

S A F E M O T H E R H O O D

Thermal Protection of the Newborn: a practical guide



MATERNAL AND NEWBORN HEALTH/
SAFE MOTHERHOOD UNIT
DIVISION OF REPRODUCTIVE HEALTH (TECHNICAL SUPPORT)
WORLD HEALTH ORGANIZATION
GENEVA

P r a c t i c a l G u i d e

WHO/RHT/MSM/97.2
Distri.: GENERAL
Orig.: ENGLISH

TABLE OF CONTENTS

INTRODUCTION	3
1. THERMAL PROTECTION OF THE NEWBORN	5
1.1 What is thermal protection of the newborn?	5
1.2 How the newborn loses heat	5
1.3 The optimal thermal environment	6
1.4 The warm chain.....	8
1.5 The warm chain in institutions	13
1.6 The warm chain at home.....	13
1.7 Measuring or assessing the newborn's temperature	14
2. HYPOTHERMIA IN THE NEWBORN.....	17
2.1 Effects and signs of hypothermia	18
2.2 Causes and risk factors.....	18
2.3 Distribution and incidence	19
2.4 Management of hypothermia.....	20
Management in hospital	21
Management at home	22
3. HYPERTHERMIA IN THE NEWBORN.....	23
3.1 Effects and signs of hyperthermia	23
3.2 Causes and prevention of hyperthermia	23
3.3 Management of hyperthermia	24
4. THERMAL PROTECTION OF LOW BIRTH WEIGHT AND SICK NEWBORNS	26
4.1 Warm rooms	28
4.2 Radiant heaters.....	29
4.3 Heated water-filled mattress	29
4.4 Light-bulb heated cots or beds.....	30
4.5 Air heated incubators	30
Monitoring the temperature of babies in incubators.....	32
Cleaning incubators.....	33
4.6 Kangaroo-mother care.....	33
Advantages of kangaroo-mother care.....	33
How to practise kangaroo-mother care	34
4.7 Keeping low birth weight newborns warm at home.....	36
4.8 Keeping newborns warm during transportation	37
5. IMPLEMENTING THERMAL PROTECTION	38
6. REFERENCES.....	40
ANNEX: THERMAL PROTECTION OF THE NEWBORN: A SUMMARY GUIDE. i-xxi	

EXECUTIVE SUMMARY

Thermal protection of the newborn is the series of measures taken at birth and during the first days of life to ensure that the baby does not become either too cold (hypothermia) or too hot (hyperthermia) and maintains a normal body temperature of 36.5-37.5°C (97.7-99.5°F).

The newborn infant regulates body temperature much less efficiently than does an adult and loses heat more easily. The smaller and more premature the baby, the greater the risk. After birth, the wet newborn immediately starts losing heat and unless heat loss is prevented, hypothermia will develop. Hypothermia of the newborn occurs throughout the world and in all climates and is more common than believed. This condition is harmful to newborn babies, increasing the risk of illness and death.

The temperature of the environment during delivery and the postnatal period has a significant effect on the risk to the newborn of developing hypothermia. In general, newborns need a much warmer environment than an adult. The smaller the newborn, the higher the temperature needs to be.

The "warm chain" is a set of ten interlinked procedures carried out at birth and during the following hours and days which will minimize the likelihood of hypothermia in all newborns. The room where the birth occurs must be warm (at least 25°C/77°F) and free from draughts. At birth, the newborn should be immediately dried and covered, before the cord is cut. While it is being dried, it should be on a warm surface such as the mother's chest or abdomen (skin-to-skin contact). Skin-to-skin contact with the mother is the best way of keeping the baby warm. If this is not possible, alternative means of preventing heat loss and providing warmth – such as wrapping the newborn baby and putting it in a warm room or under a radiant heater – will be necessary. Bathing and weighing the baby should be postponed.

Breast-feeding should start within one hour of delivery. This will provide the baby with calories to produce body heat.

In the days following birth, hypothermia can be prevented by keeping the baby and mother together (rooming-in), by breast-feeding as long and as often as the baby wants, and by dressing the baby appropriately for the environmental temperature.

Low birth weight or sick newborns are most vulnerable to hypothermia. Methods to keep these high-risk babies warm include kangaroo-mother care (round-the-clock skin-to-skin contact), "warm rooms", heated water-filled mattresses, radiant heaters, and incubators. A newborn baby placed in a heating device or a "warm room" should be taken out periodically for skin-to-skin contact with the mother and for breast-feeding. The body temperature of the baby should be monitored frequently.

Hypothermia occurs when the newborn's temperature drops below 36.5°C (97.7°F): 36-36.5°C (96.8-97.7°F) is mild hypothermia (cold stress); 32-36°C (89.6-96.8°F) is moderate hypothermia; less than 32°C (89.6°F) is severe hypothermia. Hypothermic newborns must be rewarmed as quickly as possible by skin-to-skin contact or any of the above-mentioned methods, depending on the availability of staff and equipment and the severity of the hypothermia.

Hyperthermia is as dangerous to the newborn as hypothermia and can be prevented by dressing the baby appropriately for the environmental temperature and not placing it too close to a source of heat or in full sunlight. In particular, incubators should not be exposed to direct sunlight, and the temperature inside the device as well as the baby's own temperature should be monitored frequently.

The information presented in this guide provides a basis on which managers and health care providers can develop their own strategies and procedures for thermal protection and management of hypothermia and hyperthermia of newborn babies.

INTRODUCTION

In the early 1900s it was realized that a warm environment was essential in the care of low birth weight newborns because they could not maintain their own body heat. Hypothermia (i.e. a body temperature below normal) has since been recognized as a significant cause of neonatal illness and death, and has been described in low birth weight as well as normal newborns, on every continent, and even in tropical countries.

In the developed world, awareness of the importance of a warm environment has resulted in improved care of the newborn, especially of preterm and low birth weight babies, who are at special risk. In many parts of the developing world, however, there is little understanding of the thermal needs of newborn babies or of the extent and significance of neonatal hypothermia. Although data are scarce, recent studies in selected countries have shown that hypothermia is still a common problem and that it contributes to the high perinatal mortality rate seen in the developing world.

This situation results more from lack of knowledge than from lack of equipment. Health personnel and mothers are not aware of the importance of keeping newborn babies warm by simple methods such as drying and covering them immediately after birth, encouraging early breast-feeding and keeping newborns in close contact with their mothers. In health facilities where managers and health workers have not received training in thermal protection, the policies and procedures necessary for maintaining a suitable thermal environment for newborn babies are lacking, and harmful practices are common. Under such circumstances, the risk of neonatal hypothermia or hyperthermia (a body temperature above normal) is considerable.

A World Health Organization (WHO) consultative group on Thermal Control met in 1992 to address this issue and suggest appropriate measures for intervention. The Maternal and Child Health Programme of the WHO issued guidelines to help programme managers and health workers understand the principles and methods for preventing and treating hypothermia (*Thermal control of the newborn: a practical guide*, WHO/FHE/MSM/93.2). The guidelines were field tested in eight countries.¹

This guide is a revised version of the first edition. It takes account of the experience gained during field testing and presents new evidence on the effectiveness of skin-to-skin contact. It focuses on the concept of thermal protection – that is, protection from both cold and heat, and the maintenance of a thermal environment that is specifically adapted to the size and gestational age of the newborn baby. The concept of the "warm chain" has been developed into a 10 step package for preventing heat loss in the newborn. The 10 steps include thermal protection at birth and in the first days of life.

¹ The countries where the guidelines were field tested are: Brazil, China, India, Indonesia, Kazakhstan, Nepal, Mozambique and Zimbabwe

The guide is designed to inform health personnel and managers in health facilities about thermal protection of the newborn and to help them put the theory into practice. It describes the principles and procedures of thermal protection of the newborn, with special reference to preterm, low birth weight and sick babies. The management of hypothermia and hyperthermia is also described, and the harmful effects of certain cultural and institutional practices are pointed out.

The guide is accompanied by a summary containing the main messages and the most essential information on thermal protection, to be adapted and/or translated by countries and used for training purposes.

The World Health Organization welcomes comments and feedback from health workers and managers in the field and would be glad to receive documentation on the subject from other experts.

1. THERMAL PROTECTION OF THE NEWBORN

1.1 What is thermal protection of the newborn?

Thermal protection of the newborn is the series of measures taken at birth and in the first days of life to ensure that the newborn does not become either cold or overheated and maintains a normal body temperature of 36.5-37.5°C (97.7-99.5°F).

The newborn cannot regulate its temperature as well as an adult. It therefore cools down or heats up much faster and is able to tolerate only a limited range of environmental temperatures. The smaller the newborn, the greater the risk. Thermal stability improves gradually as the baby increases in weight.

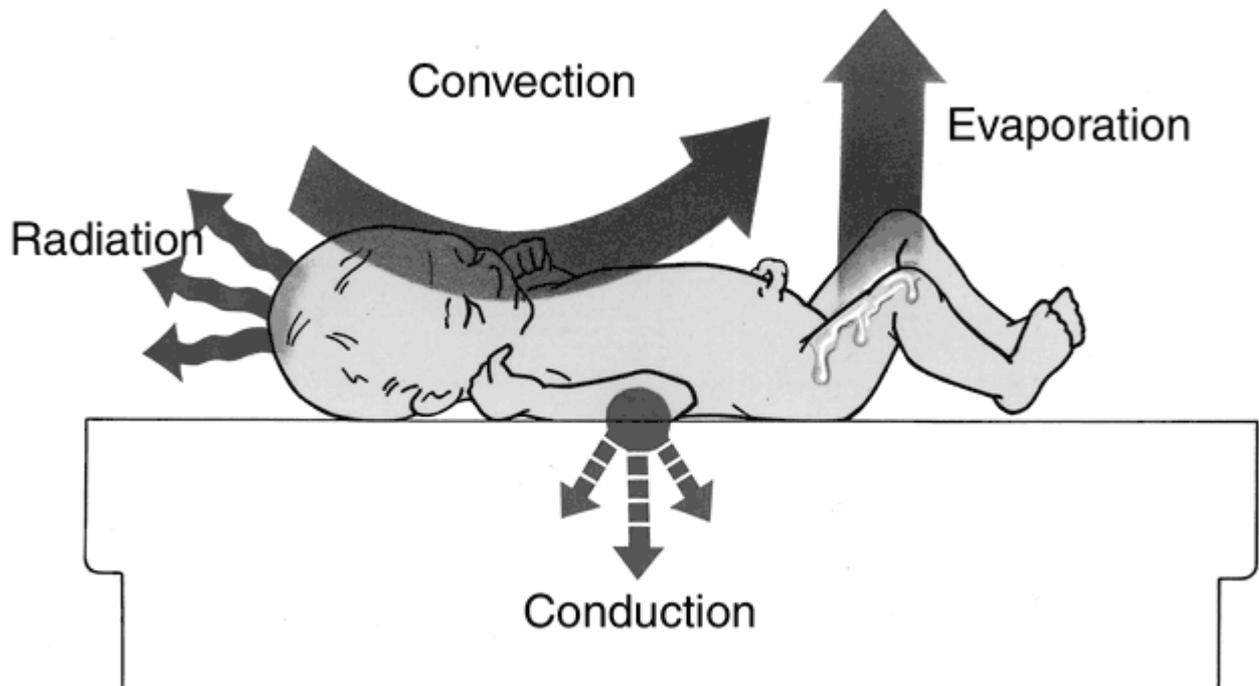
The newborn cannot regulate its temperature as well as an adult and therefore needs to be protected from cold and heat.

1.2 How the newborn loses heat

The temperature inside the mother's womb is 38°C (100.4°F). Leaving the warmth of the womb at birth, the wet newborn finds itself in a much colder environment and immediately starts losing heat.

The newborn baby loses heat in four different ways. Heat loss is mainly due to *evaporation* of amniotic fluid from the baby's body.^{1,2} But loss of body heat also occurs by *conduction* if the baby is placed naked on a cold surface (e.g. a table, weighing scale or cold mattress); by *convection* if the naked newborn is exposed to cooler surrounding air; and by *radiation* from the baby to cooler objects in the vicinity (e.g. a cold wall or a window) even if the baby is not actually touching them. Heat loss increases with air movement, and a baby risks getting cold even at a room temperature of 30°C (86°F) if there is a draught.

Most cooling of the newborn occurs during the first minutes after birth. In the first 10-20 minutes, the newborn who is not thermally protected may lose enough heat for the body temperature to fall by 2-4°C (3.6-7.2°F), with even greater falls in the following hours if proper care is not given.^{1,2} If heat loss is not prevented and is allowed to continue, the baby will develop **hypothermia**, i.e. a body temperature below normal.



Four ways a newborn may lose heat to the environment

A hypothermic baby, especially if it is small or sick, is at increased risk of developing health problems and of dying.³ However, if heat loss is prevented, the newborn will stay warm and will have a much better chance of remaining healthy, or of surviving if it is already sick.

In trying to keep babies warm, it is important to make sure they do not become overheated. The mechanisms described above may act in reverse and cause **hyperthermia**, i.e. a body temperature above normal. Although less common, hyperthermia is as dangerous as hypothermia.

1.3 The optimal thermal environment

The newborn infant regulates body temperature much less efficiently than does an adult. It will therefore have trouble maintaining a normal body temperature in an environment that is thermally comfortable for an adult. In fact, a naked baby exposed to an environmental temperature of 23°C (73.4°F) at birth, suffers the same heat loss as does a naked adult at 0°C (32°F).

A naked newborn exposed to an environmental temperature of 23°C suffers the same heat loss as a naked adult in 0°C.

Since the consequences of an environment that is too cold or too warm are serious, it is important to know what is the optimal – i.e. the most suitable – thermal environment for the newborn baby. This is the range of thermal conditions under which a newborn baby can maintain normal body temperature. The range is narrow, especially in low birth weight or sick babies. Basically speaking, the smaller and more premature the newborn is, the less it tolerates cold and heat.

