Heat Related Emergencies

Epidemiology

- **4,000 heat related deaths yearly**
- **80% of the fatalities are elderly**
  - Occurs in 5 per million over age 85 compared to 1 per million in the 5-44 age group
- **2nd leading cause of death among young athletes**
- **Very young (<4yo) also at increased risk**
  - Occurs in 0.3 per million compared to 0.05 per million in patients > 4yo.

Epidemiology

- High heat or humidity requires ~2 weeks of acclimatization.
- Individuals with heat exposure can require from 5-13 glass of water per day depending upon the type of work they do.
- Salt consumption should be slightly increased to compensate for loses due to sweating.

Pathophysiology

- **Heat Balance**
  - **Conduction**
  - **Convection**
  - **Radiation**
  - **Evaporation**

Heat Balance equation

Body Heat = Metabolism

+ [+conduction + radiation]

+ convection – evaporation

Body Heat = M + [+ K + R + C – E]

Pathophysiology **(cont.)**

- **Physiologic Response to Heat**
  - Anterior hypothalamus
    - ANP stimulation
    - ↑ vasomotor tone and ↑ coetaneous blood flow.

      Results in ↑ heart rate and cardiac output. Pt with cardiac disease at increased risk for heat injury.
  - Parasympathetic stimulation
    - Sweating

      Dehydration can predispose individual to heat injury
  - Acclimatization
    - Results from repeated exposure (exercise)

