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Cold Injury in Newborns: Still an Emergency

Kamaldeep Arora, Rashmi Ranjan Das, M. Jeevasankar

Abstract

Thermal care of newborn represents the basic care provided to the neonate. In the developed world, thermal protection of the neonate has resulted in improved survival of the newborns, but this issue still needs to be addressed in developing world. Hypothermia in neonates is an important contributor to neonatal morbidity and mortality; with premature and low birth weight (<1500 gm) infants at greatest risk of hypothermic injury.Hypothermia is regarded as one of the major causes of neonatal death in developing world. It does not require a special equipment to keep the neonate warm but requires knowledge of importance of thermal care and methods to keep the neonate warm. In this review we would be discussing, why newborns are at risk of hypothermia,basic mechanisms of thermoregulation and treatment of any grade of hypothermia, particularly severe hypothermia, as a neonatal emergency. The small but important interventions to protect newborn from hypothermia would not only reduce the individual mortality but also reduce the global burden of neonatal mortality.

Keywords: Hypothermia; Low birth weight; Neonate; Prematurity; Thermal care; Thermoregulation.

Introduction

Thermal care represents one of the fundamental aspects of neonatal care.The incidence of neonatal hypothermia has decreased in the developed world but it is still very high in the developing world.It is estimated that annually, about 17 million neonates develop hypothermia in the developing world.[1]The incidence of neonatal hypothermia in developing countries is still at large with incidence as high as 67.6% in Nigeria, and 43% in India among normal weight neonates.[2,3]In Nepal the condition is even worse, with 85% neonates hypothermic within 2 hours of birth even in institutional setting.[4]In study in Uganda hypothermia was detected in 8 out 10 newborns in immediate postpartum period.[5]

Hypothermia in neonates is an important contributor to neonatal morbidity and mortality.[6]In astudy by mathur et al, fatality rate was 39.3% in mildly hypothermic infants, 51.6% in moderatelyhypothermic babies and 80% in severely hypothermic babies.These figures are even higher in newborns who are low birth weight and suffer asphyxia or have neonatal depression.[7]Hypothermia also carries a high neonatal morbidity due to increased risk of respiratory distress, metabolic acidosis, jaundice and hypoglycemia.[8]

As per the WHO definition hypothermia in newborn is defined as temperature below 36.5°C and is further categorized into cold stress (36-36.4°C), moderate hypothermia (32-36°C) and severe hypothermia (<32°C). A newborn placed naked in an environment of 23°C at birth suffers the same cold as does a naked adult at 0°C.[9]Care providers and mothers need to be aware of the importance of temperature maintenance of the newborn.Lack of knowledge among mothers and care providers of simple methods to maintain the "WARM CHAIN" has been

Author Affilation: Department of Pediatrics, All India Institute of Medical Sciences, New Delhi.

Reprint's request: KamaldeepArora, Department of Pediatrics, All India Institute of Medical Sciences, New Delhi
E-mail: dockamalpaeds@yahoo.com

found to be the most common factor contributing to hypothermia.[10]World health organization (WHO) developed ten step practice guidelines, described as **"WARM CHAIN"** which emphasized in keeping the newborn warm from immediately after birth to first few days of life.[9]

Appropriate policies, comprising simple practices such as establishing a warm delivery room, immediate drying at birth, skin-to-skin contact, early breastfeeding, delay in bathing the newborn, appropriate clothing, warm resuscitation, warm transportation, and training/awareness, are essential to prevent hypothermia.[9]

