Management & Return to Work/Activity Following Exertional Heat Illness

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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

Gubernot et al. *Am J Ind Med*, 2015

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

Morano et al. *Am J Ind Med*, 2015

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

NATA Position Statement: Exertional Heat Illnesses, 2015

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)

NATA Position Statement: Exertional Heat Illnesses, 2015

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

NATA Position Statement: Exertional Heat Illnesses, 2015

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

NATA Position Statement: Exertional Heat Illnesses, 2015

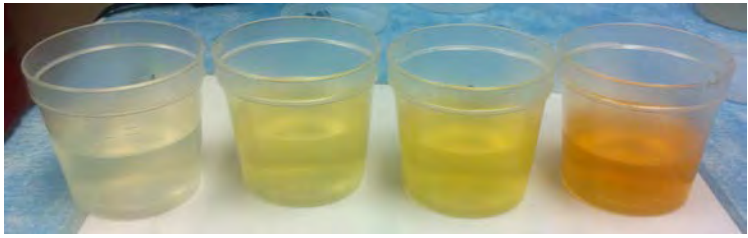
Heat Exhaustion

- 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

NATA Position Statement: Exertional Heat Illnesses, 2015

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



NATA Position Statement: Exertional Heat Illnesses, 2015

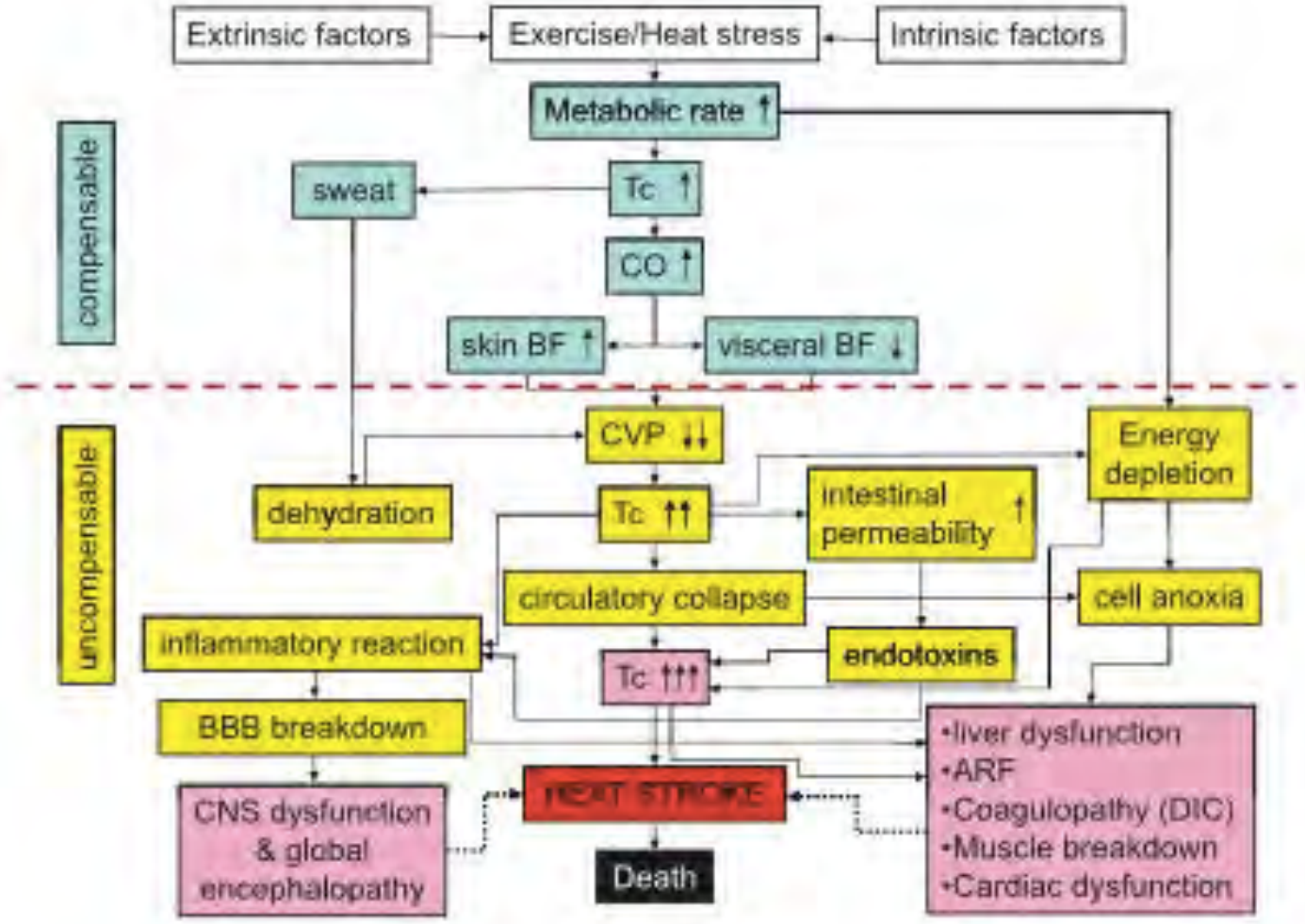
EXERTIONAL HEAT STROKE

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

NATA Position Statement: Exertional Heat Illnesses, 2015
ASCM EHI Position Statement, 2007

Pathophysiology of EHS



Epstein & Roberts. *Scand J Med Sci Sports,* 2011.

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

  Present on-site (prior to transport)
  - 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)

