

# Heat Illness and Emergency

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# Disclosures

- No financial disclosures

# Outline

- Introduction
  - Definitions/Epidemiology
  - Heat physics (truncated)
  - Pathophysiology/Physiology
  - Classification (exertional vs. non-exertional/classic)
  - High risk populations
- Presentation/Physical Exam
- Approach to Initial Evaluation and Treatment
- Related Illness and Comorbid Conditions
- Disposition Decisions

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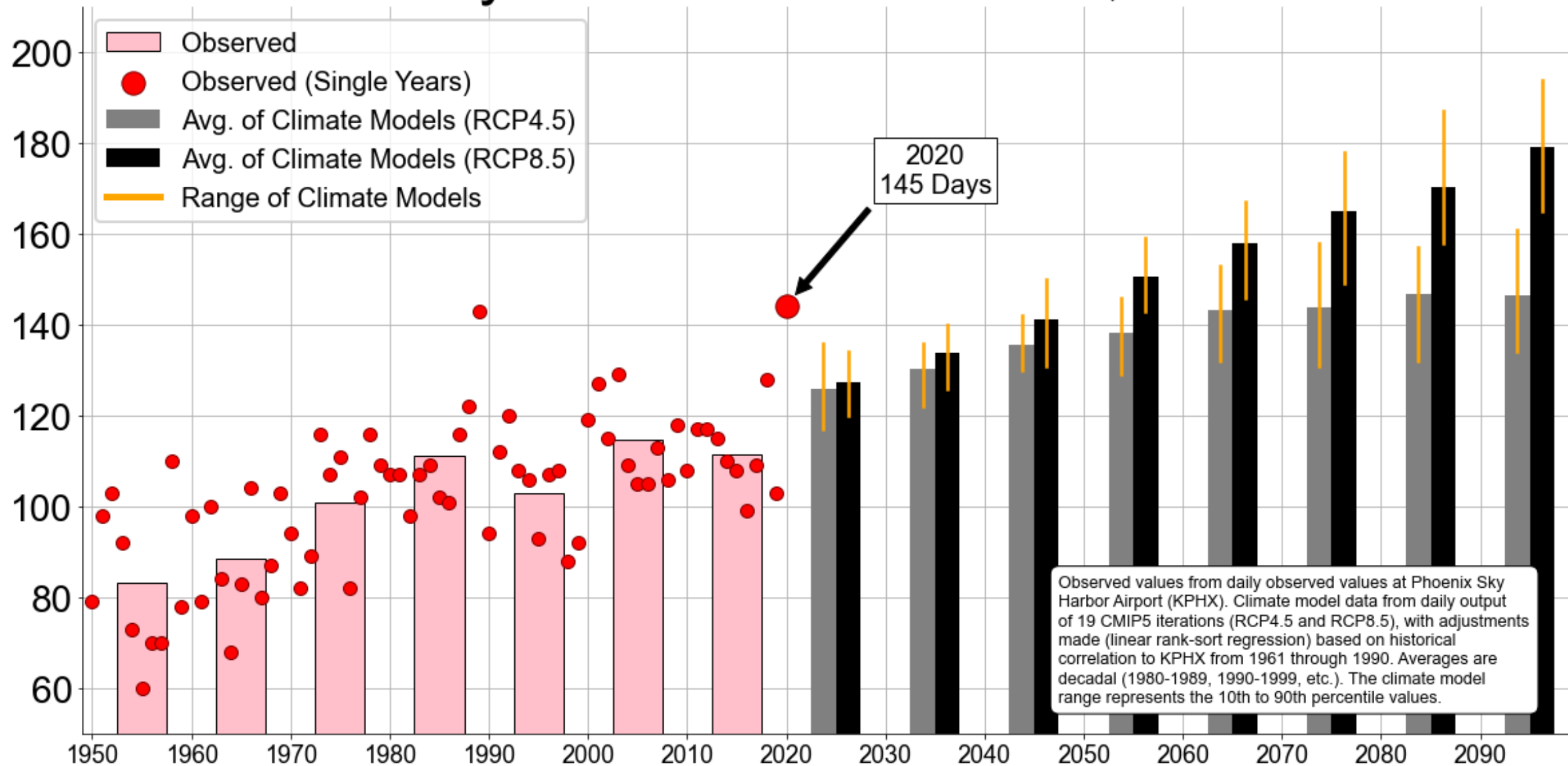
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# What is heat illness?

