

# Heat Illness in Sports

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# Goals

- Recognize signs and symptoms of heat related illnesses
- Be able to diagnose heat related illnesses in athletes
- Review treatment of heat related illnesses on site and in health-care facilities
- Learn about interventions to help prevent heat related illnesses

# Introduction

- Prolonged environmental heat exposure and endogenous heat production during activity both require elaborate regulation by the endocrine, exocrine, circulatory, and neurologic systems.
- Heat illnesses are best thought of as a collection of illnesses that range from benign to potentially fatal.
  - Mild heat syncope and cramps
  - Moderate heat exhaustion
  - Life threatening heat stroke

# Epidemiology

- In the US, heat injury results in ~650 preventable deaths per year
- From 1999-2009, 7000 heat related deaths
  - 72% directly related to heat exposure
  - 28% heat induced exacerbation of underlying problem
- Estimated 9000 high school athletes treated for exertional heat illness per year
  - Third leading cause of death in athletes
- Risk rises dramatically in July and August when practices begin
  - Athletes are often deconditioned and not heat acclimated

# How Does the Body Keep Cool?

- Conduction-direct transfer of heat across temperature gradient through physical contact (ice packs)
- Convection-heat is lost through movements of liquid or gas (wind, fan, water)
- Radiation-heat transfer to or from an object via electromagnetic radiation (sun rays-decreased in shade)
- Evaporation-heat lost through dissipation of sweat. Most effective.
  - Must evaporate (not wiped off) to contribute to cooling
  - Athletes can lose 1-2.5 liters per hour (30-75 ounces)

# Heat Syncope

- Peripheral vasodilation and pooling of blood
  - Leads to decreased cardiac output and stroke volume
  - Can induce transient loss of consciousness
- **Diagnosis**-based on signs and symptoms
  - Normal rectal temperature
  - Brief episode of fainting, improved with supine position
  - Dizziness, tunnel vision
  - Pale and wet skin
- More common in athletes that have been standing for long periods of time or those who have stopped exercising suddenly

# Heat Syncope Treatment

- Place athlete in recumbent position with legs elevated above head level
- Remove any excess clothing/equipment
- Place athlete in cool shaded environment
- Monitor vital signs
- Oral hydration if dehydrated

# Heat Cramps

- Involuntary, painful contractions of large muscles during or after prolonged exercise
- Often induced by large sodium losses via sweat in conjunction with copious water consumption
  - Thought to be from decreased sodium and chloride
- Studies have shown that cramp prone athletes can lose twice the sodium in sweat as non-cramp prone teammates<sup>3</sup>
- May be difficult to determine whether cramps in athletes with sickle cell trait are due to heat cramps or sickle cell crisis
  - Sickle cell crisis must be considered, misdiagnosis can lead to serious consequences
- Neuromuscular fatigue may also cause cramping

# Heat Cramps-Diagnosis

- Normal rectal temperature for an exercising individual
  - $<104^{\circ}\text{F}$  or  $40^{\circ}\text{C}$
- Commonly affect hamstrings, gastrocnemius, and soleus muscles
- Common after strenuous long exercise bouts
- May see “salt stains” on skin or clothes from excess sodium loss
- Normal central nervous system (CNS) function

# Heat Cramps-Treatment

- Stop exercise
- Place athlete in cool shaded environment
- Passive stretching of painful muscles
- Remove constrictive clothing/equipment
- Re-establish normal hydration status with high sodium containing fluid
  - At first sign of heat cramps, it is recommended that the athlete drink 480 ml (16 fl oz.) of a sports drink with 2.5 ml (.5 tsp) of salt added to avoid full-blown heat cramps and to continue this until the contest is over.

