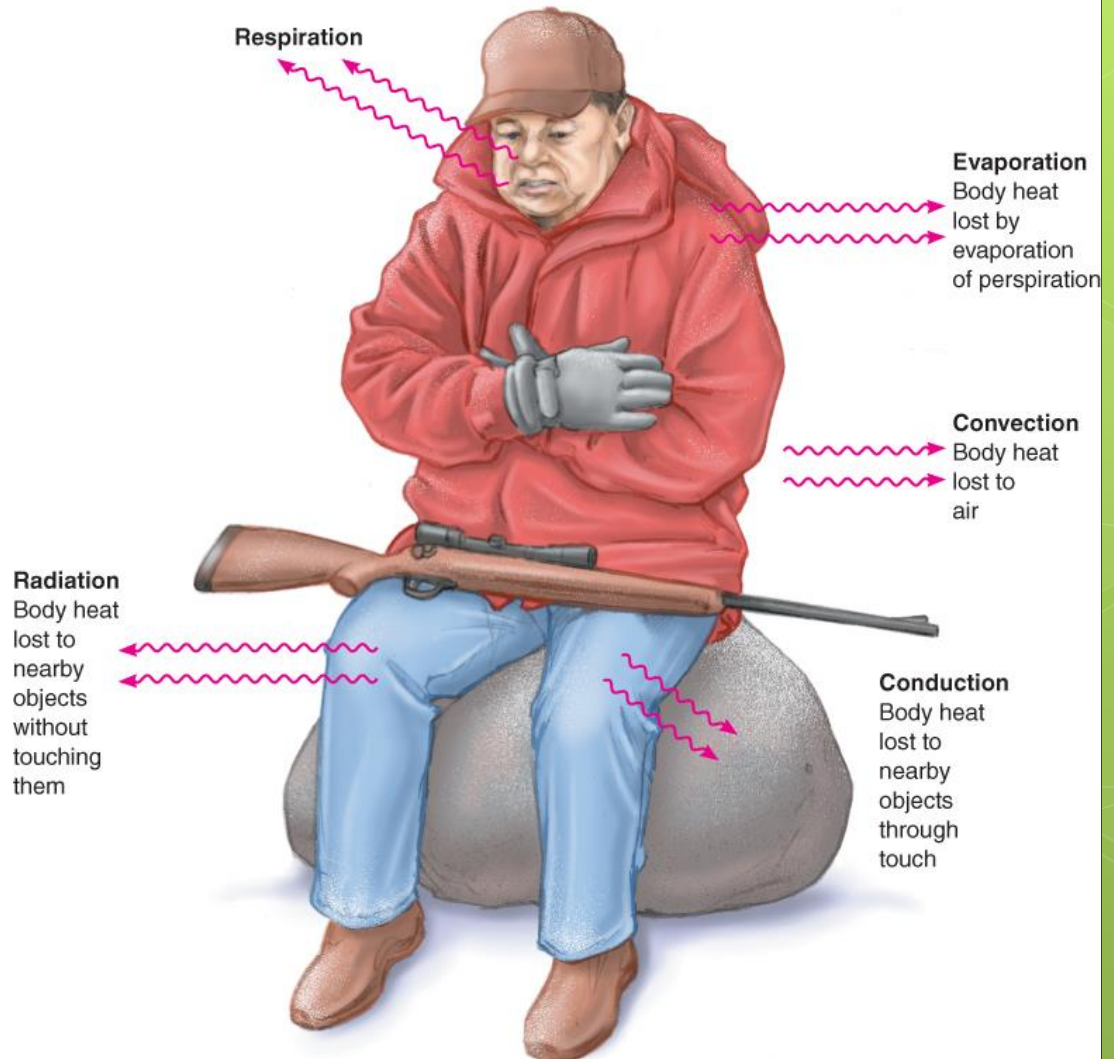


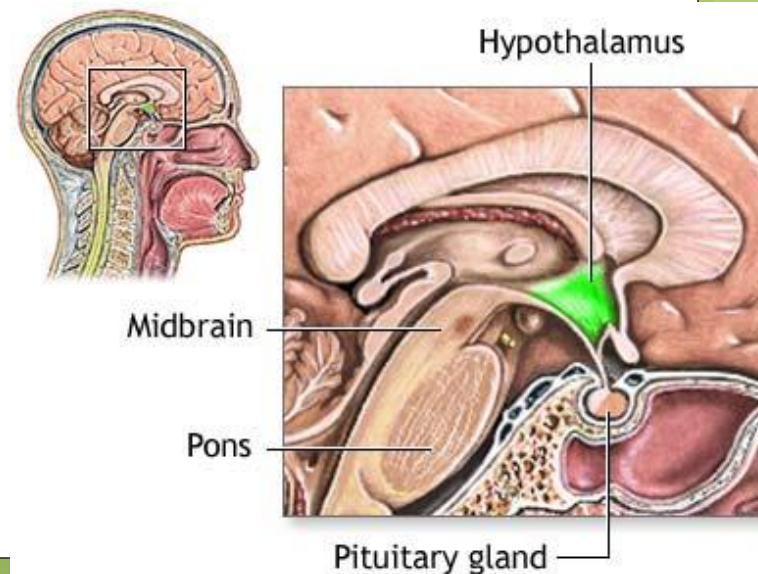
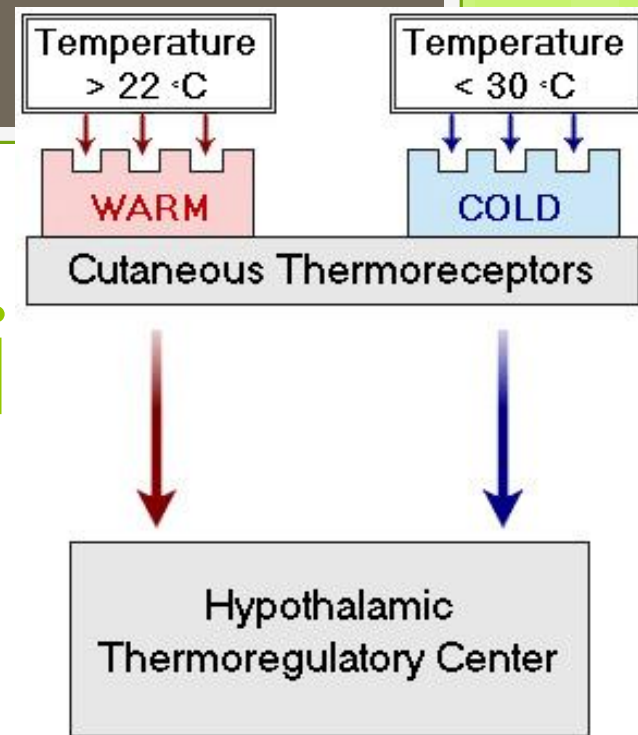
Mechanisms of Heat Loss

- Radiation
- Conduction
- Convection
- Respiration
- Evaporation



Thermoregulation

- Control Mechanism
- Hypothalamus
- Peripheral thermoreceptors



Body Temperature Regulation

- Activated by cold exposure
- Reflex vasoconstriction
- Stimulation of the hypothalamic nuclei
- Heat preservation mechanism
 - Shivering
 - Autonomic and endocrine responses
 - Adaptive behaviors

HYPOTHERMIA AND FROSTBITE

- Accidental Hypothermia
 - Body's core temperature unintentionally drops below 35°C (95°F)
- Primary Accidental Hypothermia
 - Results from direct exposure to the cold
- Secondary Hypothermia
 - Complication of systemic disorders such as sepsis, cancer, hypoglycemia, trauma
 - Mortality much higher
 - Many are elderly and found indoors

Impaired Thermoregulation

Central	Trauma or Neoplastic lesions, degenerative processes, congenital
Peripheral	Acute spinal cord transection (loss of peripheral vasoconstriction)
Metabolic	DKA, uremia, hypoglycemia, sepsis, pancreatitis
Medications	Narcotics (stops shivering response) barbituarates, benzodiazepines, anti-seizure meds, anti-psychotics and sedative, NSAIDS