- Classically -> "Exposure without alteration of hypothalamic thermoregulation"
- Generally classified by cause
  - A. Classic
  - B. Exertional
  - C. Pharmaceutical
- Difficult to estimate prevalence
- Common in warmer climates, more frequent during heat waves

# Number of Days 100+ °F in Phoenix, AZ

Source: NOAA/NWS Phoenix, AZ



# How does this happen?

- Heat is energy transfer through 3.5 primary mechanisms:
  1. Conduction
  2. Convection
  3. Radiation
  4. *Evaporation*

Radiation (<95F)

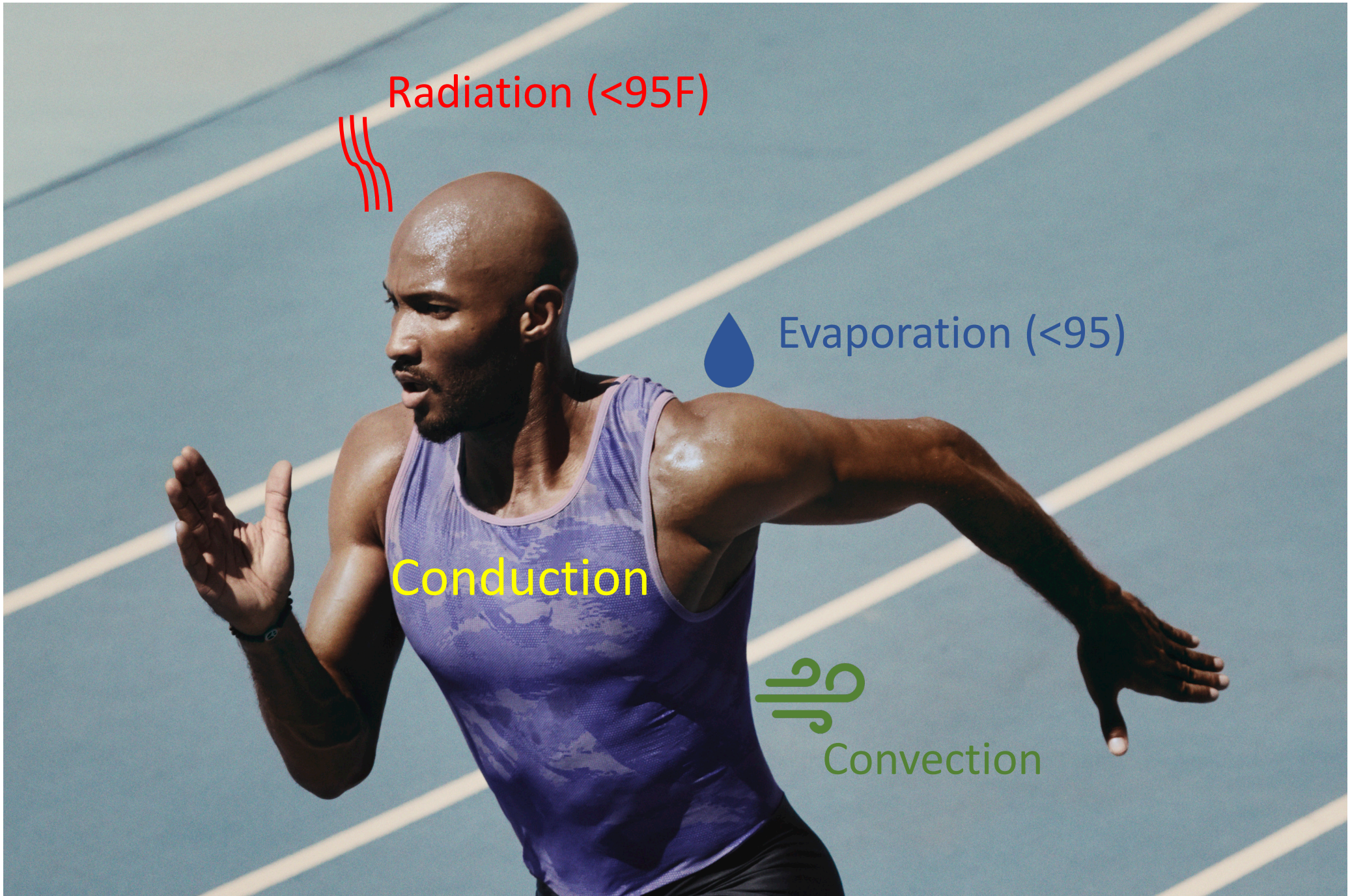


Evaporation (<95)

