Management & Return to Work/Activity Following Exertional Heat Illness

Rebecca M. Lopez, PhD, ATC, CSCS
University of South Florida
Athletic Training/ Orthopaedics & Sports Medicine
Korey Stringer Institute
SCCAHS 2018
Objectives

• After this presentation, attendees will learn:
  – Brief epidemiology of heat-related illness in occupational setting
  – Exertional heat illness (EHI) overview
  – On-site management of exertional heat illness
  – Importance of recognizing predisposing factors when addressing return to work/activity (RTA) in the heat
  – Various physiological tests that should be considered when making a RTA decision following EHI
EPIDEMIOLOGY OF HEAT-RELATED ILLNESS IN OCCUPATIONAL SETTINGS
Recent Epidemiology of Heat Illness in Occupational Setting

• Between 2000-2010, 359 heat-related deaths in U.S.
  – 0.22 per 1 million workers
  – Majority of cases between June-August
    • Noon – 6PM
  – Agriculture: > 35x the risk of heat-related death
  – Construction: 13x the risk of heat-related death

Recent Epidemiology of Heat Illness in Occupational Setting

• Between 2007-2011: 8,315 heat-related emergency department (ED) visits and inpatient hospitalizations (IH) in Southeast U.S.
  – Out-of-state workers may not be well acclimated to heat/humidity in Southeast
  – Many cases occur on first few days of exposure
  – Those with co-morbidities are at greater risk for more serious condition
  – Greatest risk May through September
  – Many employers had no heat illness prevention program

What happens when employees leave ED and return to work?

Is the risk of EHI still present?
Exertional Heat Illness

• Exercise-associated muscle cramps (i.e. heat cramps)
• Heat syncope
• Heat exhaustion
• Exertional heat stroke
Exercise-Associated Muscle Cramps (EAMC)

• Recognition
  – Visible muscle group cramping, localized pain, thirst, dehydration, sweating, fatigue
  – Differentiate from sickle cell trait muscle pain

• Initial Treatment
  – Rest, passive stretching, ice massage
  – If sodium depleted → sodium containing fluids & food

• Prevention
  – Two basic theories/schools of thought:

Electrolyte (sodium chloride) Depletion

Muscle Fatigue/Overload

Exercise-Associated Muscle Cramps (EAMC)

- Return to Work/Clearance for Activity
  - Exercise as tolerable (muscle soreness)
  - Determine cause of muscle cramps
    - Electrolyte depletion vs fatigue vs combo
  - Patient education (diet, exercise, hydration)
  - R/O “cramping” associated with exertional sickling (sickle cell trait)
Heat Syncope

• Recognition
  – Fainting or collapse with normal body temperature
  – Assess responsiveness, breathing, HR to rule out cardiac condition

• Initial Treatment
  – Move to cooler area, monitor vitals, elevate legs above heart
  – Cool skin, rehydrate
  – Call 911 if condition does not improve

Heat Syncope

• Clearance for Activity
  – **Rule out more serious cause of syncope**
    • (Cardiac, heat stroke, sickle-cell associated collapse, others?)
  – Educate on exercise-associated collapse or lack of heat acclimatization
  – Determine cause of syncopal episode

Heat Exhaustion

• Initial, On-Site Treatment
  – Remove excess clothing and equipment
  – Move to cooler area
  – Body cooling via ice towels, fans
  – Place in supine position with legs above level of heart
  – Fluid replacement if possible
  – Transfer to physician if IV needed or symptoms persist for more than 30 min

Heat Exhaustion

• Follow Up Treatment/ Return to Activity
  – Determine cause of heat exhaustion
    • Fluid depletion, sodium depletion?
    • Lack of heat acclimatization?
    • Exercise demands unmatched to fitness level
  – Rule out heat stroke (normal enzyme levels, CK)
  – Ensure cause of event is eliminated/modified

EXERTIONAL HEAT STROKE
Exertional Heat Stroke

• Most severe exertional heat illness (medical emergency)
• Defined by hyperthermia (> 105°F/ 40.5°C) associated with central nervous system and potential for multiple organ system failure → death
• Result of metabolic heat production and environmental heat load
• Excessive heat production and/or inhibited heat loss
Pathophysiology of EHS

Extrinsic factors → Exercise/Heat stress → Intrinsic factors

Metabolic rate ↑

sweat

Tc ↑

CO ↑

skin BF ↑

visceral BF ↓

compensable

dehydration

CVP ↓

intestinal permeability ↑

uncompensable

inflammatory reaction

CNS dysfunction & global encephalopathy

BBB breakdown

HEAT STROKE

Death

CNS dysfunction & global encephalopathy

Liver dysfunction

ARF

Coagulopathy (DIC)

