FACT SHEET # 2

Thermoregulation of the Near- Term Infant

"Instinct leads mothers to keep their infants warm," (1) and this instinct surely prevailed during the millennia that preceded recorded history. Organized institutional programs for the care of preterm and near-term infants did not appear until the last quarter of the 19th century. In Paris, Tarnier, his intern and successor, Budin were largely responsible for the first protocols for in-hospital global care of preterm infants. (2) Previously, "foundling asylums" cared for the unwanted infants who were "dropped off" by their parents. (2) Provision of "warmth, breast milk, and tender nurture" by mothers (1) were the very fabric of infant care at home, and because preterm infants were "weaklings," it followed that their postnatal care should be a continuation of the nurture that began in-utero. Physicians cared for neonates at birth only if survival was in question or if the infant was obviously ill. Care at home by mothers was the rule. (1)(3)(4)

Temperature and Homeothermy

Babies are homeotherms who increase and decrease their heat production to maintain their internal body temperatures within a narrow range. The consequences of prolonged and maximum heat-production include the loss of life-sustaining substrates and their conversion to acidic metabolic by-products.

The concept of an optimum thermal environment for Newborn infants evolved during the 1960s. This idealized setting, called the Neutral Thermal Environment (NTE), is characterized as "the range of environmental temperature within which the metabolic rate is at a minimum and within which temperature regulation is achieved by non-evaporative physical processes alone." (5)

ATTRIBUTES OF THE PRETERM INFANTS AND NEAR-TERM

RESPONSE TO CHANGES IN THERMAL ENVIRONMENT

1. Preterm infants can maintain core temperature, but only in a narrow range of environmental temperature change.
2. Vasodilatation occurs in warm air, but sweat glands in the preterm infant are not functional.
3. The thermo-conductivity of preterm tissue is greater than that of adults, increasing the propensity of the preterm infant to lose heat.
4. The ratio of surface area to body mass in preterm infants is considerably higher than in adults.
5. Subcutaneous fat insulation is negligible in preterm infants.
6. The muscular activity of preterm infants is minimal.
7. Neonates are able to maintain, continually or for limited periods, their body temperature within a narrow range, usually above that of their surroundings despite varying environmental temperatures (6)(7)(8).

The loss of heat to the environment

RADIATION

Radiant heat loss is described as the net rate of heat loss in the form of electromagnetic waves between the body and surfaces not in contact with the body, for example the walls of an incubator or a nearby glass window. This type of heat loss depends on a number of factors, including the temperature of the skin, the relative surface area of the infant and the distance to the incubator walls or window. (9)

EVAPORATION

This is defined as the total heat transfer by energy carrying water molecules from the infant's skin and exhaled respiration's to a drier environment. Preterm infant's skin (immature stratum corneum) differs to that of a term infant for the first 2 weeks of life and therefore he or she is more prone to this type of heat loss. (9)

CONVECTION

Convection is the transfer of thermal energy from the molecules of the body to the molecules of an adjacent gas. Heated gas expands (Boyle's law) and is displaced upwards by the force of gravity of the cooler and denser surrounding gas. This gas movement is called free convection. An example of this would be cooler air currents within a nursery. (9)

CONDUCTION

Conduction is the transfer of energy from the molecules of a body to the molecules of a solid object in contact with that body. An example of this would be the infant lying on a cold mattress. This type of heat loss is regarded as minimal as approximately only 10% of the infant's body surface area is in contact with the mattress. (9)

The Warm Chain

1. Warm birthing room
2. Immediate drying of infant
3. Skin to skin contact with mother
4. Breastfeeding
5. Bathing and weighing postponed
6. Appropriate clothing and bedding
7. Mother and baby together
8. Warm transportation
9. Warm resuscitation
10. Education, training and raising awareness

The "warm chain" is a set of interlinked procedures to be undertaken at birth and during the next few hours and days to minimise heat loss in all newborns. Failure to implement any one of these procedures will break the chain and put the newborn baby at risk of becoming cold. (10)

Methods for warming and maintaining a Neutral Thermal Environment

When making decisions regarding thermoregulation, it is important to consider resources required to maintain equipment and monitor for potential changes in infection colonization patterns.

Kangaroo Mother Care (Skin to Skin)

Kangaroo-mother care is a non-conventional method for caring for low birth weight and preterm newborns after initial stabilization. The primary features of kangaroo-mother care are uninterrupted use of adult body heat (skin-to-skin contact) in order to maintain the newborn's body temperature and exclusive breast-feeding.

The newborn is placed in a prone and upright (or diagonal) position between the mother's breasts, and covered with the mother's clothes and a cloth/blanket/shawl, for most of the day and night. Kangaroo-mother care is suitable for low birth weight newborns with no medical problems or after they have been corrected and when clinical signs are stable. Apart from being an efficient way of keeping the newborn baby warm, kangaroo-mother care promotes breast-feeding, physical growth and extra-uterine adaptation, and increases the mother's confidence, ability and involvement in the care of her small newborn. (10)

AIR HEATED INCUBATORS

Air-heated incubators are widely used for the care of very small and/or sick newborns. They provide a clean, warm environment, where the temperature and humidity can be controlled and oxygen can be supplied if necessary. Incubators also allow easy observation of the naked infant if necessary, and isolation.