Conduction



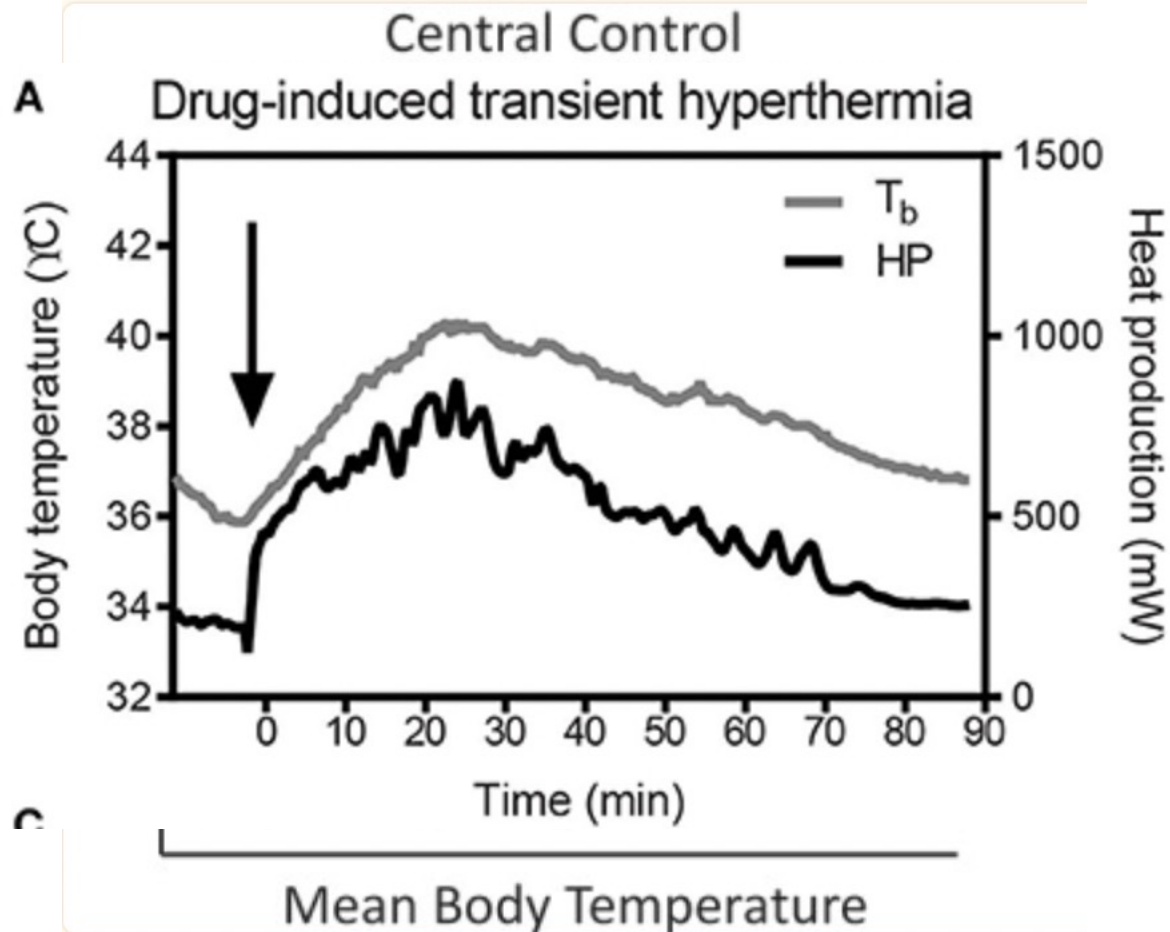
Convection





# Physiologic Response to Heat Stress

Involuntary



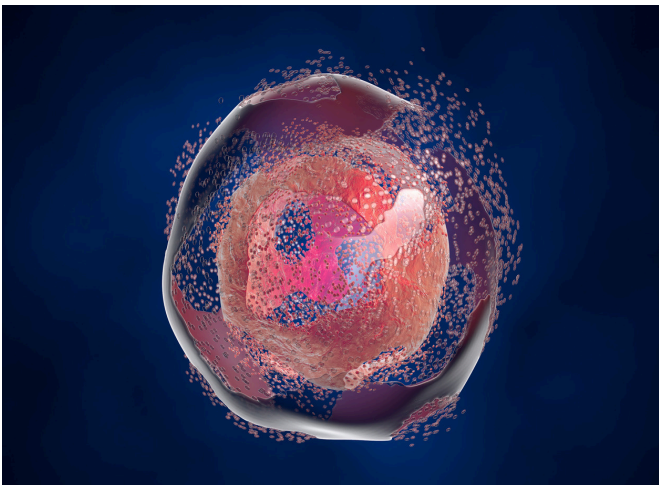