Factors Predisposing to Hypothermia

- ◉ Decrease heat production
 - ◉ Age extremes
 - ◉ Inadequate stored fuel (hypoglycemia, malnutrition)
 - ◉ Endocrine or neuromuscular (low thyroid, etc)
- ◉ Increased heat loss
 - ◉ Exposure (including poor prep and acclimatization)
 - ◉ Skin (burns, etc)
- ◉ Impaired thermoregulation
- ◉ Cold Water Submersion

Cold Disorders

Table 10-1

KEY FINDINGS AT DIFFERENT DEGREES OF HYPOTHERMIA

C°	F°	Clinical Findings
37.6	99.6	Normal rectal temperature
37	98.6	Normal oral temperature
36	96.8	Metabolic rate increased
35	95	Maximum shivering seen Impaired judgment
34	93.2	Amnesia Slurred speech
33	91.4	Severe clouding of consciousness/apathy Uncoordinated movement
32	89.6	Most shivering ceases Pupils dilate
31	87.8	Blood pressure may no longer be obtainable
30	86	Atrial fibrillation/other dysrhythmias develop Pulse and cardiac output decreased by 33%
29	84.2	Progressive decrease in pulse and breathing Progressive decrease in level of consciousness
28	82.4	Pulse and oxygen consumption decreased by 50% Severe slowing of respiration Increased muscle rigidity Loss of consciousness High risk of ventricular fibrillation
27	80.6	Loss of reflexes and voluntary movement Patients appear clinically dead
26	78.8	No reflexes or response to painful stimuli
25	77	Cerebral blood flow decreased by 66%
24	75.2	Marked hypotension
22	71.6	Maximum risk for ventricular fibrillation
19	66.2	Flat electroencephalogram (EEG)
18	64.4	Asystole
16	60.8	Lowest reported adult survival from accidental exposure
15.2	59.2	Lowest reported infant survival from accidental exposure
10	50	Oxygen consumption 8% of normal
9	48.2	Lowest reported survivor from therapeutic exposure

Measuring Core Temperature

- **Rectal:** preferred and more closely approximates the core temperature
- Tympanic/axillary/oral: poor measures of core temperature for a hypothermic pt.
- Electronic thermometers may not be accurate if left in the cold.

Degrees of Hypothermia

Mild (32-35 °C)	CNS depression Increased metabolic rate Increased pulse Shivering thermogenesis Dysarthria, amnesia, ataxia, apathy
Moderate (28-32 °C)	Further CNS and vital sign depression Loss of shivering Arrhythmias common, QT prolonged, J waves Inability to rewarm spontaneously Cold diuresis
Severe (< 28 °C)	Comatose and areflexic Profoundly depressed vitals Little respiratory stimulation 2° to low CO ₂