Thus there is no single environmental temperature that is appropriate for all sizes, gestational ages and conditions of newborn babies. What is appropriate for a healthy term baby is too cold for a preterm baby, and what is appropriate for the preterm baby is too hot for the term infant. However, as a general rule, most newborns at birth, if left wet and naked, cannot cope with an environmental temperature of less than 32°C (89.6°F).⁴ But if the baby is immediately dried, put skin-to-skin with the mother and covered, the delivery room temperature can be as low as 25-28°C (77.0-82.4°F).

Optimal room temperatures for newborns at delivery are very warm by adult standards. Therefore adults should not determine the delivery room temperature according to their own comfort. If the temperature in the delivery room cannot be measured accurately, the guiding rule is that when the temperature in the room is becoming too warm for adults in short sleeves it is the right one for the newborn.

It is more difficult to determine the *upper* limit of the optimal thermal environment. Except for the wet baby at birth, the maximum tolerable air temperature is about 35°C (95°F) for a naked baby, and slightly less for a dressed baby. This upper limit is likely to be higher for low birth weight or sick babies.

Adults should not determine the delivery room temperature according to their own comfort.

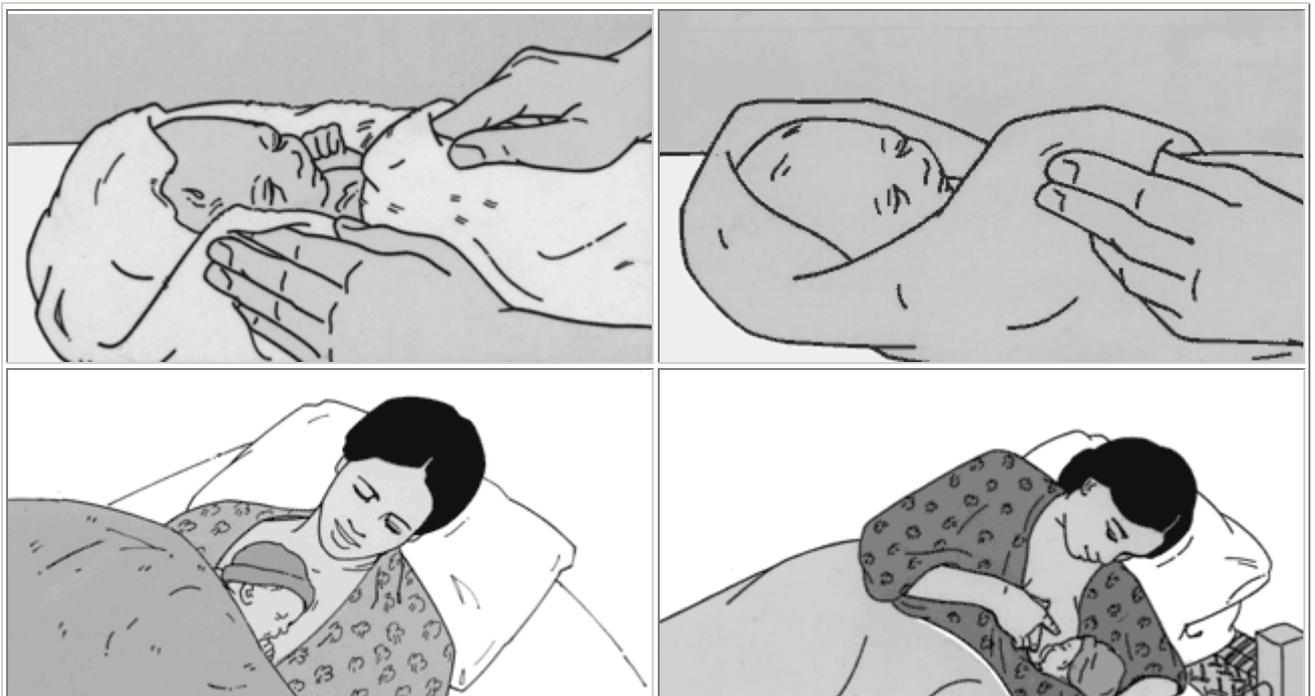
1.4 The warm chain

Thermal protection of newborns is very important and not difficult. The basic principles are the same whether the baby is born at home or in an institution. As most cooling of the newborn occurs during the first minutes after birth, it is important to act quickly to prevent heat loss.

The "warm chain" is a set of interlinked procedures to be taken at birth and during the next few hours and days in order to minimize 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 getting cold. The 10 steps of the "warm chain" are described below.

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



Preventing heat loss at the time of birth:
drying - wrapping - skin-to-skin - breast-feeding

Step 1. Warm delivery room

Preparation of the place of delivery and of the supplies that will be needed at this time is the first step in the warm chain. The room should be clean, warm (at least 25-28°C/77.0-82.4°F), and free from draughts from open windows and doors, or from fans. If the temperature of the room is less than optimal, a heater should be available to warm the room. In some circumstances, it might be easier to warm a small area of a room rather than the whole room. In hot weather, air conditioning or fans should be turned off or adjusted in the delivery room.

Supplies needed to keep the newborn baby warm should be prepared ahead of time. The supplies should include as a minimum: two absorbent towels large enough to cover a newborn baby's whole body and head, a cap, a sheet or blanket for covering mother and baby, and suitable baby clothes and bedding. In cool weather a source of heat should be available to prewarm the clothes and towels.

The delivery room temperature should be at least 25°C.

Step 2. Immediate drying

After birth the baby should be immediately dried with a dry towel, including its head, while the cord is still attached. While the newborn is being dried, it should be on a warm surface such as the mother's chest or abdomen (skin-to-skin contact), or a prewarmed cloth on the bed.

The baby should then be covered with a second, dry towel (discard the first towel) and a cap put on its head. If the room temperature is less than optimal (less than 25°C/77°F), towels and cap should be pre-warmed.

Step 3. Skin to skin contact

Skin-to-skin contact is an effective method of preventing heat loss in newborns, whether they be full term or preterm babies.^{5,6,7,8} The mother's chest or abdomen is the ideal surface to receive the newborn as it is clean and at just the right temperature. The newborn can be dried as it is laying on the mother and then covered. If skin-to-skin contact is not acceptable, the baby could be wrapped after having been dried, and placed in its mother's arms.

The baby should be uncovered as little as possible during assessment of its condition, during eye care, and while the cord is being tied and cut. It can be kept in skin-to-skin contact with the mother while she is being attended to (placenta delivery, suturing of tears), during transfer to the postnatal ward and for the first

hours after birth. Skin-to-skin contact can also be used afterwards to keep the baby warm if the room is cool, for example at night, or to rewarm a baby that is found to be mildly hypothermic.

Step 4. Breast-feeding

Breast-feeding should begin as soon as possible after delivery, preferably within an hour. An early and adequate supply of breast milk is essential to provide the newborn with calories so that it can generate body heat. The first milk, called colostrum, is rich in nutrients and antibodies, and is all the nourishment and liquid a baby needs. The baby should not be given any other food or drink. In cultures where colostrum is considered useless or dirty, families will need to be informed and persuaded of its importance.

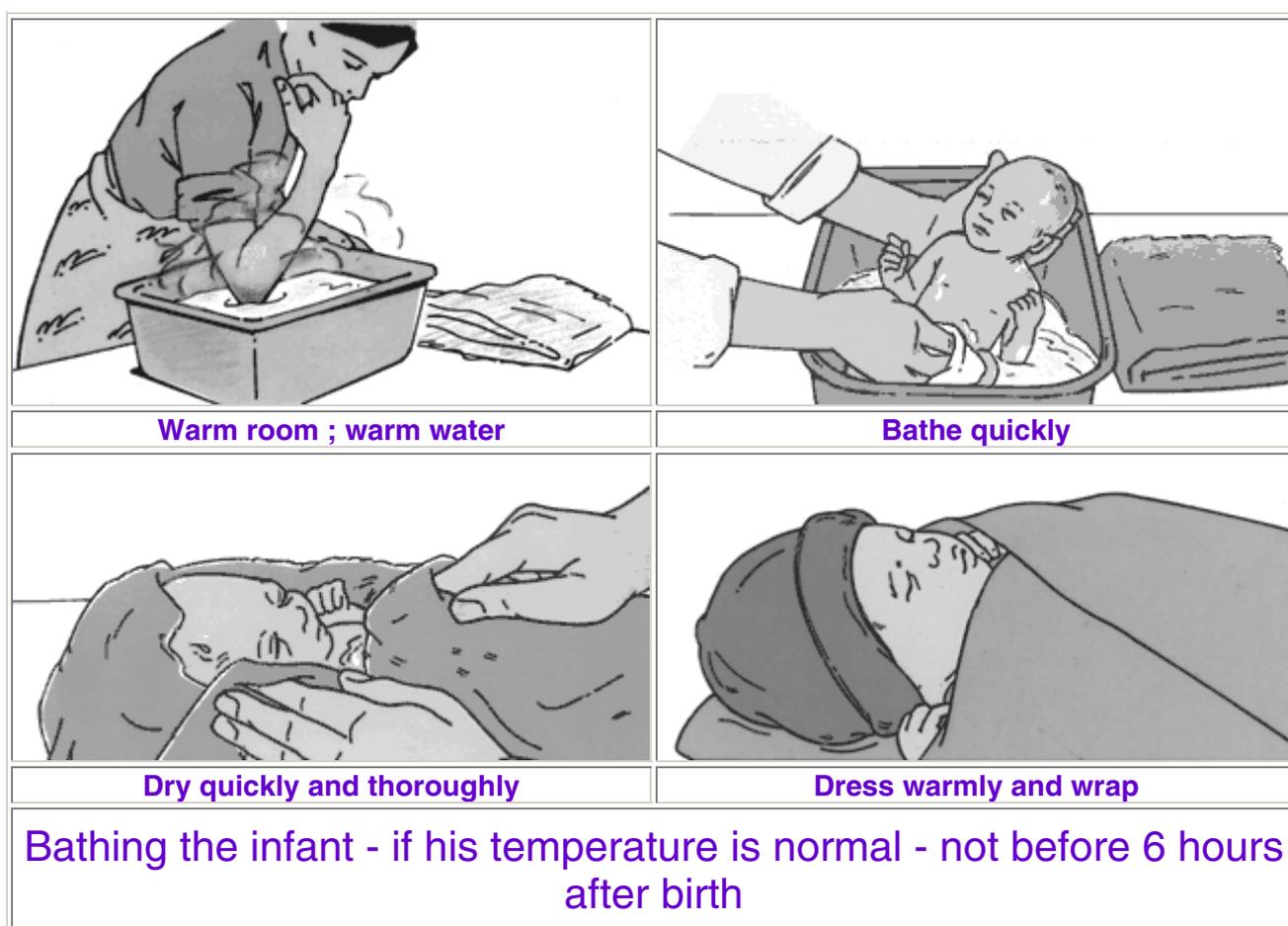
In the hours and days following birth it is very important that the newborn be allowed to suckle at the breast "on demand" – that is, whenever and as long as it wishes, both day and night. This stimulates milk production and provides the baby with enough calories for heat production and for growing. A mother should receive encouragement, support and assistance for breast-feeding from health staff and/or relatives.

Step 5. Bathing and weighing postponed

Bathing the newborn soon after birth causes a drop in the baby's body temperature⁹ and is not necessary. Blood, meconium and some of the vernix will have been wiped off during drying at birth. The remaining vernix does not need to be removed as it is harmless, may reduce heat loss and is reabsorbed through the skin during the first days of life. If cultural tradition demands bathing, this should not be carried out before 6 hours after birth, and preferably on the second or third day of life so long as the baby is healthy and its temperature is normal.

Bathing in warm water followed by rapid drying leads to less heat loss than cleaning the baby with a wet towel.¹⁰ When bathing the baby, the midwife or birth attendant must ensure that it is done in a warm room and using warm water. After the bath, the baby should immediately be wrapped in a dry warm towel, dried thoroughly, dressed quickly and placed near the mother.

Weighing of the baby at birth also puts it at risk of heat loss and should be postponed for several hours. Before weighing the baby, it should be well wrapped. The weight recorded can then be adjusted by subtracting the weight of the covers.



Step 6. Appropriate clothing and bedding

In the first few days after birth, the newborn should be protected by clothing and bedding that are appropriate for the environmental temperature. The number of layers of clothing and bedding necessary depends on the environmental temperature. As a general rule, newborns need one or two more layers of clothes and bedding than adults. In the first hours after birth, clothing should always include a cap, since as much as 25% of heat loss in a newborn baby may be from an uncovered head.¹¹

Clothing and bedding should not be too tight to allow air spaces between the layers as trapped air is a very efficient insulator. Swaddling – the custom of wrapping bands tightly around the baby – is common in some cultures and should be discouraged. Swaddling excludes air and reduces the efficiency of heat retention; it restricts movement and may increase the risk of pneumonia and other acute respiratory infections because it does not allow the baby's lungs to expand fully.¹²

Newborns should be adequately protected from exposure to ambient temperature by clothing and bedding.

Step 7. Mother and newborn together

Babies born at home as well as in institutions should be kept with their mothers 24 hours a day, preferably in the same bed, in a warm room (at least 25°C/77°F). This is known as "rooming-in". When mother and baby are together it is easier to keep the baby warm and to breast-feed on demand. In institutions, rooming-in also limits the exposure of the newborn to hospital acquired infections.

When mother and baby are together it is easier to keep the baby warm and breast-feed on demand.

Step 8. Warm transportation

If the baby needs to be transferred to hospital, or to another section of a hospital such as the postnatal ward or neonatal care unit, it is important to keep the baby warm during transportation. This is a step that, if overlooked, can result in a drop of the newborn baby's body temperature even if thermal protection measures were adequate at the time of birth.¹³ The simplest and safest way to transport most newborns is in skin-to-skin contact with the mother (see section 0 for more information on the methods to use).