Voluntary/Behavioral



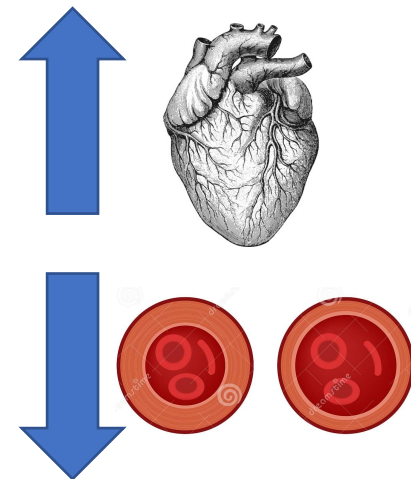
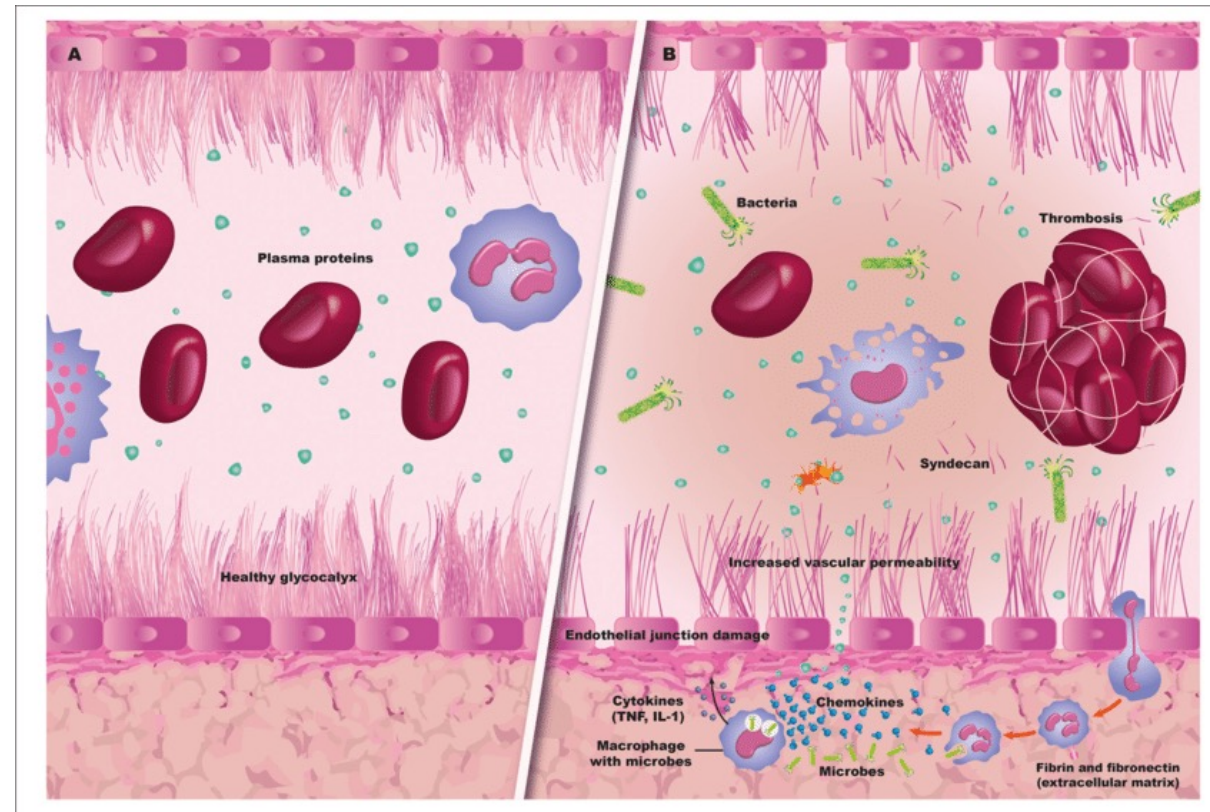
# Pathophysiology of heat injury