# Heat Exhaustion-Definition

- The inability to continue exercise in the heat
- Most common form of heat illness seen in athletes
  - Does not necessarily progress to heat stroke
  - Heat exhaustion and heat stroke are separate entities but occur under similar hot weather conditions

# Heat Exhaustion-Diagnosis

- Inability to continue exercise in the heat, collapse
- Core body temperature (rectal) may be elevated (102-104 degrees F) but within normal limits for an exercising individual
  - Tachycardia
  - Pale and wet skin, sweating
  - Nausea and/or vomiting
  - Headache, dizziness and/or faintness
  - Rapid/shallow breathing/weak pulse
  - Thirst

# Heat Exhaustion-Differential

- Rule out other serious conditions that may be present such as:
  - Exertional Heat Stroke
  - Hyponatremia
  - Head Injury
  - Hypoglycemia/hyperglycemia
  - Cardiac event
  - Exertional Sickling

# Heat Exhaustion Treatment

- Check temperature if exertional heat stroke suspected or improvement not seen in first 5-10 minutes of treatment
- Place athlete in cool shaded environment
- Remove excess clothing and equipment
- Cool athlete with fans, ice towels, water dousing and move them to an air-conditioned or shaded/cool environment
- Rehydrate orally with sports drink if athlete is not nauseated or vomiting, or experiencing CNS dysfunction. Evaluate for IV fluids
- Transport to an emergency facility if recovery is not prompt and EHS has been ruled out (consider other causes)
- If symptoms persist following 10-15 minutes of treatment and EHS is suspected begin more aggressive cooling therapy

# Exertional Heat Stroke (EHS): MEDICAL EMERGENCY!

- Occurs when heat generation exceeds heat loss leading to a rise in core temperature and thermoregulatory failure
- A serious, life-threatening condition requiring immediate medical attention
- It is distinguished from heat exhaustion by CNS dysfunction in combination with a dangerously high core body temperature

# Exertional Heat Stroke-Diagnosis

- High core-body temperature  $>40^{\circ}\text{C}$  ( $104^{\circ}\text{F}$ )
  - Only rectal temperature should be used for accurate temperature reading
  - Other devices may give false readings and should not be used in the absence of a valid device
- CNS dysfunction, such as altered consciousness, coma, convulsions, disorientation, irrational behavior, decreased mental acuity, irritability, emotional instability, confusion, hysteria, or apathy
- **\*Temperature and CNS dysfunction will distinguish EHS from other serious conditions and are the main diagnostic criteria that should be used\***

# Exertional Heat Stroke-Other Signs and Symptoms

- Hot, sweaty skin
- Coagulopathy may be present: conjunctival hemorrhages, purpura, melena, hemoptysis, and hematuria
- Rapid pulse rate (>160 BPM)
- Rapid respirations (>20 per min)
- Decreased blood pressure
- Nausea, vomiting or diarrhea
- Headache, dizziness or weakness
- Laboratory testing-electrolytes, liver function tests, renal function tests
  - May be used to determine recovery/severity of heat stroke
  - May be elevated for days or weeks afterwards, especially if not treated effectively

# Exertional Heat Stroke

- EHS is a medical emergency and can be a fatal condition if the individual's core body temperature remains above 104° F (40° C) for an extended period of time (usually around 30-60 minutes) without the proper treatment
- Duration of time body core temperature is above 104° F (40° C) predicts clinical outcome

# Intrinsic Risk Factors

- History of exertional heat illness or cramping
- Presence of a fever, other illness, skin condition (sunburn), or medical condition (sickle cell)
- Inadequate heat acclimatization
- Dehydration
- Intensity unmatched to physical fitness
- Barriers to evaporation (equipment)
- Overweight athletes/athletes with a high body-mass index (BMI)
- Low body fat/BMI (lean and fit)
- Heavy or “salty” sweaters, or athletes who lose >3% weight loss during activity
- Medications or supplements (diuretics, ephedrine, antihistamines)
- ADD/ADHD medications
- High intensity athletes/tendency to push oneself
- Salt deficiency/athletes on restricted or low salt diets

# Extrinsic Risk Factors

- Vigorous activity in hot-humid environment
  - Typically > 1 hour or prolonged exercise with minimal breaks
  - Wet bulb globe temperature-can help determine proper exposure
- High temperature/humidity/sun exposure
- Equipment-dark colors, heavy clothing, helmets, other protective equipment
- Inadequate rest breaks
- Inappropriate work/rest ratios based on exercise intensity, clothing, fitness, heat acclimatization, or medical conditions
- Lack of education or awareness among coaches, athletes and medical staff
- No access to shade or fluids during rest breaks
- Delay in recognition of early heat illness warning signs-lack of proper medical care

