

# THERMOREGULATION

This module is designed to improve knowledge, skills and clinical practice of all stakeholders involved in the care of preterm neonates in thermoregulation.

## Learning objectives

The participants will learn

- To understand the importance of thermal wellbeing in preterm neonates
- To be able to use thermoregulation measures/ equipment safely and effectively at birth, during transport and in NICU
- To be able to identify and manage neonates with hypothermia and hyperthermia
- To be able to improve outcome and processes related to thermoregulation using quality improvement methods in local context

## Module contents

This module includes following elements

- **Script:** Easy to read format, gives quick introduction and is an essential reference material for the participants.
- **Key messages:** After having read through the script, these key messages summarize the important learning points in the webinar and the script
- **Video demonstration:** The videos in this module cover the use of radiant warmer, use of incubator, how to take temperature of baby using digital thermometer, how and when to use skin-to-skin contact for prevention of hypothermia, use of food grade plastic or bag, wrapping of baby while at mothers side, identifying harmful practices which can lead to hypothermia and how to keep baby warm during transport in special newborn care unit and ward.
- **Webinar:** The webinar in this module shall help the participant to gain knowledge of hypothermia in preterm infants and prevention of hypothermia.
- **Poster demonstration:** The participant shall learn about prevention and management of hypothermia and hyperthermia in newborns.
- **Self-assessment:** This will be done at the end of each objective, based on what you have already learnt. Feel free to consult your text material, if you need assistance in recapitulating.
- **Checklist:** There will be a checklist on transport of newborn.
- **Skill check:** The skill check includes evaluation of your skills on “using radiant warmer”, “measuring axillary temperature”, “thermal care in delivery room”, “wrapping the baby”, “skin to skin contact”, “thermal care at home”, “using plastic wrap”, “assessing baby temperature”, and “potential harmful practices which can lead to hypothermia”.
- **Simulation:** After reading through the text material, seeing videos and webinars and reading through the posters, you shall be asked to perform the necessary procedure/ act as a team. While performing as a team doing thermoregulation, individual feedback and debriefing of team will be done.

## Learning objective 1

### **The importance of thermal well-being in preterm neonates**

This objective covers the concept of thermal well-being in preterm neonates and is delivered as

- Webinar
- Script
- Key messages

After seeing the webinar and reading the script and the key messages you shall undergo a self-evaluation based on what have you already learnt.





### 1.1: Webinar

You will be seeing and listening to webinar on hypothermia in preterm infants with your facilitator. You are free to interrupt your facilitator anytime for any clarifications or suggestions. The power point slides of the webinar are given herewith.

#### Hypothermia in preterm infants

DR. Tejopratap Oleti  
Consultant Neonatology  
Fernandez Hospital,  
Hyderabad

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#### Objectives

- Effect of hypothermia on mortality and morbidities
- Thermal well being in preterm infants

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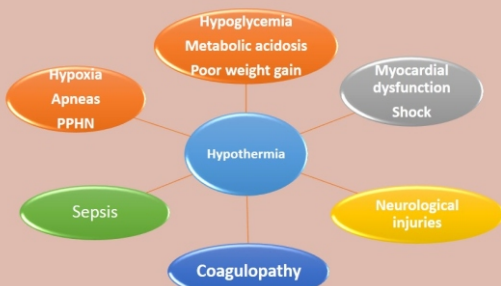
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#### Effect of hypothermia




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## Effect of low admission temperatures

For each drop in 1°C

- Mortality – increases by 28%
- Late onset sepsis – 11%

Laptook et al. Pediatrics; 2007.

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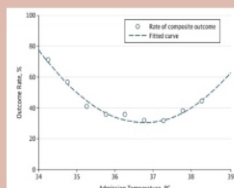
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## Admission temp–mortality/morbidities

### • Outcomes

- Mortality
- Severe Neurological injury
- Severe ROP
- BPD
- Late onset sepsis
- Ventilation
- Severe NEC




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## Effect on incidence of mortality and morbidity

- Interventions to prevent hypothermia will lead to decrease in mortality and morbidities by 18%–42%

UNICEF, Progress for children: a world fit for children statistical review. New York, NY: United Nations Children's Fund; 2007.