- Thermal regulation begins to fail when  $>40^{\circ}\text{F}$
- Unable to maintain temperature homeostasis

Poor organ perfusion



Inflammatory cytokines



# Models of Heat Injury

- Classic -> high environmental heat stress
- Exertional -> environmental + physical activity
- Confinement Hyperpyrexia -> high risk low ventilation environments

# High Risk Populations

- Concurrent EtOH or drug use
  - EtOH -> diuresis
  - Opiates/Stimulants -> blunt heat adaptation
  - Stimulants/LSD/PCP -> increase metabolic rate



# High Risk Populations

- Prescription medication use
  - Blood pressure Rx (B-blockers, CCBs)
  - Diuretics
  - Anti-nausea meds (Phenothiazines) -> interferes with heat response center of brain

# High Risk Populations

1. Elderly
  - Blunted physiologic response to heat
  - Rx
  - Reduced mobility
2. Physically disabled persons
3. Children
  - Proportionally large TBSA
  - Smaller circulating plasma volume
  - Very young (<mobility)
4. Low socioeconomic status

# High Risk Populations

5. “Ravers”
6. Regional (Southwestern US etc.)
7. Immigrants/Refugees
8. Poorly acclimatized
  - Around 1-3 weeks to acclimate

# Introduction Summary

- Heat illness comprises a spectrum of disease from mild to life threatening
- Heat illness is the result of an overwhelmed physiologic cooling mechanism
- Heat stress can cause cellular damage and illicit a large inflammatory response similar to sepsis
- Heat injury is classically defined as non-exertional, exertional and confinement hyperpyrexia
- Persons with concurrent Rx use, recreational drug/EtOH use, lower socioeconomic status, and extremes of age are at higher risk



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# Clinical Presentation - A spectrum of heat



**Illness Severity**

# Heat Edema/Cramps



# Heat Rash “Miliaria rubra”



# Heat Syncope



# Heat Exhaustion – “Heat Stress”



# Heat Stroke



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# Mitigating Risk: WBGT Index

		Temperature in Degrees Fahrenheit															
		68.0	71.6	75.2	78.8	82.4	86.0	89.6	93.2	96.8	100.4	104.0	107.6	111.2	114.8	118.4	122.0
Relative Humidity (%)	0	58.6	60.9	64.3	65.5	67.7	69.9	72.1	74.3	76.4	78.5	80.6	82.6	84.7	86.6	88.6	90.5
	5	59.6	62.1	65.6	67.0	69.3	71.7	74.0	76.4	78.6	80.9	83.1	85.3	87.5	89.9	92.1	94.2
	10	60.7	63.3	66.9	68.4	70.8	73.3	75.8	78.2	80.7	83.0	85.5	88.0	90.3	92.8	95.1	97.6
	15	61.7	64.5	68.1	69.6	72.2	74.8	77.4	80.0	82.6	85.2	87.8	90.2	92.8	95.4	98.0	
	20	62.7	65.6	69.4	70.9	73.6	76.3	79.2	81.8	84.5	87.1	89.8	92.5	95.2	97.8		
	25	63.8	66.7	70.5	72.2	75.1	77.8	80.6	83.4	86.2	89.0	91.8	94.6	97.4			
	30	64.8	67.6	71.7	73.4	76.3	79.2	82.1	84.9	87.8	90.8	93.6	96.6	99.4			
	35	65.6	68.6	72.7	74.6	77.5	80.5	83.5	86.4	89.4	92.4	95.3	98.3				
	40	66.7	69.6	73.8	75.7	78.8	81.8	84.8	87.8	90.9	94.0	97.0					
	45	67.5	70.6	74.8	76.8	79.9	83.0	86.1	89.2	92.3	95.4	98.6					
	50	68.4	71.5	75.8	77.8	81.1	84.1	87.4	90.5	93.7	96.9						
	55	69.3	72.4	76.7	78.8	82.1	85.3	88.5	91.9	95.1	98.3						
	60	70.1	73.3	77.7	79.8	83.2	86.4	89.8	93.1	96.3	99.6						
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80	73.2	76.7	81.2	83.6	87.1	90.4	93.9	97.4									