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

RTP Following EHS in High School Football

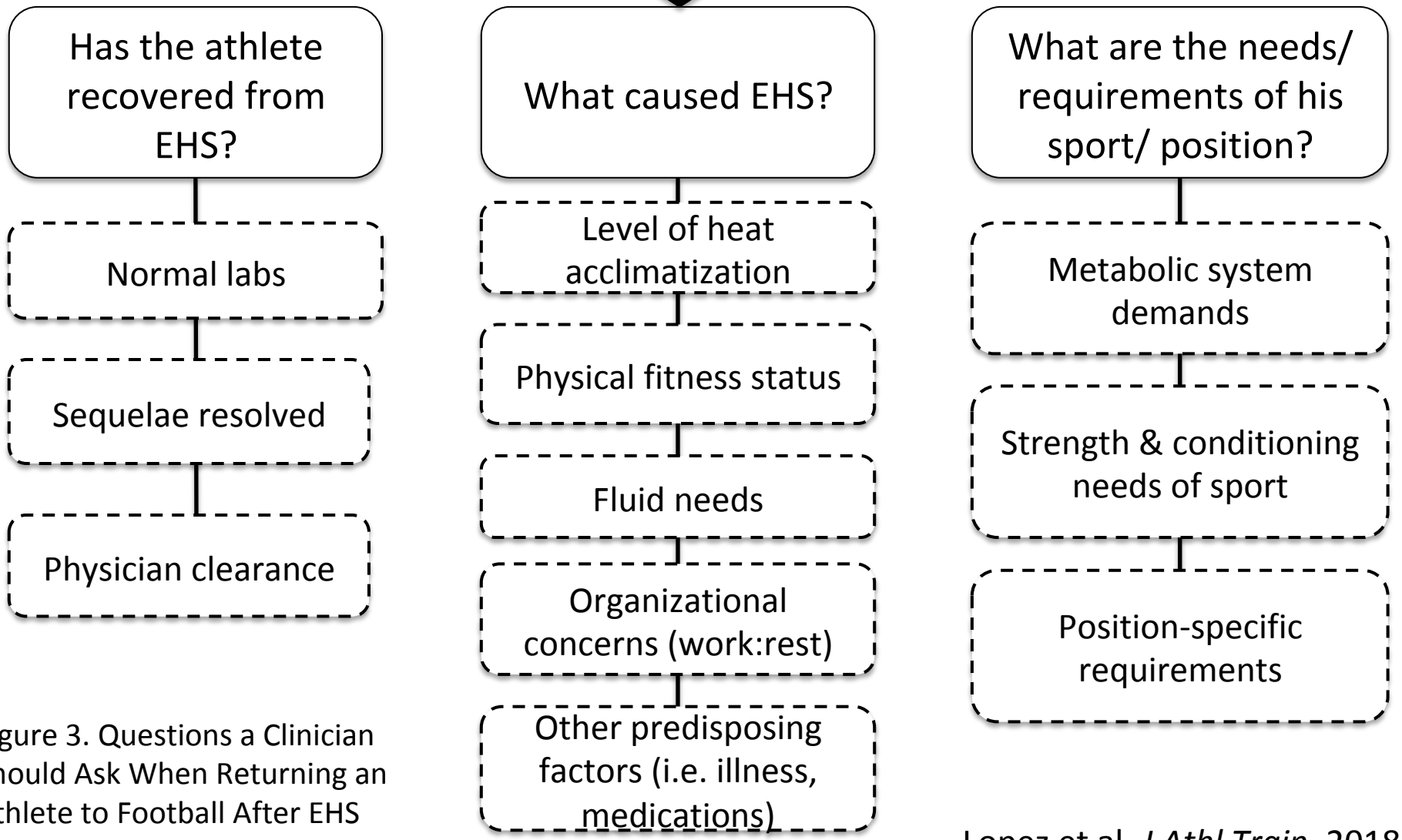


Figure 3. Questions a Clinician Should Ask When Returning an Athlete to Football After EHS