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## Physiology - thermoregulation

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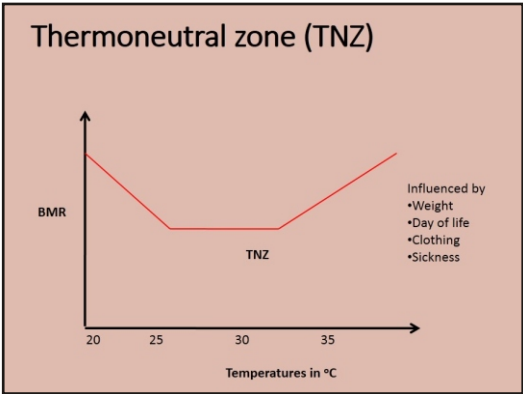
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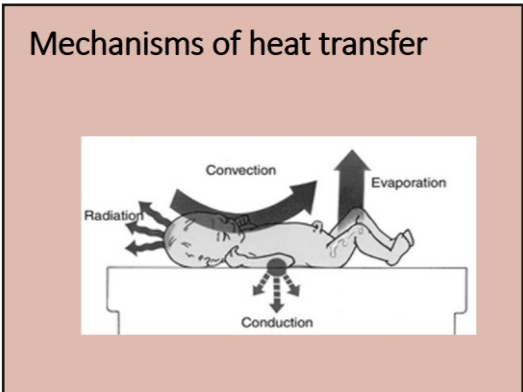
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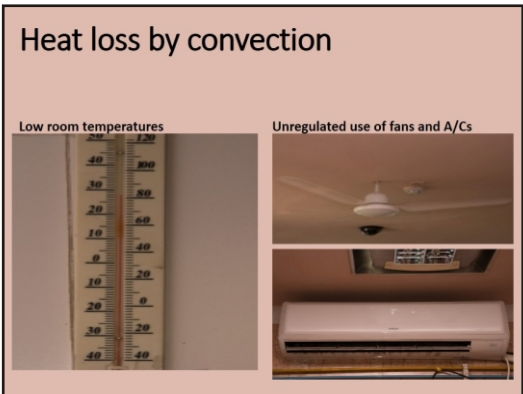
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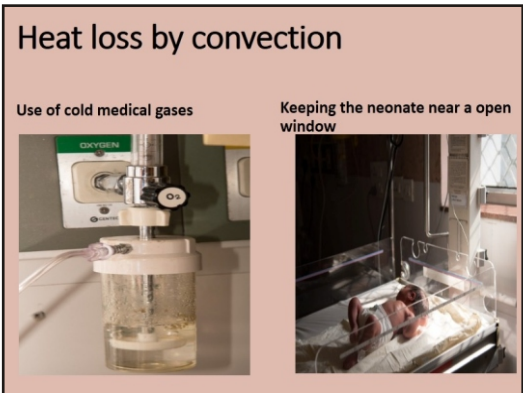
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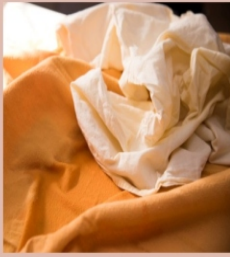
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## Heat loss by conduction

Use of cold linen at delivery room



Keeping the baby directly on cold surfaces like weight machine and x-ray




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## Heat loss by radiation

- Nursing the neonate near a cold wall
- Inadequate clothing
- Too many cold objects in the room




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## Heat loss by evaporation

- Delayed drying at birth
- Prolonged contact with wet linen
- Frequent bathing
- Wet diapers




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Why Preterms are at higher risk?