**Table 4. Wet Bulb Globe Temperature Categories And Recommended Activity Levels**

WBGT Category	ACSM Guideline	US Military Guideline	Risk Level And Recommendations
1 (white flag)	< 50°F (10°C)	78°F-81.9°F (25.6°C-27.7°C)	Very low risk. Use caution and preventive measures during physical activity.
2 (green flag)	< 65°F (18.3°C)	82°F-84.9°F (27.8°C-29.4°C)	Low risk. Use caution and preventive measures during physical activity.
3 (yellow flag)	65°-73°F (18.3°-22.8°C)	85°F-87.9°F (29.4°C-31.1°C)	Moderate risk. Curtail strenuous outdoor activity for all persons not acclimatized.
4 (red flag)	73°-82°F (22.8°-27.8°C)	88°F-89.9°F (31.1°C-32.2°C)	High risk. Use extreme caution and preventive measures during physical activity.
5 (black flag)	> 82°F (27.8°C)	> 90°F (32.2°C)	Extreme risk. Restrict physical activity to air-conditioned or climate-controlled environments.

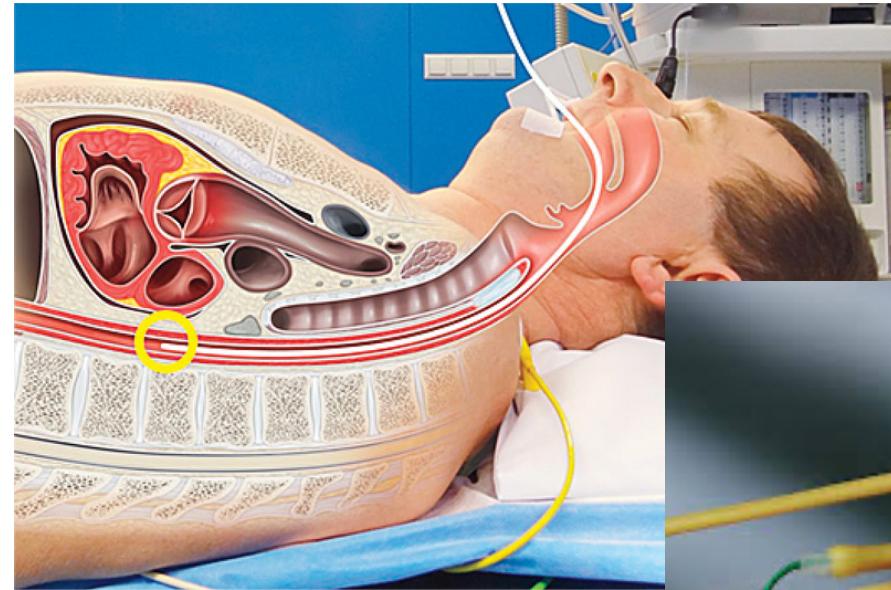
Abbreviations: ACSM, American College of Sports Medicine; WBGT, wet bulb globe temperature.

# Initial Evaluation - Arrival

- Establish scene safety
- Collateral information/history
- Address immediate life threats
  - ABCs\*
  - Exposure – full body survey
- Consider relocation
  - Cooler/Dryer environment
  - Shaded

# Secondary evaluation

- Temperature
- Core = rectal, bladder or esophageal
  - External = oral, axillary, skin and tympanic
- External temps are often cooler
- External temp does not match well with core



# So what thermometer should we use!?

- External temp – for trends and use until a core temp can be obtained



# Treatment

- Prognosis worsens with time when core  $>40.5\text{C}$
- Rapid cooling is the mainstay of treatment\*
- “Cool first, transport second”
- Target  $<39\text{C}$  (38.5C common endpoint)