# Heat Stroke Treatment

- If heat stroke is suspected, call EMS and prepare to cool the patient
  - Immediate whole body cooling and rapid reduction of core body temperature within 30 minutes is priority
  - Remove any excess equipment or clothing
  - “Cool first, transport second”
  - Best if EMS is aware of guideline to cool first then transport.
  - Guideline should be reviewed with EMS annually

# Heat Stroke Treatment

- Transport or assist athlete to cold tub
- Determine vital signs
  - Assess core body temperature with rectal thermistor
- Begin ice water immersion
  - Total body coverage
  - Water temperature <60 degrees
  - Assistant to keep head/neck above water-may need towel or sheet
  - Vigorously circulate water
- Continue to check vital signs
- Assess for IVF hydration if medical personnel present

# Cool First, Transport Second

*The most important message of this presentation!*

- “Exertional heat stroke has had a 100% survival rate when immediate cooling (via cold water immersion or aggressive whole body cold water dousing) was initiated within 10 minutes of collapse.”
- From Korey Stringer Institute, University of Connecticut:  
<http://ksi.uconn.edu/info/basic.html>

# Heat Stroke Treatment-Cooling Duration

- Continue cooling until the patient's rectal temperature lowers to 39°C (102°F)
- If rectal temperature cannot be measured and cold water immersion is indicated, cool for 12-15 minutes and then transport to a medical facility
- An approximate estimate of cooling via ice water immersion is 1°C for every five minutes and 1°F every 3 minutes (if the water is aggressively stirred)

# Heat Stroke Treatment-Cooling Methods

- If cold water immersion is not available or feasible given the constraints of the athletic activity being performed or location, then cool via the best available means
  - A good (although not optimal) highly portable alternative is a cooler filled with ice, water, and 12 towels. Place six ice/wet towels all over body and leave on for 2-3 minutes, then place those back in cooler and put the six others on the patient. Continue this rotation every 2-3 minutes
  - Another alternative when a tub is not available is cold water dousing from a locker room shower or from a hose

# Heat Stroke Treatment-Patient Transfer

- Remove the patient from the immersion tub only after rectal temperature reaches 39°C (102°F) and then transfer to the nearest medical facility via EMS as quickly as possible
- Notify medical facility that a patient with heat stroke is being transferred and cooling therapy has been performed
- Cooling is the primary goal before transport
  - If appropriate medical staff is available, an aggressive cooling modality is readily available (cold water immersion, ice/wet towel rotation, high flow cold water dousing); and no other emergency medical services are needed besides the rapid lowering of temperature, then always follow the “cool-first, transport second” doctrine

# Heat Stroke Treatment-ED and Hospital

- ABCs
- Continue cooling if target temperature not reached: 101°-102°
  - Continuous temperature monitoring or rectal temp every 10 minutes
- Labs
  - Complete blood count (hemoglobin, platelet and white blood cell counts)
  - Basic serum electrolytes (Na, K, Cl, HCO<sub>3</sub>), including calcium
  - Renal function studies (BUN, creatinine)
  - Urinalysis
  - Creatine kinase (CK)
  - Liver function tests (AST, ALT)
  - Coagulation studies (PT, INR, aPTT)

# Heat Stroke Treatment-On-site and ED

- If rapid cooling is initiated on-site or at healthcare facility
- Patient does not develop further signs or symptoms of EHS
- Observation for 6 hours
- May be discharged to home with responsible adult monitoring for 24 hours
- Hospitalize for observation and monitoring if develop complications

# Heat Stroke Treatment-ED and Hospital

- Evaluate for related conditions: Sickle cell trait, neuroleptic malignant syndrome, infection, cardiovascular disease, compartment
- Fluid resuscitation
- Correct of electrolyte abnormalities
- Diagnosis and treatment of complications
  - CNS, rhabdomyolysis, renal failure, liver failure, DIC, cardiac function
- No specific pharmacologic treatment
  - Antipyretics can cause complications (NSAIDs, acetaminophen)

# Heat Illness Prevention Recommendations

- Each school should have an Emergency Action Plan
  - Includes procedures for dealing with Exertional Heat Illness as well as guidelines for Preseason Heat Acclimatization.
- All medical staff, athletes, coaches, emergency personnel, and parents should be educated about EHI, proper hydration and familiar with the Heat Illness Guidelines.
- Student athletes should be adapted to heat gradually over 10-14 days.
- Student athletes with a positive response to prior heat illness on pre-participation exam or with a history of sickle cell trait/family history of sickle cell anemia should be allowed to pace themselves and be allowed appropriate rest breaks.

