**Exertional Heatstroke in an Athlete**

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Case Title: **Exertional Heatstroke in an Athlete**

# Target Audience: Medical students, Residents, Nurses

Primary Learning Objectives:

1. Recognize exertional heatstroke in an athlete based on presenting signs/symptoms.
2. Select appropriate management of a patient with heatstroke including fluids and rapid body cooling.
3. Differentiate exertional heatstroke from other etiologies of heatstroke/hyperthermia.

Secondary Learning Objectives: detailed technical goals, behavioral goals, didactic points

1. Treat the patient with appropriate whole body cooling methods.
2. Identify laboratory abnormalities in heatstroke, including those associated with higher morbidity and/or mortality.
3. Effectively communicate with consultants, patients, and family members regarding the appropriate management of heatstroke.

Critical actions checklist

1. Review history with EMS/friend
2. Examine the patient thoroughly, including rectal/esophageal (core) body temperature.
3. Set up rapid body cooling mechanism (either evaporative cooling with water spray & fans, or with cold water immersion).
4. Identify core temperature (esophageal, rectal, or pulmonary artery) either continuously or at least twice prior to presenting the case for admission, after cooling measures have been initiated.
5. Identify hypoglycemia and treat appropriately.
6. Identify unstable vital signs, rhabdomyolysis, and lactic acidosis and treat appropriately.
7. Admit patient to ICU.

Dangerous actions checklist

1. The examinee fails to discover elevated core body temperature (rectal or esophageal).
2. The examinee employs no cooling measures.
3. The examinee fails to employ either cold water immersion bath or evaporative cooling as a cooling measure.
4. The examinee presents the case for admission after having instituted cooling measures but without first measuring core temperature either twice or continuously, predisposing to iatrogenic hypothermia.
5. The examinee discharges the patient home.

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**CASE SUMMARY**

**CORE CONTENT AREA**

Heat Illness, Environmental Pathology

**SYNOPSIS OF HISTORY / Scenario Background**

This case involves a 27 year-old man who presents with heatstroke: core temperature 42.7°C (108.9°F), altered mental status, diarrhea, and hemodynamic instability following intense exercise in a hot environment. The patient’s friend called 911 after he abruptly stopped training with him for their triathlon, and started chasing other people, accusing them of stealing his chickens. Patient has been confused, refusing IV access by EMS. He has no specific complaints. The friend arrives shortly after patient and provides history of exercising all day. Friend states patient has no past medical history and takes no medications/recreational drugs and is in excellent physical condition. Patient is tachycardic, hypotensive, has warm skin, and is asking questions and saying things that are irrelevant or are nonsensical. A few minutes into the case, the patient has a brief tonic-clonic seizure that spontaneously resolves, followed by coma.

**SYNOPSIS OF PHYSICAL**

Physical examination by EMS: tachycardic, hypotensive, warm skin, tympanic temperature 37.8°C (100°F). In ED oral temperature 37.9°C (100.2°F), and rectal/esophageal temperature 42.7°C(108.9°F). There is also profuse sweating, altered mental status, and a brief seizure followed by coma. Diarrhea is present, and worsens with body cooling. Stool is trace hemoccult positive. Mental status is initially confused and agitated, followed by coma that persists after a seizure that spontaneously resolved. The rest of the physical exam is normal.

**SYNOPSIS OF MANAGEMENT**

The candidate must obtain a rectal and/or esophageal temperature, perform a thorough physical examination looking for non-exertional etiologies of the hyperthermia, elicit history from EMS and the friend, initiate continuous core temperature monitoring, initiate rapid cooling of the body with either evaporative cooling or cold water immersion (see explanation below), and admit to the ICU.

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**CRITICAL ACTIONS**

**Scenario branch points / PLAY OF CASE GUIDELINES**

Key teaching points or branch points that result in changes in patient’s condition

1. **Critical Action**

Review history with EMS/friend

Cueing Guideline: The patient presents via EMS with altered mental status. Friend states that they are both army rangers in excellent physical condition. They are training for a thriathlon and had been bicycling and running all day. It is above 100°F (37.8°C) and very humid outside.

