SUBJECT

THERMOREGULATION

APPROVAL

I. PURPOSE

Thermoregulation is the ability to balance between heat production and heat loss in order to maintain body temperature within a certain "normal" range. Healthy term infants are able to self-thermoregulate by producing or losing heat. Sick term infants and low birth weight infants do not necessarily have the ability to maintain thermoregulation. Therefore, intervention strategies to prevent heat loss or to gain heat, as well as interventions to prevent heat stress, are needed for these infants. The provision of a neutral thermal environment (NTE), an environment in which the infant's body temperature is maintained within a normal range with minimal metabolic rate and oxygen consumption, minimizes thermal stressors and improves outcomes.

II. EQUIPMENT

Radiant Warmers (Air Shields, Ohmedas, and Ohmeda Giraffe Omnibeds)
Isolettes or incubators (Ohmedas and Ohmeda Giraffe Omnibeds)
Open Cribs/Bassinettes

III. PERSONNEL

RN's
PCA's
APN's
RT's
Medical Staff

IV. EXPECTED OUTCOME

A. Body temperature maintained within normal limits:
   1. Rectal temperature 36.5º-37.5º C
   2. Axillary temperature 36.0º-37.0º C
   3. Abdominal temperature (monitored by skin probe) 35.5º-36.5º C
   4. Heart rate, respiratory rate and blood pressure maintained within normal limits; no apnea.
   5. No signs or symptoms of hypothermia.
   6. No signs or symptoms of hyperthermia.

V. IMPLEMENTATION

A. Infants < 32 weeks or < 1,500 grams should be placed in, or admitted to, isolettes. Premature infants often are stabilized at temperatures slightly lower than those considered acceptable for full-term infants. (Kenner)

B. Temperature probes should be securely attached to abdomen (when supine) or flanks (when prone). Probes should not be placed over extremities, bony prominences, excoriated areas, or over areas of brown fat deposits (e.g., axilla, intrascapular).

C. Check frequently to ensure that probe remains attached to the skin. Probes that are loose or totally detached from the skin will result in rapid overheating and hyperthermia. Conversely, lying on probes or having them constricted with clothing will result in higher temperature readings and subsequent cooling of the infant.

D. Reflective probe coverings should be used.

E.

F. Hats, socks, and clothing decrease evaporative heat loss and can be used in isolettes on air control, open cribs, or bassinets. Infants that are dressed may require a decrease in air temperature in isolette.

G. Minimize **conductive** heat loss by using (a) warmed blankets, stethoscopes, diapers, and covered or warmed scales or circ boards; (b) clothing; (c) warmed gel pillows and water mattresses; (d) warm hands; and (e) other objects/equipment that may come into direct contact with the infant. Isolettes and radiant warmers should always be pre-warmed prior to use.

H. Minimize **convective** heat loss by (a) clothing and bundling infant in open cribs/bassinets; (b) avoiding drafts and cool ambient air temperature; (c) providing heated and humidified oxygen through head hoods and ventilator tubing, and (d) maintaining temperature in patient care rooms at 72º-76º degrees F.

I. Minimize **evaporative** heat loss by (a) protecting body surfaces from cooling effects of the environment; (b) drying thoroughly after bathing and/or after application of solution/soaks; and (c) providing 50% or greater humidity in isolettes for premature infants $\leq$ 30 weeks gestation for the first 2 weeks of life, (d) putting infants in hats, socks and clothing, which can be used in isolettes on air control, open cribs or bassinets. Infants that are dressed may require a decrease in air tempature in isolette.

J. Minimize **radiation** heat loss by (a) using double-walled isolettes, (b)-warming objects placed near to infant, and (c) avoiding placing infant or incubator in close proximity to cold surfaces and direct sunlight, (d) place infants in flexion when possible.

K. Consistency is important for thermal stability. For infants in isolettes, make adjustment in one mode to accommodate the infant's needs rather than switching between modes (air/servo).

L. Monitor axillary temperature on admission and at 1 hour, then with routine vital signs. Adjust the set point to maintain axillary temperatures of 36.0º-37.0º C.

M. Settings on the radiant warmer and isolette are to be charted with routine vital signs.

N. Nursery temperature will be maintained at 72º - 76º F.

O. Temperature of gas in head-hood should be the same as in the isolette.

P. Temperature of the gas from ventilators should be the same as the patient's core temperature.

Q. When phototherapy, heated water mattress, or over bed heaters are in use, monitor axillary temperature for accurate assessment of body temperature. Do not rely on temperature probes.