Muscle breakdown

Cardiac dysfunction

Death from EHS

• Death from EHS is preventable
• Why they die:
  – Misdiagnosis (no/ inaccurate temp)
  – No care or delay in care/tx
  – Inefficient cooling modality
  – Immediate transport
  – RTA too soon

Casa et al. EHS: New Concepts Regarding Cause & Care. CSMR. 2012
Clinical Presentation

• Clinical Signs, Symptoms, and Presentation
  – Elevated core (rectal) temp > 105°F (40.5°C)
  – CNS: restlessness, seizures, confusion, coma
  – Tachypnea, hyperventilation
  – Cerebral edema, decerebrate, decorticate posturing
  – Coagulopathies (disseminated intravascular coagulation; DIC)
  – Cardiac impact and dysfunction
  – Gastrointestinal hemorrhage
  – Hepatic failure
  – Elevated liver enzymes
    • Alanine Transaminase (ALT); aspartate aminotransferase (AST)
  – Explosive rhabdomyolysis (elevated CK levels)

Present on-site (prior to transport)

Wagner & Boyd, 2008; Epstein & Roberts, 2011
Basic Paradigm for Care of EHS

Rapid Recognition → Rapid Assessment → Rapid Cooling → Rapid Advanced Care

Consensus Statement- Prehospital Care of Exertional Heat Stroke, 2018
RTA CONSIDERATIONS FOLLOWING EHS
RTA Considerations

Has the individual recovered from EHS?

What caused EHS?

What are the needs/requirements of the activity/work?

Side Note: How can this be prevented for the individual RTA and others?

Prevention, Recognition, Tx, EAP
Figure 3. Questions a Clinician Should Ask When Returning an Athlete to Football After EHS

RTP Following EHS in High School Football

- Has the athlete recovered from EHS?
  - Normal labs
  - Sequelae resolved
  - Physician clearance

- What caused EHS?
  - Level of heat acclimatization
  - Physical fitness status
  - Fluid needs
  - Organizational concerns (work:rest)
  - Other predisposing factors (i.e. illness, medications)

- What are the needs/requirements of his sport/position?
  - Metabolic system demands
  - Strength & conditioning needs of sport
  - Position-specific requirements

Lopez et al. J Athl Train. 2018
RTA Considerations

• Has the individual recovered from EHS?
  – Full recovery or lingering sequelae (liver enzymes, renal function, muscle injury/CK levels)
  – Heat intolerance or temporary heat intolerance
    • Core temperature & heart rate responses to exercise in heat
  – Heat intolerance: lower thermoregulatory efficiency and the inability to properly adapt to exercise in hot environments
    • Ketko et al. 2015
Recovery

- Recovery directly associated with recognition and care provided at time of EHS
  - Was there prompt recognition of EHS?
  - Was individual aggressively cooled (via cold water immersion) to below threshold ($T_{re} < 105^\circ F$, ideally 102.5°F before transport to ED) within 30 minutes of collapse?

Prognosis poor with later intervention.


Recovery

• Recovery associated with recognition and care provided
  – Normal organ function
  – Normal blood values
  – Heat tolerance
  – Physician clearance

Stearns et al., CSMR, 2016
Recovery

Table 26-1
Normal Laboratory Blood Measures for Return to Play From Exertional Heat Stroke

<table>
<thead>
<tr>
<th>Blood or Serum Enzyme Measure</th>
<th>BUN (mg/dL)</th>
<th>Creatinine (mg/dL)</th>
<th>AST (UI/L)</th>
<th>ALT (UI/L)</th>
<th>CK (UI/L)</th>
<th>LDH (UI/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal level*</td>
<td>5 to 20</td>
<td>0.6 to 1.2; M 0.5 to 1.1; F</td>
<td>&lt;40</td>
<td>&lt;31; F BMI ≤ 23†</td>
<td>45 to 260</td>
<td>&lt;250</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>&lt;42; F BMI ≥ 23†</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>&lt;41; M BMI ≤ 23†</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>&lt;66; M BMI ≥ 23†</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Specific ranges should be established for each laboratory to determine abnormal ranges for each of the markers above.

† Values adjusted to BMI and sex.

