wallace RF et al. The Effects of Continuous Hot Weather Training on Risk of Exertional Heat Illness. *Medicine & Science in Sports & Exercise.* 2005 Jan; 37(1):84-90e.

Evidence-Based Inquiries

1. How common is symptomatic hyponatremia in endurance athletes?

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