VI. RADIANT WARMERS

A. Set up according to manual.

B. Warm bed in preparation for admission.
C. When infant is placed in the bed, switch to SERVO (skin control) and set skin temperature to maintain neutral thermal environment.

D. Place probe on infant securely using reflective cover.
E. Weaning from radiant warmer to open crib or bassinet:
1. Take axillary temperature.
2. Dress infant in hat, t-shirt, and swaddle in blanket(s).
3. Turn off radiant warmer.
4. Check temperature hourly for 4 hours, and if stable, transition infant to open crib or bassinet.
5. Once in open crib / bassinet, continue to monitor vital signs, feeding tolerance, and weight gain or loss. Infant must be able to maintain axillary temperature > 36.0º C. dressed with hat, clothing, and a maximum of 3 receiving blankets.

VII. OHMEDA GIRAFFE OMNIBEDS

A. Set up according to manual and/or guidelines attached to each bed.
B. Warm bed in preparation for admission. Prior to admitting any baby, even if bed is being used as a radiant warmer initially, with canopy down in isolette mode, set AIR TEMP according to baby's gestational age, postnatal age, and weight. This preheats the isolette for future use. After this is done, you can THEN raise the canopy for radiant warmer use.
C. When operating as a radiant warmer, use the baby mode unless the manual mode is specifically ordered; the manual mode requires constant supervision/attention.
D. Converting from radiant warmer to isolette mode: Check to see that the AIR TEMP was set appropriately. Cover baby with blanket for 20 minutes during conversion to isolette mode (due to air trapping). Use Servo or skin control for infants <1250 grams and air control for infants >1250 grams.

VIII. Giraffe Omnibed as Isolette

A. CONTROLS
1. SERVO (patient or skin control) for infants < 1,250 grams, unless otherwise ordered. Isolette temperature will fluctuate in response to changes in the infant's temperature.
2. NON-SERVO (air control) for patients > 1,250 grams. The air temperature will remain stable. The infant's temperature is monitored but does not affect the air temperature.
3. Portholes and doors must be kept closed except for specific interventions. Cluster the times when the isolette is opened, and collaborate with other health care professionals to preserve the heat in the isolette to protect the infant from temperature fluctuations.
4. Air Boost can be used when portholes are opened to help reduce temperature fluctuations.

B. SERVO CONTROL
1. Pre-warm the isolette on non-servo mode (air control) to an air temperature according to Neutral Thermal Environment guidelines based on infant age and weight. (please refer to NTE chart). (Could also use the referral hospital's records to find ideal air temp or Comfort Zone on

Omnibed menu.)
Place infant in isolette, attach skin probe and switch to SERVO control. It is imperative that skin probe is not covered and infant not lying on probe to prevent temperature fluctuations while on SERVO control.

2. Set SERVO control to maintain skin temperature at 35.5º C-36.5 C.

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3. Monitor and record skin and air temperatures and record SERVO setting at least hourly until temperature is stabilized.
4. Change skin probe cover frequently when it is not adhering to prevent hyperthermia in the event skin probe becomes unattached.

C. NON-SERVO (air temperature mode)

1. Set controls to non-servo. In non-servo, the skin probe monitors the infant's temperature, but will not regulate the air temperature.
2. Set desired temperature. When switching from servo to non-servo, set the air temperature according to air temperature reading while in non-servo mode. For a new infant, refer to NTE chart or referring hospital records.
3. If the infant's temperature is unstable, adjust the air temperature and clothing before returning to servo mode.

D. HUMIDITY

1. Humidity reduces evaporative heat losses and insensible water loss.
2. High humidity is used for all VLBW infants the first 2 weeks of life until the skin matures. Recommendations are 50% initially. It may be necessary to increase the humidity beyond 50% (from 50-70%) for extremely low birth weight (ELBW) infants; decrease if condensation occurs.
3. For all infants in isolettes, maintenance levels for humidity are to be set at an ideal of 45%, with the lowest setting 30%. (The recommended indoor relative humidity level of 30-50% is ideal; <30% is too dry). When humidity is lowered or weaned, the air temperature in the isolette may need to be increased to provide for temperature stability if in non-servo mode.
4. Sterile distilled water is added to the humidity chamber when water level falls below the fill line.
5. Parameters to consider for increasing or decreasing the humidity involve the infant's age, fluid status, urine output, serum sodium and potassium levels, urine specific gravity, and weight. A mature baby may, indeed, need an increase in humidity to decrease insensible water loss, especially when ill.