Mechanism of thermoregulation in neonates

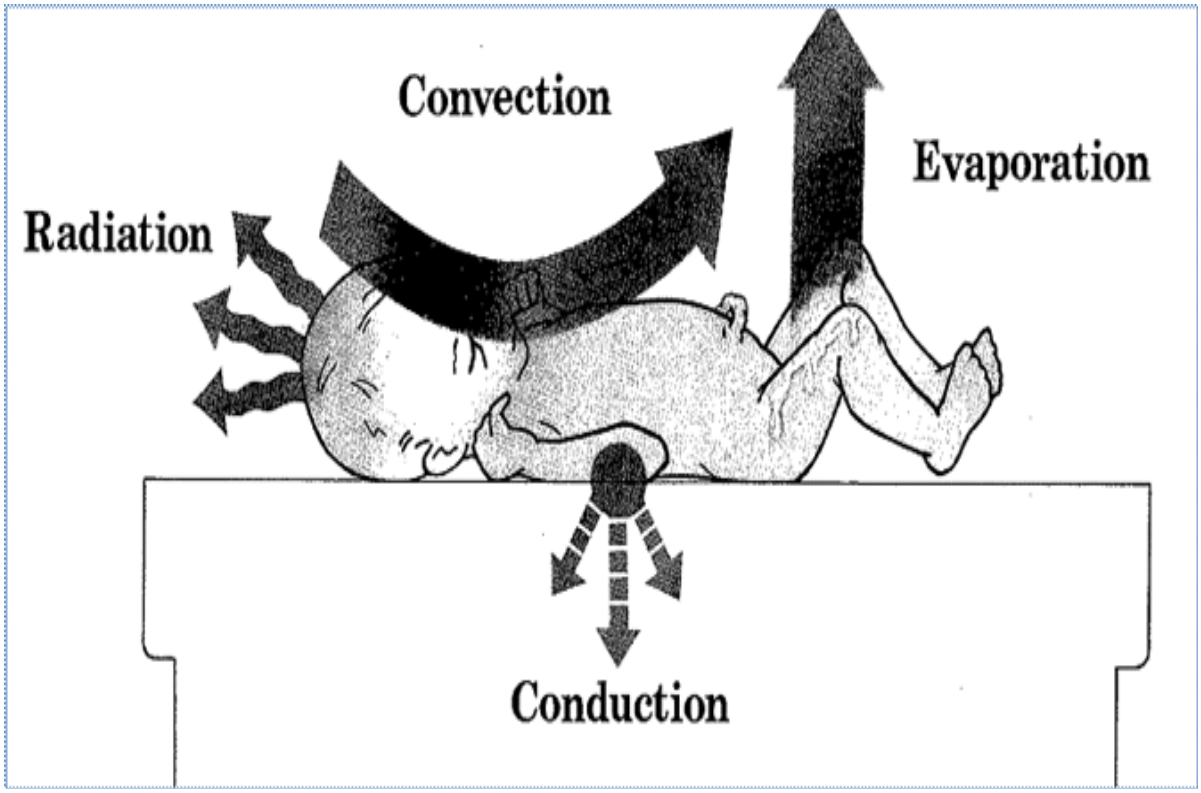
The basic aim of thermoregulation in neonates is to maintain the neonate's body temperature in thermo-neutral rangealso known as 'neutral thermal environment'.It is defined as the temperature range in which the basal metabolic rate of the neonate is at a minimum, oxygen utilization is least,yet theneonate maintains its temperature well.[11] For each baby, this range of temperature varies depending on gestational age and day of life.

Let's discuss in brief the mechanism by which the neonate loses and gains heat from environment and the ways by which he maintains his thermo neutral rangeof temperature.

Heat loses

New born loses heat to the environment immediately after birth as the milieu from where the newborn comes (amniotic fluid) is warm with temperature of nearly 38°C. The newborn loses heat by four different ways i.e evaporation, conduction, convection, radiation (Figure 1).[9]Newborn loses heat by evaporation particularly soon after birth (due to evaporation of amniotic fluid from skin surface), conduction (by coming in contact with cold objects-cloth,hands, tray), convection (by air currents in which cold air replaces warm air around baby-open

Figure 1: Four different ways a newborn can lose heat. Adapted from WHO[9] thermal protection in newborn(See text)



windows, fans) and radiation (to colder solid objects in vicinity like walls).

Heat Gain

The process of heat gain is by conduction, convection and radiation in addition to non-shiveringthermogenesis. Non-shivering thermogenesis is typical of newborn and occurs predominantly in the brown adipose fat.Brown fat is localized around the adrenal glands, kidneys, nape of neck, inter scapular region and axillary region.It is rich in mitochondria and is major source of heat production.[12]Blood flowing through the brown fat becomes warm and through circulation transfers heat to other parts of the body. Brown fat is richly supplied by parasympathetic, non epinephrine mediated nerve endings. When neonate's temperature decreases, the thermoreceptors get stimulated and activate the temperature regulating area in hypothalamus.[13]This results in norepinephrine release and this triggers nonshivering thermogenesis, and leads to lipolysis of brown adipose tissue, and this maintains the neonate's temperature.

Why neonates are different from adults in regulating thermal control?

