EXERTIONAL HEAT INJURIES
AMOPS - 2013

CDR Steven M. Kriss, DO, MC USN FAWM
Family Medicine/Sports Medicine
Senior Medical Officer
Federal Healthcare Center Captain James A. Lovell
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OBJECTIVES

- To understand the **epidemiology** of exertional heat injuries (EHI) in the U.S.
- To understand the **spectrum** of EHI, their nomenclature and their signs and symptoms
- To understand the **treatment** of EHI in the field, in the clinic and in the hospital
- To understand the **risk factors** for EHI
- To understand how to **prevent** EHI
- To understand **return to play guidelines** after an EHI
EPIDEMIOLOGY

- 9,000 cases of EHI per year from 2005-2009
- Highest incidence in American Football
- 31 deaths from EHS in football since 1995
- EHI cases during Marathons, Triathlons and other ultra-endurance events
- Nexus between high temperature, high humidity and EHS
- 300 cases of EHS in the U.S. military in 2009
- No decrease in DOD cases despite new policies
RANGERS HIKING
HEAT INDEX

NOAA's National Weather Service

Heat Index
Temperature (°F)

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Likelihood of Heat Disorders with Prolonged Exposure or Strenuous Activity

- Caution
- Extreme Caution
- Danger
- Extreme Danger
The Hypothalamus regulates temperature via:
- Evaporation
- Radiation
- Convection
- Conduction
ACCLIMATIZATION

- **Plasma volume** expansion
- Increased cutaneous **blood flow**
- Increased **sweating**
- **Decrease salt** in sweat
- Lower temperatures achieved during exercise
RISK FACTORS FOR EHI

- Intense exercise
- Obesity
- Low fitness level
- Dehydration
- Fever
- Past History of EHI
- Sleep deprivation
- Heavy or restrictive clothing
- Lack of proper acclimatization
- Medications, drugs, supplements
HEAT CRAMPS
HEAT CRAMPS

- Muscle cramps that occur during exercise
- **Pre-disposing factors:**
  - Salty sweaters and heavy sweaters
  - Dehydration
  - Inadequate sodium intake
  - Lack of acclimatization to heat
- **Treatment:**
  - Oral hydration
  - IV hydration
  - Electrolyte replacement
EXERCISE ASSOCIATED COLLAPSE (EAC)

- **Syncope** after completion of endurance events
- **Mechanism**: sudden decrease in venous return caused by loss of pressure of muscles on blood vessels
- **Treatment**: Lie person supine, elevate feet, give oral or IV Fluids

- **Warning**: No recovery after 15 min should prompt investigation for Heat Stroke (using a rectal thermometer) and/or Cardiac causes
HEAT EXHAUSTION

- **Clinical Criteria:**
  - Inability to continue exercise (decrease in Cardiac Output)
  - Core temperature near 101-104 F
  - NO Central Nervous System (CNS) dysfunction

- **Signs and Symptoms:**
  - Tachycardia
  - Dehydration and electrolyte disturbances
  - Ataxia, weakness, syncope or light-headedness
  - Usually (but not always) significant sweating
  - Headache, abdominal cramps
HEAT EXHAUSTION

- **Treatment:**
  - Lie patient supine with legs elevated
  - Remove excess clothing
  - Cool to 101 F using Ice Water Immersion, spraying with water, fanning or placing ice near the major arteries (neck, axilla, groin)
  - Oral or IV hydration and electrolytes
  - Monitor Vital Signs every 5-10 minutes
  - EMS transport if no improvement
EXERTIONAL HEAT STROKE
EXERTIONAL HEAT STROKE (EHS)

- Multi-system disorder with **CNS dysfunction**
- Other **end-organ damage**: rhabdomyolysis, renal dysfunction (dec urine output), elevated LFTs, cardiac arrhythmias
- S/S present in Heat Exhaustion
- **Temperature DOES NOT have to be > 104 F**
- Prognosis is worse the longer above 104 F
- **Differential Diagnosis:**
  - Cardiac arrest
  - Exertional hyponatremia
  - Malignant hyperthermia
PRE-HOSPITAL MANAGEMENT

- Circulation, Airway, Breathing (CAB)
- Vital Signs with *rectal temperature*
- Blood Glucose and Sodium
- Remove excess clothing
- **Ice Water Immersion or iced towels/wraps**
- Monitor **Vital Signs every 5 minutes**
- Stop cooling when temperature = 101-102 F
- Activate the EMS by calling 911

**Warning**: Waiting for EMS to cool patient can be fatal as the cells in the body will “cook”
Hospital Management

- Rapid **cooling**
- **Primary Survey and Secondary Survey**
  - Evaluate for Systemic Inflammatory Response Syndrome (SIRS)
- **Labs**: CBC, Chem-7, UA, CK, LFTs, Coag panel, lactate, toxicology panel
- **ECG**, Troponin, ABG or VBG
- **Radiography**: CXR, CT Head
- **IV Fluids and electrolyte correction**
- **Treatment of complications**
- Admit to **ICU** and **consult** specialists
COMPLICATIONS

- **Electrolyte** disturbances
- **Delirium** and Seizures
- Respiratory failure/ARDS
- **Rhabdomyolysis**
- **Renal failure**
- Hepatic injury
- Disseminated Intravascular Coagulation (DIC)
- Myocardial injury
- GI bleeds and GI ischemia
TREATMENT VIDEOS

- Field, sports event and clinic methods of rapid cooling
- Taco, Burrito and Ice-Water Immersion
HYponatremia