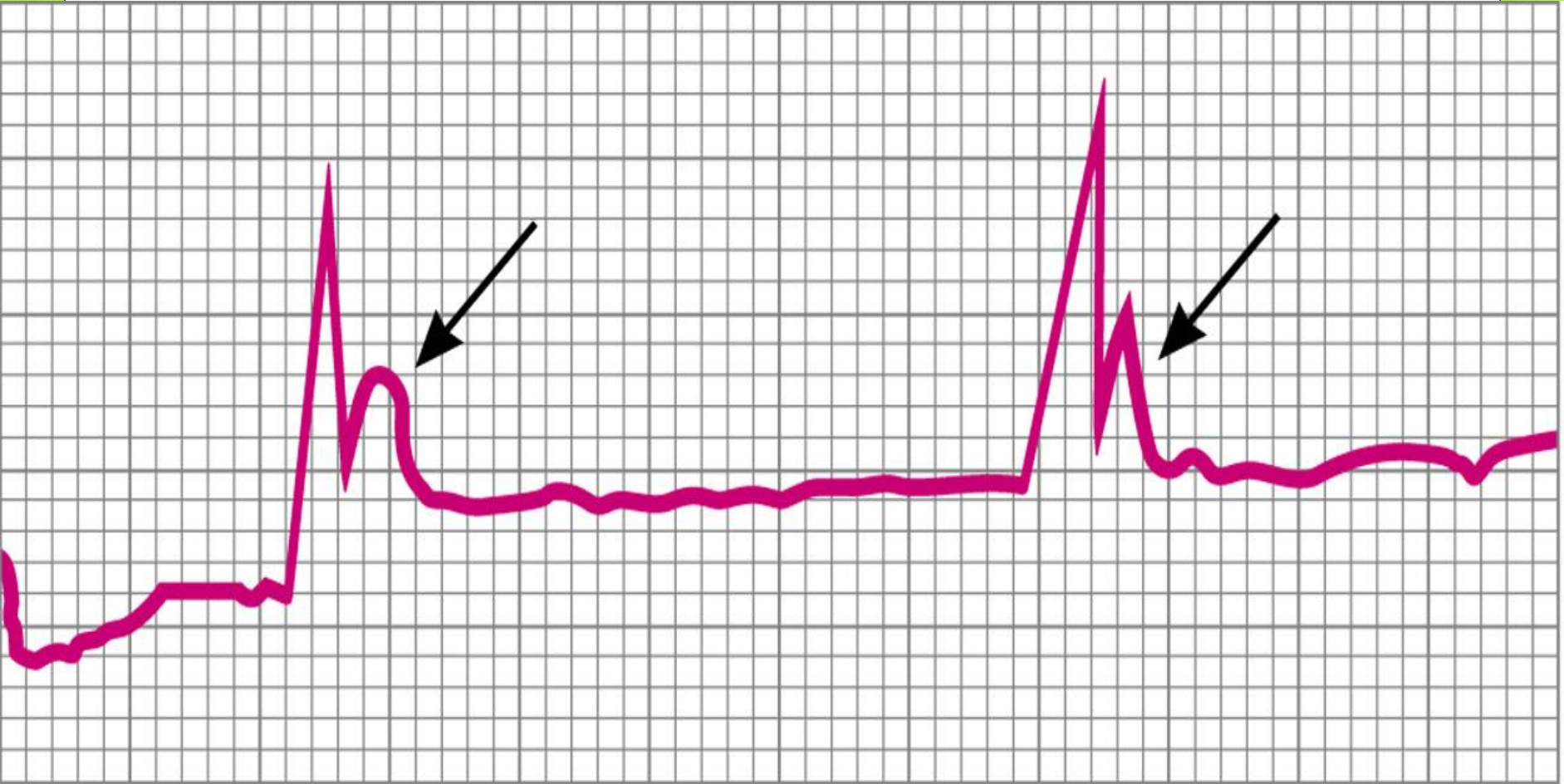
Physiological Effects of Hypothermia:

Mild 35-32 °c: catecholamine release= peripheral vasoconstriction; increased ventilatory rate; cold induced diuresis; confusion=faulty judgment; shivering, hyporeflexia.

Moderate 28-32 °c : decreased metabolic rate= decreased oxygen consumption, enzyme suppression, sympathetic nervous reduction, hyporeflexia, coagulopathies, decreased ventilation rate, stupor

Severe 20-28 °c : metabolic acidosis= increased cardiac irritability, ventricular fibrillation, severe hypotension, decreased or absent ventilation, hyperkalemia, coma.

Profound <20 °c : asystole, mimic brain death, flat EEG



Prehospital Pearls

- Prevent malignant cardiac dysrhythmias!
- **Gentle** handling; horizontal position.
- Remove patient to a warm environment.
- Remove wet clothing and replace with dry warm blankets to also cover head & neck.
- Initiate active **gentle** external rewarming
- Padded splint to frostbitten extremities to prevent additional injuries to tissues.