Step 9. Warm resuscitation

Most newborns will start breathing spontaneously within the first minute of birth. If a newborn is not breathing after drying, it needs assistance and resuscitation must start immediately. It is very important that the baby is kept warm during this procedure since newborns with asphyxia cannot produce heat efficiently¹⁴ and are at increased risk of getting cold.

To keep the baby warm during resuscitation the following measures can be taken:

- wrapping the baby in a warm blanket and laying it on a dry, warm surface, such as a warm towel or blanket; only the face and upper part of the chest should be exposed;
- putting the baby under an additional source of heat such as a radiant heater if available; a focusing heating bulb should be used with caution as it can cause burns.

After resuscitation, the newborn's temperature should be taken and, if necessary, the baby should be rewarmed by placing it skin-to-skin with the mother and helping her initiate breast-feeding as soon as possible.

Newborns with asphyxia cannot produce heat efficiently and therefore need to be kept sufficiently warm during resuscitation.

Step 10. Training and awareness raising

All health care providers involved in the process of birth and subsequent care of the newborn (physicians, midwives, maternity nurses, community health workers, traditional birth attendants) need to be adequately trained on the principles and procedures of the warm chain.

In institutions where equipment is used (radiant heaters, incubators for instance), there should be well trained staff to monitor the baby's condition and the temperature of the equipment, and to clean, maintain and repair the equipment.

Families and communities need to be made aware of the importance of keeping newborns warm and be given information on how to do so.

1.5 The warm chain in institutions

Institutions can ensure thermal protection of newborn babies by following the ten steps described above. Ideally, hospitals that care for sick and low birth weight newborns should have additional equipment such as overhead heaters, heated mattresses, incubators, and low-reading thermometers (that read down to 25°C/77°F).

Policies and procedures need to be checked, and changed, if necessary, in accordance with the principles of the warm chain, and staff should be properly trained. To repeat, the delivery room temperature should be controlled; effective measures at birth, such as drying and covering the baby and putting it skin-to-skin with the mother should be enforced; rooming-in should be instituted; and breast-feeding actively encouraged. Mothers should be given information for thermal protection at home.

1.6 The warm chain at home

Thermal protection of the newborn at home is not difficult, even in cold weather. Harmful cultural practices such as sprinkling cold water on the newborn baby to stimulate breathing, should be identified and discouraged, or replaced by acceptable, safer alternatives.

In cool weather (i.e. ambient temperature less than 25°C/77°F) the room where the

birth will occur should be warmed. Supplies for delivery and for keeping the newborn baby warm should be prepared ahead of time. Supplies should be washed, dried and stored in a clean place until delivery. A clean, comfortable material should be prepared to cover the surface where the delivery is to take place.

Families and traditional birth attendants should be given proper information on thermal protection of newborns.

1.7 Measuring or assessing the newborn's temperature

Health workers and mothers should know how to measure or assess the newborn's temperature in order to detect hypothermia or hyperthermia early. This can be done by using a thermometer or by feeling the baby's skin (touch assessment) and observing other signs.

If the 10 steps of the warm chain are followed as a matter of routine, it is not necessary to measure the temperature of healthy newborn babies routinely. However, occasional measurements of body temperature in institutions – for example, in early morning hours when the environmental temperature is at its lowest – are needed on a sample of babies to make sure that the warm chain is maintained and to identify possible weak links. Measuring the temperature at the hottest time of day is also useful to make sure that newborns are not becoming overheated.

However, the baby's temperature *will* need to be monitored closely in institutions under the following conditions:

- if it is difficult to maintain the "warm chain" and provide the optimal thermal environment;
- if it is a low birth weight and/or sick newborn;
- if the baby was resuscitated at birth;
- when there is suspicion that the baby is becoming hypothermic or hyperthermic;
- when a hypothermic baby is being rewarmed, or a hyperthermic one is being cooled down;
- if the baby has been admitted to hospital, for whatever reason.

The temperature of low birth weight or sick newborns should be measured at regular and frequent intervals, ideally every four hours or at least 3 times daily, and more often if it is under a radiant heater.

The temperature of low birth weight or sick newborns should be measured at regular and frequent intervals.

A regular thermometer that reads down to 35°C (95°F) is good enough for routine checking or monitoring of body temperature. If the body temperature cannot be detected by such a thermometer, this is an indication of moderate to severe hypothermia and measures to rewarm the baby should quickly be taken. Rewarming will be better guided by knowing the exact body temperature, and this can be done by using a low reading thermometer (one that reads down to 25°C/77°F). Every institution that cares for high risk newborn infants should have a low reading thermometer. In institutions that do not have one, rewarming can be guided by other signs, such as the colour and coldness of the skin, breathing, heart rate, and feeding behaviour (these signs are discussed in more detail in section 0).

As a general rule, taking the axillary temperature is better than the rectal temperature because of safety, hygiene and ease. Taking the axillary temperature involves no risk to the infant and if properly done gives a good approximation of body core temperature. But when hypothermia is suspected, the rectal temperature is more useful because it is a more accurate measure of the body core temperature. Rectal perforation is a rare but serious complication which can be avoided if the procedure is undertaken correctly. The thermometer should be cleaned carefully after each use.

The procedure for taking the temperature is as follows:

- if the baby is hypothermic, it should be kept in skin-to-skin contact with the mother and properly covered throughout the procedure, or properly covered on a warm surface
- the baby should lie on its back or side;
- the thermometer should be shaken down below 35°C (95°F), or 25°C (77°F) if a low reading thermometer is used;
- the clean thermometer should be placed high in the axilla, and the arm then held against the side of the baby for at least five minutes;
- if taking the rectal temperature, the thermometer should be placed in the rectum to a maximum depth of 2 cm, where it should be held for at least three minutes. The baby should never be left alone with the thermometer in the rectum since this is dangerous.

At home, the newborn's temperature can be assessed by touching the skin, especially the feet. If they feel cold, this could be a sign that the baby is becoming hypothermic; if they are red and hot, and the face is flushed and the baby restless, the baby could be overheated.

Parents should touch the newborn's feet frequently to check for coldness, especially if the baby is small or sick.

Studies in hospitals have shown that physicians and trained assistants can judge the temperature of a newborn baby with reasonable accuracy, simply by touching the feet,^{15,16} but unfortunately, there has been little research on how accurately mothers can do this. Evidence suggests that it is difficult for mothers to detect slight changes in body temperature simply by touching the feet, and easier to detect moderate to severe changes.¹⁷ However, families may not always possess a thermometer and touch may be the only method of assessment available to them. It should therefore be taught to parents in addition to other early signs of hypothermia and hyperthermia.

Families need to know danger signs that indicate that the newborn's temperature is getting dangerously low (see section 0 below) and that medical attention should be sought.

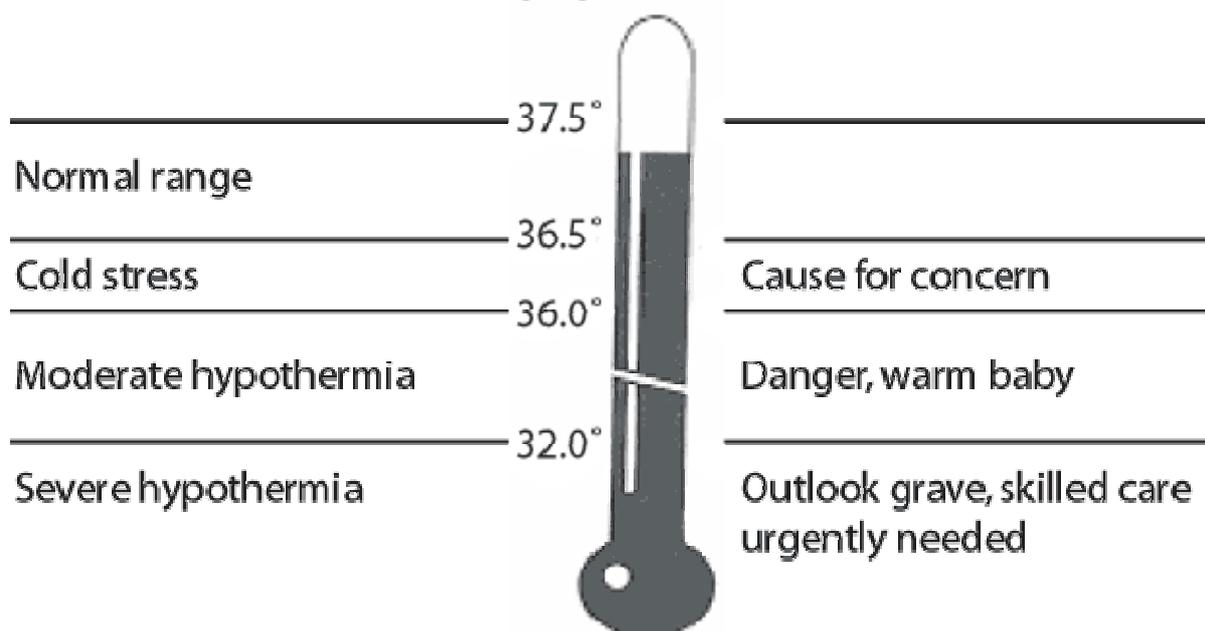
2. HYPOTHERMIA IN THE NEWBORN

Due to certain characteristics such as a large body surface area in relation to weight, a large head in proportion to the body, and little subcutaneous fat, newborns – especially low birth weight babies – are at increased risk of heat loss. When heat loss exceeds the baby's ability to produce heat, its body temperature drops below the normal range and it becomes hypothermic.

The newborn with a temperature of 36.0-36.4°C (96.8-97.5°F) is under cold stress (mild hypothermia) which should give rise to concern. A baby with a temperature of 32.0-35.9°C (89.6-96.6°F) has moderate hypothermia, while a temperature below 32°C (89.6°F) is considered to be severe hypothermia.

The newborn is most vulnerable to hypothermia during the first few hours after birth, although the condition may occur later too, for example during bathing or on a cold night, if measures to keep the baby warm are inadequate.

Body temperature in the newborn infant (°C)



Hypothermia in the newborn infant

2.1 Effects and signs of hypothermia

There is no evidence that hypothermia has any beneficial effect immediately after birth (or at any time later); for example cold stress is not needed at birth, as commonly believed, to initiate or stimulate breathing.² On the contrary there is ample evidence that hypothermia is harmful. Prolonged hypothermia is linked to impaired growth¹⁸ and may make the newborn more vulnerable to infections.¹⁹ Moreover, hypothermia, even if moderate, is associated with an increased risk of death in low birth weight newborns. Sick or low birth weight babies admitted to neonatal units with hypothermia are more likely to die than those admitted with normal temperatures.^{3,20,21,22} Preterm newborn babies are less likely to die if cared for in warm environments.^{23,24}

As already mentioned, an early sign of hypothermia is feet that are cold to the touch.^{15,16} If hypothermia is allowed to continue, the skin becomes cold all over the body, the baby becomes less active, suckles poorly and has a weak cry.

In severely hypothermic babies the face and extremities may develop a bright red colour, even in non-white neonates. Sclerema – a hardening of the skin associated with reddening and oedema – may occur on the back and limbs or over the whole body. The baby becomes lethargic and develops slow, shallow and irregular breathing and a slow heart beat. Low blood sugar and metabolic acidosis, generalized internal bleeding (especially in the lungs) and respiratory distress may occur. Such a level of hypothermia is very dangerous and unless urgent measures are taken, the baby will die.

It is important to realize, however, that all these signs are non-specific and may indicate other severe diseases such as bacterial infection in the newborn baby.

2.2 Causes and risk factors

Hypothermia of the newborn is due more to lack of knowledge than to lack of equipment. Incorrect care of the baby at birth is the most important factor influencing the occurrence of hypothermia.

In many hospitals, delivery rooms are not warm enough and the newborn is often left wet and uncovered after delivery until the placenta is delivered. The newborn is weighed naked and washed soon after birth. The initiation of breast-feeding is frequently delayed for many hours, and the baby is kept in a nursery, apart from the mother. Separation of the mother and baby makes it more difficult to keep the newborn warm;⁸ it also increases the risk of hospital-acquired infections and has an adverse effect on breast-feeding and bonding.

In many newborns these practices will result in hypothermia^{25,26} and a vicious circle might start: hypothermic newborns have decreased sucking ability, impaired feeding will lead to decreased heat production and worsening hypothermia.

Hypothermia in the newborn is due more to lack of knowledge than to lack of equipment.

At home, families and TBAs may also not be aware of the importance of drying and wrapping the newborn immediately after birth. Although many traditional practices are beneficial (such as heating the delivery room in cold weather, wrapping the baby and keeping it close to the mother), others are harmful (such as sprinkling the newborn with cold water to stimulate breathing, bathing the baby soon after birth, delaying breast-feeding in the belief that colostrum is harmful or useless).

As has already been described, low birth weight and prematurity increase the risk of hypothermia. Other risk factors include asphyxia, use of anaesthetic or analgesic drugs during delivery, infection or other illness of the infant, and inadequate measures taken to keep the baby warm before and during transportation.

2.3 Distribution and incidence

Hypothermia in the newborn occurs throughout the world and in all climates, and is more common than believed. Hypothermia occurs more often during the cooler seasons, and in regions where there is a large temperature difference between day and night. But low environmental temperatures are not necessary for the development of the condition. A high incidence of hypothermia has been reported in places with ambient temperatures of 26-30°C (78.8-86°F).^{21,25,27}

In one hospital during an 8-year study in Ethiopia, 67% of low birth weight and high-risk infants admitted to a special care unit were hypothermic on admission.³

In Nepal, primarily during the winter months, over 80% of the infants born in the Maternity Hospital in Kathmandu became hypothermic after birth and 50% remained hypothermic at 24 hours. This included nearly as many healthy babies of normal birth weight as low birth weight or sick babies. The adoption of simple measures such as increasing the delivery room temperature reduced the incidence of hypothermia considerably.²⁶

In a large study of births in the provinces in China the incidence of sclerema was 6.7 per thousand. The worst affected were premature and low birth weight babies, and a principle cause was a low temperature in the delivery room.²⁰



Hypothermia is a risk for the newborn in any climate, whether in the tropics or in cool mountainous areas

2.4 Management of hypothermia

Newborns found to be hypothermic must be rewarmed as soon as possible. The temperature of the room where the rewarming takes place should be at least 25°C (77°F). Cold clothes should first be removed and replaced with pre-warmed clothes and a cap. The newborn should be quickly rewarmed; if a warming device is used, the baby should be clothed and its temperature should be checked frequently during the rewarming process. It is very important to continue feeding the baby to provide calories and fluid. Breast-feeding should resume as soon as possible. If the infant is too weak to breast-feed, breast milk can be given by nasogastric tube, spoon or cup. It is important to be aware that hypothermia can be a sign of infection. Every hypothermic newborn should therefore be assessed for infection.