# Treatment – Evaporation/Radiation

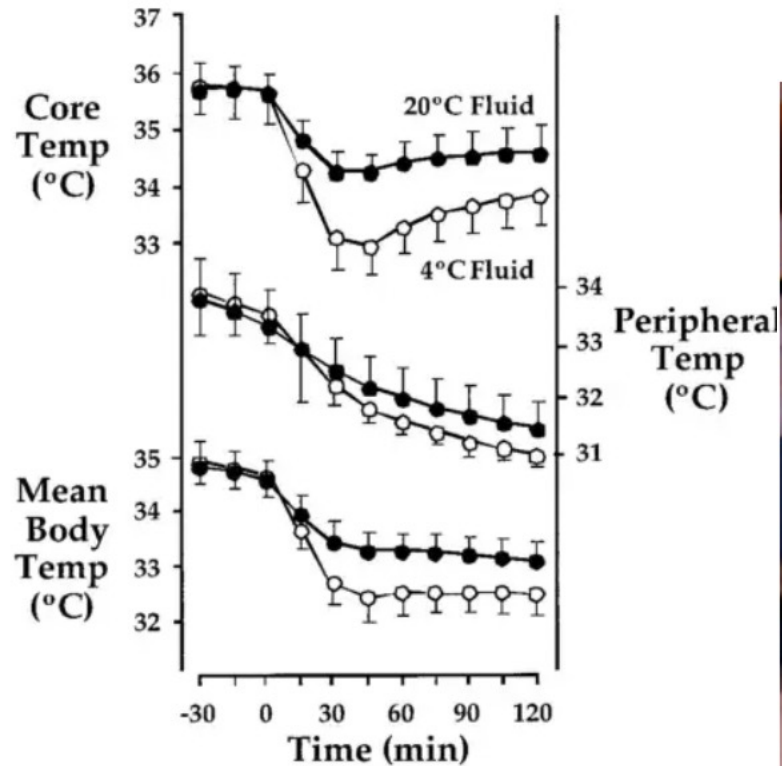


\*0.05-0.1 °C/min

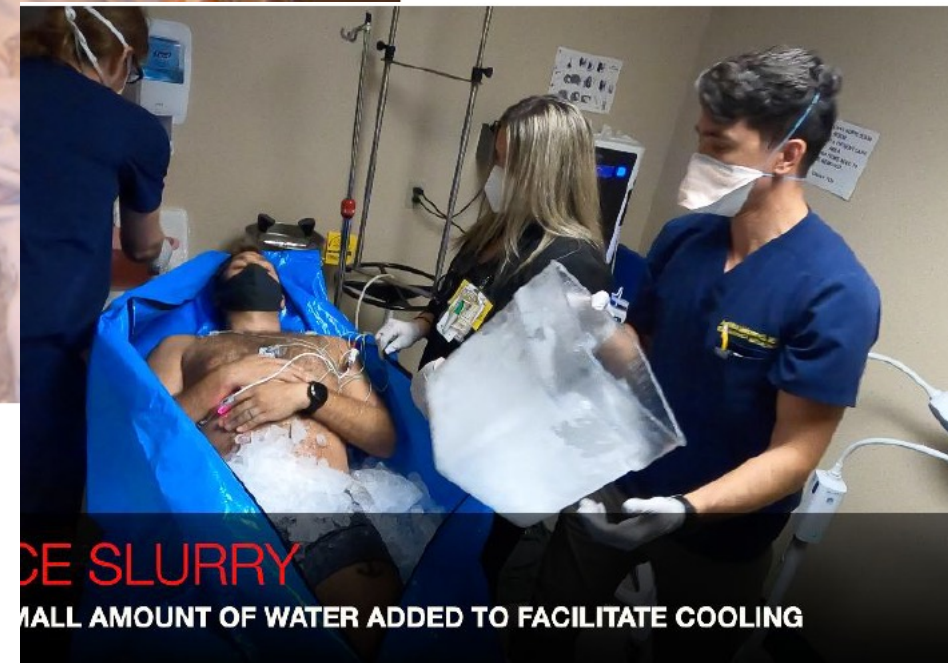


# Treatment - Conduction

Internal



External



\*ice water 0.12 – 0.35 °C

\*cold water 0.04 – 0.25 °C

\*room temp water 0.1 – 0.19 °C

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# Related Illness and Injury