Neonates, in contrast to adults, are at increased risk of hypothermia and are far more sensitive to changes in the external environment. Neonates are handicapped in many ways including a higher body surface areatobodymass ratio (which implies more radiant heat and more insensible water loss), large head in proportion to the body,higher metabolic rate, limited stores of metabolic substrates like glycogen andlittle subcutaneous fat.[14] In addition, neonates have inability to reduce the surface area by assuming flexed posture and limited and immature thermoregulatory behaviors, including inability to mount a shivering response and decreased heat production due to less brown fat. In preterm neonates all these factors are aggravated and cause more pronounced hypothermia as compared to term counterparts.

Assessment of neonatal hypothermia

Assessment of neonate's temperature is done by using the clinical thermometer which reads till 35°C but if the temperature reads low, a low reading thermometer (30-40°C) will be required to record the temperature below 35°C**.** The site of measurement of hypothermia is notspecified in WHO classification.[9]The site of measurement can be rectal or axillary, but for ease of measurement, safety and hygiene the axillary temperature measurement is the preferred method.The other method which can be used in peripheral/community setting to detect hypothermia and can be assessedwith reasonable precision is by human touch.[1] The basis of this method is that abdominal temperature is representative of the core temperature and the feet temperature is representative of peripheral temperature as abdominal vasculature does not vasoconstrict. The warm and pink feet of the baby indicate that the baby is in thermal comfort. But when feet are cold and abdomen is warm it indicates that the baby is in cold stress. In hypothermia both feet and abdomen are cold to touch. The reliability of this method can be enhanced by training the mothers and care providers.This method has been proven to be useful in many studies.[15–17]

Clinical features of severe hypothermia

Clinical features of hypothermia vary from mild hypothermia to severe hypothermia. It can range from lethargy, poor feeding, and unresponsiveness to apnea, metabolic acidosis, coagulopathy, neurological dysfunction and asystole/death. In addition severe hypothermia leads to impaired growth,increased risk of infections, sclerema, pulmonary haemorrhage, hypoglycemia. [18]

Management of hypothermia

Prevention of hypothermia

Thermal protection of newborn is a series of steps taken to ensure that the newborn does not become cold or overheated during birth or during the first few days of life. World health organization (WHO)declared neonatal

hypothermia as emergency and developed a series of ten step practice guidelines called "WARM CHAIN" (table 1), which was aimed to maintain the neonate's temperature from immediately after birth to first few days of life.[9]

Prevention of hypothermia

In the delivery room

The delivery room should be warm (>25°C), the newborn should be immediately dries and wrapped in a warm dry towel with head

Table 1: Ten steps of "WARM CHAIN" in maintaining newborns temperature

The warm Chain	
1	Warm delivery room
2	Immediate drying
3	Skin to skin contact
4	Breast feeding
5	Bathing and weighing postponed
6	Appropriate clothing/bedding
7	Mother and baby together
8	Warm Transportation
9	Warm resuscitation
10	Training and awareness raising

Adapted from WHO 1997 thermal care of newborn guidelines

adequately covered. After ensuring all these, place the baby in skin-to-skin contact with the mother and initiate early breastfeeding.

Immediate postnatal care

The neonate should be maximum time in skin to skin contact with mother; breast feeding should be encouraged exclusively and frequently. Neonate should be dressedwith extra clothing and his head covered. A baby who is born LBW (less than 2500 g) often needs special care in a hospital. If there are no signs of distress or extreme prematurity, a mother can provide warm environment by "Kangarooing" the baby at home or hospital.

Management of hypothermia

Management of hypothermia is always regarded as an emergency as unrecognized and untreated hypothermia would lead to devastating consequences as mentioned above. At health centrethe diagnosis of hypothermia should be confirmed by recording axillary/rectal body temperature. A hypothermic baby should be rewarmed as quickly as possible to maintain the integrity of vital organs of the body. The method selected will depend on the severity of hypothermia and availability of equipment**.** Methods used can be using any of the following**:** Skin-to-skin contact,warm room or bed, a heater, a radiant warmer or an incubator. Regular monitoring is the key for maintaining the temperature. Monitor axillary temperature every ½ hour till it reaches 36.5°C, then hourly for next 4 hours, 2 hourly for 12 hours thereafter and 3 hourly as a routine. Sepsis should always be kept in mind, if hypothermia persists despite above measures.