Every hypothermic newborn should be assessed for infection.

Management in hospital

In hospital a diagnosis of hypothermia is confirmed by measuring the actual body temperature with a low-reading thermometer, if available. The method used for rewarming depends on the severity of the hypothermia and the availability of staff and equipment.

In cases of **mild** hypothermia (body temperature 36.0-36.4°C/96.8-97.5°F), the baby can be rewarmed by skin-to-skin contact, in a warm room (at least 25°C/77°F).

In cases of **moderate** hypothermia (body temperature 32-35.9°C/89.6-96.6°F) the clothed baby may be rewarmed:

- under a radiant heater;
- in an incubator, at 35-36°C (95-96.8°F);
- by using a heated water-filled mattress;
- in a warm room: the temperature of the room should be 32-34°C/89.6-93.2°F (more if the baby is small or sick);
- in a warm cot: if it is heated with a hot water bottle or hot stone, these should be removed before the baby is put in;
- if nothing is available or if the baby is clinically stable, skin-to-skin contact with the mother can be used²⁸ in a warm room (at least 25°C/77°F).

When a newborn is rewarmed in a warming device its temperature as well as the temperature inside the device should be checked frequently.

The rewarming process should be continued until the baby's temperature reaches the normal range. The temperature should be checked every hour, and the temperature of the device being used or the room adjusted accordingly. The baby should continue to be fed.

In cases of **severe** hypothermia (body temperature below 32°C/89.6°F), studies suggest that fast rewarming over a few hours is preferable to slow rewarming over several days.^{29,30,31} Rapid rewarming can be achieved by using a thermostatically-controlled heated mattress set at 37-38°C (98.6-100.4°F) or an air-heated incubator, with the air temperature set at 35-36°C (95-96.8°F). If no equipment is available, skin-to-skin contact or a warm room or cot can be used.

Feeding should continue, to provide calories and fluid and to prevent a drop in the blood glucose level which is a common problem in hypothermic infants. If this is not possible, monitoring blood glucose becomes important and an intravenous line should be set up to administer glucose if needed.

Once the baby's temperature reaches 34°C (93.2°F), the rewarming process should be slowed down to avoid overheating. The temperature of the incubator and the baby's body temperature should be checked every hour.

Management at home

At home, skin-to-skin contact is the best method to rewarm a baby with mild hypothermia. For best effect, the room should be warm (at least 25°C/77°F), the baby should be covered with a warm blanket and be wearing a pre-warmed cap. The rewarming process should be continued until the baby's temperature reaches the normal range or the baby's feet are no longer cold. The mother should continue breast-feeding as normal.

Hot water bottles or hot stones can be dangerous: they may easily cause burns as the blood circulation in the cold skin of babies is poor. They should therefore *never* be put next to the baby. If used to warm a cot, they should be removed before the baby is put in.

If the baby becomes lethargic and refuses to suckle, these are danger signs and it should be taken to hospital. While being transported, the baby should be in skin-to-skin contact with the mother during transportation, otherwise one of the methods listed in section 0 can be used.

If hot water bottles or heated stones are used to warm a cot, they should always be removed from the cot before putting in the baby.

3. HYPERTHERMIA IN THE NEWBORN

When the newborn is in an environment that is too hot the baby's temperature rises above 37.5°C (99.5°F) and it develops hyperthermia. Although less common, hyperthermia can occur just as easily as hypothermia, and is equally dangerous.

Hyperthermia of the newborn can occur just as easily as hypothermia, and is just as dangerous.

Hyperthermia should not be confused with fever, which is a raised body temperature in response to infection with microorganisms or other sources of inflammation.³² However, it is not possible to distinguish between fever and hyperthermia by measuring the body temperature or by clinical signs, and when the newborn has a raised temperature it is important to consider both causes. Infection should always be suspected first, unless there are very obvious external reasons for the baby becoming overheated.

3.1 Effects and signs of hyperthermia

Hyperthermia increases the metabolic rate and the rate of water loss by evaporation, which can cause dehydration. This is a serious complication of hyperthermia. A core temperature above 42°C (107.6°F) can lead to neurological damage.

The signs of hyperthermia are not very obvious at first. Soon, however, the newborn starts breathing rapidly, the heart rate (if checked) is fast, the skin is hot, the extremities are red due to vasodilation and the face is flushed. When it is beginning to get overheated, the newborn is restless and cries, then gradually it becomes lethargic. In severe hyperthermia, shock, convulsions and coma may occur.

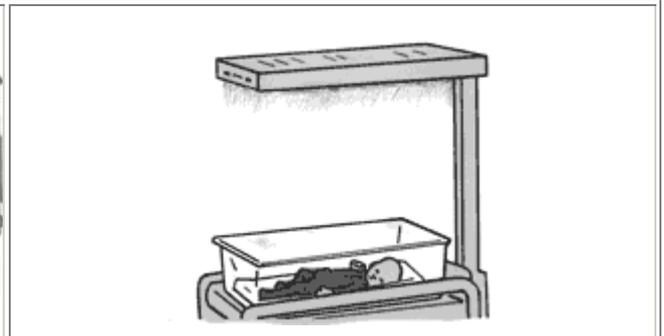
3.2 Causes and prevention of hyperthermia

Some of the commonest causes of hyperthermia are wrapping the baby in too many layers of clothes, especially in hot, humid climates; leaving a baby in direct sunlight or in a parked car in hot weather; putting a newborn baby too close to a fire or heater; putting the baby close to a hot water bottle; leaving the baby under a radiant warmer or in an incubator that is not functioning properly and/or checked regularly, or is exposed to the sun's rays.

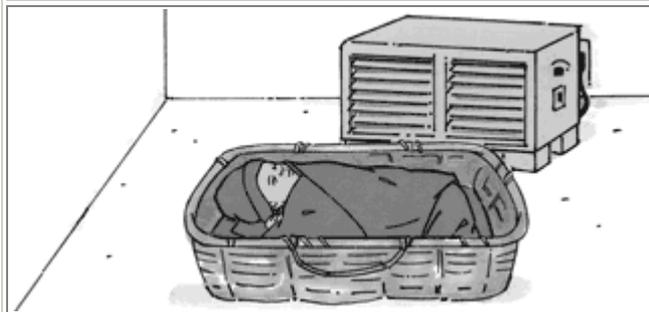
All these practices should be avoided in order to prevent hyperthermia. In hospitals, incubators should not be exposed to direct sunshine. Whenever a device such as a heater, incubator or radiant heater is used to keep babies warm or to rewarm them, the baby's body temperature and the temperature in the device should be monitored frequently.



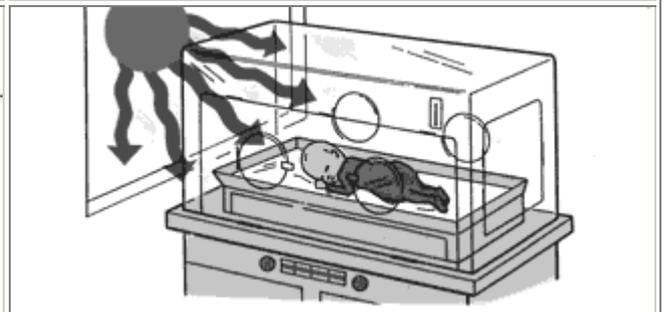
Too many wrappings in hot weather



Under radiant heater



Too close to heater



In an incubator

Causes of overheating of babies - be constantly on your guard

3.3 Management of hyperthermia

The baby should be moved away from the source of heat, and undressed partially or fully, if necessary. If the baby is in an incubator, the air temperature should be lowered. It is important that the baby be breast-fed more frequently to replace fluids. Every hyperthermic baby should be examined for infection.

When hyperthermia is severe □ i.e. body temperature above 40°C/104°F° the baby can be given a bath. The water should be warm. If it is possible to measure the water temperature, it should be about 2°C (3.6°F) lower than the baby's body temperature.³³ Using cooler or cold water is dangerous. It may not achieve the desired effect and the baby may very quickly become hypothermic. If the baby cannot breast-feed extra fluids should be given intravenously or by tube.

Every hyperthermic baby should be examined for infection.

4. THERMAL PROTECTION OF LOW BIRTH WEIGHT AND SICK NEWBORNS

Low birth weight or sick newborns are at greater risk of developing hypothermia or hyperthermia than normal weight babies because they regulate body temperature even less well. Certain characteristics such as large body surface compared to weight, less subcutaneous fat, thinner skin and inability to sweat,³⁴ put them at special risk of heat loss or excessive heat gain. The smaller the baby, the greater the risk.

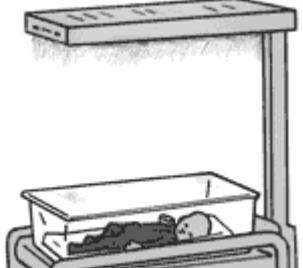
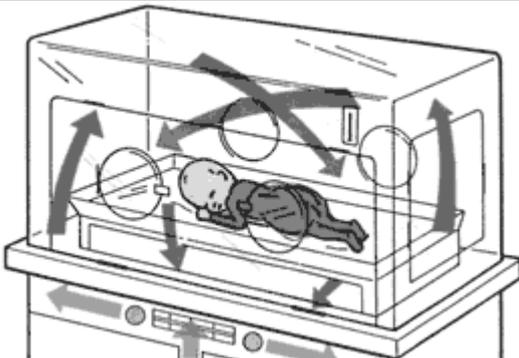
To keep low birth weight and/or sick newborn babies warm, the same principles apply as for other newborns, but these babies require extra warmth over a longer period of time. If the newborn is very small and/or sick, it will need to be cared for in hospital. The method used to keep the baby warm will depend on its weight, gestational age, and health as well as on the availability of staff and equipment. The following section is not a complete guide on the care of low birth weight and/or sick newborns, but is focused on the thermal protection component of this care.

Methods of keeping such babies warm at hospital include the use of "warm rooms", heated water-filled mattresses, incubators and radiant heaters. Kangaroo-mother care can be used for clinically stable low birth weight newborns. This is continuous skin-to-skin contact, and is described in more detail later.

Low birth weight and sick newborns need extra warmth over a longer period.

When a warming device is used, it is extremely important that the baby is taken out regularly for intermittent skin-to-skin contact with the mother, and that breast-feeding is started and maintained during the hospital stay. Examinations should be done only when strictly necessary, and if it is necessary to undress the baby, this should be done as quickly as possible.

Warming devices are convenient for taking care of very small or sick newborns as well as moderately small newborns in cold climate. The advantages of using warming devices include the fact that extra warmth can be given locally instead of having to warm the whole room; temperature control is easier; and newborns can be observed naked when needed.

<p>Birth weight (kg) 1.0-1.5 1.5-2.0 2.0-2.5</p>	<p>Room temperature 30-33°C 28-30°C 26-38°C</p>	
<p>Warm room</p>		<p>Overhead radiant warmer</p>
		
<p>Kangaroo-mother care</p>	<p>Air-heated incubator</p>	
<p>Keeping low birth weight and sick babies warm in maternity unit</p>		

Different devices serve different purposes: incubators are the proper choice for the care of very small newborns during the first days or weeks. However, when these babies do not have acute problems they can be cared for safely on heated water-filled mattresses. Radiant heaters are best used for resuscitation and interventions where a number of people are involved.

Any kind of equipment has its advantages but also its hazards. Health workers using equipment should be aware of both.

Newborns in warming devices should not be cared for naked.

Newborns in warming devices should not be cared for naked, except when necessary for certain procedures or if the baby must be observed naked. Clothed newborns require lower air temperature, have a lower risk of hypothermia, and feel more comfortable. Clothing the newborn is also a safety measure that ensures some thermal protection in case of temperature fluctuation or equipment failure. The baby's temperature and the temperature inside the device should be monitored frequently. No heating device can function efficiently in a cold room, because heat loss by radiation to the cold environment may exceed heat generated by the device. All equipment should therefore be used in room temperatures of at least 25°C (77°F).

4.1 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.³⁵ 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.

A drawback of the warm room is that the thermal environment cannot be individualized, with a consequent risk of over- or under-heating of some newborns.³⁶ This problem can be minimized by having several warm rooms or partitioning off different areas in a room and keeping them at different temperatures for newborns of different gestational and postnatal age.³⁵ Body temperature should be monitored and clothing adjusted if needed.

For many countries warm rooms will be the most practical option for the care of low birth weight and/or sick newborns. The main problem with the warm room is that the temperature is too high for the comfort of parents and nursing staff; therefore in practice the temperature is often kept lower than it should be for the good of the babies. The staff should be informed of the importance of a sufficiently warm environment and the room temperature should be carefully monitored. Light-weight clothing for adults will help them to bear the heat.

It is important to keep the temperature in the "warm room" sufficiently high, 24 hours a day.

4.2 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.

The equipment must have a temperature control that is either automatic or manual or both. It is essential that the newborn's axillary temperature be taken frequently to ensure that it is not becoming either cold or overheated, and the temperature of the radiant heater should be adjusted if necessary. Health staff should not depend on the skin temperature sensor, known as a "patient probe", as this may be inaccurate or defective, and it can become detached.