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## Risk factors

- Lesser brown fat tissue
- Larger surface area per unit kg weight
- Skin Immaturity
- High transepidermal water loss

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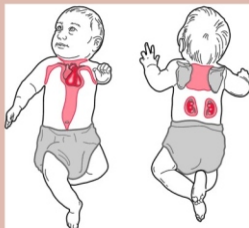
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## Brown fat

- Contributes to 4-10% of fat tissue
- Main source of non-shivering thermo genesis
- Not detectable before 26-30 weeks of gestation




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## Body surface area



7 times more per unit (kg) weight compared to adults  
Extended posture will expose more body surface area

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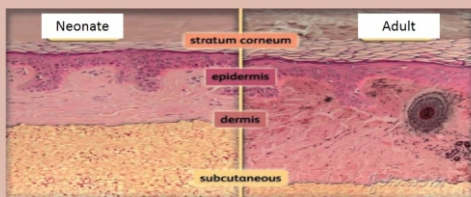
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## Skin changes

- 20 to 30% thinner than the adult skin
- More thinner epidermis
- Less hydrated and has reduced natural moisturization factors
- Increased insensible loss of losses




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Preterm prone for injuries –  
Increased insensible loss of water




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### Key messages

- Hypothermia (Temp < 36.5°C): increased mortality and major morbidities
- Ideal environmental temperature is based
  - Weight
  - Day of life
  - Clothing
  - Sickness
- Thin stratum corneum, increased IWL, larger body surface area and lesser brown fat: Risk factors

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What did you learn from this webinar?

1. ....
2. ....
3. ....

What are the queries which come to your mind?

1. ....
2. ....
3. ....



## 1.2: Script

Hypothermia is considered to be one of the major risk factor influencing the neonatal mortality and morbidities. Preterm infants are at more risk of hypothermia compared to term infants.

Hypothermia effects different organ systems. The effects include respiratory problems like apneas, aggravation of hypoxia and persistent pulmonary hypertension. Additionally, myocardial dysfunction, shock, metabolic effects like hypoglycemia and acidosis, increase in risk of sepsis, coagulopathy and neurological injuries like intraventricular haemorrhage and periventricular leukomalacia are also known in hypothermia.

It is known that, for every drop in  $1^{\circ}\text{C}$ , the mortality increases by 28%, and late onset sepsis by 11%. Neonates have fewer incidences of complications when the admission temperature is around  $36.5^{\circ}\text{C}$ . The mortality and morbidity rise exponentially in neonates with admission temperatures below  $36^{\circ}\text{C}$

### Concept of thermo-neutral zone

It is the range of environmental temperature at which the neonate can maintain normal temperature with no or minimal changes in basal metabolic rate. This zone of temperature depends on the birth weight, postnatal age, the clothing and degree of sickness in the neonate.

### Mechanisms of heat loss

There are 4 mechanisms by which neonate can have heat loss. They are convection, conduction, radiation and evaporation. Neonate can lose warmth when baby is exposed to draught of cold air (*by convection*), lying on cold surface (*by conduction*), is wet (*by evaporation*), or is surrounded by cold surfaces like walls (*by radiation*).

### Handicaps of neonates in temperature regulation

*The risk factors for hypothermia are* lesser brown fat tissue, larger surface area per unit kg weight, skin immaturity and high trans-epidermal water loss.

A neonate is more prone to develop hypothermia because of a large surface area per unit of body weight. In addition, preterm babies have decreased thermal insulation due to less subcutaneous fat and decreased heat production due to lack of brown fat.

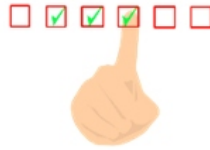
Brown fat is the site of heat production. It is localized around the adrenal glands, kidneys, nape of neck, interscapular and axillary region. Metabolism of brown fat results in heat production. Blood flowing through the brown fat becomes warm and through circulation transfers heat to other parts of the body. This mechanism of heat production is called as '*non shivering thermogenesis*'. Preterm infants lack this effective mechanism of heat generation.