1. **Critical Action**

Examine the patient thoroughly, including rectal/esophageal (core) body temperature.

Cueing Guideline: The patient’s friend should ask, “Hey, Doc, did we overdo it?"

1. **Critical Action**

Set up rapid body cooling mechanism (either evaporative cooling with water spray & fans, or with cold water immersion).

Cueing Guideline: The nurse should ask “How should we treat this, doctor?”

Cueing Guideline: If the candidate does not specifically state it, ED staff should ask how soon cooling should be initiated (IMMEDIATELY! IV access and blood for labs, if not already obtained, should be obtained immediately after cooling has begun or while its equipment is being assembled)

1. **Critical Action**

Identify core temperature (esophageal, rectal, or pulmonary artery) either continuously or at least twice prior to presenting the case for admission but after cooling measures have been initiated.

Cueing Guideline: If core temperature is not measured either continuously or at least twice prior to presenting the case for admission but after cooling measures have been initiated, while presenting the case for admission the patient should become hypothermic with precipitous bradycardia, hypotension, and Vfib arrest.

Cueing Guideline: If the candidate attempts discharge, the patient will die. Resuscitation will be impossible.

1. **Critical Action**

Identify hypoglycemia and treat appropriately.

Cueing Guideline: If the candidate does not ask for a fingerstick blood sugar (FBS) after seizure, once patient becomes unresponsive, ED staff can suggest it.

Cueing Guideline: If the candidate does not ask for a repeat FBS after treatment with D50 IV solution, the nurse may ask if they desire a repeat FBS. Upon discovery of persistent hypoglycemia the nurse can ask “Doctor, what should we do for the blood sugar now?” Continuous dextrose-containing IV solution should be administered.

1. **Critical Action**

Identify unstable vital signs, rhabdomyolysis, and lactic acidosis and treat appropriately.

Cueing Guideline: Patient BP and HR should improve significantly as core temperature is reduced and IV fluids are given. If cooling and IV fluids are not initiated in the 1st 10 minutes of the case, vital signs should worsen, leading to hemodynamic collapse and death within 12 minutes. Resuscitation will be impossible.

1. **Critical Action**

Admit patient to ICU.

Cueing Guideline: The patient’s friend asks “Doc, is he going to have to stay in the hospital? We have to get back to training for our triathlon.”

Cueing Guideline: The admitting team asks if this patient can just be admitted to telemetry instead of the ICU.

Cueing Guideline: If the candidate attempts discharge, the patient will die. Resuscitation will be impossible.

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**CRITICAL ACTIONS**

**Scenario branch points / PLAY OF CASE GUIDELINES (continued)**

1. **Dangerous Action**

The examinee fails to discover elevated core body temperature (rectal or esophageal).

1. **Dangerous Action**

The examinee employs no cooling measures.

1. **Dangerous Action**

The examinee fails to employ either cold water immersion bath or evaporative cooling.

1. **Dangerous Action**

The examinee presents the case for admission after having instituted cooling measures without either measuring core temperature at least twice, or continuously, predisposing to iatrogenic hypothermia.

1. **Dangerous Action**

The examinee discharges the patient home.

Early on, the examinee should recognize elevated tympanic temperature and request core temperature measurement.

The examinee should fail the case if no core (rectal/esophageal) temperature is obtained/requested.

The examinee should be scored down if they do not perform a thorough physical examination evaluating for non-exertional etiologies of heatstroke.

The examinee should fail the case if core temperature is not measured continuously or at least twice prior to presenting the case for admission but after cooling measures have been initiated.

The examinee should be scored up if they choose continuous esophageal over continuous rectal temperature measurement in anticipation of worsening diarrhea with cooling.

The examinee should fail the case if no cooling measures (required or adjunctive) are instituted.

The examinee should be severely scored down if neither of the required cooling methods (evaporative cooling or ice water immersion) is initiated.

The examinee should be scored up if they initiate both a required and an adjunctive cooling method.

The examinee should be scored up if they initiate *chilled* IV fluids.

The examinee should fail the case if they do not admit the patient to the hospital.

The examinee should be severely scored down if they do not admit the patient to the ICU.