The body temperature of newborns under radiant heaters must be taken frequently.

4.3 Heated water-filled mattress

The heated water-filled mattress is a safe device for keeping low birth weight/sick babies warm and is more economical than an incubator.³⁶

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.

The main problem with this device is that it often breaks down and spare parts are not readily available.

4.4 Light-bulb heated cots or beds

A method commonly used for thermal protection of newborns is the light-bulb heated cot. These cots have a separate enclosed compartment which is fitted with several light bulbs and is situated directly underneath a frame upon which the mattress lies. The frame has holes in it which allows the heat from the bulbs to rise up to the mattress. The light bulbs can be turned on and off individually to allow some degree of heat control.

Although such a cot is temptingly simple to make, it is not considered safe because the heat cannot be controlled accurately and the device may be a fire hazard.

However, in many cases this may be the only device available for keeping newborn babies warm. Health professionals should be well aware of its dangers and should try to use alternative warming methods, such as the warm room and skin-to-skin contact, if at all possible.

4.5 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. Furthermore, if they are not used and maintained correctly, they may be more of a hazard than a benefit to the newborn.

The delicate and sophisticated heating mechanisms of modern incubators require a reliable electricity supply, and the availability of spare parts and skilled personnel to maintain, and repair them when necessary. There should also be well trained health staff to care for babies in incubators. These devices should therefore only be used in hospitals where such conditions and skills are available. Hospitals that accept donations of older, second-hand incubators may encounter a host of problems. Often there is no manual with information on operating and maintaining them correctly, and spare parts for repair may be impossible to get.

Incubators need to be cleaned and disinfected regularly if they are to be safe. However, these procedures are often overlooked or performed infrequently because of shortage of staff, too few incubators, inadequate training of staff in disinfection procedures, and lack of suitable disinfecting materials. This increases the risk of infection □ as does the habit of putting more than one baby in an incubator at a time because of shortage of space.

Incubators may be more of a hazard than a benefit to newborns if they are not used and maintained correctly.

Another disadvantage of incubators is that they create a barrier between mother and baby, which delays bonding and makes breast-feeding difficult. Babies should therefore be taken out of their incubators regularly for skin-to-skin contact with the mother and for breast-feeding. This also provides a good opportunity to clean the incubator.



Intermittent skin-to-skin contact

Breast-feeding

Babies should be taken out of their incubators regularly for breast-feeding and skin-to-skin contact

It is important that the advantages and disadvantages discussed above be carefully considered before a decision is taken to procure incubators for the care of newborns. In any case, the disadvantages involved make it advisable to restrict their use to the smallest and sickest babies. Where the main clinical problem is heat loss, other means of providing warmth – such as skin-to-skin contact, heated mattresses etc – should be chosen in preference to incubators, in developed as well as in developing countries.

Monitoring the temperature of babies in incubators

Nursing staff must regulate and record the incubator air temperature regularly. Even if the incubator has heat-sensitive probes that monitor skin temperature, nursing staff must take the baby's body temperature regularly (every 4-6 hours) and adjust the temperature of the incubator if necessary to ensure that the newborn maintains normal body temperature. It should be possible to regulate the air temperature inside the incubator between 30-37°C (86-98.6°F).

Staff should make use of the port-holes and small inlets in the incubator as far as possible, because opening the main lid or canopy allows much of the warm air to escape and the baby will be exposed to cold.

The room temperature in which incubators (or other heating devices) are used should be at least 25°C.

The environment in which the incubator is put is very important. If the walls of the incubator are colder than the air inside the device, the baby may lose a substantial amount of heat through radiation to the cold walls. The temperature of the incubator walls depends on the air temperature of the room in which the incubator is placed and whether or not there are draughts. If the room temperature is below 25°C (77°F), it is often impossible to compensate for radiant heat loss by increasing the air temperature inside the incubator. Under such conditions, extra clothing should be put on the baby as appropriate. If the baby must be observed naked, a plastic shield placed over the infant or a plastic tunnel can be used to minimize radiant heat loss.

Exposing the incubator to sunlight has the opposite effect. A baby inside an incubator which is placed in direct sunlight can become dangerously overheated. This is the effect of radiant heat experienced by an adult who is sitting by a window or in a closed car which is directly exposed to the sun.

In the same way, a baby given phototherapy by fluorescent tubes above the incubator can become overheated; therefore the baby's temperature should be monitored very frequently.

Cleaning incubators

Incubators should be thoroughly cleaned and disinfected after each baby is discharged and before being used again. A baby should not be cared for in an incubator for more than 7 days without the equipment being cleaned and disinfected. Special attention should be given to the water reservoir. Unless the water is changed regularly and it is thoroughly cleaned, it can harbour harmful microorganisms, and many infections of the newborn can be traced to this source.

4.6 Kangaroo-mother care

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

Kangaroo-mother care is suitable for newborns with no medical problems or after these have been corrected, and when clinical signs (breathing, heart rate, temperature) are stable.³⁷ The baby must be able to breast-feed at least partially. The mother must be fit, healthy and willing to cooperate. The method is safe and effective^{38,39} provided skin-to-skin contact is continuous, and feeding and monitoring of clinical signs are done correctly. Kangaroo-mother care has been used with success in some countries as an alternative to incubator care for stabilised low birth weight newborns.³⁷

In hospitals with no equipment to care for the low birth weight newborn during the initial stabilization period, very early kangaroo-mother care seems to offer the baby the best chances of survival.^{40,37} It should be started as soon as possible after delivery.

Kangaroo-mother care is suitable for newborns with no medical problems, or after these have been corrected.

Advantages of kangaroo-mother care

So far, kangaroo-mother care has been evaluated in institutions. Besides being an efficient way of keeping the newborn warm,^{5,41,42} kangaroo-mother care promotes breast-feeding^{43,44} and extra uterine adaptation, and increases the mother's confidence, ability and involvement in the care of her small newborn.^{45,46,39} Newborns under kangaroo-mother care grow at least as well as newborns cared for in incubators.³⁸ There is also evidence that breathing is more regular and the frequency of apnoeic spells is reduced.^{39,47}

How to practise kangaroo-mother care



Kangaroo-mother care keeps baby warm, promotes breast-feeding and increases mother's confidence

A warm room, also kept warm at night, must be set apart in the health facility for kangaroo-mother care. The mothers must have the opportunity to see relatives.

The baby is held upright (or diagonally) and prone against the skin of the mother, between her breasts; the newborn's head is on its side under the mother's chin, and the head, neck and trunk are well extended to avoid obstruction to the airways. The mother covers the infant with her own clothes and an added blanket or shawl. If the mother is walking around, a belt around the waist and snug clothes will help keep the baby in position.

The infant is usually naked except for a nappy and a cap. In some cultures and climates, it is more acceptable and comfortable to dress the baby with light clothing; this does not seem to affect results; cap and light clothing help reduce cold stress when the baby is separated from the mother for changing the nappy or when the mother takes a break; during that time, the baby should be well wrapped and placed on a warm surface near a source of heat.

The newborn should be breast-fed frequently, initially supplemented by feeding of expressed breast milk from a cup or spoon.

Newborns in kangaroo-mother care should be supervised closely and their temperature monitored. If kangaroo-mother care is done correctly, the risk of hypothermia is very low. If however the baby's temperature is found to be below normal, it should be rewarmed by using an extra blanket to cover mother and baby, and by increasing the temperature of the room.

In order for the method to be effective, the baby should be in skin-to-skin contact with the mother as continuously as possible, day and night. For example, the baby should be removed only for changing the nappy, and for the mother to bathe and go to the toilet, and for clinical examination if needed. Studies show that this is tiring for mothers and restricts their freedom. A lot of support from relatives and health workers is therefore needed to help them accept and practise this method correctly. Once initial difficulties and cultural resistance are overcome, the method is usually well accepted and mothers become confident in their ability to care for the baby.^{37,48}

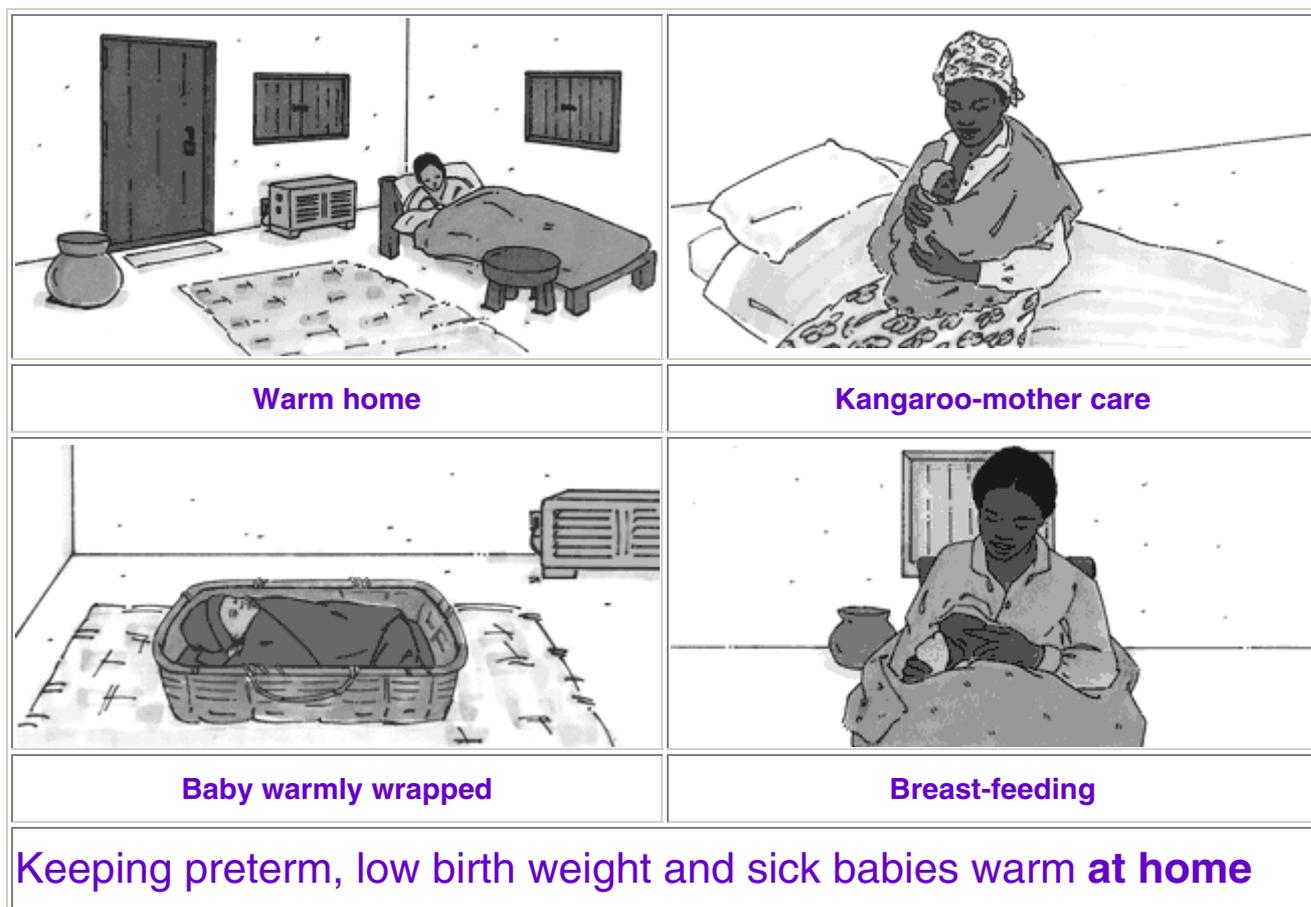
The mother will not be able to keep the infant in skin-to-skin contact all the time. During those times a relative can take over or the infant can be dressed in several layers of warm clothing, covered with blankets and kept in a warm place. Care should be taken to dress the baby in a warm place so that minimal heat is lost.

Experience shows that in order for mothers to have adequate support, all staff must be informed about this method, including non-medical personnel such as the guards. The maternity staff also need skills on helping mothers express breast milk, feeding small babies with spoon or cup, and storing breast milk.

The baby can be discharged from hospital as soon as breast-feeding is established, it is disease free, gaining weight steadily and staff are confident the mother is able to care for it at home. Mothers should be encouraged to continue the method at home until the baby reaches about 2000 g.³⁷ Follow-up and support by health personnel is essential.

In order for kangaroo-mother care to be effective, the baby should be in skin-to-skin contact as continuously as possible, day and night.

4.7 Keeping low birth weight newborns warm at home



Moderately preterm and/or low birth weight newborns (e.g. 1800-2500 g; cut-offs vary between countries) with no danger signs, such as difficulty in breathing, and who are able to breast-feed can be cared for at home. To keep the baby warm the following options can be used:

- kangaroo-mother care;
- dressing and wrapping the baby warmly (the baby needs one or two more layers of clothing and bedding than does a normal birth weight baby) and putting it in a warm room;
- a combination of the two methods.

When caring for a preterm or low birth weight newborn at home, it is very important to keep the home warmer than is comfortable for adults.

Whatever method is used, it is very important that the baby is kept in a warm room – warmer than it is comfortable for adults – and a heater should be used if necessary. Early and frequent breast-feeding is essential.

4.8 Keeping newborns warm during transportation

If a newborn is taken to hospital soon after birth, there is a real risk that it will develop hypothermia during transportation, and that this will make effective treatment at the hospital difficult or impossible. It is therefore essential that measures be taken to prevent hypothermia during transportation and that the baby be taken directly to the institution that can provide adequate newborn care.

While waiting for transportation to be arranged, the newborn should be kept warm or rewarmed if already cold, using a warming device or skin-to-skin contact with the mother, or another person if necessary. It is best to wait until the newborn has been rewarmed before transporting it. Exceptions to this are newborns whose condition is already critical or deteriorating and who would probably die without immediate medical attention.