Incubators have numerous advantages but they are expensive to buy and the running costs are high. Another potential issue is that air heated incubators may create an extra physical barrier between mother and baby. Furthermore, if they are not used and maintained correctly, they may be more of a hazard than a benefit to the newborn. (10)

RADIANT HEATERS

Radiant heaters are overhead heating elements that provide warmth locally. The advantage of using this form of heating is that it allows for direct observation and free access to the baby. Radiant heaters can be used to produce a limited area of warmth where sick and low birth weight newborns can be rewarmed, given oxygen if needed and observed naked. A 400-watt radiant warmer placed 50 cm above the baby will be sufficient. This method is effective only if the room temperature is kept high (above 25°C/77°F). Spot lights or bulbs are dangerous because they focus the heat and may burn the baby.

However radiant heaters have several disadvantages. If a baby is left for a prolonged period under a radiant heater it risks becoming dehydrated if enough fluids are not given, especially if it is very premature. If the temperature of the radiant heater is not monitored adequately, there is also a risk of overheating or first degree burns. There should never be more than one baby under one lamp because of the risk of cross infection and of unequal heat distribution causing some babies to be too warm and others not warm enough.

Thus radiant heaters should only be used for short periods - for example, in the delivery room, for resuscitation or during procedures in intensive care units. This method of heating should be replaced by other alternatives as soon as possible. (10)

Environmental temperature (warm rooms)

The "warm room" (also called space heated room) is one that is set apart and kept sufficiently heated to meet the needs of hypothermic newborns, preterm and sick babies, but it may also be a blocked-off portion of a larger room. The room or area can be kept warm by electrical or solar heaters. It is important to keep the babies clothed.

Experience has shown that warm rooms are effective at maintaining the body temperature of low birth weight babies. The lower the birth weight of the baby and the more premature, the higher the temperature of the room should be. For example, the appropriate room temperature for a clothed newborn weighing 1-1.5 kg at birth is 30-33°C (86-91.4°F), for those weighing 1.5-2 kg it is 28-30°C (82.4-86°F), and for those weighing 2.0-2.5 kg it is 26-28°C (78.8-82.4°C). The room temperature required by the baby will gradually decrease over the first days of life. A baby with asphyxia, respiratory distress or sepsis needs a higher room temperature than a baby of the same weight without these problems. (10)

HEATING/WARMING PADS

The heated water-filled mattress is a safe device for keeping low birth weight/sick babies warm and is more economical than an incubator.

The mattress is placed in an ordinary cot and filled with five litres of water. An electric heating plate and control unit fit into a compartment in the bottom of the mattress and keep the temperature of the water at 35-38°C (95-100.4°F). The baby is kept clothed and covered with a blanket in the cot. A reliable electricity supply is needed for this method. However, the mattress will maintain a constant temperature for several hours if the electricity does fail. The device does not create as much of a barrier between the mother and baby as an incubator. (10)

PLASTIC WRAPS AND COVERINGS

Recent studies have encouraged the introduction of polyethylene bags and wraps for use with babies born at approximately 30 weeks' gestation or less. This type of warming is ideal for a preterm infant (at birth and the immediate hours following) awaiting transportation to a tertiary care facility, or indeed a baby born in a tertiary care facility.

The baby is placed on a warm towel (but not dried) and placed under a radiant warming heating device (or if unavailable, into an incubator). The baby (excluding his or her head) is placed fully in the polyethylene bag or wrapped in the polyethylene sheet. It is important that the baby remains under the radiant warmer (or in the incubator) as this heat acting through the covering and on the baby's moist skin creates a warm thermal environment for the baby. Cutting an appropriately sized hole through the covering over the area of insertion can facilitate the introduction of any catheters or cannulae. (11) (12) (25) (26)

HUMIDIFICATION AND TOPICAL OINTMENT

Over the years there have been many studies and clinical trials that have demonstrated the importance and clinical application of both the uses of humidity and topical ointment therapy with preterm infants. The optimal humidity level for the Neonate is 50% relative humidity (RH). (13) This can be achieved by a variety of methods such as closed humidified incubators and humidity "tents". It should be noted that extremely premature infants might require RH of up to 85% in the first 2 weeks of their lives. (14) (15) (16) (17)

Topical ointment application (petroleum jelly base) has been advocated since the 1980's. (18) (19) (23) (24) This involves the application of commercially available preparations to the extremely preterm infant's unbroken skin on a regular basis after birth. This application reduces the effect of transepidermal water loss (TEWL) and acts as a "barrier" to the preterm infant's skin assisting in thermal control. (18) (19) (20) (21) (22)

Recent studies suggest that there may be an increase in the risk of nosocomial bacterial sepsis, associated to the application of topical ointment to infants below 30 weeks gestation and between birth weights of 501 to 1000g. (27)

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