Early recognition of hemodynamic instability and severe hyperthermia dictate the necessity to aggressively treat this patient with cooling measures. Aggressive and rapid cooling along with IV fluids should significantly improve vital signs.

Persistent hypoglycemia necessitates the administration of continuous IV dextrose-containing fluids.

At the end of the case, the patient’s friend should ask if the patient can go home soon, noting their upcoming triathlon. The admitting team should likewise request admission to telemetry rather than ICU. The examinee should decline these requests, and should be scored higher for politely explaining the potential severity of the illness. Note that any deviation from closely monitoring the core temperature will result in unintended detrimental consequences such as iatrogenic hypothermia.**For Examiner Only**

**HISTORY**

**Presenting Complaint:** Altered mental status, unstable vital signs per EMS

**History of Present Illness:** The patient is a healthy 27 year-old male athlete who was in the middle of an intense workout with a friend preparing for an upcoming triathlon. He abruptly stopped running with his friend and started chasing other people and accusing them of stealing his chickens. EMS states he has unstable vitals and was uncooperative with them. He denies any complaints.

**Review of Systems:**
+Abrupt change in mental status. Was his fully-functional, independent, normal self prior to this

+1 Episode of loose stool while in the ambulance, and another during initial evaluation
ROS otherwise negative

**Past Medical History**

 Surgical: None

 Medical: None

 Medications: Multivitamin every other day

 Allergies: None

**Medications**: None

**Social History**

 Smoking: Never

 Drugs: Never

 Alcohol: Socially

 Physical fitness: Excellent. Runs, bicycles, or swims for at least several hours daily

 Occupation: Army Ranger

**Family Medical History**

 Details unknown. Mother, father, and 3 siblings alive without known medical problems.

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**PHYSICAL EXAM**

**Patient Name:** Steve Armstrong  **Patient Name:** 27 year old man

**General Appearance:** Well-developed, well-nourished thin, physically fit muscular man in no distress. Agitated and confused, looking and asking for his “chickens.”

**Vital Signs (EMS) Vital Signs (ED)**

 BP : 87/43 BP : 85/52

 P : 168/min P : 162/min

 R : 24/min R : 24/min

 Ttympanic : 37.8°C (100°F) Toral : 37.9°C (100.2°F)

 Trectal/esoph : 42.7°C (108.9°F)

**Head:** Normal

**Eyes:** Pupils mildly constricted ~3mm B/L but briskly reactive. Otherwise normal.

**Ears:** Normal

**Mouth:**  Normal

**Neck/Thyroid:** Normal

**Skin:** Profuse sweating. Otherwise normal.

**Chest:** Mild tachypnea. Otherwise normal/clear bilaterally.

**Heart:** Severe tachycardia. RRR, no murmurs rubs or gallops. Otherwise normal.

**Abdomen:** Normal. Nontender.

**Rectal:** Has a small loose bowel movement during the exam. Normal besides trace hem-occult positive, brown stool.

**Extremities:** Normal.

**Neurological:** Altered mental status. Normal tone and reflexes. Unable to obtain motor and sensory exam (patient uncooperative). No myoclonus or nystagmus.

**1st Mental Status:** Altered. Oriented only to self, believes we are on his home on Mars, and thinks it is 2003. Keeps asking for everyone to return his chickens to him.

**2nd Mental Status:** Unresponsive after seizure.

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**STIMULUS INVENTORY**

**Suggested items as relevant to the case**

#1 Emergency Admitting Form

#2 EKG

#3 Arterial Blood Gas (ABG)

#4 Complete Blood Count (CBC)

#5 Basic Metabolic Panel (BMP)

