Exertional Heat Illness
Overview

Objectives
- Thermoregulation
- Heat injuries
- Predisposing factors
- Return to activity
- Prevention

Sudden Death in Athletes

#1 overall cause:
- Cardiovascular conditions
- Very difficult to prevent

#1 non-CV cause:
- Exertional Heat Illness (EHI)
- More preventable

Thermoregulation

Metabolic Heat +
Environmental Heat +

Body Temperature

Thermoregulation (cont.)

Heat exchange mechanisms

Thermoregulation (cont.)

Heat gain (+)  Heat loss (-)

Metabolic
Convection
Conduction
Radiation
Evaporation

* When Environmental $t^e$ < Skin $t^s$
Non EHI Injuries

• Parade Syncope - syncope from standing in the heat
• Dehydration
• Vasovagal reactions
• Heat edema
• Heat rash

Types of EHI

• Heat Cramps - skeletal muscle cramping, usually in abdomen or extremities
• Heat Exhaustion – inability to continue to exercise (+/- collapse), but no lab evidence of organ dysfunction

Types of EHI (cont)

• Rhabdomyolysis – muscle damage causing CPK > 3000 (> 5 x upper limit of normal), possibly leading to AKI
• Heatstroke – CNS dysfunction (mental status changes ranging from confusion to delirium to seizure, coma and death) with lab evidence of organ dysfunction (e.g. renal, hepatic, muscle)

Early Signs and Symptoms

• weakness
• fatigue
• headache
• slowed mentation

• thirst
• muscle cramps
• nausea, vomiting
• diarrhea

Heat Cramps

• Etiology: fatigue > Na+ loss > dehydration
• Symptoms
  • Painful muscle contractions
  • Skeletal muscle only
  • Last 1-3 min usually, up to 8 hours

Exertional Rhabdomyolysis

• Etiology: intense exertion, muscle damage
• S/S
  • Muscle pain, but not cramps
  • Muscle tenderness, +/- swelling
  • May have rice-urine
Heat Exhaustion

• Etiology:
  • widespread peripheral vascular dilation
  • Heat and dehydration usually involved

• S/S
  • VS: high HR, low BP
  • Sweaty, pale, ashen appearance
  • Headache, irritability, n/v, decreased coordination, weakness, dizziness
  • May have muscle cramps
  • Temp < 40 °C

Exertional Heatstroke

• Temp > 40.5°C (105°F)
• S/S of heat exhaustion, PLUS
  • disorientation
  • confusion
  • dizziness/ataxic gait
  • irrational behavior
  • Inappropriate comments
  • seizures, coma
  • Organ dysfunction: Kidneys, liver, clotting system

Diagnosis of Heat Stroke

• In a previously healthy individual who collapses when exerting in a hot environment for long periods, and whose rectal temperature is above 40.5°C (105°F), the diagnosis of heat stroke is virtually certain


**Table 139-1** Usual Characteristics of Heatstroke

<table>
<thead>
<tr>
<th>EXERTIONAL</th>
<th>CLASSIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Healthy</td>
<td>Predisposing factors/medications</td>
</tr>
<tr>
<td>Younger</td>
<td>Older</td>
</tr>
<tr>
<td>Exercise</td>
<td>Sedentary</td>
</tr>
<tr>
<td>Sporadic</td>
<td>Heat wave occurrence</td>
</tr>
<tr>
<td>Diaphoresis</td>
<td>Anhidrosis</td>
</tr>
<tr>
<td>Hypoglycemia</td>
<td>Normoglycemia</td>
</tr>
<tr>
<td>DIC</td>
<td>Mild coagulopathy</td>
</tr>
<tr>
<td>Rhabdomyolysis</td>
<td>Mild CPK elevation</td>
</tr>
<tr>
<td>Acute renal failure</td>
<td>Oliguria</td>
</tr>
<tr>
<td>Marked lactic acidosis</td>
<td>Mild acidosis</td>
</tr>
<tr>
<td>Hypocalcemia</td>
<td>Normocalcemia</td>
</tr>
</tbody>
</table>

**CPK**, creatinine phosphokinase; **DIC**, disseminated intravascular coagulation.

**AXIOM**

A sudden collapse during physical exertion carried out under warm climatic conditions should a priori be diagnosed as heat stroke (unless and until proven otherwise)
Spectrum of Severity

- Heat exhaustion
- Heat Stroke
- Rhabdomyolysis and cramps can present anywhere on the spectrum

Core Body Temperature

- MUST assess by rectal thermistor
- Heat exhaustion
  - T usually < 40
- Heat Stroke
  - T > 40
  - T > 40 by itself is NOT diagnostic of heat stroke, need CNS/organ dysfunction also

Core Temperature — necessary in assessment but NOT good method of predicting level of severity or outcome.