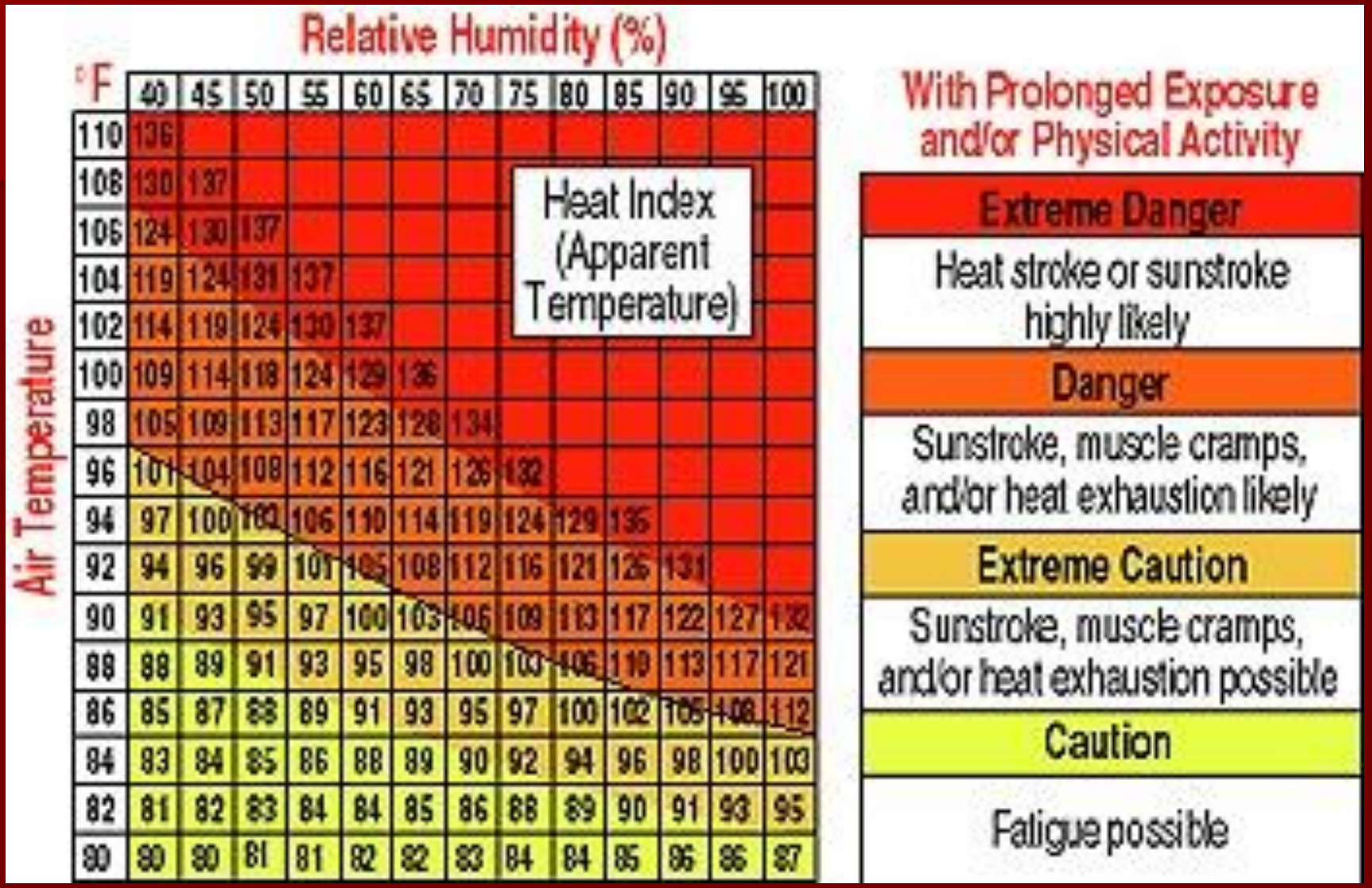
Pathophysiology **(cont.)**

- **Heat Injury Predisposition**
  - **3 Factors Influencing Heat Production**

1. Increased Internal Heat Production.
   - *Physical Activity*
   - *Febrile illness*
   - *Pharmacologic agents*

2. Increased External Heat Gain
   - *Exposure to high ambient temperature*

3. Decreased Ability to Disperse Heat


Relative Humidity (%)
°F
40 45 50 55 60 65 70 75 80 85 90 95 100
110 136
108 130 137
106 124 130 137
104 119 124 131 137
102 114 119 124 130 137
100 109 114 118 124 129 136
98 105 109 113 117 123 128 134
96 101 104 108 112 116 121 126 132
94 97 100 103 106 110 114 119 124 129 135
92 94 96 99 101 105 108 112 116 121 126 131
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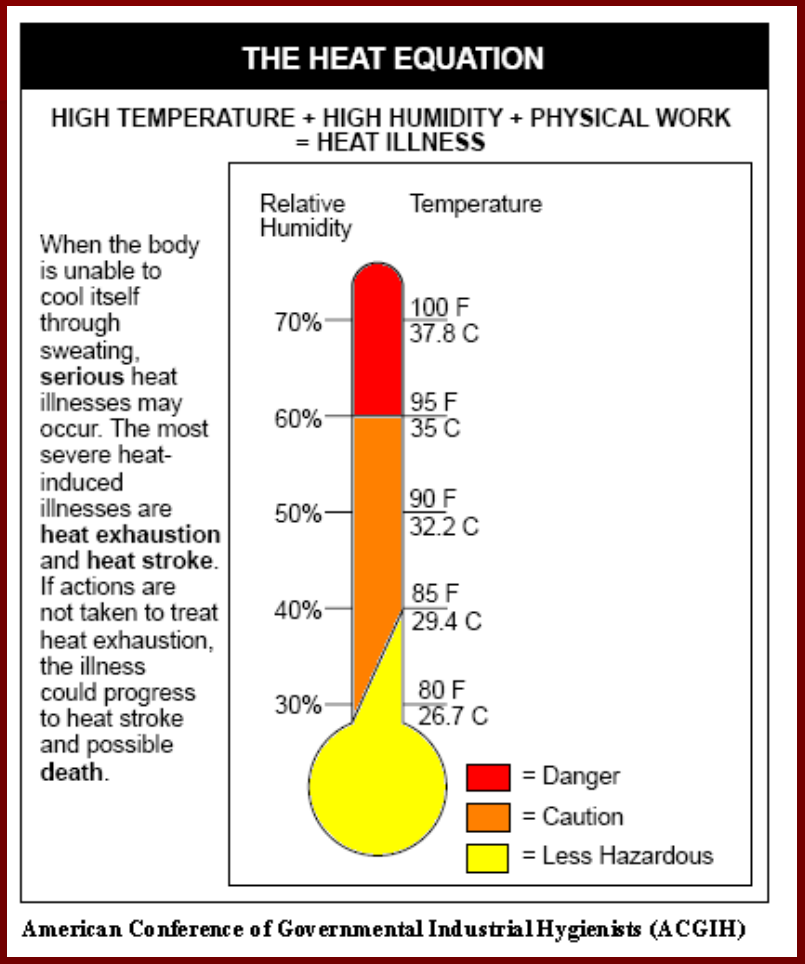
86 85 87 88 89 91 93 95 97 100 102 105 108 112
84 83 84 85 86 88 89 90 92 94 96 98 100 103
82 81 82 83 84 84 85 86 88 89 90 91 93 95
80 80 80 81 81 82 82 83 84 84 85 86 86 87
Air Temperature
Heat Index (Apparent Temperature)
With Prolonged Exposure and/or Physical Activity
Extreme Danger
Heat stroke or sunstroke highly likely
Danger
Sunstroke, muscle cramps, and/or heat exhaustion likely
Extreme Caution
Sunstroke, muscle cramps, and/or heat exhaustion possible
Caution
Fatigue possible