# Heat Illness Prevention Recommendations

- During all Preseason Heat-Acclimatization practices it is recommended that:
  - A NV Licensed Athletic Trainer or qualified EMS Personnel should be present for the entire practice.
  - A cold immersion tub should be available for the benefit of any player showing early signs of heat illness.
    - The cold immersion tub should be body sized and maintained at 35-58 degrees Fahrenheit.
- The cold immersion tub should be within a reasonable distance (within about 5 minute access) of the practice fields.

Relative Humidity (%)

	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
80	77	78	78	79	79	79	80	80	80	81	81	82	82	83	84	84	85	86	86	87
81	78	79	79	79	79	80	80	81	81	82	82	83	84	85	86	86	87	88	90	91
82	79	79	80	80	80	80	81	81	82	83	84	84	85	86	88	89	90	91	93	95
83	79	80	80	81	81	81	82	82	83	84	85	86	87	88	90	91	93	95	97	99
84	80	81	81	81	82	82	83	83	84	85	86	88	89	90	92	94	96	98	100	103
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96	89	90	92	93	94	96	98	101	104	108	112	116	121	126	132	138	145			
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98	91	92	94	95	97	99	102	105	109	113	117	123	128	134	141	148				
99	92	93	95	96	98	101	104	107	111	115	120	126	132	138	145	153				
100	93	94	96	97	100	102	106	109	114	118	124	129	136	143	150	158				
101	93	95	97	99	101	104	108	112	116	121	127	133	140	147	155					
102	94	96	98	100	103	106	110	114	119	124	130	137	144	152	160					
103	95	97	99	101	104	108	112	116	122	127	134	141	148	157	165					
104	96	98	100	103	106	110	114	119	124	131	137	145	153	161						
105	97	99	102	104	108	112	116	121	127	134	141	149	157	166						
106	98	100	103	106	109	114	119	124	130	137	145	153	162	172						
107	99	101	104	107	111	116	121	127	134	141	149	157	167							
108	100	102	105	109	113	118	123	130	137	144	153	162	172							
109	100	103	107	110	115	120	126	133	140	148	157	167	177							
110	101	104	108	112	117	122	129	136	143	152	161	171								
111	102	106	109	114	119	125	131	139	147	156	166	176								
112	104	107	111	115	121	127	134	142	150	160	170	181								
113	104	108	112	117	123	129	137	145	154	164	175									
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115	106	110	115	121	127	134	143	152	162	173	184									
116	107	111	116	122	129	137	146	155	166	177										
117	108	112	118	124	132	140	149	159	170	181										
118	108	113	119	126	134	142	152	162	174	186										
119	109	114	121	128	136	145	155	166	178											
120	110	116	122	130	138	148	158	170	182											
121	111	117	124	132	141	151	162	174	187											
122	111	118	125	134	143	154	165	178												
123	112	119	127	136	146	157	169	182												
124	113	120	129	138	148	160	172													
125	114	121	130	140	151	163	176													

# Heat Index

## Heat Index



Extreme Danger	Heat stroke likely.
Danger	Sunstroke, muscle cramps, and/or heat exhaustion likely. Heatstroke possible with prolonged exposure and/or physical activity.
Extreme Caution	Sunstroke, muscle cramps, and/or heat exhaustion possible with prolonged exposure and/or physical activity.
Caution	Fatigue possible with prolonged exposure and/or physical activity.