Lopez et al. *J Athl Train.* 2018

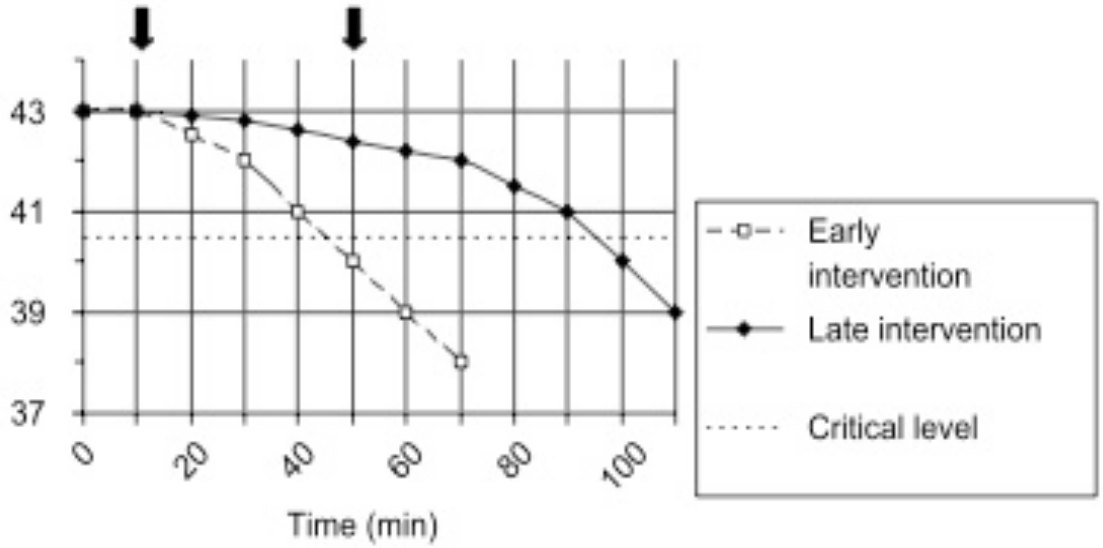
RTA Considerations

- 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°F, ideally 102.5°F before transport to ED) within 30 minutes of collapse?

Prognosis poor with later intervention.