Exercise Associated Collapse

- Conscious/oriented
- Unconscious/disoriented
- Positional Hypotension
- Rectal Temperature
  - <95F
  - 95F-103F
  - >=104F
  - Hypothermia
  - EAC
  - Hyperthermia

EHI Initial Eval & Treatment

- Rest
- Shade
- Remove excess clothing/equipment
- Fluid replacement (electrolytes)
- Measure core temperature!
- Cooling (if necessary)

Muscle Cramps

- Rest, Massage, Stretch, Oral hydration, Ice
- Re-eval in 10-15 minutes
- Serum Na+, give 2 liters of IV saline
- Re-eval in 10-15 minutes
- Transport if poor response

BOX 139-6 DIFFERENTIAL DIAGNOSIS OF HEATSTROKE

- CNS hemorrhage
- Toxins/drugs
- Seizures
- Malignant hyperthermia
- Neuroleptic malignant syndrome
- Serotonin syndrome
- Thyroid storm
- High fever/sepsis
- Encephalitis/meningitis

CNS, central nervous system.
Heat Exhaustion

- Monitor VS
- Cooling if hyperthermic
- Supine, legs up
- Most improve w/ rest, oral hydration
- IV fluids (NS) if slow response
- No evidence for faster recovery

Heatstroke Treatment: Cool Quickly! (after calling EMS)

External cooling
- Cold ice packs
- Water spraying
- Fans
- Cooling blankets
- Ice bath

Internal cooling
- Intravenous fluids
- Peritoneal lavage

Antipyretics have no role in the acute treatment of heatstroke

Temperature - duration area

The severity of the illness is a function of the temperature-duration area above a critical temperature (40.6°C), not so much the absolute max temperature.

Methods of rapid field cooling

- Mist spray and fanning
- Ice in axillae, groin, neck
- Ice water bath immersion

Monitoring Response to Cooling

- Monitor mental status
- Temp will drop rapidly, 10~30 minutes
- When 39°C reached, STOP ice bags/ice bath
- Continue cooling w/ mist/fan until about 38°C
- If prolonged temp elevation, think fever
- Transport ASAP!

Cooling modalities to lower body temperature in heatstroke

Preferred
- Evaporative cooling using large circulating fans and skin wetting
- Ice water immersion

Adjuncts
- Ice packs to axillae and groin
- Cooling blanket
- Peritoneal lavage (unproven efficacy in humans)
- Rectal lavage
- Gastric lavage
- Cardiopulmonary bypass
Return to activity

- Heat Cramps: maybe same day
- Heat Exhaustion: 1~3 days
- Heatstroke: 2~3 weeks at least

Prevention is the Best Treatment

Predisposing factors

- Previous Hx of heat stroke
- Medications
- Sweat gland dysfunction
- Upper respiratory illness
- Gastrointestinal illness
- Overmotivation
- Genetic predisposition
- Lack of acclimatization
- Hot and humid climate
- Dehydration
- Obesity
- Excessive clothing
- Low physical fitness
- Sleep deprivation
- Lack of acclimatization
- Hot and humid climate
- Dehydration
- Obesity
- Excessive clothing
- Low physical fitness
- Sleep deprivation
- Lack of acclimatization
- Hot and humid climate
- Dehydration
- Obesity
- Excessive clothing
- Low physical fitness
- Sleep deprivation

Heat Acclimatization

- Exercise in the heat
- Improves response to heat in a few days, most gains within 10 days
  - Increase blood volume
  - Increase stroke volume
  - Decrease resting heart rate
  - Decrease metabolic heat production
  - Sweat sooner, more, and with less sodium
  - Skin vasodilates more quickly

Prevention

- Avoid working in high heat load
- Plan work rest cycles
- Avoid the sun (work at night)
- Calculate heat index
- Sleep at list 6 hours a day
- Drink (cool and flavored water)
- Consider salt intake (food)
- Acclimatize (>2 weeks)
- Understand the cumulative effects of heat
- Educate athletes, coaches
Wet Bulb Globe Temp (WBGT)

- Used to determine risk of heat illness
- Depends on athletes’ risk
- Depends on activity type

Points to Remember

- Assume heatstroke in any collapsed athlete in hot conditions; COOL FAST!
- Assess core temp ASAP, but it alone doesn’t define heat stroke
- Heatstroke = T >40 + CNS dysfxn + organ damage
- Cooling: ice bath + mist/fan + ice bags

Thank you