# Heat Illness Prevention-Pre-Season

- Thorough and complete pre-participation history and physical examination
  - Note history of heat illness
  - Note history of sickle cell trait and screening test results if available
    - Sickle cell trait does not predispose to heat illness but the conditions may be confused with each other and outcome from EHS may be more severe
  - Type and duration of training activities within the past 1-2 months
  - Extent of training done in heat
  - Acclimatize athletes to high heat and humidity gradually over 10-14 days
  - Set up strength and conditioning/acclimatization programs
  - Education athletic training staff and coaching staff on heat illness recognition, management and prevention
  - Perform training sessions when medical care is available and on-site

# Heat Illness Prevention-Pre-Season

- Emergency planning/Communication
  - Communication between athletic trainers, team physicians and local EMS
  - Availability of cell phones or radios
  - Practice emergency algorithms and drills
  - Carts for patient transport-if available

# Heat Illness Prevention-Pre-Practice

- Preparation of Practice Facilities
  - Ice/water, ice towels, coolers/water bottles, Gatorade, water
  - Ice tubs/cold whirlpools
    - Location ideally close to practice facility or transport available
  - Cold tubs-checked and filled before every practice
  - Rectal thermistor for core body temperature
  - Lower air conditioning in buildings (70°) in case need to move athletes into cooler area

# Heat Illness Prevention-Pre-Practice

- Monitor Heat Index via internet weather report
- Communicate with coaches (adjust practice times, breaks, intensity of workout)
- Equipment check-utilize light colors, lightweight, and sun-protection clothing
- Communicate with athletes
- Diet/nutrition (when and what to eat)
- Stop medications that impair heat loss, increase thermogenesis, or decrease sweating (Ephedra compounds, antihistamines, large amounts of caffeine, diuretics) and substitute with safer medications

# Heat Illness Prevention-Pre-Practice

- Emphasize hydration
- Weight charts
  - Daily weigh-in pre and post practice
  - If > 3% weight loss from day before, must increase salt/fluid intake before practice and monitor athletes for signs of symptoms heat illness closely
    - At discretion of Sports Medicine team, student athlete may be held from practice until rehydrated
- Ice/water/ice towels available
- Designate cool/shaded area
- Ice tubs (field, locker room, athletic training room)
- Emergency equipment (AED, oxygen, thermometer, transport carts, etc)

# Heat Illness Prevention-During Practice

- Monitor Heat Index every 20-25 minutes via internet weather report as needed
- Minimize warm up time in heat
- Conduct warm ups in the shade or cooler (indoor) environments when possible
- Communication with coaching staff
  - Increase breaks
  - Lower intensity of workout depending on heat
  - Minimal equipment, clothing
- Ice, water, towel availability
- Injured athletes observe practice from cool/shaded areas
- Cold tubs
  - Plan for transporting athletes to tubs if needed
  - If with cart can use ice towels during transport
- Sports Medicine Staff field communication (cell phones, radios)

# Heat Illness Prevention-During Practice

- Heat Illness recognition
  - Any athletes who display signs and symptoms of heat illness must have participation restricted based on the judgment of the sports medicine staff
- Practice modification
  - Rest breaks should be planned to match conditions and intensity of activity
  - Minimize the amount of equipment and clothing worn in hot or humid conditions
- Pre-hydration and hydration during activity

# Heat Illness Prevention-After Practice

- Communicate with coaches (injury report; weather forecast, etc.)
- Communicate with student athletes
  - Encourage athletes to sleep at least 6-8 hours at night in a cool environment
  - Eat a well-balanced diet that includes proper hydration
    - Lots of fluids; low-fat meal; no caffeine or alcohol
    - Lightly salted foods; no fast food; drink fluids with meal
  - Extra sodium may be required when exercising in hot conditions or on days with multiple practices, either in diet or rehydration beverages
- Weight charts
  - Note > 3% weight loss and monitor athletes for signs or symptoms heat illness closely and educate athlete regarding appropriate rehydration
- Follow NIAA practice guidelines

# Return to Activity After Heat Stroke

- If no complications, can usually resume modified activity within one month.
  - 7-21 day rest period
  - No symptoms
  - Labs back to normal: CBC, CMP, CPK
  - Gradual progression of physical activity-supervised
    - Low to high intensity in temperate (not hot) environment
    - Increased duration
    - Graded progression of heat acclimation-watch for EHI symptoms
  - In some cases, full recovery is not possible

# References

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