Discuss the importance of thermoregulation in the neonate.

To maintain correct body temperature range in order to:

- Reduce oxygen consumption
- Reduce calorie expenditure
- Maximize metabolic efficiency
- Protect enzyme function
Definitions

Neutral Thermal Temperature – A body temperature at which an individual's oxygen use and energy expenditure are minimized.

Neutral Thermal Environment – A range of environmental temperatures (air temp surrounding the baby), in which a baby's metabolic rate is at a minimum and body temp is maintained.

Mechanisms of Heat Loss and Production

Heat Loss –
- Decreased subcutaneous fat
- Increased surface area to weight ratio
- Transepidermal water loss

Heat Production –
- Physical
  - Increased muscle activity
  - Posture may increase or decrease surface area
  - Shivering – rare in infants

Mechanisms of Heat Loss and Production

Heat production –
- Norepinephrine released in cold stress
  - Peripheral vasoconstriction triggered
  - Nonshivering thermogenesis
Methods of Heat Transfer

Conduction - heat exchange that occurs between objects in direct contact.
- Cold scale, x-ray plate or blanket
- Chemical warming mattress or warm blanket

Evaporation - occurs when liquid is turned to vapor.
- Amniotic fluid on newly delivered baby (accounts for 25% of heat loss at delivery)
- Wet diaper
- Bath
- Tachypnea
- Phototherapy lights

Methods of Heat Transfer

Radiation - radiant energy exchange occurs between 2 objects that are not in direct contact through absorption and emission of infrared rays.
- Cold/warm room temperature
- Cold/warm walls
- Cold/warm items on bed

Methods of Heat Transfer

Convection - occurs when airflow carries heat to or away from the body (air currents).
- Bed near air vent
- Oxygen flow left on
- Passing traffic
Thermoregulation

- Body temperature is a physiologic variable controlled by the body
- Hypothalamus is the master control center
  - Signals received from thermal receptors
    1. Peripheral thermoreceptors
      - Sense temperature of the skin
      - Distributed over the entire skin surface
    2. Central thermoreceptors
      - Located in deep body structures including hypothalamus, spinal cord and abdominal organs

Thermoregulation

- Stimulation of the receptors result in chilling and calorie expenditure
- Majority of infant’s receptors are in the face, neck and shoulder area
- Neonatal disadvantages
  - Thin skin and blood vessels closer to the surface
  - Little subcutaneous fat for insulation
  - Term infants have 3x the surface to body mass of an adult, and preterm have 5x

Nonshivering Thermogenesis

- Infants main method of generating heat
- Brown adipose tissue is the major component
  - Full term - 4-10% of deposits
  - Preterm - not found until 26-28 weeks and only in small amounts
  - Cannot be replaced once used
  - Found near kidneys and adrenals, neck, mediastinum, scapula and axillary areas
  - Conversion uses oxygen and glucose (anaerobic heat production)
Nonshivering Thermogenesis

Dependent on thermogenin levels – protein found in brown fat mitochondria
- Low levels at 32 weeks
- Increases from 26-4 weeks with major increase at 32 weeks and 4 fold by term

Thermoreceptors stimulated → message to hypothalamus →
increased activity of the sympathetic nervous system → norepinephrine released →
increased TSH stimulates the release of thyroid hormones (mostly T4) → activates enzyme causing T4 to convert to T3 →
upregulates thermogenin → mitochondrial oxidation in brown fat → HEAT PRODUCTION
### Risk Factors
- Prematurity
- SGA
- Sepsis
- Neurological problems
- Endocrine
- Cardiac/Respiratory issues
- Large skin defects
- Drug exposure
- Prolonged resuscitation efforts
- All infants first 8-12hr of life
- Sedated infants

### Etiology of Risks
- Brown adipose tissue
- Hypoxia
- Sedation
- Body surface area
- Anomalies
- Body water content
- CNS issues
- Subcutaneous fat
- hypoglycemia
- Glycogen stores
- Posture
- Hypothermia

### Hypothermia
**Classification**
- Normal – 36.5-37.3
- Cold stress – 36-36.4
- Moderate hypothermia – 32-35.9
- Severe hypothermia - <32 (89.6)
**Hypothermia**

**Signs and symptoms**

1. Metabolic acidosis
2. Increased respiratory distress
3. Increased restlessness and lethargy
4. High energy expenditure/decreased growth
5. Skin cool to touch and mottling
6. Poor feeding, gastric distention, feed intolerance

**Signs and Symptoms**

1. Tachypnea or Apnea
2. Hypoglycemia
3. Hypoxia
4. Metabolic acidosis
5. Acute renal failure
6. NEC and ultimate death

**Prevention**

- Maintain neutral thermal environment
- Reduce heat loss
- Apply external heat sources
- Avoiding stressing the baby
- Monitor skin temperature closely
Hyperthermia

Caused by:
- Overheated environment – skin temp up first
- Fever – core temp up before skin temp

Consequences of:
- Increased metabolic rate
- Increased O2 consumption
- Dehydration
- Peripheral vasodilation/hypotension
- Fluid & electrolyte imbalances
- Seizures

Risk factors
1. Excessive environmental temperature
2. Sepsis
3. Dehydration
4. Alteration in hypothalamic control mechanism
   - Birth trauma
   - Anomalies
   - Drugs

Signs and Symptoms
1. Warm to touch
2. Tachypnea
3. Apnea
4. Tachycardia
5. Flushing
6. Hypotension
7. Irritability
8. Poor feeding
**Hyperthermia**

Treatment
1. Eliminate external heat sources
2. Position extended not flexed
3. Expose skin surfaces
4. Prevent dramatic heat losses

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**Equipment**

- Radiant warmer -
  - Warsms by use of radiant heat
  - Used in L&D following delivery
  - Used in NICU on skin servo monitoring
- Incubators (isolette)
  - Maintains NTE by convection
  - Usually double walled to prevent heat loss from radiation

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**Conclusion**

Hypothermia is preventable, and associated with increased morbidity and mortality. Maintaining a neutral thermal environment and preventing heat loss or overheating is critical in the care of the neonate, and the responsibility of everyone.
References