The management would depend on the degree of hypothermia as described below:

Cold stress (36°C to 36.4°C)

Ensure that the baby is covered adequately; remove cold clothes andreplace with warm clothes. Use a room heater to warm the room. Measures should be taken to reduce further heat loss. Skin-to-skin contact with mother and breastfeeding should be initiated as soon as possible.

Moderate hypothermia (>32°C to < 36°C)

Moderate hypothermia at home is treated rapidly by keeping the baby in warm room in skin-to-skin contact with mother or care provider. Cover the baby on the mother's chest with her clothes and an additional warmed blanket. In hospital settings warmer/incubator should be used. Temperature monitoring should continue every 15-30 minutestill neonate is euthermic.

Severe hypothermia (<32°C)

This degree of hypothermia poses a real threat to the life of the newborn. Rewarming should begin as early as possible and can be

achieved by three methods: passive external, active external and active internal rewarming.[19,20]

Passive external rewarming measures included drying the baby, covering the head with warm cloth like hat and wrapping the baby in warmed blankets. Active external rewarming measures include the use of air heated incubator or manually operated radiant warmer or thermostatically controlled heated mattress set at 37-38°C and packing warmed saline bags against the body. Internal rewarming measures included administration of warm intra-venous fluids and warm, humidified ventilator gases.

Passive external cooling increases the body temperature rise at rate of 0.5-2°C/hour. The combined measures from all three techniques results in a rapid initial rise in core temperature of approximately 5- 8°C/h over 2 hours.[20]Once baby's temperature reaches 34°C, the rewarming process should be slowed down (0.5°C/hr) for the danger of hyperthermia.Vitals (heart rate, blood pressure, temperature)should be monitored regularlyalong with blood glucose. Blood sugar monitoring is very important in these neonates as they are prone to hypoglycemia,intravenous line should be established and dextrose should be started as these infants are lethargic and not able to take feeds. If no equipment is available as in home conditions or during transport to health facility, neonates should be kept in skin to skin contact with the mother and mother neonate dyad properly covered. All neonates with severe hypothermia should be given Inj. Vitamin K 1 mg for term and 0.5 mg forpreterm as there is risk of coagulopathy with severe hypothermia. These neonates are at risk of hypoxia due to increased energy demand and poor circulation and should be provided supplemental oxygen.

Rapid cooling versus slow cooling

Although the controversy of rapid versus slow rewarming in neonatal hypothermia is debated, the available literature points towards beneficial effects of rapid rewarming over hours rather than slow rewarming over days.Till date, there are no randomisedstudies on rapid versus slow rewarming in accidental neonatal hypothermia. A retrospective study from Israel in late 80's on rewarming 56 hypothermic infants reportedbetter outcomes (death) with rapid rewarming (no deaths versus 3 deaths in rapid versus slow rewarming, respectively).[8]There are many proposedphysiological consequences of rapid rewarming as these neonates should be monitored closely because of the risk of apnea, rewarming shock and the after-drop phenomenon.[21] Possible causes of rewarming shock include vasodilatation and lowered peripheral vascular resistance which occurs during the process of rewarming, especially rapid rewarming. The intravascular volume depletion can add on to this and cause significant hypotension. The other problem with rapid rewarming is the 'after-drop phenomenon'..This condition refers to deterioration following early rewarming of the peripheries. The blood in the peripheries is under anaerobic metabolism and leads to accumulation of lactic acid. This lactic acid rich blood when returns to the central parts leads to metabolic acidosis and the cooler blood results in decrease in core temperature.[22]The active external rewarming should be applied to thetrunk rather than the extremities because an "afterdrop" incore temperature may occur when blood supply to the coldperiphery is re-circulated to the core.[19]

Conclusion

In conclusion, neonates are handicapped in their thermal protection and need support from the mother/care provider to maintain their temperature. Knowledge of importance of temperature maintenance and simple, low cost methods such as warming of the delivery room, immediate drying, keeping in skin to skin contact with mother, immediate and frequent exclusive breastfeeding, appropriate clothing; can prevent this devastating neonatal emergency. This holds true especially for low resource settings. In severely hypothermic infants, rapid external rewarming is effective

and safe with no evidenced no complications. Increased knowledge among mothers and care providers including the hospital staff can significantly decrease the current incidence and case fatality of hypothermia.

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