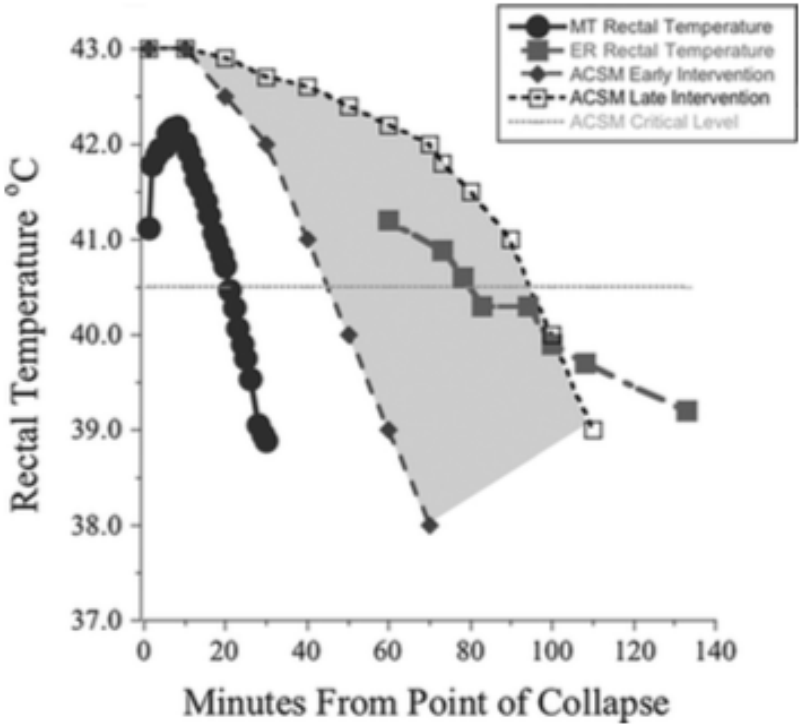


NATA Position Statement: Exertional Heat Illnesses, 2015

Armstrong et al. ACSM Position Stand on EHI, 2007.

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

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

* 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.

Huggins & O'Connor. When can an athlete return to play following an exertional heat illness? In: Lopez RM, ed. *Quick Questions in Heat-Related Illness and Hydration: Expert Advice in Sports Medicine*. SLACK, Inc. 2015

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 <u>before</u> 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

O'Connor et al. *Curr Sports Med Rep,* 2010

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

O'Connor et al. *Curr Sports Med Rep,* 2010

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
    - <u>Progression should be slowed, delayed or stopped if any signs or symptoms are experienced</u>

NATA Position Statement: Exertional Heat Illnesses, 2015

General Guidelines for Acclimatization to Work in Hot Conditions

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

Recommendations for Heat Acclimatization for Warm/Hot Conditions						
	Light Work (125 - 275 W)		Moderate Work (275 - 375 W)		Heavy Work (375 - 475 W)	
WBGT ℉	Time Spent working in hot environment	Heat Acclimatization Days	Time Spent working in hot environment	Heat Acclimatization Days	Time Spent working in hot environment	Heat Acclimatization Days
78-81.9	90-100%	2 - 3	70-100%	3 - 5	50-100%	6
82-84.9	80-100%	2 - 4	70-100%	3 - 5	50-100%	6
85-87.9	70-100%	3 - 5	60-100%	4 - 6	50-100%	6
88-89.9	60-100%	4 - 6	50-100%	6	50-100%	6
90+	50-100%	6	50-100%	6	50-100%	6

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

Recommendations for Re-Acclimatization for Warm/Hot Conditions																	
Routine Absence	Absence Due to Illness	GREEN					YELLOW						RED					
		Day 1	Day 2	Day 3	Day 4	Day 5	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6
< 4	--	100					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)