#6 Urinalysis

#7 PT/PTT/INR

#8 Cardiac Enzymes

#9 Toxicology Screen

#10 Thyroid Studies

#11 Liver Function Tests

#12 CSF Studies

#13 Head CT

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|  |  |
| --- | --- |
| Stimulus #3 - Arterial Blood Gas pH 7.22 pCO2 18 mm Hg pO2 95 mm Hg O2 sat 99% (room air) HCO3- 12 mEq/L Lactate 14.6 mmol/LStimulus #4 - CBCComplete Blood Count WBC 10,900/mm3  RBC 5.34 x 106/mm3 Hgb 15.1 g/dL Hct 45.5% Platelets 169,000/mm3Differential Segs 67% Bands 0% Lymphs 21% Mono 8% Eos 4%Stimulus #5 - BMP Na+ 132 mEq/L K+ 3.1 mEq/L CO2- 15 mEq/L Cl- 92 mEq/L Glucose 54 mg/dL BUN 29 mg/dL Creatinine 2.2 mg/dL Calcium 7.2 mg/dLStimulus #6 - Urinalysis Color Brown, turbid Sp Gravity 1.041 Glucose Negative Protein 2+ Ketone Negative Leuk. Est. Negative Nitrite Negative WBC 0-2/HPF RBC 40-50/HPF Many Granular Casts  | **Stimulus #7- PT/PTT** PT 20.1 secondsPTT 58.9 secondsINR 1.6**Stimulus #8 - Cardiac Enzymes** CPK 8,438 ng/mL CKMB 82.1 ng/mL Troponin 0.02 ng/mLStimulus #9 - Toxicology Screen Serum Osm 278 mmol/L Cocaine Neg Amphetamin Neg TCA Neg Barbiturates Neg Benzo Neg Marijuana Neg Opiates Neg Methadone Neg PCP Neg Tylenol <5 mcg/mL Salicylate <5 mg/dL EtOH level <10 mg/dL Serum Osm 278 mmol/L**Stimulus #10 - Thyroid Studies** TSH 2.1 microunits/mL Free T4 1.2 mcg/dL**Stimulus #11 - Liver Function Tests** Albumin 4.6 g/dL Total Protein 6.2 Total Bili 0.8 mg/dL Direct Bili 0.3 mg/dL AST 664 units/L ALT 538 units/L Alk-Phos 82 units/L Ammonia 14 mcg/dL**Stimulus #12 CSF Studies** Pressure 93 mm H2O Appearance Clear, colorless Protein 60 mg/100 mL Glucose 51 mg/100 mL Cell count 2 WBC’s, 0 RBC’s |

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 **Lab Data & Imaging Results**

**Learner Stimulus #1**

 **ABEM General Hospital**

 **Emergency Admitting Form**

Name: Steve Armstrong

Age: 27 years

Sex: Male

Race: Caucasian

Method of Transportation: EMS/Ambulance

Person giving information: EMS and patient’s friend

Presenting complaint: Altered mental status

**Background:** Patient had been exercising intensely for several hours in the hot, humid outdoors today and became delirious and paranoide, accusing others around him of stealing his chickens. He was also uncooperative with EMS.

**Initial Vital Signs from EMS**

 BP : 88/43

 P : 168

 R : 24/min

 Ttympanic : 37.8°C (100°F)

 **Learner Stimulus #2**

**Learner Stimulus #3**

**Arterial Blood Gas (ABG)**

pH 7.22

paCO2 18 mmHg

paO2 95 mmHg

O2 sat 99%

HCO3- 12 mEq/L

Lactic Acid 14.6 mmol/L

**Learner Stimulus #4**

**Complete Blood Count (CBC)**

WBC 10,900/mm3

RBC 5.34 x106/mm3

Hgb 15.1 g/dL

Hct 45.5%

Platelets 169,000/mm3

Segs 67%

Bands 0%

Lymphs 21%

Mono 8%

Eos 4%

**Learner Stimulus #5**

**Basic Metabolic Panel (BMP)**

Na+ 132 mEq/L

K+ 3.1 mEq/L

CO2- 15 mEq/L

Cl- 92 mEq/L 92 mmol/L

Glucose 54 mg/dL

BUN 29 mg/dL

Creatinine 2.2 mg/dL

Ca+2 7.2 mg/dL

Anion Gap 25

**Learner Stimulus #6**

**Urinalysis**

Color Brown, Turbid

Sp Gravity 1.041

Glucose Negative

Protein 2+

Ketone Negative

Leuk. Est. Negative

Nitrite Negative

WBC 0-2/HPF

RBC 40-50/HPF

Many Granular Casts

**Learner Stimulus #7**

**PT/PTT/INR**

PT 20.1 seconds (Normal 12.6-16.6 secs)