E. TRANSITION TO AN OPEN CRIB

1. Insulating the infant
   a. Clothe infant as soon as he/she is considered medically stable; this may occur several days or weeks before the infant is ready to be weaned.
   b. Clothing may consist of hat, t-shirt, and/or sleeper.
2. Weaning from the isolette may be considered when the following are met:
   a. Approximately 1,500 grams.
   b. Five days of consistent weight gain.

c. Stabilization of apnea and bradycardia episodes.
d. Medically stable.
e. Able to tolerate the environment with overhead shielding removed.

3. Once the above requirements are met, the second step of the transition process can begin: Swaddle in one blanket and make sure the isolette is on non-servo (air) mode. (Humidity should have been weaned to 30% lowest point for at least one day prior to weaning).
   a. The starting point of the isolette air temperature should be the average temperature of the last 5 days minus 5% of the average temperature.
   b. Record the temperature from the continuous monitor (skin probe) every 15 minutes for the first hour after the isolette temperature has been decreased. Optimal infant skin (abdominal) temperature should be between 35.5º – 36.5º C.
   c. If the infant's temperature is greater than 36.5º C., lower the isolette temperature another 0.5º C.
   d. If the infant's temperature is less than 35.5º C, increase the isolette temperature 0.5º C.
   e. The goal is to have four stable temperature readings over a 1-hour period. (Temperature monitoring every 15 minutes should be maintained until four stable temperature readings are obtained.)
   f. After the infant's temperature is stable, temperature should be recorded every 3 to 4 hours.
4. After 24 hours, each day:
   a. Lower isolette air temperature 1.5º C. (There may be smaller decreases for the smaller infants and larger decreases for the larger infants.)
   b. Continually monitor temperature, with every 3 to 4 hour caregiving sessions.
5. Once the infant has reached a 28º C isolette temperature:
   a. Keep the infant in 28º C for 8 - 24 hours.
   b. If weight gain has remained stable over the entire weaning process, move to open crib.
6. Open crib-first day
   a. Place open crib in draft-free environment; if temperature in nursery is greater than 3º C different from the isolette temperature, you may add additional blanket on infant.
   b. Recheck infant's temperature. If infant's axillary temperature is less than 36º C, then add additional blanket, for no more than 3 blankets maximum.
   c. Record infant's axillary temperature every 15 minutes for the first hour, then during routine vital signs.
   d. Do not bathe the infant on the first day of the open crib.
   e. Record daily weights.
7. Second and third day in an open crib
   a. Record temperature every 3 to 4 hours.
   b. Record daily weight.

c. If infant's temperature drops below 36º C, record temperature more frequently and take action to increase the temperature.

8. Transition failure
   a. If temperature is less than 36º C for more than 1 hour after a third blanket is added, return the infant to the isolette until temperature is stable. Record any identified problems. Try weaning again in 72 hours.
   b. If there is a failure due to any other problem, document.

IX. SPECIAL CONSIDERATIONS

A. HYPERTHERMIA (Rectal temperature > 37.5ºC)

1. If rectal temperature (core) > 37.5º C, it is important to determine whether the infant has a fever versus high body temperature due to overheating.
   Notify physician/NNP of changes in infant's body temperature.
2. When core temperatures are elevated in **febrile** conditions, the skin temperatures of the distal extremities remain cool in comparison to the skin temperature of the trunk. With fever, the infant will have a high axillary and/or rectal temperature with abdominal skin temperature generally within normal limits (35.5ºC-36.5ºC). Febrile infants are usually vasocontricted with cool distal extremities.
3. For febrile infants, it may be inappropriate to attempt to lower axillary temperature to a normal range, particularly if the infant is vasoconstricted with cool distal extremities.
4. When an infant is **overheated,** he/she is warm over the entire body. Overheated infants are usually vasodilated with warm extremities. Some drugs such as prostaglandins or atropine can cause hyperthermia in the infant.
5. For overheating, cool infant to a normal axillary temperature by decreasing environmental heating or decreasing thermal insulation by removing external heat sources (blankets and clothing), leaving the infant's skin surface exposed to enhance evaporative heat loss. It may help to position the baby in an extended position to encourage heat loss. Active temperature reduction methods should be used sparingly to prevent a dramatic loss of heat, potentially leading to cold stress and shock.

