

## **Newborn Guideline 2**

# **NEONATAL THERMOREGULATION**

## **1. DEFINITIONS**

### **1.1 THERMOREGULATION**

Thermoregulation is the ability to balance between heat production and heat loss in order to maintain body temperature within a certain “normal” range. This ability is very limited in the newborn.

### **1.2 HEAT PRODUCTION**

Non-shivering thermogenesis, the production of heat by metabolism, is the primary source of heat production in the neonate. Brown fat (deposited after 28 weeks gestation principally around the scapulae, kidneys, adrenals, neck and axilla) is a thermogenic organ unique to the neonate.

### **1.3 HEAT LOSS**

Heat loss occurs when heat is transferred to the surrounding environment. The four mechanisms of heat loss are:

- **Evaporation:** Loss of heat when water evaporates from the skin and respiratory tract.
- **Convection:** Heat loss to cooler surrounding air, dependent on air temperature and air movement.
- **Conduction:** Heat loss to cooler solid objects in direct contact with the body.
- **Radiation:** Heat loss to surrounding colder solid objects not in direct contact with the body.

### **1.4 NEUTRAL THERMAL ENVIRONMENT (NTE)**

The thermal conditions required to ensure minimal metabolic expenditure of energy (as measured by oxygen consumption) to maintain normal body temperature. For the neonate the normal temperature range is approximately: 36.6 – 37.2°C. (See Appendix A: Management and Use of Heating Devices used to Maintain Infant’s Temperature and Appendix B: Recommended Ranges for Incubator Temperatures).

## **2. RELEVANCE**

Cold stress and hyperthermia may have serious metabolic consequences for all newborns. In small for gestational age and preterm infants (<2500 g), these consequences may be devastating and may increase both mortality and morbidity rates.

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### **2.1 COLD STRESS MAY RESULT IN**

- Increased metabolic rate, leading to increased O<sub>2</sub> consumption
- Increased caloric consumption and decreased glycogen stores
- Development of acidosis due to pulmonary vasoconstriction
- Thermal shock and DIC (in the more serious cases), progressing to death

### **2.2 HYPERTHERMIA MAY RESULT IN**

- Vasodilatation
- Increased metabolic rate
- Increased fluid loss

### **3. RISK FACTORS**

- All neonates in the first 8 – 12 hours of life
- Prematurity
- Small for gestational age
- Infants with CNS problems
- Prolonged resuscitation efforts
- Sepsis

### **4. PREVENTIVE MEASURES**

#### **4.1 AT DELIVERY**

- Dry the baby thoroughly immediately after birth and remove wet blankets.
- Place a cap on the baby's head (the most significant area of heat loss for the infant).
- Place in "skin to skin" contact with mother and cover baby with warm blankets, OR
- Bundle in warm blankets and give the baby to mother to hold, OR
- Place naked under a pre-heated radiant source.
- Cover the scales with warm cloth or diaper.
- Transfer sick or unstable infant to pre-warmed incubator as soon as possible.

#### **4.2 CONTINUING CARE**

##### **A. Healthy Term Newborns**

- Warm hands and stethoscope prior to contact with baby.
- Pre-warm beds, linen and examining tables, when possible.
- Position cot/incubator away from outside walls, windows and drafts.
- Delay initial bath until body temperature has stabilized (minimum 3 normal readings one hour apart).
- Tub bath rather than sponge bath and dry quickly.

**B. Low Birth Weight or Compromised Infants (See Newborn Guideline 3: Stabilization of the Asphyxiated Infant)**

- Provide a neutral thermal environment (See Appendix A: Management and Use of Heating Devices used to Maintain Infant's Temperature and Appendix B: Recommended Ranges for Incubator Temperatures).
- Administer humidified air or O<sub>2</sub> warmed to recommended incubator temperature (See Appendix B: Recommended Ranges for Incubator Temperatures).
- Do not bath infant (may need to wipe infant immediately after birth if maternally transferred infection suspected to reduce risk to health care workers).

**5. DIAGNOSIS**

Diagnosis of hypothermia or hyperthermia is made by taking the baby's temperature. Axillary temperatures (using a tympanic or electronic thermometer) may be used provided there is consistency in the method chosen. Rectal temperatures are not recommended as they provide a late indication of cold stress and may cause rectal trauma.

**5.1 SIGNS OF HYPOTHERMIA**

- Apneic spells
- Lethargy
- Mottled, pale skin
- Cold extremities (< 1 degree C from central temperature)

**5.2 SIGNS OF HYPERTHERMIA**

- Tachypneic
- Diaphoretic
- Flushed, bright pink skin

**6. MANAGEMENT OF NEONATAL HYPOTHERMIA**

**6.1 STABILIZE TEMPERATURE**

- Determine cause of hypothermia and treat appropriately (abnormal neonatal temperatures may be caused by disease processes or environmental conditions).
- Place sick term or preterm infants in incubators or under radiant heaters (See Appendix A: Management and Use of Heating Devices used to Maintain Infant's Temperature).
- For sick term and preterm infants use NTE Chart to determine incubator temperature (See Appendix B: Recommended Ranges for Incubator Temperatures).
- Monitor environmental temperature.
- Monitor axillary and skin temperature at least every hour until infant's temperature becomes normal.

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### **6.2 MONITOR FOR COMPLICATIONS**

- Observe for respiratory problems (cold infants have a significantly higher incidence).
- Monitor vital signs.
- Monitor urine output (low perfusion may cause renal impairment).
- Consider complications affecting other organ systems, e.g. cardiovascular.
- Monitor blood sugars (See Newborn Guideline 5: Neonatal Hypoglycemia).
- Monitor blood gases prn.

