Thermoregulation in preterm born babies

What is thermoregulation in babies?

Thermoregulation, or control of body temperature, has been studied as a fundamental physiological parameter defining health and disease for centuries.[2] The normal body temperature range for the human body is 36.5 to 37.5˚C. Thermoregulation is fundamentally important for newborn babies in order to prevent hypothermia (a low body temperature) and to a lesser extent, though still critical, hyperthermia (a high body temperature). Hypothermia is defined by the World Health Organisation (WHO) as a body temperature of less than 36.5˚C with 3 different categories:

- Mild: 36 – 36.4˚C
- Moderate: 32 – 35.9˚C
- Severe: <32˚C

Concerning the "moderate" category of hypothermia it is important to note that this can be considered as too broad a range. The relative risk of death ranged from 2 to 30 times within the current WHO classification for moderate hypothermia, increasing with greater severity of hypothermia.[3]

Hyperthermia is defined as a body temperature of more than 37.5˚C.

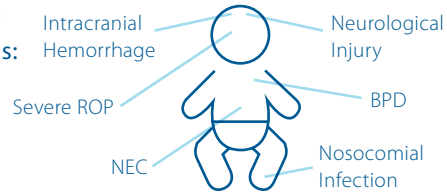
4 out of 10

babies still arrive cold into the NICU[1]

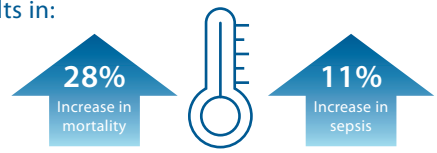
Why is this particularly important for preterm born babies?

For babies born preterm, low temperatures are independently associated with a higher risk of mortality, a negative effect on surfactant function, impaired growth, increased risk of sepsis and apnea of prematurity.[4] The smaller and more preterm the baby is born, the greater the risks are of mortality and morbidity. Globally, hypothermia upon NICU admission ranges from 26%[5] to 74%[6] which indicates how serious this challenge still is.

Cold, stressed or hypothermic babies potential complications:



Every 1°C decrease under 36°C in neonatal temp results in:



Providing an environment in which body temperature can be controlled after birth is one of the major aspects to get right in order to ensure an optimal outcome for preterm babies.

"Maintaining a baby's temperature within the normal range, is one of the most important things that healthcare professionals can do when a baby is first born. It is especially important in the first few hours after birth, particularly if babies are born very prematurely or small. Hypothermia is associated with increased mortality and morbidity, and so avoiding it is an essential part of newborn care."

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What are the main ways in which babies lose heat?

Evaporation

Evaporation is one of the main ways in which a baby can lose heat when it is born. Water loss occurs through the skin or respiratory tract. Preterm infants are especially at risk of heat loss through evaporation as their immature skin loses water more easily, and their high respiratory rates cause more water loss on their breath. Upon birth, a baby is wet and there is a dramatic temperature drop between the intrauterine and extrauterine environments. There is a linear relationship between the ambient humidity and the evaporation rate, with higher evaporation rates at lower levels of humidity[7]. Evaporation causes 0.6kcal of heat to be lost for every 1 gram of water lost from the body[8]. Research has shown that evaporative heat loss is greatest right after birth. Drying and wrapping the baby in a warm towel in the delivery room will reduce evaporative heat loss. In babies born before 32 weeks gestation, drying should be avoided and the baby should instead be placed directly in a plastic bag.[9]

The use of humidified incubator environments and humidified circuits for respiratory support is also important.[10]

Radiation

All body surfaces emit heat energy in the form of electromagnetic waves[8], which is called radiation. Energy transferred through radiation will cause the body temperature to change, depending on the rate of heat loss and the proportional temperature difference between the skin and the radiating surface.[11] A baby may lose heat due to a cold wall or window located nearby. Likewise, a preterm baby can be warmed by an overhead warmer or sunshine through a window.

Convection

Moving air or fluid across the baby's body that is colder than the baby's skin temperature can cause convective heat loss. The baby's skin warms the air above it, and the warm air is then swept away by convection through air or water. A common example of convective heat transfer is after birth, when the baby is delivered into a cold room, then carried from the mother to a nearby warming table. As the baby is carried through the cold air, heat easily rises off the skin and is swept away.[12] Other examples include air draughts from doors or air conditioning units, and even walking past the baby. Raised sides on cots, incubators and warmers can help prevent convection currents.

Conduction

Conductive heat loss occurs when heat is lost from the baby coming into contact with a cold surface or object, for example, a cold blanket, a hand or a stethoscope. Conductive heat loss can occur through exposure to colder air, fluids, or solid surfaces. In the process of conduction, heat is transferred from the baby's skin to an alternate surface. Pre-warming surfaces and fluids will minimise conductive heat losses while caring for a preterm baby.[12]

The first day of life

The table below summarises the important factors and who is key at different time intervals in a preterm born baby's first day of life.