PTT 58.9 seconds (Normal 22.7- 33.9 secs)

INR 1.6

**Learner Stimulus #8**

**Cardiac Enzymes**

 CPK 8,438 ng/mL

 CKMB 82.1 ng/mL

 Troponin 0.02 ng/mL

**Learner Stimulus #9**

**Toxicology Screen**

 Serum Osm 278 mmol/L

 Cocaine Negative

 Amphetamin Negative

 TCA Negative

 Barbiturates Negative

 Benzo Negative

 Marijuana Negative

 Opiates Negative

 Methadone Negative

 PCP Negative

 Tylenol <5 mcg/mL

 Salicylate <0.5 mg/dL

 EtOH level <10 mg/dL

**Stimulus #10**

**Thyroid Studies**

 TSH 2.1 microunits/mL

 Free T4 1.2 mcg/dL

**Stimulus #11**

**Liver Function Tests**

 Albumin 4.6 g/dL

 Total Protein 6.2

 Total Bili 0.8 mg/dL

 Direct Bili 0.3 mg/dL

 AST 664 units/L

 ALT 538 units/L

 Alk-Phos 82 units/L

 Ammonia 14 mcg/dL

**Stimulus #12**

**CSF Studies**

 Pressure 93 mm H2O

 Appearance Clear, colorless

 Protein 60 mg/100 mL

 Glucose 51 mg/100 mL

 Cell count 2 WBC’s, 0 RBC’s

**Stimulus #13**

**CT Head**

#### http://www.migraine-aura.org/site/content/e27891/e27265/e42285/e54218/e56917/e56928/headct_en.jpeg

**Addendum 1:**

**Critical / Dangerous Actions Checklist**

**Heatstroke**

**Candidate \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Examiner \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Critical Actions:**

* Review history with EMS/friend
* Examine the patient thoroughly, including rectal/esophageal (core) body temperature.
* Set up rapid body cooling mechanism (either evaporative cooling with water spray & fans, or with cold water immersion).
* Identify core temperature (esophageal, rectal, or pulmonary artery) either continuously or at least twice prior to presenting the case for admission, after cooling measures have been initiated.
* Identify hypoglycemia and treat appropriately.
* Identify unstable vital signs, rhabdomyolysis, and lactic acidosis and treat appropriately.
* Admit patient to ICU.

**Dangerous Actions:** (Performance of one dangerous action results in failure of the case)

* The examinee fails to discover elevated core body temperature (rectal or esophageal).
* The examinee employs no cooling measures.
* The examinee fails to employ either cold water immersion bath or evaporative cooling as a cooling measure.
* The examinee presents the case for admission after having instituted cooling measures but without first measuring core temperature either twice or continuously, predisposing to iatrogenic hypothermia.
* The examinee discharges the patient home.

**Overall Score:**

* Pass
* Fail

 **Addendum 2:**

**Core Competency Assessment**

**Heatstroke**

 **Candidate \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Examiner \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Does Not Meet Expectations** | **Meets Expectations** | **Exceeds Expectations** |
| **Patient Care** |  |  |  |
| **Medical Knowledge** |  |  |  |
| **Interpersonal Skills and Communication** |  |  |  |
| **Professionalism** |  |  |  |
| **Practice-based Learning and Improvement** |  |  |  |
| **Systems-based****Practice** |  |  |  |

**Addendum 3:**

**Standardized Direct Observational Tool (SDOT)**

**Heatstroke**

 **Candidate \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Examiner \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

Scoring: In accordance with the Standardized Direct Observational Tool (SDOT)

The learner should be scored (based on level of training) for each item above with one of the following:

 NI = Needs Improvement

 ME = Meets Expectations

 AE = Above Expectations

 NA= Not Assessed

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Critical Actions**  | **NI** | **ME** | **AE** | **NA** | **Category** |
| Review history with EMS/friend. |  |  |  |  |  |
| Examine the patient thoroughly, including rectal/esophageal (core) body temperature. |  |  |  |  |  |
| Set up rapid body cooling mechanism (either evaporative cooling with water spray & fans, or cold water immersion). |  |  |  |  |  |
| Identify core temperature (esophageal, rectal, or pulmonary artery) either continuously or at least twice prior to presenting the case for admission, after cooling measures have been initiated. |  |  |  |  |  |
| Identify hypoglycemia and treat appropriately. |  |  |  |  |  |
| Identify unstable vital signs, rhabdomyolysis, and lactic acidosis and treat appropriately. |  |  |  |  |  |
| Admit patient to ICU. |  |  |  |  |  |