The Heat Equation



Role of Dehydration in Heat Disorders

- Close Relationship to Heat Disorders
  - Dehydration prevents thermolysis.
- Signs & Symptoms
  - Nausea, vomiting, and abdominal distress
  - Vision disturbances, decreased urine output
  - Poor skin turgor and signs of hypovolemic shock
- Treatment
  - Oral fluids if the patient is alert and oriented
  - IV fluids if the patient has an altered mental status or is nauseated

Pathophysiology (cont.)

- Dehydration
- Obesity
- Heavy/Impermeable Clothing
- Poor Physical Fitness
- Lack of Acclimatization
- Cardiovascular Diseases
- Skin Diseases
  - –Burns
  - –Scleroderma
  - –Eczema/Psoriasis
  - –Glandular disorders
- Extremes of Age
- Lack of Mobility
- Febrile Illnesses
- Hyperthyroidism
- Alcoholism
- Drug Use
  - –Cocaine
  - –Amphetamines
  - –Opiates
  - –LSD/PCP
- Poor Socioeconomic
  - — No air-conditioning
  - – multistory building living
- Prolonged Exertion in Heat
- Medications
  - –Antipsychotics
  - –Anticholinergics
  - –CA channel, β, blocker
  - –Diuretics
  - –α agonists/Sympathomimetics

Table 2 Causes for Decreased Heat Dispersal

Clinical Features

- **Heat Edema**
  - Due to cutaneous vasodilatation and orthostatic pooling of interstitial fluid in extremities
  - Most often found in elderly, non-acclimated travelers
  - Usually self limiting

Clinical Features

- **Prickly Heat** (aka lichen tropicus, miliaria rubra, heat rash)
  - Erythematous rash caused by acute inflammation of sweat ducts
  - Presentation includes itching, pruritic rash in warm environment (itching usually responds to antihistamines)
  - If prolonged can develop into chronic dermatitis

Clinical Features **(cont.)**

- **Heat Syncope**
  - Results from cumulative effect of peripheral vasodilatation, decreased vasomotor tone and relative volume depletion.
  - Usually occurs in non acclimated pt's in early stage of exposure.
  - Dx includes excluding more serious causes of syncope
  - Tx includes rehydration, removal from heat, and rest

Clinical Features **(cont.)**

- **Heat Cramps**
  - Painful spasmodic contractions of skeletal muscle.
  - Usually occur after exercise or after a latent period. Unconditioned, non acclimated individuals at high risk
  - Pathogenesis thought to be deficiency of Na, K+, and H_2O at cellular level.
  - Tx includes rest/rehydration

Clinical Features **(cont.)**

- **Heat Tetany**
  - Hyperventilation resulting in respiratory alkalosis, paresthesia, and carpopedal spasm
  - Usually associated with short periods of intense heat stress
  - Tx includes removal from heat and decreasing respirations.