Depending on the circumstances at the time and the equipment available, any of the following methods may be used to keep the baby warm during transportation:

- Skin-to-skin contact: the newborn can be lightly dressed; it should be held in position snugly with the person's clothes, covered with a blanket if necessary, and wearing a cap.
- If skin-to-skin contact is not possible, the fully wrapped newborn, wearing a cap, may be transported in the arms of an adult in a closed vehicle.
- A device for transporting babies, such as a box, padded and insulated on all sides with holes for ventilation, produced locally and prewarmed in very cold weather by a hot water bottle which is removed before putting in the baby;⁴⁹ a transport incubator with a hot water reservoir; an electrically heated transport incubator.

The newborn should never be put naked into one of these devices. It should always be clothed in several layers of lightweight, warm clothing and wrapped in blankets. The internal temperature of the heated device can fluctuate during transportation, with the risk – especially on a long journey – that the baby may become too cold or too hot. The infant's temperature and the temperature inside the device should therefore be monitored during the journey.

Keeping the preterm or sick newborn warm during transportation is crucial to its survival.

5. IMPLEMENTING THERMAL PROTECTION

Thermal protection should be high priority when planning for the care of the newborn. This is true for full-term newborns, but is critically important for preterm and low birth weight newborns because of the increased risk of illness and death.

Keeping most newborn babies warm does not require special equipment and supplies, and is not difficult. However, despite these facts, thermal protection is not practised systematically. An organized effort is therefore needed to change – and to maintain – practices in institutions and in families and communities.

If there are policies at national level, this will help hospitals to improve thermal protection measures. National standards of care should be developed and supported with training courses and materials. The principles of thermal protection should be part of the curricula of medical, midwifery and nursing schools, and health personnel should also be given in-service training periodically.

Every health institution should have a written policy on thermal protection of newborns, adapted to their specific needs, and to the climate and equipment available. Policies on the "warm chain" will be more respected if developed or adapted with the participation of the staff. An initial self-assessment of existing practices should be carried out to determine which ones need to be changed.

Every health institution should have a written policy on the 10 steps of the warm chain and on thermal protection of low birth weight newborns.

If equipment is used, instructions for its correct use, cleaning, routine maintenance, and emergency repair should be written and followed. Regular training sessions should be given to update staff and train new employees.

However good the policy and organization, training is rarely enough in itself to ensure good practice, and should be backed up by monitoring, evaluation and supervision. To assess whether staff are observing the recommended procedures, practices should be evaluated regularly and always when hypo- or hyperthermia is diagnosed in a newborn. The team should analyse together what caused the problem, make recommendations, plan for necessary changes, and make sure they are carried out. It may help to develop a checklist of required standards for the "warm chain" for monitoring purposes. Priority targets and indicators should be selected to guide the health manager. Indicators should be measured at regular intervals to assess whether practices are correct.

An example of target and indicator:

Indicator: The proportion of newborns with body temperature greater than 36°C (96.8°F), 2 hours after birth.

Number of newborns with temperature > 36 °C, 2 hours after birth, in the past day (or week)
Total number of births in the past day (or week)

Target: This proportion will be at least 80% by the end of 1997 and 90% by 1998.

If there are discrepancies between planned and current status of targets, then problems need to be identified and solutions planned.

At community level, traditional practices should be reviewed to determine which ones support the principles of thermal protection and which ones could be harmful. Harmful practices should be discouraged and community based health care providers should be taught the principles of thermal protection of the newborn.

Annex

THERMAL PROTECTION OF THE NEWBORN: A SUMMARY GUIDE

This annex was developed to help introduce the concept and principles of thermal protection of the newborn. It summarizes the main messages and the most essential information contained in the guidelines *Thermal Protection of the Newborn* (WHO/RHT/MSM/97.2). The summary guide can be translated/adapted by countries and used during training of health care staff in maternity units, or when teaching medical, nursing and midwifery students.

On the upper half of each page are messages and illustrations; these can be translated and used for slides, transparencies, handouts or flipcharts. On the lower half is the most important information that health care providers involved in deliveries and newborn care should know.

The summary guide is not intended as a complete teaching tool. It must be used in conjunction with the guidelines *Thermal Protection of the Newborn* (WHO/RHT/MSM/97.2) and supplemented by additional instructions, and above all, by practical experience of newborn care in local situations.

What is thermal protection?

A series of measures taken at birth and during the first few days of life to ensure that the baby:

- Maintains a normal body temperature (36.5°C - 37.5°C)
- Does not become too cold (<36.5°C =hypothermia)
- Does not become too hot (>37.5°C = hyperthermia)

Thermal protection is the series of measures taken at birth and during the first days of life to ensure that the newborn baby does not become either too cold (hypothermia) or too hot (hyperthermia) and maintains a normal body temperature of 36.5-37.5°C (97.7-99.5°F).

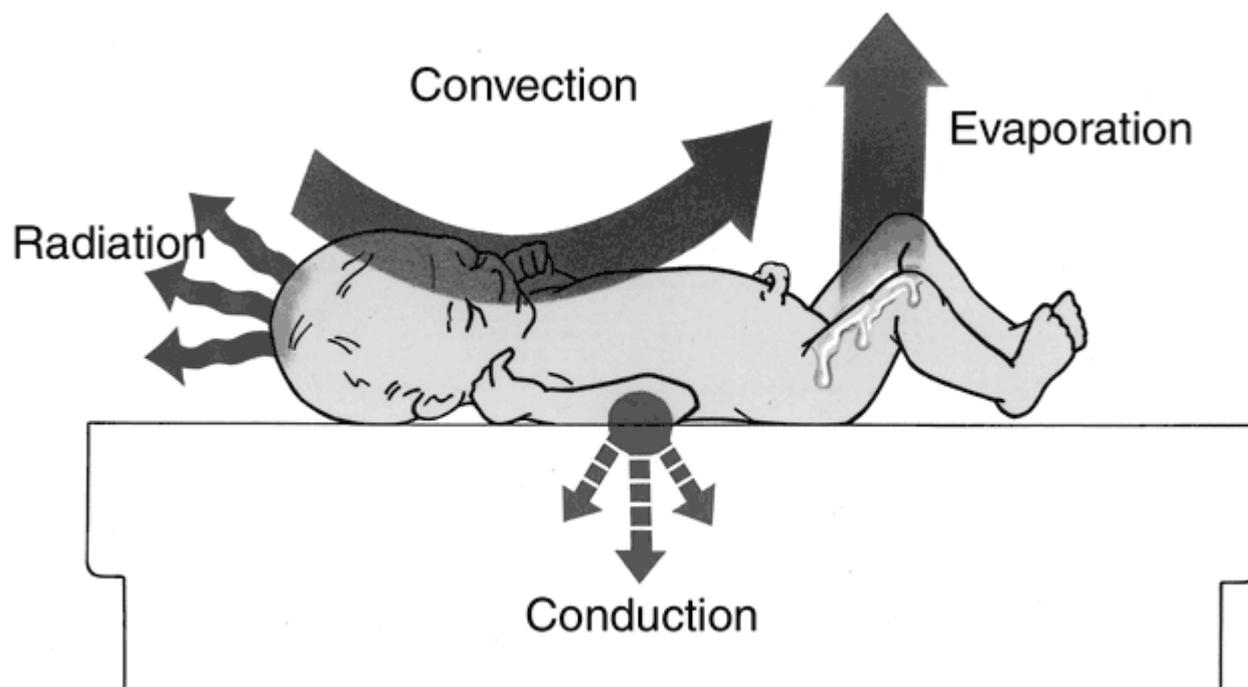
Newborn babies cool down or heat up much quicker than adults because they cannot regulate body temperature as well. The smaller the baby and the more premature, the greater the risk.

In general, newborns need a warmer environment than adults. In fact, a naked newborn exposed to a room temperature of 23°C (73.4°F) suffers the same heat loss as does a naked adult at 0°C (32°F).

All health care providers need to be alert to the risk of hypothermia (temperature <36.5°C/97.7°F) which is a common condition, and of hyperthermia (temperature >37.5°C/99.5°F) which is much less frequent.

Both are dangerous and may cause the death of the baby, but are easily prevented, by simple procedures, without any special equipment.

How does the newborn lose body heat?



There are four ways in which a newborn baby loses body heat:

Evaporation: When amniotic fluid evaporates from the skin.

Conduction: When the baby is placed naked on a cooler surface, such as table, weighing scales, cold bed.

Convection: When the baby is exposed to cool surrounding air or to a draught from open doors and windows or a fan.

Radiation: When the baby is near cool objects, walls, tables, cabinets, without actually being in contact with them.

Most cooling of the newborn occurs during the first minutes after birth. In the first 10-20 minutes the newborn may lose enough heat for the body temperature to fall by 2-4°C (3.6-7.2°F), with even greater falls in the following hours if proper care is not given.

Understanding how a baby loses heat allows us to take effective measures to keep this heat loss to a minimum.

How can heat loss be prevented?

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 and bedding
- 7 Mother and baby together
- 8 Warm transportation
- 9 Warm resuscitation
- 10 Training/awareness raising

The "Warm Chain" is a set of ten interlinked procedures carried out at birth and during the following hours and days which will minimize the likelihood of hypothermia in all newborns.

They will be explained in detail below.

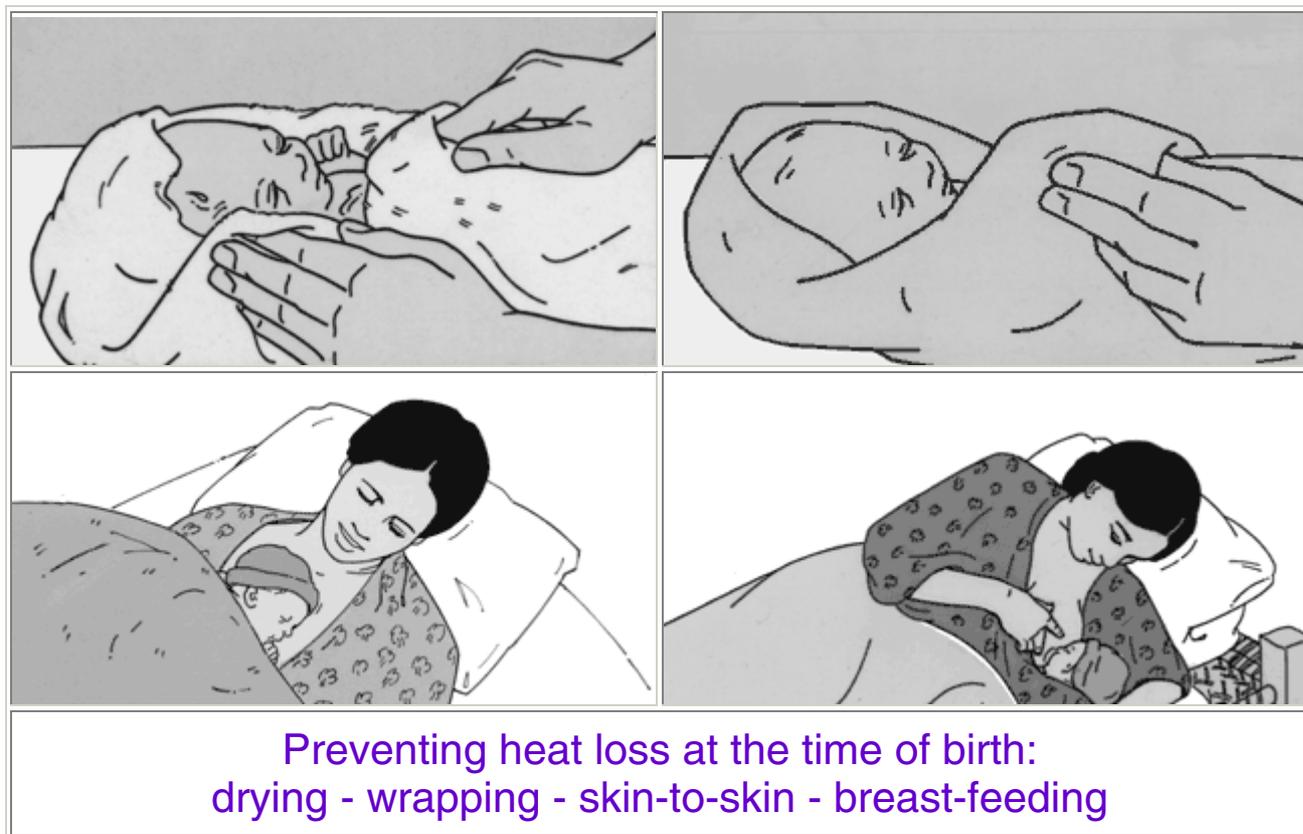
How warm should the delivery room be? (step 1)

The delivery room temperature should be at least 25°C.

The temperature of the delivery room should be at least 25°C (77°F) and there should be no draughts (to prevent heat loss from convection). Supplies needed to keep the newborn warm should be prepared ahead of time.

Adults should never determine the temperature of the delivery room according to **their** comfort.

How can you prevent heat loss at the time of birth? (steps 2, 3, 4)



Immediately dry the newborn after birth with a warm towel or cloth to prevent heat loss from evaporation.

While the newborn is being dried, it should be on a warm surface such as the mother's chest or abdomen (skin-to-skin contact) to prevent heat loss from conduction.

Cover the baby with a second towel and put a cap on its head to prevent heat loss from convection.

Leave the newborn on the mother and keep it covered.

Initiate breast-feeding within one hour of birth.

When would you bathe the newborn baby? (step 5)

	
Warm room ; warm water	Bathe quickly
	
Dry quickly and thoroughly	Dress warmly and wrap
Bathing the infant - if his temperature is normal - not before 6 hours after birth	

Bathing of the newborn baby soon after birth causes a drop in temperature and is not necessary.

If cultural tradition demands bathing, this should not be carried out before 6 hours after birth and preferably the second or third day of life. The newborn should be healthy and its temperature normal.