The average examinee should be scored as “meets expectations” for completion of the above actions. “Above average” scoring is reserved for examinees who demonstrate prompt administration of critical and non-critical action therapeutic modalities, pathophysiologic knowledge of the disease, and excellent patient interactions. “Needs improvement” should be scored whenever excessive prompting is required.**Addendum 4:**

**Core Competency Definitions**

**Heatstroke**

Category: One or more of the ACGME Core Competencies as defined in the SDOT

 PC= Patient Care

Compassionate, appropriate, and effective for the treatment of health problems and the promotion of health

 MK= Medical Knowledge

Residents are expected to formulate an appropriate differential diagnosis with special attention to life-threatening conditions, demonstrate the ability to utilize available medical resources effectively, and apply this knowledge to clinical decision making

 PBL= Practice Based Learning & Improvement

Involves investigation and evaluation of their own patient care, appraisal and assimilation of scientific evidence, and improvements in patient care

 ICS= Interpersonal Communication Skills

Results in effective information exchange and teaming with patients, their families, and other health professionals

 P= Professionalism

Manifested through a commitment to carrying out professional responsibilities, adherence to ethical principles, and sensitivity to a diverse patient population

 SBP= Systems Based Practice

Manifested by actions that demonstrate an awareness of and responsiveness to the larger context and system of health care and the ability to effectively call on system resources to provide care that is of optimal value

**Addendum 5:**

**Exertional Heatstroke: A Brief Summary**

**Overview**

*Heatstroke is a potentially fatal diagnosis resulting from severe elevation in body temperature with associated neurologic dysfunction/altered mental status. It results from inability of the body to sufficiently dissipate heat relative to heat production/absorption. The 2 key findings will be core temperature >40°C and neurologic dysfunction, the latter of which may occur abruptly. Diagnosis is clinical. Initial management in the Emergency Department is paramount, as rapid reduction in core temperature (goal within <30-60 minutes) is the single most important factor in preventing morbidity and mortality. Patients with heatstroke should be admitted to the ICU.*

**Epidemiology**

Heatstroke occurs in 2 primary groups of patients. Classic heatstroke occurs in elderly patients with psychiatric, physical, mental, or medical conditions that prevent appropriate responses to heat exposure. Exertional heatstroke occurs in young, healthy patients; typically very physically fit (soldiers, athletes) who over exercise in a hot, humid environment.

**Pathophysiology**

Heatstroke at its core results from failure of the body’s homeostatic thermoregulatory mechanisms to maintain body temperature (in contrast to heat exhaustion, or fever,when these remain intact), producing severe and dangerous elevation of body temperature, typically >40.5°C or >105°F. Recall in fever temperature elevation is due to release of prostaglandins, which elevate the temperature set-point for the body. Thermoregulatory failure and hyperthermia can result in tissue and frank organ damage in multiple organ systems. Heatstroke is defined by core temperature > 40°C (104°F) with neurologic dysfunction. Heatstroke results from a failure of the body’s thermoregulatory mechanisms to maintain temperature homeostasis at the target temperature set-point. Both morbidity and mortality increase with delays in reducing core body temperature; rapidly cooling the core (to a goal of <39°C) can reduce mortality from 60-80% down to 0%.