Abbreviations: ALT, alanine transaminase; AST, aspartate aminotransferase; BMI, body mass index; BUN, blood urea nitrogen; CK, creatine kinase; F, female; g/dL, grams per deciliter; LDH, lactate dehydrogenase; M, male; UI/L, international units per liter.

What Caused the EHS?

• Causes must be addressed **before** RTA
  – EHS is multifactorial
  – Intrinsic and extrinsic factors

• **Use factors that led to EHS as guideline for the RTA process**
  – Johnson et al. 2013; Adams et al. 2015
What Causes Can Be Addressed?

Organizational Factors
- Heat acclimatization
- Work to rest ratio
- Modifications based on environmental conditions
- Improper rehydration or limited access to fluid
- Recognition & treatment

Physiological Factors
- Poor physical fitness
- Illness (fever, gastrointestinal)
- Medications
- Body composition
- Sleep deprivation
- Co-morbidities

Education and awareness of these risk factors can assist in RTA efforts.
CURRENT GUIDELINES FOR RETURN TO ACTIVITY/ DUTY
Return to Activity After EHS

• Military Setting- Heat Tolerance Testing (HTT)
• Athletic Setting-
  • ACSM general guidelines
  • NATA Position Statement, 2015
  • Korey Stringer Institute utilizing HTT + RTP progression
  • More recent case reports
  • Functional progression to activity

– Must have physician clearance and normal labs before returning to exercise
ACSM/DOD Roundtable, 2010

- No comprehensive and validated guidelines or recommendations for RTA/RTD
- Most guidelines are common sense recommendations:
  - Return to asymptomatic state
  - Normal labs
  - Cautious reintroduction to physical activity to ensure acclimatization

ACSM/DOD Roundtable, 2010

• ACSM Recommendations:
  – Refrain from exercise for at least 7 days following release from medical care
  – Follow up 1 wk post-incident for physical examination and lab testing or diagnostic imaging of affected organs based on clinical course of EHS incident
  – Once cleared, begin activity in a cool environment and gradually increase duration, intensity and heat exposure over 2 wk to demonstrate heat tolerance and acclimatization
  – If return to vigorous activity not accomplished in 4 wk, consider laboratory exercise-heat tolerance test
  – Full clearance if heat tolerant after 2 to 4 wk of full training

NATA Recommendations

• NATA Return to Activity/ Return to Play
  – 7 to 21 day rest period
  – Normal blood work
  – Physician clearance
  – Progression of physical activity
    • Low → high intensity
    • Use signs/symptoms of heat tolerance and gradual increase in exercise demands
    • Core temperature and heart rate should be monitored
    • Progression should be slowed, delayed or stopped if any signs or symptoms are experienced

# General Guidelines for Acclimatization to Work in Hot Conditions

## Table 1. Recommendations for Heat Acclimatization for Warm/Hot Conditions

<table>
<thead>
<tr>
<th>WBGT $^\text{a}$</th>
<th>Time Spent working in hot environment</th>
<th>Heat Acclimatization Days</th>
<th>Time Spent working in hot environment</th>
<th>Heat Acclimatization Days</th>
<th>Time Spent working in hot environment</th>
<th>Heat Acclimatization Days</th>
</tr>
</thead>
<tbody>
<tr>
<td>78-81.9</td>
<td>90-100%</td>
<td>2 - 3</td>
<td>70-100%</td>
<td>3 - 5</td>
<td>50-100%</td>
<td>6</td>
</tr>
<tr>
<td>82-84.9</td>
<td>80-100%</td>
<td>2 - 4</td>
<td>70-100%</td>
<td>3 - 5</td>
<td>50-100%</td>
<td>6</td>
</tr>
<tr>
<td>85-87.9</td>
<td>70-100%</td>
<td>3 - 5</td>
<td>60-100%</td>
<td>4 - 6</td>
<td>50-100%</td>
<td>6</td>
</tr>
<tr>
<td>88-89.9</td>
<td>60-100%</td>
<td>4 - 6</td>
<td>50-100%</td>
<td>6</td>
<td>50-100%</td>
<td>6</td>
</tr>
<tr>
<td>90+</td>
<td>50-100%</td>
<td>6</td>
<td>50-100%</td>
<td>6</td>
<td>50-100%</td>
<td>6</td>
</tr>
</tbody>
</table>

Percentage of time should be increased for every day of acclimatization (i.e. for 80-100% across 2-4 days would me Day 1 is 80%, Day 2 90% and Day 3 is 100%. These ranges are intended to allow for flexibility dependent on work experience, clothing worn, etc.