Bathing should be done quickly in a warm room, using warm water. The baby should be dried thoroughly, dressed and placed near the mother.

How can you prevent heat loss in the first days of life?

- Dress newborns with several layers of loose clothing and bedding (step 6)
- Keep mother and newborn together in a warm room (step 7)
- Encourage frequent breast-feeding day and night (step 4)
- Use skin to skin contact if baby is cold (step 3)

Dress newborns with several layers of light weight, loose clothing and bedding.

The number of layers should be appropriate to the environmental temperature.

Newborns need one or two more layers of clothing than adults.

Mother and baby should be kept together 24 hours a day (rooming-in), in a warm room (at least 25°C/77°F).

The baby should be breast fed on demand.

Skin-to-skin contact can be used to rewarm a cold baby.

How can a baby that needs transportation be kept warm? (step 8)

- Rewarm the newborn while waiting for transportation
- Use skin to skin contact during the trip
- Dress the baby and wrap it in blankets if a transport device is used
- Monitor the baby's temperature during the trip

If the newborn needs to be transported to a hospital or within a hospital, there is a real risk that it will develop hypothermia during transportation. This will make effective treatment at the hospital difficult, if not impossible.

It is therefore important to keep the baby warm during transportation.

While waiting for transportation to be arranged, the newborn should be kept warm/rewarmed by skin-to-skin contact or in a warming device.

The simplest and safest way to transport a newborn is to place the baby in skin-to-skin contact with the mother or another adult.

Other means of keeping the baby warm include carrying the fully clothed and wrapped baby in the arms of an adult, or using a transport device. The newborn's temperature should be monitored during the trip.

**What steps should be taken to keep a baby warm during resuscitation?
(step 9)**

- Wrap in a warm blanket
- Lay on a warm surface in a warm room
- Put under an addition source of heat
- Uncover as little as possible during procedure

Newborns with asphyxia cannot produce heat efficiently and thus get cold easily.

Special attention should therefore be given to keeping these babies warm during resuscitation by laying them on a warm surface, covering them and putting them under an additional source of heat.

What should the aims of training/awareness raising be? (step 10)

- Alert health care providers and families to the risks of hypothermia
- Teach the principles of thermal protection of the newborn
- Provide on the job training and supervised practice to ensure that the 10 steps of the warm chain become part of the routine care of the newborn
- Demonstrate and provide supervised practice on the appropriate use of equipment for low birth weight/preterm infants.

Minimal standards of practice should be established to ensure that the ten steps of the warm chain become part of routine care at birth.

All health care providers involved in the process of birth and newborn care need to be trained on the principles of thermal protection of the newborn and receive on-the-job training/supervised practice. They need to be trained on how to recognise and manage appropriately the different degrees of hypothermia and hyperthermia.

Parents should be given information on how to prevent and/or recognise hypothermia and or hyperthermia.

If equipment is used for low birth weight/premature infants then:

- All staff using the equipment must have received the appropriate on-the-job training in its use.
- An instruction manual must always be available for reference purposes.
- A specific procedure for cleaning and maintenance of equipment must be specified and adhered to.

Does the newborn's temperature need to be measured routinely?

No, in most cases.

Yes, if the newborn is:

- pre-term/low birth weight or sick
- admitted to hospital, regardless of the reason.
- suspected of being either hypothermic or hyperthermic
- being re-warmed during management of hypothermia
- being cooled down during management of hyperthermia

If the ten steps of the warm chain are followed as a matter of routine, it is not necessary to measure the temperature of healthy newborn babies routinely.

However, the temperature of low birth weight and/or sick newborns, and of babies recovering from hypothermia or hyperthermia, should be measured frequently.

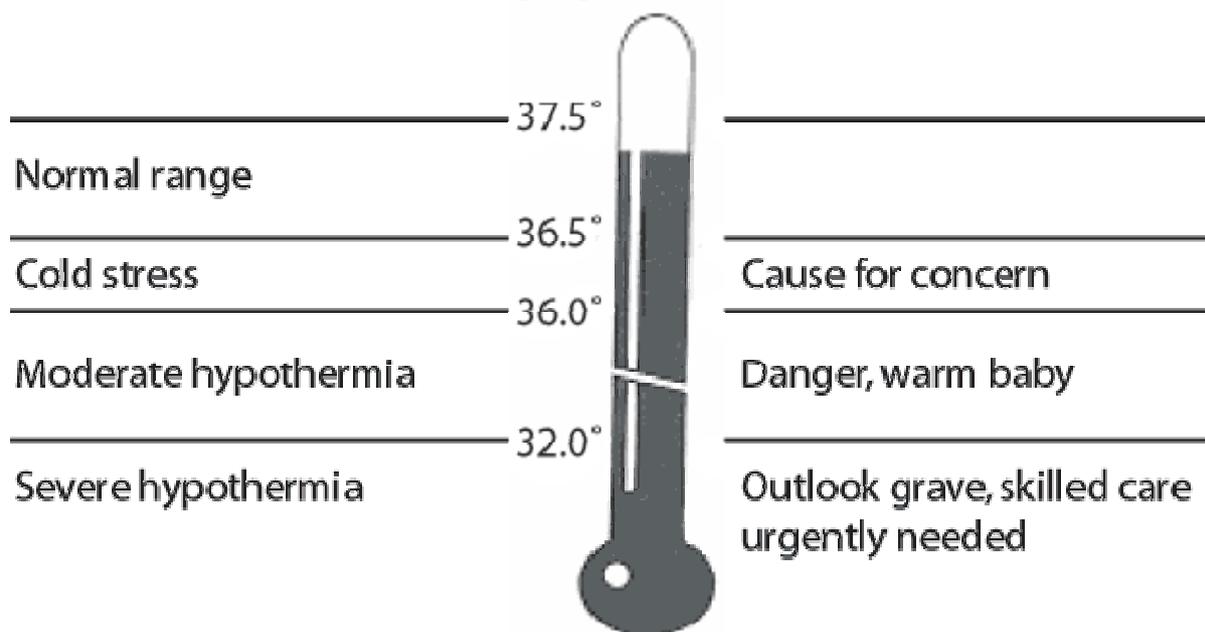
A regular thermometer can be used for checking the temperature routinely.

A low reading thermometer should be used when hypothermia is suspected.

At home the temperature of the newborn can be assessed by feeling the feet to check for coldness.

What is hypothermia?

Body temperature in the newborn infant (°C)



Hypothermia in the newborn infant

Hypothermia occurs when the newborn's body temperature drops below 36.5°C (97.7°F) generally because the environment is too cold for the baby:

- 36-36.4°C (96.8-97.5°F) is mild hypothermia - cold stress.
- 32-35.9°C (89.6-96.6°F) is moderate hypothermia.
- Less than 32°C (89.6°F) is severe hypothermia.

Hypothermic newborns, especially if they are sick or of low birth weight, are more at risk of developing health problems and of dying.

Hypothermia is caused more by lack of knowledge than lack of equipment.

Hypothermia can be prevented by following the principles of the warm chain.

Where does hypothermia occur?



Hypothermia is a risk for the newborn in any climate, whether in the tropics or in cool mountainous areas

Hypothermia occurs throughout the world even in warm climates and is more common than believed. It occurs more frequently during the cooler seasons and in regions where there is a large difference in temperature between day and night.

The ambient temperature does not have to be low for newborns to develop hypothermia.

How can a hypothermic baby be rewarmed?

- Make sure the room is warm
- Remove cold clothes and replace with warm clothes
- Rewarm quickly by skin to skin contact and/or a heating device such as radiant heater or incubator
- Continue breast-feeding
- Assess for infection

A hypothermic newborn has to be rewarmed as quickly as possible.

The methods to use include:

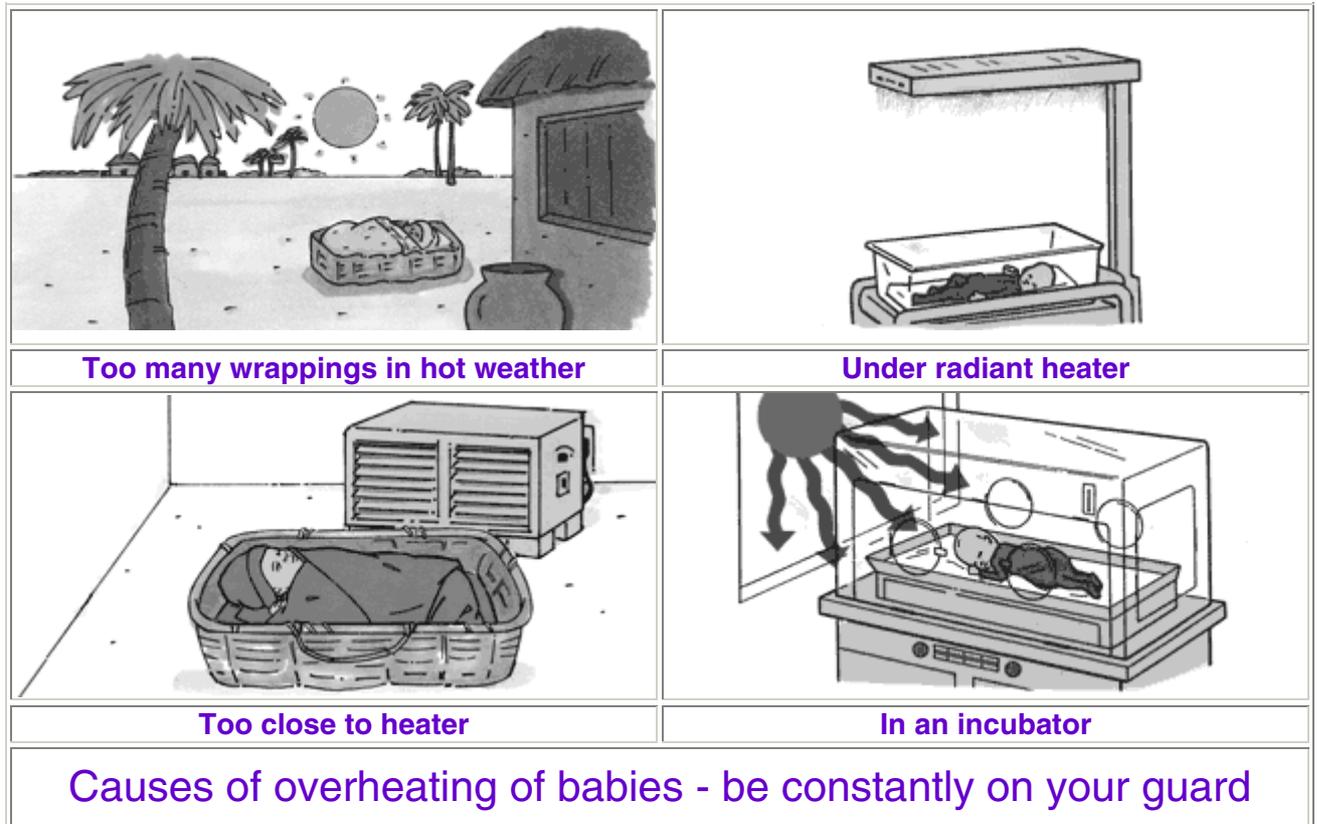
- skin-to-skin contact.
- a warm room or warm cot.
- a radiant heater or an incubator.

The method, or combination of methods selected will depend on the severity of the hypothermia and the availability of staff and equipment.

Infection should always be suspected because signs of infection are similar to those of hypothermia.

Give parents information on how to recognise and manage hypothermia in the home.

What is hyperthermia and what are the common causes?



Hyperthermia occurs when the newborn's body temperature rises above 37.5°C (99.5°F) because the environment is too hot for the baby or the baby is overdressed.

Always be on the alert and avoid exposing a baby to situations in which overheating may occur.

Temperatures must be monitored regularly when any kind of equipment is being used to warm and/or maintain the temperature of a baby.

How would you manage hyperthermia?

- Assess for infection
- Move baby away from the source of heat and undress
- Give baby a bath if necessary
- Give frequent breast-feeds
- Monitor temperature

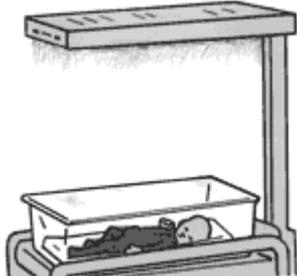
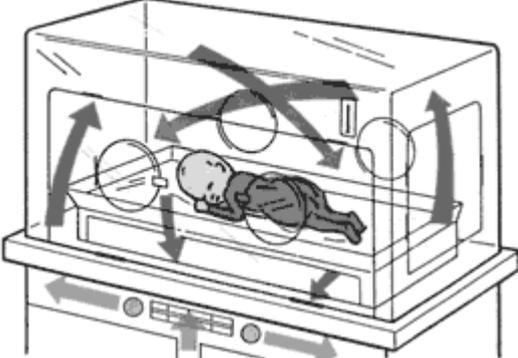
When a newborn baby has a raised body temperature, it is not possible to distinguish between fever and hyperthermia.

Infection should therefore always be suspected first unless there is an obvious external cause for the baby becoming overheated.

If there are no signs of infection, then the probable cause is an environment that is too hot for the baby.

The baby should be moved away from the source of heat (heater, sun, radiant warmer etc) and adjustments made to its clothes and bedding.

How do you keep a small/preterm/ sick newborn warm in hospital?

<p>Birth weight (kg)</p> <p>1.0-1.5</p> <p>1.5-2.0</p> <p>2.0-2.5</p>	<p>Room temperature</p> <p>30-33°C</p> <p>28-30°C</p> <p>26-38°C</p>	
<p>Warm room</p>		<p>Overhead radiant warmer</p>
		
<p>Kangaroo-mother care</p>	<p>Air-heated incubator</p>	
<p>Keeping low birth weight and sick babies warm in maternity unit</p>		

Low birth weight, preterm and sick newborns are at greater risk of developing hypothermia and hyperthermia than normal weight babies.