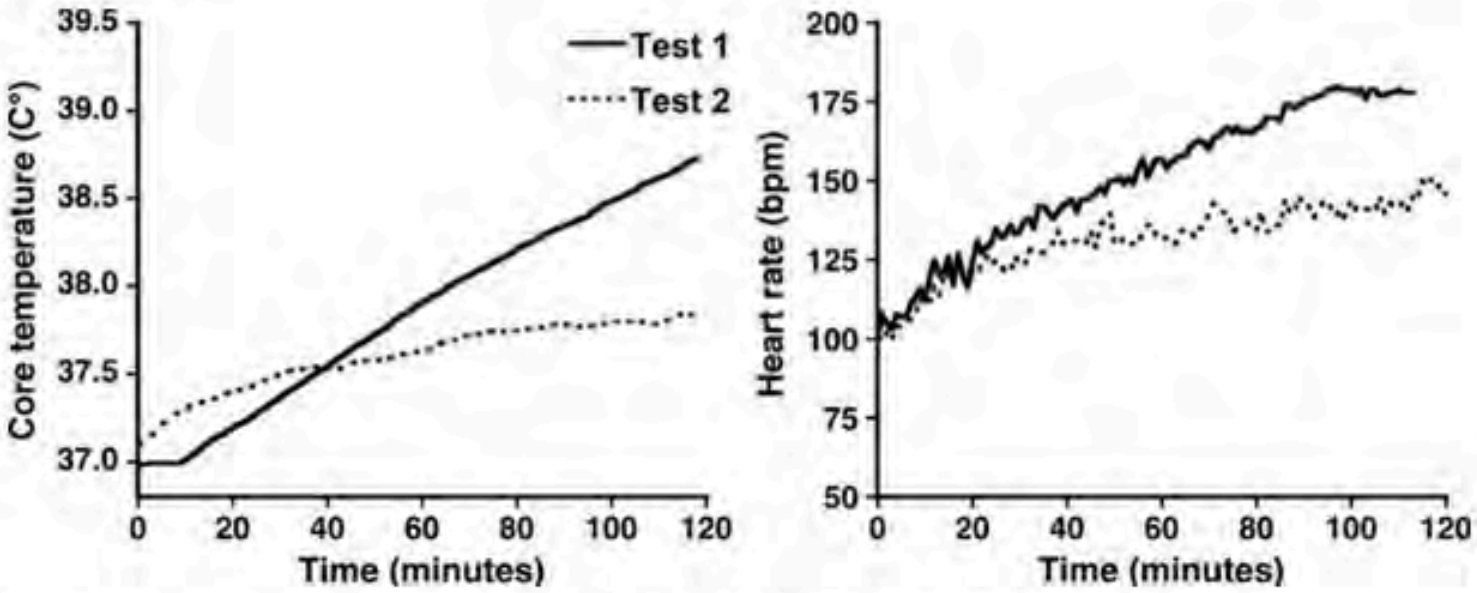


Figure 1: Core body temperature and heart rate during HTT 2 and 5 months post-EHS in an IDF soldier.

Kazman et al. *Curr Sports Med Rep.* 2013

Heat Tolerance Testing (HTT)

Temporarily Heat Intolerant

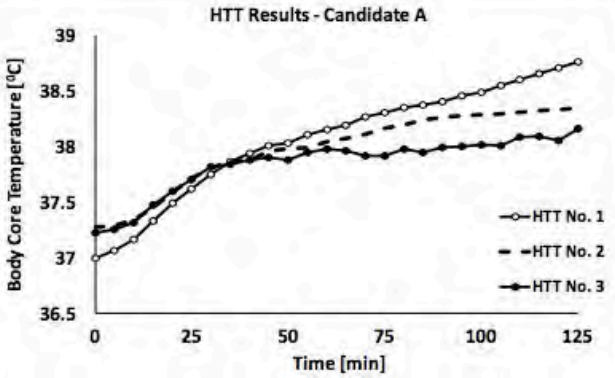


Fig. 1 Body core temperature values of candidate '*A*' that were measured during four HTTs. First test: —∘—; Second test: - -; Third test: —•—; data are presented at a sampling rate of 1–5 min