Clinical Features **(cont.)**

- **Heat Exhaustion**
  - Sx non-specific
  - May also include
    - Syncope
    - Orthostatic hypotension
    - tachypnea
    - Diaphoresis
    - Hyperthermia
  - Diagnosis of exclusion
  - Tx includes rest, volume and electrolyte replacement

Clinical Features **(cont.)**

- **Heatstroke**
  - Triad
    - Temp > 40.5^0 C (104.9^0)
    - CNS dysfunction
    - Anhidrosis
  - **Anyone with hyperpyrexia and AMS is considered heatstroke until proven otherwise.**
  - Any neurological disturbance can occur with heatstroke

Clinical Features **(cont.)**

- **Heatstroke**
  - **Effect on Organ Systems**
    - CNS
      - Irritability, bizarre behavior
      - Combativeness
    - Cerebellum
      - Highly sensitive to heat
      - Ataxia common
    - Cerebral edema
    - Anhidrosis may be later finding due to volume depletion and sweat gland dysfunction
  - **Total breakdown of thermoregulation**

Clinical Features **(cont.)**

- **Heatstroke**
  - Non-exertional
    - Slow evolution, onset insidious
    - Increases exogenous heat gain with decreased heat dispersal
    - Elderly, poor, infants, and chronically ill at greatest risk.
    - Increased risk with
      - CV disease
      - Older age
      - Cardiovascular/anticholinergic drugs
  - Exertional
    - Due to vigorous activity
    - Sx same as for non-exertional

Clinical Features **(cont.)**

- **Heatstroke**
  - **Treatment**
    - Initial ABC's, high flow O_2
    - Continuous pulse oximetry
    - EKG, IV access, volume replacement
    - Temperature

Clinical Features **(cont.)**

- **Heatstroke**
  - Cooling Techniques
    - Evaporative
    - Immersion
    - Ice packing
    - Gastric lavage
    - Peritoneal lavage
    - Cardiac bypass

Clinical Features **(cont.)**

- **Complications of heatstroke**
  - Heart failure, pulmonary edema, cardiovascular collapse
  - Hepatic injury (thermal)
  - Renal injury
    - rhabdomyolysis, myoglobinuria, and renal failure
  - Hematological insult
    - Micro-hemorrhages
    - Thrombocytopenia
    - Increased platelet aggregation (thermal)
  - Fluid/Electrolyte disturbances

Precautions for Heat Stroke

- Heat stroke is a medical emergency, be aware that heat exhaustion can progress to heat stroke
- Wet sheets over a patient, without good air flow, will tend to increase temperature and should be avoided
- Do not let cooling in the field delay your transport. Cool patient if possible while en-route

Prevention and Control

- **Engineering controls**
- **Personal protective equipment (PPE)**
- **Work practice controls**

Engineering Controls

- General ventilation
- Air treatment/air cooling – air conditioning
- Local air cooling
- Convection
- Heat conduction
- Radiant heat sources
  - Shielding
  - Insulation and surface modification

Personal Protective Equipment

- **Reflective clothing**

- **Auxiliary body cooling**
  - Ice vests
  - Wetted clothing – low humidity
  - Circulating air

Work Practice Controls

- **Work rate**
  - The fastest way to decrease the rate of heat production is to decrease the work rate.
- **Age** – (over 40)
  - The maximum possible output of heat decreases with age.
  - Older people start sweating later and at a rate.

- **Body size**
  - Skin area to weight ratios

Acclimatization

- **Acclimatization**
  - Successive heat exposures of at least one hour per day
  - Initially, 20% exposure for the first day, followed by 20% per day increase in exposure over the next four days

Re-Acclimating

- **After long absences**
  - 50% exposure on day back
  - 20% per day increase for the next 2 days
  - Final 10% on the 3rd day

Administrative Controls

- **Administrative controls**
  - Perform work activities during cooler periods of the day
  - Minimize activity in hot area
  - Slow down the work pace
  - Reduce the number and duration of exposures
  - Wear proper clothing
  - Provide recovery areas

Work Monitoring Programs

- **Personal monitoring**
  - Heart rate
  - Recovery heart rate
  - Oral temperature
  - Extent of body water loss

Training

- Knowledge of hazards
- Predisposing factors – age, etc.
- Signs and symptoms
- PPE
- First aid
- Health effects of heat stroke

Bottom Line

- Excessive heat in the work environment can lead to:
  - Serious physical harm, ***and***
  - Even death
- The keys are:
  - Recognition of the potential, ***and***
  - Prevention