



Thermoregulation Best Practices for Premature Infants



Overview

Thermal regulation is important in the care of the premature infant, with the goal of maintaining the infant in a neutral thermal environment. Normal axillary temperature in an infant is 36.5-37.4 degrees Celsius (97.7-93.3°F) with appropriate clothing, no respiratory distress, and while awake with an appropriate heart rate. (Kilpatrick 2017, Roychoudhury 2017). Well known variables that predispose the premature infant to cold stress may include low caloric intake, reduced insulation due to smaller amounts of body fat, underdeveloped stores of brown fat responsible for non-shivering thermogenesis, and a high ratio of skin surface area to weight. Infants who are growth restricted may have reduced glycogen stores. Overhead radiant warmers and double-walled convective isolettes are commonly used until the neonate is able to maintain his or her own temperature in an open crib with desired weight gain and minimal impact on metabolic activities.

Goals

A systematic approach to weaning a preterm infant from an enclosed or overhead heat source into a well-controlled NICU environment should be utilized to facilitate parental engagement and discharge from the hospital. The American Academy of Pediatrics emphasizes that weaning to an open crib enables modeling of safe sleep practice (supine positioning, firm surface, and avoidance of loose bedding) which is critical for reducing SIDS and SUID risk, especially in preterm infants who are at higher risk than term infants. The rationale is that acclimating infants to supine sleep and safe environments before discharge improves parental adherence and infant safety at home (Moon 2022).

Environmental Setting

The ambient temperature in the NICU or nursery environment should remain stable and be maintained at an appropriate setting. Ambient NICU temperatures should be kept at 22°C – 26°C (72-78°F) with relative humidity between 30% to 60% (Kilpatrick 2017). Fluctuating temperatures or cool environments often result in failure to successfully transfer an infant to an open crib. This may also result in poor weight gain, reduced feeding ability and apnea. Furthermore, drafts from air vent registers and returns should be avoided to minimize convective heat loss, as should proximity to outside windows to which body heat may be radiated.

Criteria for Weaning from an Isolette

- Incubator temperature is less or equal to 28 degrees Celsius.
- Infant demonstrates ability to self-regulate temperature. This is not based on the neonate's actual weight, corrected gestational age, or attainment of full oral feedings.
- Infant has consistent weight gain (15-20 grams/day) in the incubator or is demonstrating expected weight gain based on the infant's gestation and corrected gestational age.
- Infant shows evidence of cardiovascular stability (i.e., stable vital signs).

There is very little evidence and lack of consensus on the optimal age for transferring a preterm infant to an open crib (New 2011). Several studies have shown variation on when infants are weaned to an open crib which has shown to be associated with an increase in time to achieve full oral feedings and an increase in length of stay. Infants under 1500 grams can be weaned from an isolette without significant effects on weight gain and energy expenditure which can help reduce overall length of stay (Barone 2014, Berger 2014, Zecca 2010, New 2011, and Lin 2022, Al-Matary 2023).

Delaying incubator weaning can also decrease parental interaction, bonding, and discharge planning (Schneiderman 2009). Furthermore, weaning from an incubator can be an important milestone for premature babies to have early contact with their parents and carry out family-integrated care. Studies have shown that early contact can improve the neurobehavioral development of premature infants and improve their long-term neurodevelopment (Franck 2020). In the absence of consensus guidelines, different strategies have been used. Some NICUs switch to the air-control mode before weaning, while others prefer to challenge the clothed infant in a crib (Roychoudhury 2017).



Evidence shows that infant's weighing <1500 grams can successfully be weaned to an open crib and continue to achieve appropriate weight gain

The appropriateness of size for gestational age and brain maturity may influence this transition as several studies have shown that brain maturity is an important factor when considering weaning small babies to an open crib (Jacob and Casteli 2020). The more mature small-for-gestational-age infant may be ready for a trial in a crib at a lower weight than an appropriate-for-gestational-age extremely low birth weight infant. Most infants are candidates for weaning to a crib after they have achieved several days of weight gain (approximately 15-20 grams/day), metabolic homeostasis, cardiopulmonary stability, minimal apnea or bradycardia, and feeding tolerance.