**Presentation**

As noted, heatstroke is defined by significant rise in core body temperature with neurologic dysfunction. Neurologic changes will typically be abrupt/acute in onset. Tympanic, skin, and oral temperatures are particularly unreliable. Evaporation from profuse sweating will reduce the apparent skin temperature. Tachypnea to compensate for metabolic acidosis (most commonly lactic acidosis in Exertional heatstroke) will reduce the apparent oral temperature. Exertional heatstroke will typically occur in the healthy young athlete/soldier, most commonly with exertion in a hot, humid environment. Hypoglycemia, rhabdomyolysis, lactic acidosis, and transaminitis (followed by jaundice 24 hrs after presentation) is common in exertional heatstroke. The exercise consumes the glucose, and hepatic function is impaired (evidenced by abnormal Coagulation profile, and elevated LFT’s) interfering with gluconeogenesis. Glucose must be corrected. One may also find hyponatremia, hypokalemia, and hypocalcemia. Lactic acidosis due to anaerobic metabolism is common in Exertional heatstroke and levels may be as high as 10-20 without increased mortality.

**Evaluation**

By definition, core temperature must be obtained, and it must continue to be closely monitored as cooling measures are instituted. Appropriately diagnostic workup should include studies to determine the etiology of altered mental status. Non-exertional etiologies of the hyperpyrexia should also be pursued.

**Morbidity & Mortality Considerations**

Elevated lactic acid and hypernatremia both independently carry very high mortality in classic heatstroke (elderly with psychiatric/physical/medical conditions preventing appropriate responses to heat), which is in contrast to exertional heatstroke. Abnormal bleeding & coagulation profile abnormalities universally carry a very poor prognosis in all forms of heatstroke. Abnormal pH on ABG is always associated with increased morbidity and mortality. If cooling is not initiated immediately, heat stroke carries a mortality of up to 80%. With appropriate cooling measures, mortality has been shown to drop to 0% in multiple studies. The goal is to reduce core temperature to <39.5°C within 60 minutes, the so-called “Golden Hour of Heatstroke”.

**Management**

Initial management includes IV fluids and rapid body cooling. This should be done aggressively, as every study and policy statement from sports medicine/training organizations have concluded that delays in reducing core temperature directly correlate with increases in morbidity and mortality. If IV fluids and adequate cooling are instituted, all vital signs should normalize and most electrolyte and metabolic derangements will at least partially improve. The only abnormality that is expected to worsen with cooling is diarrhea. If cold water immersion is used, extremities should be massaged continuously to prevent peripheral vasoconstriction and maintain adequate blood flow in the periphery. Airway should be protected with altered mental status in a tub of water. If evaporative cooling is used, water must be sprayed continuously while the fan blows air to evaporate said water. Adjunctive cooling methods include peritoneal lavage (only ever tested on dogs, never in humans, safety profile unknown), cold-irrigant gastric lavage, rectal lavage, or bladder lavage (will not provide significant heat exchange if used as the primary cooling modality), peritoneal dialysis with cold fluids, and cardiopulmonary bypass with a heat exchanger. Without ice water immersion or evaporative cooling, these cooling methods are considered inadequate treatment for heatstroke. Ice packs have been shown not to significantly reduce cooling time either with or without evaporative cooling [1]. One study showed that core temperature <39°C can be attained in 10-40 minutes in 252 subjects using evaporative cooling, with no fatalities (no other study on heatstroke has included anywhere near this many human subjects)[2]. Yet another study showed ice water immersion can cool a body twice as fast as evaporative cooling [3]. The Emergency Medicine Clinics of North America’s “Heat-related Illness” takes into account all of the relevant studies and literature, and states “It would seem that ice water immersion is the fastest way to lower core temperature. Evaporative cooling is an alternative primary rapid body cooling technique. Other techniques such as the use of cooling blankets, ice packs to the neck, groin, axillae, and gastric and peritoneal lavage can be considered as extra treatment but not as primary treatment.” [4] Similar conclusions about the superiority of ice water immersion, necessity for either ice water immersion or evaporative cooling, and necessity for rapid body cooling in cases of heatstroke have been drawn by multiple other reviews of the relevant literature by experts in sports- and environmental-medicine, including recommendations by the American College of Sports Medicine and National Athletic Trainers’ Association position statements on exertional heatstroke. [5] [6] [7] [8]

**Disposition**

Patients with heatstroke should be admitted to an ICU.

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**Keywords:**

Heatstroke, Heat Illness, Heat Exhaustion, Hyperthermia, Hyperpyrexia, Environmental Pathology, Environmental Illness, Heat-related Illness, Altered Mental Status, Critical, ICU

**Has this work been previously published?**

No