Rewarming

○ Passive

- Noninvasive
- Remove wet/cold clothes
- Cover patient in warm environment out of wind
- Healthy patients with mild hypothermia

○ Active

- Whenever there is cardiovascular instability (more susceptible to VF)
- Temp $<32^{\circ}\text{C}$
- Age extremes (geriatric and very young)
- Neuro or endocrine insufficiency

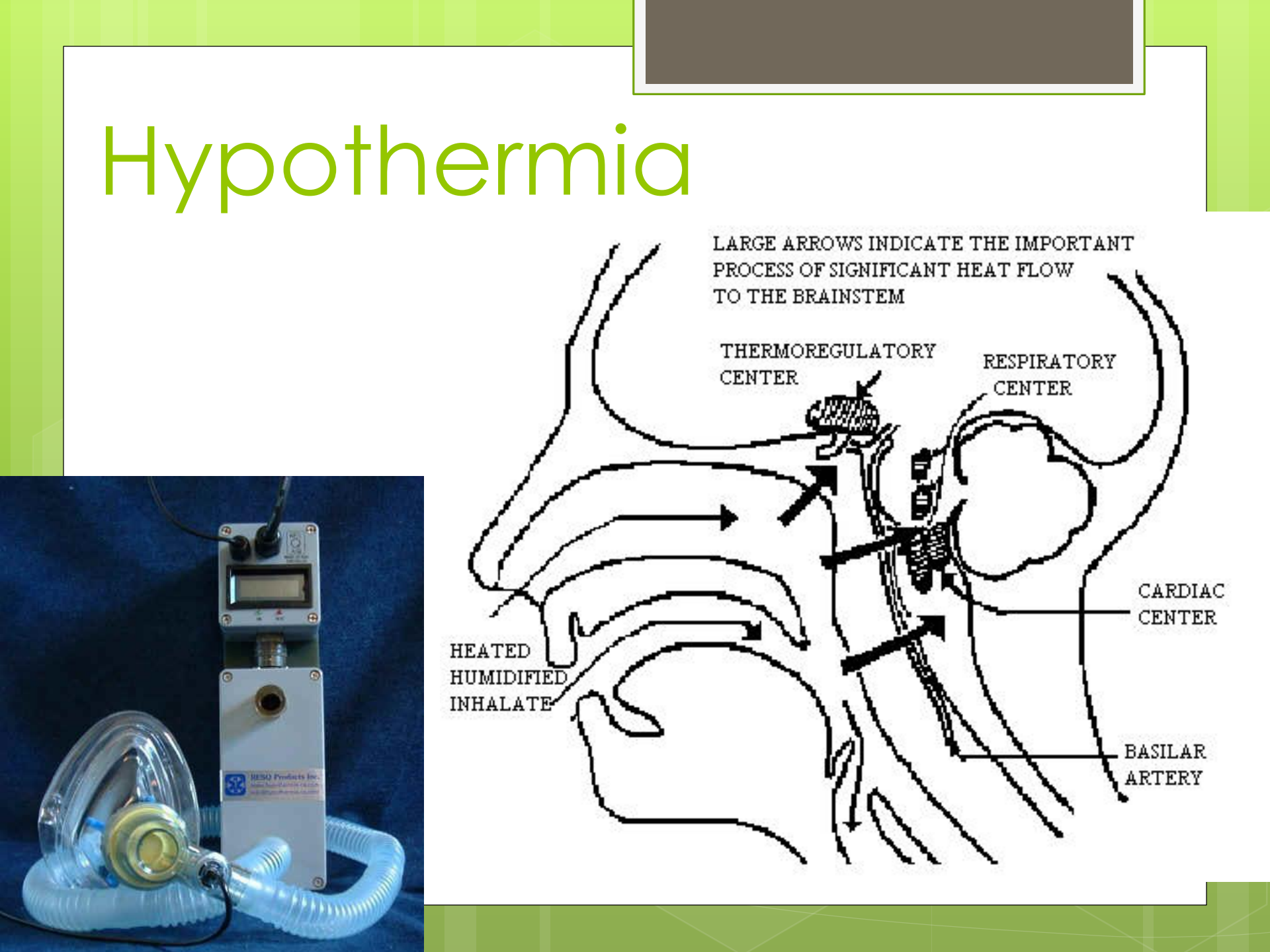
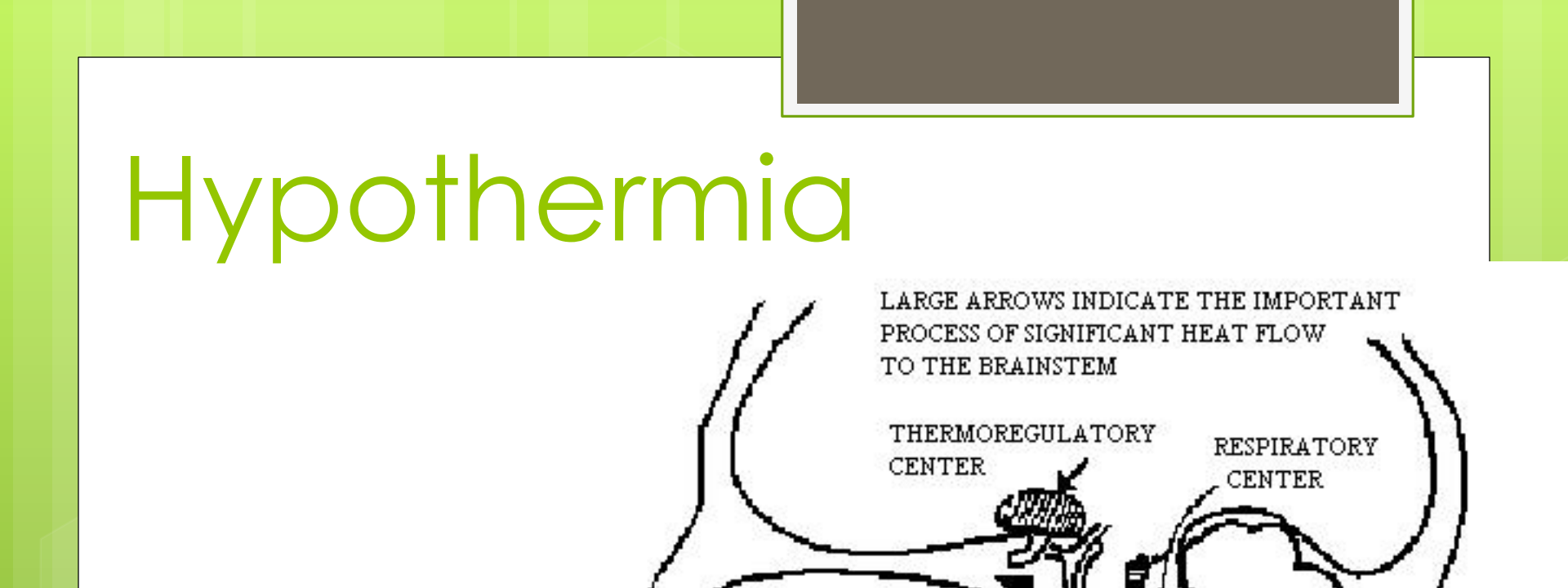
Active Core Rewarming