The Golden Hour: 0 – 1 hour	1 – 6 hours	1 hour - xx days
Labour & Delivery	**Stabilisation & Transfer**	**In the NICU**
What?	**What?**	**What?**

Room temperature
Convective heat loss can be significantly reduced through adequate delivery room temperature. The WHO recommends that delivery rooms be at least 26˚C for babies less than 28 weeks gestational age and at least 25˚C for all births.[9]

Drying
Babies born after 32 weeks gestation should be dried immediately after birth. Apart from the face, the head and body should be wrapped in a warm and dry towel with a hat placed on the baby's head. Alternatively, the baby can be placed on the mother and both covered with a warm and dry towel[13]. These measures prevent evaporative heat loss.

Plastic covering
Babies born at less than 32 weeks gestation should have their head and body, excluding the face, covered with a polyethylene (plastic) wrapping without drying beforehand[13] to prevent evaporative heat loss.

Radiant heater
Placing a preterm born baby under a radiant heater prevents heat loss due to radiation and conduction.[14]

Air draughts
The baby should be protected from all draughts including from windows, doors, air-conditioning and excessive walking past the baby. This causes convective heat loss.

Objects in direct contact
Any objects coming into direct contact with the baby should be pre-warmed upon use, for example, all micro-environments (warmers, incubators) and bedding accessories (blankets, sheets, positioning aids, mattresses).

Objects not in direct contact
The baby should not be placed directly beside a cold wall or window since this can cause heat loss through radiation.

Humidified respiratory gases
Some babies, particularly those born before 32 weeks gestation, may require heated and humidified gases[13] to maintain a temperature of between 36.5˚C and 37.5˚C. Evaporative heat loss is reduced when respiratory gases are warmed and humidified by sending warm air into the nose, mouth or trachea of the baby[12]. However, studies to date are small and more research is needed in this area of care which can be difficult to control.

One baby, one bed
Bed transfers are a source of stress and heat loss in the preterm born baby. Ideally, these should be minimised to avoid all types of heat loss and the same bed in the form of a shuttle incubator or other technologies could be used for the transfer between the delivery room and the NICU, both inter- and intra-hospital. Where this is not possible, the use of pre-warmed transport and unit incubators is necessary.

Incubator opening
During stabilisation and/or transfer, the incubator should only be opened for absolutely necessary interventions to eliminate any heat loss.

Incubator use
Studies show that double walled incubators are superior over single walled incubators for decreasing heat loss, decreasing radiant heat loss and reducing oxygen consumption. However, there are no long-term benefits for preterm born babies due to care in a double walled incubator.[12]

Incubator mode
Using a mode most appropriate to the patient (clinical condition, gestational age, post conceptual age) and clinical workflow will minimise the effects of cold stress and provide a thermoneutral environment.

Humidity
A humid environment improves thermal stability, fluid and electrolyte balance, and skin integrity for a preterm born infant[15,16,17]. There are varying practices on the ideal level of relative humidity according to gestational age and birth weight. Generally, a greater level of humidity is beneficial.[17] A gradual reduction in incubator humidity from 85% to 50% after the first postnatal week allows higher transepidermal water loss, therefore promoting skin barrier formation.[18]

Temperature probes
Central (abdominal) and peripheral (foot) temperature may be constantly monitored in neonates. The probes should not be placed against the mattress and care should be taken that they do not fall off. If there is more than a 2˚C difference between a lower peripheral and central temperature this indicates cold stress.[4]

Interventions
When possible, all interventions and care of the baby should be carried out through the portholes of the incubator, unless a radiant heater is used as part of a hybrid bed. Opening of the incubator should be avoided as much as possible to reduce heat loss.

Who?	Who?	Who?
Physicians **Midwives/nurses**	**Bedside caregiver (physicians, nurses)** **Hospital transport staff**	**Nurses working in a neonatal unit** **Physicians**

Skin to skin care

Whenever possible skin to skin or kangaroo care should be offered during the first day of the baby's life and continually afterwards. This not only promotes temperature regulation but also bonding and care. It is important to note this may not be possible for many extremely preterm born babies for several hours or days, as they transition to ex-utero life.

A delicate balance: hyperthermia is also a risk

Whilst prevention of hypothermia is a more common cause of concern, care should be taken in order to avoid hyperthermia (particularly a body temperature of >38.0°C). This can occur when multiple interventions are carried out to avoid hypothermia. Animal studies indicate that hyperthermia during or following ischaemia is associated with a progression of cerebral injury.[13]

Beyond the first day of life

This factsheet concentrates mainly on the first day of life of a preterm born baby but thermoregulation remains centrally important throughout the entire NICU stay and beyond: from admission, to incubator weaning, discharge and going home.

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About EFCNI

The European Foundation for the Care of Newborn Infants (EFCNI) is the first pan-European organisation and network to represent the interests of preterm and newborn infants and their families. It brings together parents, healthcare experts from different disciplines, and scientists with the common goal of improving long-term health of preterm and newborn children. EFCNI's vision is to ensure the best start in life for every baby.

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