B. HYPOTHERMIA (Rectal temperature (core) < 36.5º C or 97.6º F)

1. The goal of rewarming the infant is to keep oxygen consumption to a minimum. Rapid rewarming may result in hypotension and apnea.
2. Isolette temperature should be adjusted 1º-1.5º C higher than the infant's temperature (Dodman, 1987).
3. Assess temperature every 15-30 minutes; this is done to monitor rate and success of rewarming.
4. The isolette temperature may be increased by 1 degree every hour until the infant's temperature has been stabilized. (Kenner, 1998).
5. If the infant has been severely cold stressed, the temperature may continue to decline during the early stages of rewarming (Laburn & Laburn, 1985).

6. Remove caps, plastic wrap, clothing, and blankets to prevent them from interfering with heat gain. Consider positioning infant in a flexed position, to minimize heat loss.
7. Warm feedings. Warm IV fluids if necessary, using blood-warming devices or by placing an extra length of tubing inside the isolette to allow the warmed environment to warm the fluids.

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SUBJECT THERMOREGULATION

Neutral Thermal Environment Temperatures

Age and Weight	Starting Temp	Range of Temp
0-6 Hours		
Under 1200 g	35.0	34.0-35.4
1200-1500 g	34.1	33.9-34.4
1501-2500 g	33.4	32.8-33.8
Over 2500 (and > 36 weeks)	32.9	32.0-33.8
6-12 Hours		
Under 1200 g	35.0	34.0-35.4
1200-1500 g	34.0	33.5-34.4
1501-2500 g	33.1	32.2-33.8
Over 2500 (and > 36 weeks)	32.8	31.4-33.8
12-24 Hours		
Under 1200 g	34.0	34.0-35.4
1200-1500 g	33.8	33.3-34.3
1501-2500 g	32.8	31.8-33.8
Over 2500 (and > 36 weeks)	32.4	31.0-33.7
24-36 Hours		
Under 1200 g	34.0	34.0-35.0
1200-1500 g	33.6	33.1-34.2
1501-2500 g	32.6	31.6-33.6
Over 2500 (and > 36 weeks)	32.1	30.7-33.5
36-48 Hours		
Under 1200 g	34.0	34.0-35.0
1200-1500 g	33.5	33.0-34.1
1501-2500 g	32.5	31.4-33.5
Over 2500 (and > 36 weeks)	31.9	30.5-33.8
48-72 Hours		
Under 1200 g	34.0	34.0-35.0
1200-1500 g	33.5	33.0-34.0
1501-2500 g	32.3	31.2-33.4
Over 2500 (and > 36 weeks)	31.7	30.1-33.2
72-96 Hours		
6-8 days	30.6	29.0-32.2
8-10 days	30.3	29.0-31.8
10-12 days	30.1	29.0-31.4
12-14 Days		
Under 1500 g	33.5	32.6-34.0
1501-2500 g	32.1	31.0-33.2
Over 2500 (and > 36 weeks)		
2-3 Weeks		
Under 1500 g	33.1	32.2-34.0
1501-2500 g	31.7	30.5-33.0
3-4 Weeks		
Under 1500 g	32.6	31.6-33.6
1501-2500 g	31.4	30.0-32.7
4-5 Weeks		
Under 1500 g	32.0	31.2-33.0
1501-2500 g	30.9	29.5-32.2
5-6 Weeks		
Under 1500 g	31.4	30.6-32.3
1501-2500 g	30.4	29.0-31.8

Under 1200 g	34.0	34.0-35.0
1200-1500 g	33.5	33.0-34.0
1501-2500 g	32.2	31.1-33.2
Over 2500 (and > 36 weeks)	31.3	29.8-32.8
4-12 Days		
Under 1500 g	33.5	33.0-34.0
1501-2500 g	32.1	31.0-33.2
Over 2500 (and > 36 weeks)	31.0	39.5-32.6
4-5 days		
5-6 days	30.9	29.4-32.8