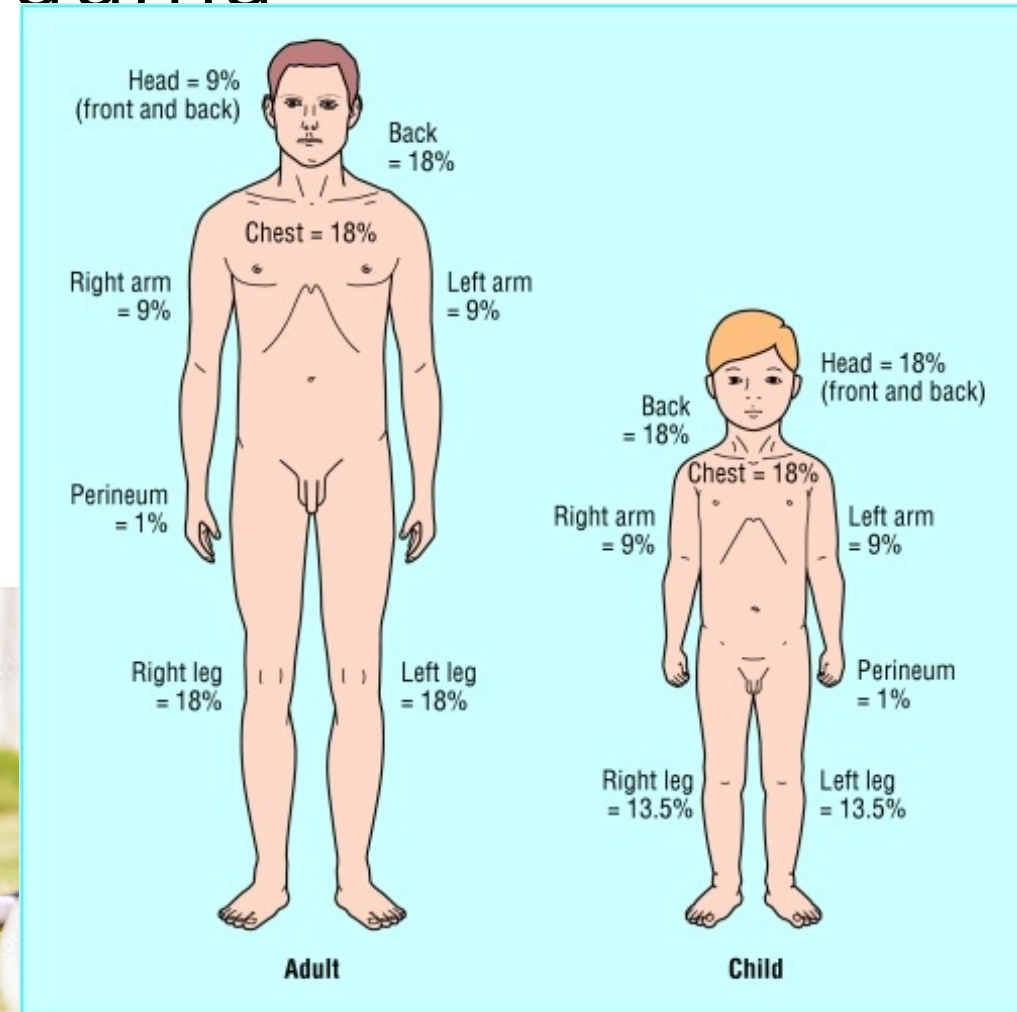
- Consider the broad diagnosis for heat stroke
- History and physical are key
- Treat while gathering information

**Table 2. Differential Diagnosis In Hyperthermia<sup>1,2,4-6</sup>**

Origin/Cause	Diagnosis
Endocrine	<ul style="list-style-type: none"><li>• Pheochromocytoma</li><li>• Thyroid storm</li></ul>
Infectious (including central nervous system)	<ul style="list-style-type: none"><li>• Brain abscess</li><li>• Encephalitis</li><li>• Malaria</li><li>• Meningitis</li><li>• Sepsis</li><li>• Tetanus</li><li>• Typhoid fever</li></ul>
Neurologic	<ul style="list-style-type: none"><li>• Cerebrovascular accident</li><li>• Status epilepticus/seizures</li></ul>
Toxicological	<ul style="list-style-type: none"><li>• Alcohol withdrawal (delirium tremens)</li><li>• Anticholinergic toxidromes</li><li>• Aspirin overdose</li><li>• Complex drug interactions (PCP, heroin, MDMA, cocaine, amphetamines)</li><li>• Malignant hyperthermia</li><li>• MAO inhibitors</li><li>• Neuroleptic malignant syndrome</li><li>• Serotonin syndrome</li></ul>

# Related Injury - Burns and Trauma

- Trauma = poor mobility
- Poor mobility in a hot environment
  - Contact burns
  - Severe sun/radiation burn



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# Disposition Decisions

- “Cool first, transport second”
- Patient stability is paramount
  - Cardiovascular stability
  - Evidence of end organ dysfunction
- Distance from receiving center
- Ability to cool in transport
- Receiving center?
  - Suspected etiology



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