### ***SUGGESTED READINGS***

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## APPENDIX A

### MANAGEMENT AND USE OF HEATING DEVICES USED TO MAINTAIN INFANT'S TEMPERATURES

#### I. RADIANT WARMERS

**Servo-controlled radiant warmers are recommended.**

- Attach the servo-controlled probe to the upper right quadrant of the abdomen and/or on whichever surface is closest to the radiant source. The probe should be attached firmly to the skin with a reflective disc visible for inspection at all times.
- Set the Servo control to 36.5 degrees C.
- Monitor the infant's temperature, respiratory rate, heart rate and blood pressure q5mins when rewarming a hypothermic infant. **Note:** the skin probe temperature will read 36.5 degrees C *before* the infant's core temperature is normal.
- Do not dress or bundle the infant.
- Assess and adjust the newborn's fluid requirements. Fluids may need to be increased by as much as 30% to compensate for insensible water loss.

#### II. INCUBATORS

- Adjust incubator temperature to recommended guidelines (See Appendix B) as the infant's temperature nears normal.
- Record incubator temperature hourly.
- Servo-control mode may be used.
- Sick newborns and small prematures may benefit from the use of a double walled incubator, heat shield or supplementary humidity.
- **When rewarming a hypothermic infant, set the incubator temperature to 1-1.5 degrees above the infant's temperature.**
- **Adjust the temperature q30 minutes until the infant is warmed.**

**APPENDIX B**

**RECOMMENDED RANGES FOR INCUBATOR TEMPERATURES**

<b>RANGE OF OPTIMAL INCUBATOR TEMPERATURES ( °C)</b>					
<b>Birth Weight Group</b>					
<b>Age</b>	<b>&lt; 1000 gm</b>	<b>1000 – 1500 gm</b>	<b>1500 – 2000 gm</b>	<b>2000 – 2500 gm</b>	<b>2500 gm + 36 weeks</b>
0 – 6 hr	36.7 – 36.2	36.2 – 35.4	35.7 – 34.2	34.8 – 33.6	34.8 – 32.7
6 – 12 hr	36.7 – 36.0	36.2 – 35.4	35.7 – 34.1	34.8 – 33.0	34.8 – 32.0
12 – 36 hr	36.6 – 35.9	36.0 – 35.2	35.6 – 34.1	34.7 – 32.5	34.7 – 31.6
24 – 36 hr	36.5 – 35.9	35.9 – 35.1	35.5 – 34.0	34.7 – 32.3	34.4 – 31.2
36 – 48 hr	36.5 – 35.9	35.9 – 35.0	35.4 – 33.9	34.6 – 32.0	34.2 – 31.0
48 – 72 hr	36.4 – 35.8	35.9 – 34.8	35.2 – 33.6	34.4 – 31.8	34.1 – 30.6
72 – 96 hr	36.3 – 35.7	35.8 – 34.7	35.1 – 33.5	34.2 – 31.7	33.6 – 30.2
4 – 5 days	36.3 – 35.6	35.7 – 34.4	35.0 – 33.3	34.1 – 31.6	33.4 – 29.9
5 – 6 days	36.2 – 35.5	35.6 – 34.3	34.9 – 33.2	33.9 – 31.6	33.1 – 29.8
6 – 8 days	36.0 – 35.2	35.5 – 34.1	34.8 – 33.0	33.8 – 31.6	32.5 – 29.3
8 – 10 days	35.9 – 35.1	35.2 – 34.0	34.6 – 32.8	33.5 – 31.6	32.5 – 29.3
10 – 12 days	35.8 – 34.9	35.0 – 33.9	34.4 – 32.7	33.4 – 31.6	32.0 – 29.3
12 – 14 days	35.7 – 34.7	35.0 – 33.4	34.3 – 32.6	33.3 – 31.6	31.4 – 29.3
2 – 3 weeks	35.6 – 34.1	35.0 – 33.0	34.2 – 32.4	33.2 – 31.0	–
3 – 4 weeks	35.2 – 33.6	34.6 – 32.3	34.1 – 32.0	33.0 – 30.4	–
4 – 5 weeks	34.7 – 33.3	33.9 – 31.8	33.9 – 31.5	32.6 – 29.9	–
5 – 6 weeks	–	33.1 – 31.0	–	31.8 – 29.3	–

**NOTE: No single temperature is a full statement of the thermal environment of the baby.**

**A. Conditions for which above temperature ranges apply:**

1. Single – walled incubator
2. Incubator relative humidity approximately 50%
3. Incubator air temperature measured directly over the baby’s chest
4. Nursery temperature 26.5°C (80°F)
5. Draft – free surroundings

**B. Conditions which will necessitate changes in incubator temperature:**

1. Use of thermometer in the corner of incubator	Subtract 0.5° - 1.0°C
2. Phototherapy	Subtract 1.0° - 1.5°C
3. Room temperature - 30°C - 23°C	Subtract 0.5°C Add 0.5°C
4. Incubator humidity 100%	Subtract 0.5°C
5. Proximity of incubator to heat sources or cold, windows etc.	Add or subtract (Variable)
6. Double – walled incubator, in a heat shield	Subtract (Variable)
7. Hyperthermia	Subtract (Variable)

**C. Smaller, sicker infants will require incubator temperatures at the upper part of the ranges**  
Higher temperatures may be necessary to maintain an axillary temperature of 36.3° C to 37.2° C.

**Adapted from Scopes & Ahmed (1996), Hey & Katz (1971) and Oliver (1971) Revised: Dec. 1991**