- Delivers heat directly to the core
 - Heated/humidified inhalation
 - Heated IV fluids (104-107.6)
 - Padded warm packs to major pressure point areas(neck, axillary, groin)
 - Peritoneal lavage (hospital)
 - GI/bladder irrigation (hospital)
 - Extracorporeal rewarming (hospital)
 - Dialysis(hospital)



One of the advantages of warmed IV Fluids at normal body temperature is the improved absorption of administered medications ($\pm 10\%$ per degree F compared to cold IV fluids) Cold IV fluids may induce hypothermia in compromised patients and those that are predisposed to hypothermia, for example:

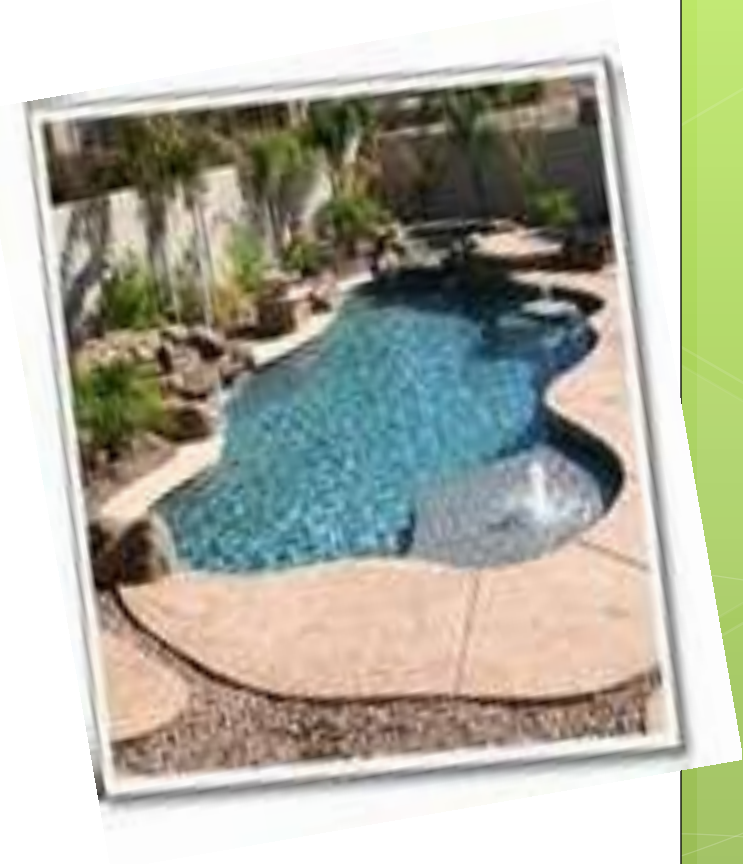
- further cooling of hypothermic patients
- cooling of traumatized patients (slowed metabolic heat production)
- cooling of geriatric patients (poor circulation, slowed metabolism) - diabetic patients
- cooling of pediatric patients (small body mass)
- cooling of burn victims (replacing plasma loss)
- Holds at a safe temperature indefinitely with out overheating



Cold Water Subm

- What is cold water?

-20 degrees and below



Cold Water Submersion:

- Critical Elements
 - Principal physiologic consequence - Hypoxemia
 - Oxygen needs reduced when body is cold
 - May avoid permanent brain damage from hypoxemia may not occur
 - 10% to 20% of individuals maintain tight laryngospasm
 - Cold water immersion victims have been fully resuscitated when treated carefully with a variety of warming techniques.

Cold Water Submersion

- Mammalian Diving Reflex:
 - Apnea
 - Bradycardia
 - Vasoconstriction
 - Shunting to inner core of body: pulmonary, coronary, and cerebral circulation.

Treatment of cold water drowning/near drowning:

- Remove from water with full spinal precautions preferable.
- **Gentle** ABC's of resuscitation asap (pts. respirations and pulse rate may be difficult to detect; any doubt: start CPR)
- Move to warm environment. Forced warm air.
- **Gently**: remove wet or constricting clothing, dry off, active rewarming: insulated warm packs to major pressure point areas & wrap in blankets.
- Warm IV solutions and warm humidified O-2 if possible.
- "Patient is not dead until rewarmed."

What is Frostbite?

- ◉ Most common freezing injury of tissues
- ◉ Occurs at temp below 32°F
- ◉ Ice crystal formation damages cells
- ◉ Stasis progressing to microvascular thrombosis

EROSTRITE



Factors Predisposing to Frostbite

- Contact with thermal conductors
- Wind-chill quickly freezes acral areas
- Immobility, constrictive clothing
- Atherosclerosis, nicotine, alcohol

Trench foot (Immersion foot)

- Prolonged exposure to wet cold above freezing
- Feet are edematous, cold, cyanotic
- Liquefaction gangrene more common than with frostbite

Presentation of Frostbite

- Initially may look benign
- Frozen tissues appear yellow, waxy mottled, or violaceous – white
- Early clear blebs more favorable than delayed hemorrhagic blebs
- Lack of edema suggests major tissue damage

Symptoms of Frostbite

- Sensory deficits always present (light-touch, pain, temperature perception)
- “chunk of wood” sensation and clumsiness
- “frostnip” transient numbness and tingling without tissue destruction

How should frozen tissues be thawed?

- May be intensely painful (anticipate analgesics orders)
- Never use dry heat or allow tissues to refreeze
- Rubbing may be harmful
- Final demarcation may take 60-90 days

● Questions?