Lopez & Ashley 2017
# General Guidelines for Re-Acclimatization to Work in Hot Conditions

## Table 2. Recommendations for Re-Acclimatization for Warm/Hot Conditions

| Routine Absence Absence Due to Illness | GREEN Day 1 Day 2 Day 3 Day 4 Day 5 | YELLOW Day 1 Day 2 Day 3 Day 4 Day 5 Day 6 | RED Day 1 Day 2 Day 3 Day 4 Day 5 Day 6 |
|--------------------------------------|------------------------------------|--------------------------------|--------------------------------|--------------------------------|
| < 4                                 | 100                                | 90 100                        | 80 90 100                      | 80 90 100                      |
| 4-5                                 | 1-3                                | 90 100                        | 80 90 100                      | 60 80 90 100                   |
| 6-12                                | 4-5                                | 80 90 100                      | 70 80 90 100                   | 50 60 80 90 100                |
| 12-20                               | 6-8                                | 60 80 90 100                   | 60 70 80 90 100                | 50 60 70 80 90 100             |
| >20                                 | >8                                 | 50 60 80 90 100                | 50 60 70 80 90 100             | 50 60 70 80 90 100             |

The color zones are based on the increased risk of heat strain due to WBGT and/or work intensity, where Green = Low, Yellow = Moderate, and Red = High level of risk.

---

Lopez & Ashley 2017
HEAT TOLERANCE TESTING
Heat Tolerance Testing (HTT)

- Israeli Defense Forces (IDF) using HTT since 1979 (Shapiro, 1979)
  - Stepping on bench 3 hrs

- HTT
  - Treadmill walking for 2 hrs in environmental chamber
  - 3.1 mph, 2% incline
  - 104°F (40°C), 40% relative humidity

Lisman et al. Military Medicine, 2014
Heat Tolerance Testing (HTT)

• HTT: Physiological Measures
  – Core Temperature (Tc)
  – Heart rate (HR)
  – Sweat rate

• Cut offs
  – Tc exceeds 101.3°F (38.5°C) OR HR > 150 bpm

• Tc and HR must plateau during HTT

Lisman et al. Military Medicine, 2014
Heat Tolerance Testing (HTT)

• HTT Controversial
  – Military physicians in U.S. do not rely solely on HTT for return to duty decisions

• Some issues raised:
  – Predictive capacity for future EHS?
  – Ability to measure potential deficits in thermoregulation
  – Utility in guiding return to activity process

Lisman et al. Military Medicine, 2014
Heat Tolerance Testing (HTT)

**Figure 1:** Core body temperature and heart rate during HTT 2 and 5 months post-EHS in an IDF soldier.

Heat Tolerance Testing (HTT)

Temporarily Heat Intolerant

**Fig. 1** Body core temperature values of candidate ‘A’ that were measured during four HTTs. First test: ---; second test: - -; third test: ---; data are presented at a sampling rate of 1–5 min.

**Fig. 2** Heart rate values of candidate ‘A’ that were measured during four HTTs. First test: ---; second test: - -; third test: ---; data are presented at a sampling rate of 1–5 min.

Heat Intolerant

**Fig. 3** Body core temperature values of candidate ‘B’ that were measured during three HTTs. First test: ---; second test: - -; third test: ---; data are presented at a sampling rate of 1–5 min.

**Fig. 4** Heart rate values of candidate ‘B’ that were measured during the three HTTs. First test: ---; second test: - -; third test: ---; data are presented at a sampling rate of 1–5 min.

Ketko et al. *Disaster and Mil Med.* 2015
Figure 2: Clinical algorithm for return to play/return to duty following EHS. Kazman et al. Curr Sports Med Rep. 2013
Necessities for Implementation

• Heart rate monitor
• Accurate body temperature monitoring
  – Rectal, gastrointestinal thermistor
• Monitor signs and symptoms of heat stress
• Hydration status
  – Body weights, urine color/specific gravity, fluid consumed, sweat rate
• Exercise/Work protocol
  – Need to work with supervisor
  – Work toward gradually matching individual’s work environment, duration, intensity, etc.

Conclusions

• Death from exertional heat stroke is preventable with proper recognition and immediate aggressive cooling
• Have a plan for how to treat EHI on-site
• Determining initial causes of EHS is key to implementing individualized RTA protocol
Conclusions

• Gradual progression to work intensity and environment ensures acclimatization to work & safe adaptations to extreme environments
• EHS may lead to heat intolerance or other complications where work in the hot environment would be contraindicated
Questions?

rlopez@health.usf.edu
813-396-9078