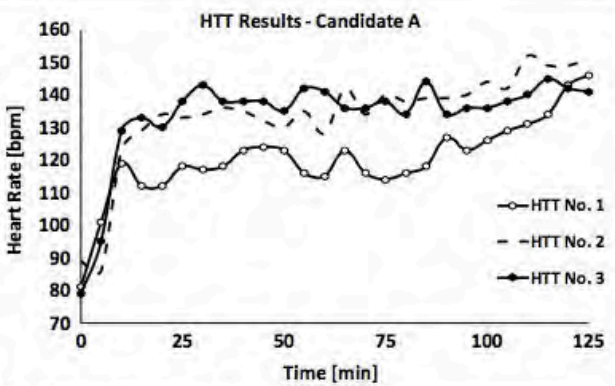


Fig. 2 Heart rate values of candidate '*A*' that were measured during four HTTs. First test: —∘—; second test: - -; third test: —•—; data are presented at a sampling rate of 1–5 min

Heat Intolerant

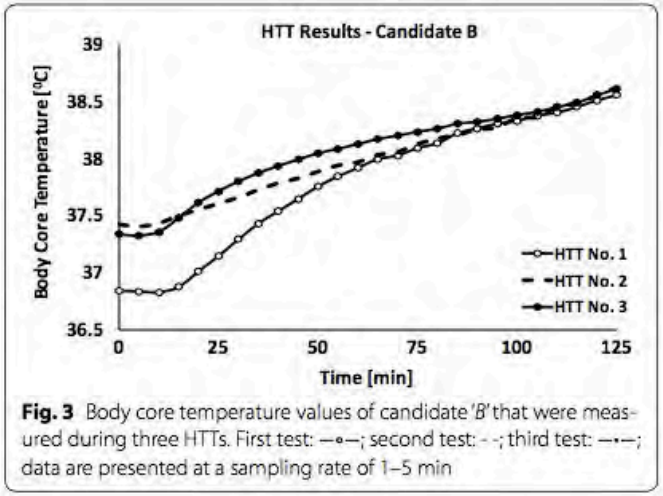


Fig. 3 Body core temperature values of candidate '*B*' that were measured during three HTTs. First test: —∘—; second test: - -; third test: —•—; data are presented at a sampling rate of 1–5 min

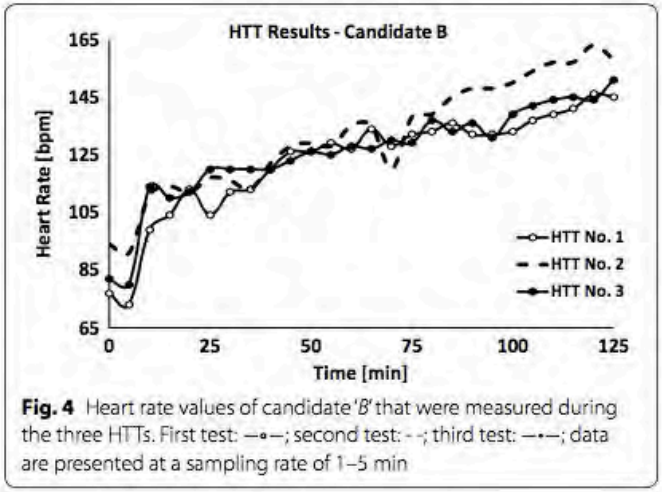


Fig. 4 Heart rate values of candidate '*B*' that were measured during the three HTTs. First test: —∘—; second test: - -; third test: —•—; data are presented at a sampling rate of 1–5 min

Ketko et al. *Disaster and Mil Med.* 2015

Heat Tolerance Testing (HTT)