Weaning Process

Preterm infants who are initially managed phase of their illnesses are commonly transferred to closed isolettes for most of their hospitalization prior to weaning to cribs. Infants in an isolette under servo control may be switched to air mode for manual weaning or weaned to a crib directly from servo control.

Transfer to a crib from air mode should occur when the infant's temperature remains stable (higher than 36.5°C (97.7°F)) in an ambient temperature of 28°C (82.4°F) in an isolette for at least 12-24 hours. Larger infants and infants with body temperatures of > 37°C may tolerate faster weaning rates.

Servo controlled systems can result in hypothermia or hyperthermia if the skin probe becomes dislodged. However, weaning from this mode may occur by undressing the infant or by clothing him/her with a lighter outfit. A secure skin probe is required, in addition to monitoring the infant's axillary temperature and isolette settings.

- Switch isolette to manual control and dress the baby in a shirt and blanket.
- Start weaning 0.5°C below the average isolette temperature over the previous 24 hours. If infant's temperature is $\geq 36.5^{\circ}\text{C}$, reduce temperature by 0.5°C at each assessment until the isolette temperature is 28°C. The temperature of the isolette may be reduced by 1-2 degrees Centigrade every 12-24 hours, in increments of 0.5°C.
- Monitor the infant's temperature every two hours for stability during weaning. Add a shirt, hat and blankets as the temperature is progressively decreased until the temperature is at the lowest setting, weight gain is steady and axillary temperature is stable. The infant can then be moved to an open crib if the temperature is stable with acceptable weight gain.
- When in a crib, the infant's outfit and coverings should vary according to the environmental temperature.
- If the infant's temperature is low or unstable in a crib, return the infant to the isolette, as needed. When the infant's temperature stabilizes, the weaning process may continue.

If the axillary temperature declines to less than 36.5°C during the weaning process prior to crib entry, the following guidelines may be followed:

- Increase isolette temperature by 0.5°C every 30 minutes until axillary temperature is greater than 36.5°C.
- Assess axillary temperature every 15 minutes until axillary temperature is greater than 36.5°C for one hour.
- Resume the weaning process.

Skin-to-skin contact with a parent or guardian may continue throughout the weaning process. The American Academy of Pediatrics highlights that kangaroo care promotes temperature stability, blood glucose stability, and improved oxygen saturation, all of which are critical for safe weaning to an open crib environment. Kangaroo care also enhances maternal-infant bonding, which can facilitate neurobehavioral development and self-regulation skills in infants. These physiologic and psychosocial benefits contribute to readiness for open crib care by improving the infant's ability to maintain homeostasis outside the incubator (Goodstein 2021).

Kangaroo care may facilitate the weaning process to an open crib and promotes bonding and parental interaction



Failure to Wean or Maintain Temperature in an Open Crib

If hypothermia (temperature less than 36.5 degrees Celsius) or signs of cold stress develop despite the application of a hat and additional blankets when the infant is in a crib, the infant should return to an isolette. Isolated weight loss is not an indication to place an infant back in an isolette. In addition, consider external environmental factors that may affect infant's heat regulation. Weaning may be resumed after 24-48 hours if the infant's temperature has stabilized.

Infants who return to an isolette for phototherapy without the need for heat support, except for that provided by the phototherapy device, may return to a crib after completion of treatment to monitor the infant's axillary temperature and isolette ambient temperature. Infants who have already successfully weaned and return to isolette for phototherapy, do not need a period of time.

Weaning may be resumed after 24-48 hours if the infant's temperature has stabilized

Hospital Discharge

Infants who have been successfully weaned to a crib and have maintained stable temperatures of at least 36.5°C for 1-2 days, with acceptable weight management and oral feedings, may be ready for discharge provided that they meet discharge criteria. (Please refer to ProgenyHealth Best Practice: Discharge Best Practices for NICU Patients.)

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