- Exercise Associated Hyponatremia (EAH)
- Common with increased endurance sports such as Triathlons and Marathons
- Risk factors: overzealous fluid replacement, weight gain during endurance events
- Female gender
- Pathophysiology: Rapid lowering of sodium to less than 120 mmol/L causes swelling of brain and increased cerebral pressure
- Signs and symptoms: weakness, dizziness, headache, nausea, mental status changes
HYponatremia treatment

- Fluid restriction
- Immediate EMS transfer to nearest hospital ICU
- Bladder catheterization to monitor Input vs Output
- 3.0% IV Saline
- Diuretics

Prevention: Avoid overzealous fluid replacement
PREVENTION OF EHI

- Wet Bulb Globe Temperature (WBGT)
- Education
- Acclimatization
- Uniforms and clothing
- Adequate sleep
- Avoid medications, drugs and supplements
- Policies and Instructions
# WORK REST CHART

## Work/Rest and Water Consumption Table

Applies to average sized, heat-acclimated soldier wearing BDU, hot weather. (See TB MED 507 for further guidance.)

<table>
<thead>
<tr>
<th>Easy Work</th>
<th>Moderate Work</th>
<th>Hard Work</th>
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</table>
| • Weapon Maintenance  
• Walking Hard Surface at 2.5 mph, < 30 lb Load  
• Marksmanship Training  
• Drill and Ceremony  
• Manual of Arms | • Walking Loose Sand at 2.5 mph, No Load  
• Walking Hard Surface at 3.5 mph, < 40 lb Load  
• Calisthenics  
• Patrolling  
• Individual Movement Techniques, i.e., Low Crawl or High Crawl  
• Defensive Position Construction | • Walking Hard Surface at 3.5 mph, ≥ 40 lb Load  
• Walking Loose Sand at 2.5 mph with Load  
• Field Assaults |

### Heat Category

<table>
<thead>
<tr>
<th>Heat Category</th>
<th>WBGT Index, °F</th>
<th>Easy Work</th>
<th>Moderate Work</th>
<th>Hard Work</th>
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<tr>
<td>1</td>
<td>78° - 81.9°</td>
<td>NL</td>
<td>½</td>
<td>NL</td>
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<tr>
<td>2 (GREEN)</td>
<td>82° - 84.9°</td>
<td>NL</td>
<td>½</td>
<td>50/10 min</td>
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<td>3 (YELLOW)</td>
<td>85° - 87.9°</td>
<td>NL</td>
<td>¾</td>
<td>40/20 min</td>
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<td>4 (RED)</td>
<td>88° - 89.9°</td>
<td>NL</td>
<td>¾</td>
<td>30/30 min</td>
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<td>5 (BLACK)</td>
<td>&gt; 90°</td>
<td>50/10 min</td>
<td>1</td>
<td>20/40 min</td>
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</table>

- The work/rest times and fluid replacement volumes will sustain performance and hydration for at least 4 hrs of work in the specified heat category. Fluid needs can vary based on individual differences (± ¼ qt/hr) and exposure to full sun or full shade (± ¼ qt/hr).
- **NL** = no limit to work time per hr.
- **Rest** = minimal physical activity (sitting or standing) accomplished in shade if possible.
- **CAUTION:** Hourly fluid intake should not exceed 1½ qts.
  
  **Daily fluid intake should not exceed 12 qts.**
- If wearing body armor, add 5°F to WBGT index in humid climates.
- If doing Easy Work and wearing NBC (MOPP 4) clothing, add 10°F to WBGT index.
- If doing Moderate or Hard Work and wearing NBC (MOPP 4) clothing, add 20°F to WBGT index.

For additional copies, contact: U.S. Army Center for Health Promotion and Preventive Medicine Health Information Operations Division at (905) 223-9696 or CHPPM - Health Information Operations@apg.army.mil.


June 2004
RETURN TO PLAY AFTER EHI

- Controversial
- Vital signs stable
- Patient must be asymptomatic
- Blood tests should be normal
- Gradual increase in physical activity levels
- Some suggest one week of rest before exercise

* Heat Tolerance Testing (similar to Exercise Treadmill Testing for the Heart and mTBI Stress Testing for the Brain)
FEMALE RUNNER ON BEACH
FEMALE RUNNER COLLAPSING IN RACE
CASE NUMBER 1

- 35 yo novice female runner with EAC and mental status changes during 10K race in JAX, FL presents to EMS on the race course

- What do you want to know?
Young boy playing in summer heat
CASE NUMBER 2

- 12 yo male with Hx fever and diarrhea playing outdoors in FL during the summer presents to ED with mental status changes and temp = 106 F

- Questions about this patient?
Marines training at Camp Lejeune
CASE NUMBER 3

- Camp Lejeune, NC: 2 Marines from a pre-deployment field exercise present to the ED within 2 hours with Altered Mental Status and temperatures > 105 F

- What do you do as the ED attending?
MARSOC MARATHON
CASE NUMBER 4

- Camp Pendleton, CA: 35 yo male running a Marathon in the mountains of the base has brief LOC and cannot continue race due to weakness

- What are next steps in his management?
MARINES PATROLLING ON OKINAWA
CASE NUMBER 5

- Camp Hansen, Okinawa, Japan:
- 25 yo male Marine presents to the Hansen Branch Medical Clinic with Altered Mental Status and rectal temperature of 107 F

- You are the EHI Treatment Team Leader. What do you do now?
REFERENCES

- **Up to Date** On-Line
- American College of Sports Medicine (ACSM) Position Stand on EHI
- Wilderness Medical Society (WMS) guidelines on EHI
- ACSM Sports Medicine A Comprehensive Review
- Clinical Sports Medicine - Johnson and Mair
- Clinical Sports Medicine - Brukner and Khan
- Sports Injuries - Fu
THANK YOU

- Semper Fidelis
- Semper Paratus
- Semper Gumby 😊