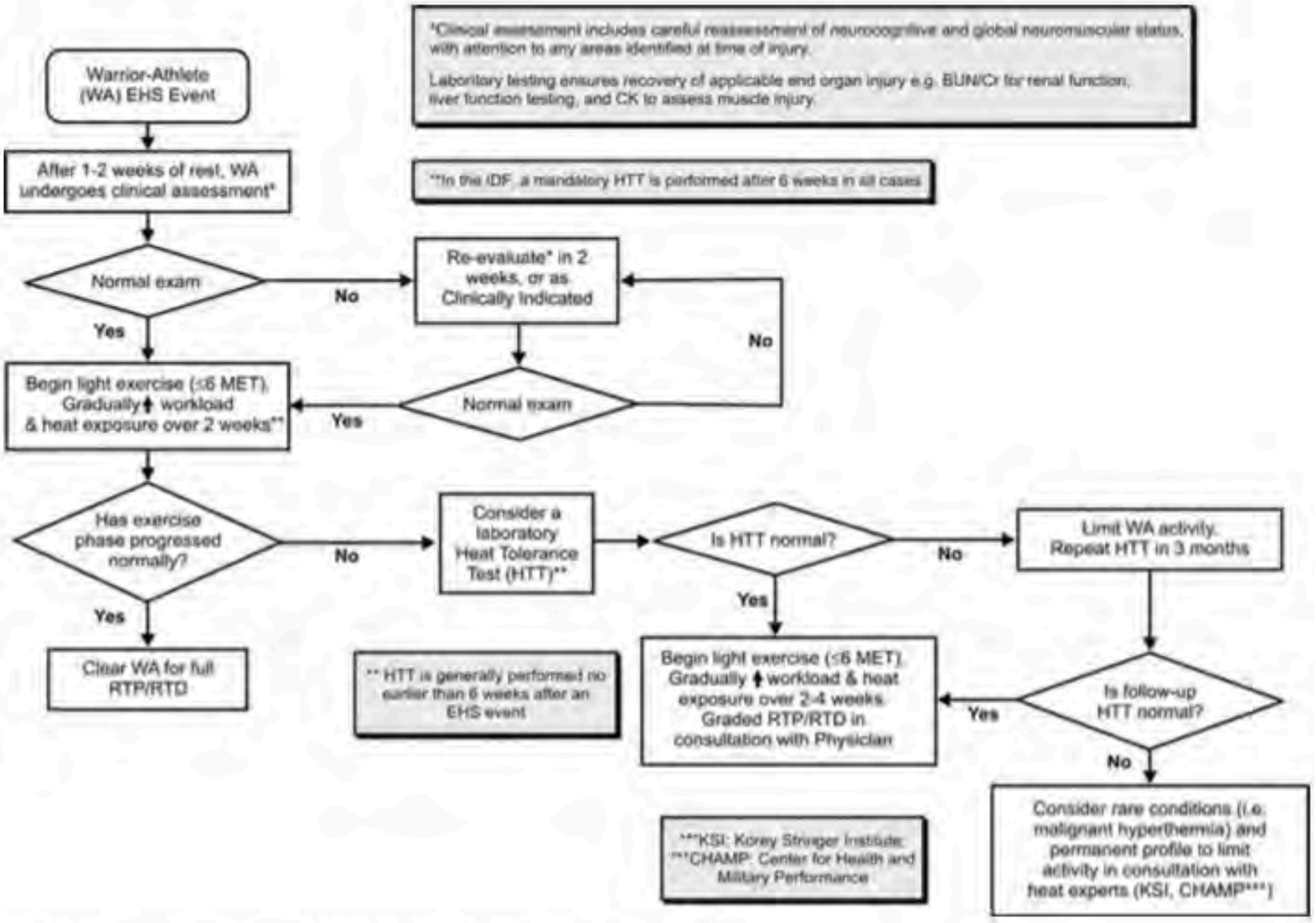


Figure 2: Clinical algorithm for return to play/return to duty following EHS. Kazman et al. *Curr Sports Med Rep.* 2013

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.

Lopez et al. Functional return to play protocol following EHS in high school football player, *J Athl Train.* 2018.

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?

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