To keep these babies warm, the same principles apply as for other newborns, but they require extra warmth over a longer period of time.

The method used to keep the baby warm will depend on its weight, gestational age, and health, as well as on the availability of staff and equipment.

Warming devices such as radiant heaters, heated water-filled mattresses, and incubators, should only be used in institutions that have a reliable electricity supply, skilled personnel to care for babies in warming devices, staff skilled in maintaining, cleaning and repair of the warming device, and where spare parts are available.

When using a warming device to care for a low birth weight or sick newborn:

- The baby should be clothed.
- The baby's body temperature should be monitored regularly.
- The temperature inside the heating device must be monitored regularly.
- The room must be heated to at least 25°C (77°F).
- The baby should be removed from the device regularly for skin-to-skin contact with the mother and breast-feeding.

What is kangaroo-mother care and what are its advantages?



Kangaroo-mother care keeps baby warm, promotes breast-feeding and increases mother's confidence

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.

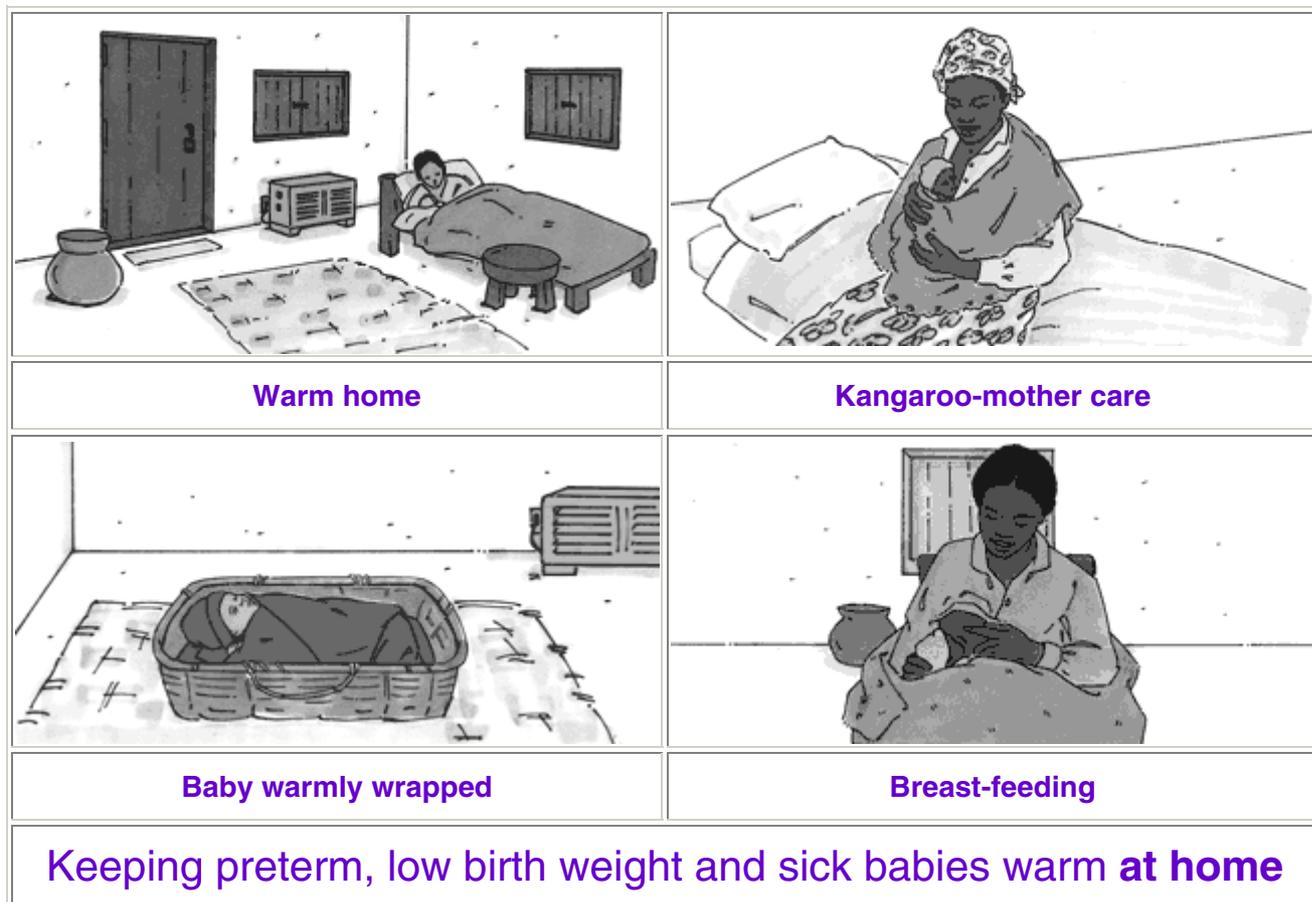
The newborn is placed in a prone and upright (or diagonal) position between the mother's breasts, and covered with the mother's clothes and a cloth/blanket/shawl, for most of the day and night.

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.

This method can be tiring for the mother and restricts her freedom of movement. A lot of support is therefore required from relatives and health workers to help mothers accept and practise this method correctly.

How would you teach a mother to keep a low birth weight baby warm at home?



Moderately premature or low birth weight newborn babies with no signs of illness who are breathing well and are able to breast-feed normally, can be cared for at home.

They can be kept warm at home by using kangaroo-mother care in combination with keeping the newborn in a warm room, well-wrapped in blankets.

An effort should be made to keep the home warmer than is comfortable for adults.

How can thermal protection of the newborn be implemented effectively in institutions?

- Establish a policy and set standards of practice.
- Assess existing practice, knowledge, skills and attitude of birth attendants
- Arrange in-service teaching sessions to review/revise theoretical knowledge and/or on-the-job training
- Monitor practices

Thermal protection should be a high priority when planning the care of newborn infants.

Thermal protection does not require expensive, sophisticated equipment but rather, a well organised effort to teach to all health care providers and parents of newborn babies, the simple principles of thermal protection.

At national level, a policy and standards of care should be defined and thermal protection should be included in curricula for training all levels of health care providers. Institutions should:

- Review and revise existing policies and procedures.
- Implement uniform standards of care for all newborn babies that include the ten steps of the warm chain.
- Provide appropriate levels of monitoring and supervision to ensure the ten steps of the warm chain are implemented effectively.
- Review traditional practices at the community level to determine which practices support the principles of thermal protection and which could be harmful. Discourage harmful practices and teach all community based health care providers the principles of thermal protection of the newborn.

6. REFERENCES

1. Adamsons K, Towell M. Thermal homeostasis in the fetus and newborn. *Anaesthesiology*, 26:531-548, 1965.
2. Dahm LS, James LS. Newborn temperature and calculated heat loss in the delivery room. *Pediatrics*, 49:504-513, 1972.
3. Tafari N. Hypothermia in the tropics: epidemiologic aspects. In: Sterky G, Tafari N, Tunell R. (eds). *Breathing and warmth at birth*. Sarec Report: 53-58, 1985.
4. Brück K. Temperature regulation in the newborn infant. *Biol Neonate*, 3:65, 1961.
5. Karlsson H. Skin-to-skin care: heat balance. *Arch Dis Child*, 75: F 130-F132, 1996.
6. Färdig JA. A comparison of skin-to-skin contact and radiant heaters in promoting neonatal thermoregulation. *J Nurse Midwifery*, 25(1):19-28, 1980.
7. Acolet D et al. Oxygenation, heart rate and temperature in very low birthweight infants during skin-to-skin contact with their mothers. *Acta Ped Scan*, 78:189-93, 1989.
8. Christensson K et al. Temperature, metabolic adaptation and crying in healthy full-term newborns cared for skin-to-skin or in a cot. *Acta Ped Scan*, 81: 488-93, 1992.
9. Smales ORC, Kime R. Thermoregulation in babies immediately after birth. *Arch Dis Child*, 53:58-61, 1978.
10. Henningson A, Nyström B, Tunell R. Bathing or washing babies after birth. *Lancet*, ii:1401-1403, 1981.
11. Stothers JK. Head insulation and heat loss in the newborn. *Arch Dis Child*, 56:530-534, 1981.
12. Yurdakok K et al. Swaddling and acute respiratory infections. *AJPH*, 80:873-874, 1990.
13. Ellis M et al. Postnatal hypothermia and cold stress among newborn infants in Nepal monitored by continuous ambulatory recording. *Arch Dis Child*, 75:F42-F45, 1996.
14. Burnard EE, Cross KW. Rectal temperature in the newborn after birth asphyxia. *Br Med J*, ii: 1197-1199, 1958.
15. Johanson RB. Diagnosis of hypothermia - a simple test? (letter). *J Trop Pediatr*; 39:313-312,1993.
16. Singh M et al. Assessment of newborn baby's temperature by human touch: A potentially useful primary care strategy. *Indian Pediatrics*, 29:449-452, 1992.
17. Kumar R, Aggarwal AK. Accuracy of maternal perception of neonatal temperature,

- accepted for publication in *Indian Pediatrics*, Jul/Aug 1996.
18. Glass L, Silverman WA, Sinclair JC. Effect of the thermal environment on cold resistance and growth of small infants after the first week of life. *Pediatrics*, 41(6):1033-46, 1968.
 19. Dagan R, Gorodischer R. Infections in hypothermic infants younger than 3 months old. *Am J Dis Child*, 138:483-5, 1984.
 20. Ji X et al. Epidemiological study on hypothermia in newborns. *Chinese Medical Journal*, 106(6):428-432, 1993.
 21. Chintu C, Sukhani S. Perinatal and neonatal mortality and morbidity in Lusaka. *Med J Zambia*, 12:110-5, 1978.
 22. Daga AS et al. Determinants of death among admissions to intensive care units for newborns. *J Trop Ped*, 37:53-5, 1991.
 23. Silverman WA, Fertig JW, Berger AP. The influence of the thermal environment upon the survival of newly born premature infants. *Pediatrics*, 22:876-86, 1958.
 24. Buetow KC, Klein SW. Effect of maintenance of "normal" skin temperature on survival of infants of low birth weight. *Pediatrics*, 34:163-170, 1964.
 25. Christensson K et al. Midwifery care routines and prevention of heat loss in the newborn: a study in Zambia. *J Trop Ped*, 34:208-12, 1988.
 26. Johanson RB et al. Effect of post delivery care on neonatal body temperature. *Acta Ped Scan*, 81:859-63, 1992.
 27. Omene JA et al. Heat loss in Nigerian newborn infants in the delivery room. *Int J Gyn Obst*, 16:300-302, 1979.
 28. Bhat GJ et al. Skin-to-skin care for rewarming low-risk hypothermic neonates: a randomized study in a developing country, 1995 (unpublished).
 29. Kaplan M, Eidelman AI. Improved prognosis in severely hypothermic newborn infants treated by rapid rewarming. *J Ped*, 105(3):470-474, 1984.
 30. Tafari N, Gentz J. Aspects on rewarming newborn infants with severe accidental hypothermia. *Acta Ped Scan*, 63:595-600, 1974.
 31. Sarman I, Can G, Tunell R. Rewarming preterm babies on a heated, water-filled mattress. *Arch Dis in Child*, 64:687-692, 1989.
 32. World Health Organization. *The management of fever in young children with acute respiratory infections in developing countries*. Programme for the control of acute respiratory infections, WHO, Geneva. WHO/ARI/93.30.

33. Aujard Y et al. Hyperthermie majeure de l'enfant. *Arch franç Ped*, 35:477-485, 1978.
34. Harpin VA, Rutter N. Sweating in preterm babies. *The J of Ped*, 100(4):614-618, 1982.
35. Daga SR et al. Appropriate technology in keeping babies warm in India. *Ann Trop Ped*, 6:23-25, 1986.
36. Green Abate C et al. Comparison of heated water-filled mattress and space-heated room with infant incubator in providing warmth to low birth weight newborns. *Int J of Epidemiology*, 23:1226-1232, 1994.
37. Davanzo R. *Care of the low birth weight infants with the kangaroo-mother method in developing countries. Guidelines for health workers*. Trieste, 1993.
38. Sloan NL et al. Kangaroo-mother method: randomized controlled trial of an alternative method of care for stabilised low birth weight infants. *Lancet*, 344:782-785, 1994.
39. Ludington-Hoe SM. *Kangaroo Care*. pp. 70-71, 1993.
40. Bergman NJ, Jürisoo LA. The kangaroo-mother method for treating low birth weight babies in a developing countries. *Tropical doctor*, 24:57-60, 1994.
41. Ludington-Hoe SM et al. Efficacy of kangaroo care with preterm infants in open air cribs. *Neonatal Network*, 11(6):101, 1992.
42. DeLeeuw R et al. Physiologic effects of kangaroo care in very small preterm infants. *Biology of the neonate*, 59:149-55, 1991.
43. Whitelaw A et al. Skin-to-skin contact for very LBW infants and their mothers. *Arch Dis Child*, 63:1377-81, 1988.
44. Wahlberg V et al. A retrospective, comparative study using the kangaroo-mother method as a complement to the standard incubator care. *European Journal of Public Health*, 2:34-37, 1992.
45. Lamb ME. Early mother-neonate contact and mother-child relationship. *J Child Psy Psychiatry*, 24:487-94, 1983.
46. Ross GS. Parental responses to infants in intensive care. The separation issue re-evaluated. *Clin Perinatol*, 7:47-60, 1980.
47. Hadeed AJ, Ludington S, Siegal S. Skin-to-skin between mother and infants reduces idiopathic apnea of prematurity. *Pediatric Research*, 37(4), Part 2, 208A, 1233, 1995.
48. Colonna F et al. The kangaroo-mother method: evaluation of an alternative model for the care of LBW newborns in developing countries. *Int J Gyn Obs*, 31:335-9, 1990.
49. Malhotra AK et al. A new transport incubator for primary care of LBW babies. *Indian Pediatrics*, 29:587-593, 1992.