In addition to the above mentioned mechanisms, the lack of skin maturity (thinner stratum corneum) and also increased epidermal water loss due to extended posture and skin injury during procedures and interventions.

### **1.3: Key messages**

- Hypothermia is defined when baby's body temperature falls below 36.5°C.
- Hypothermia increases mortality and major morbidities in preterm neonates.
- Ideal environmental temperature of preterm neonates is based on weight, postnatal age, clothing and sickness
- The four mechanisms of heat loss in preterm neonates are convection, conduction, radiation and evaporation
- The risk factors of hypothermia in preterm neonates are lesser brown fat tissue, larger surface area per unit kg weight, skin immaturity, high trans-epidermal water loss





### 1.4: Self-check MCQs

1. Which one of the following is true of thermoregulation in the newborn?
  - a. The normal newborn baby has a core temperature of 36 - 36.5 °C.
  - b. Preterm babies have little subcutaneous fat, but can auto regulate their temperature well using thermogenesis from brown fat.
  - c. Babies should be placed in a thermoneutral environment to promote energy conservation and growth.
  - d. Shivering is an effective treatment for hypoxic ischemic brain injury
  
2. Match the following
 

a. Conduction	( )	1. Delay in drying at birth
b. Convection	( )	2. Many cold steel objects in the room
c. Radiation	( )	3. Room temperature 24°C
d. Evaporation	( )	4. Baby has undergone x-ray
  
3. Why newborns are prone to develop hypothermia?
  - a. Larger surface area
  - b. Decreased thermal Insulation due to lack of subcutaneous fat
  - c. Reduced amount of brown fat
  - d. All the above
  
4. A nurse in a delivery room is assisting with the delivery of a newborn infant. After the delivery the nurse prepares to prevent heat loss in the newborn resulting from evaporation by
  - a. Warming the crib pad
  - b. Turning on the overhead radiant warmer
  - c. Closing the doors to the room
  - d. Drying the infant with a warm sheet
  
5. Which of the following statement is false about thermo neutral zone-
  - a. It depends on birth weight and day of life
  - b. It is the temperature at which the infant has minimal metabolism and minimal oxygen requirements
  - c. It is constant for all the infants
  - d. Depends on sickness of the neonate

## Learning objective 2

### **The use of thermoregulation measures/ equipment safely and effectively at birth, during transport and in NICU.**

This objective covers the use of thermoregulation measures/ equipment safely and effectively at birth, during transport and in NICU and is delivered as:

- Webinar
- Script
- Key messages
- Videos
- Posters
- Checklists

After seeing the videos, posters and reading the script and the key messages you shall undergo a self- evaluation based on what have you already learnt.



## 2.1: Webinar

You will be seeing and listening to webinar on prevention of hypothermia in preterm infants with your facilitator. You are free to interrupt your facilitator anytime for any clarifications or suggestions. The power point slides of the webinar are given herewith.

### Preventing Hypothermia in Neonates

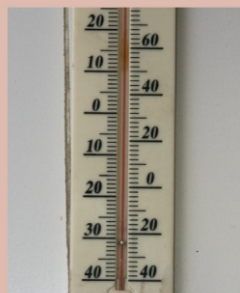
DR. NISHAD PALAKKAL  
MD (Pediatrics)  
Assistant Professor  
Department of Neonatology  
JIPMER, Pondicherry

### What is warm chain?

- Warm chain is a series of interlinked steps to prevent hypothermia in neonates

### 1. Keep the room warm

- Make sure the delivery room is kept at 26-28°C
- Heat maternity wards in winter



## 2. Skin-to-skin contact (STS)

- For stable babies, start skin-to-skin contact on the mother's abdomen immediately after birth
- Allow breast crawl for up to an hour
- Vitamin K & weighing: after STS

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## 3. Warm resuscitation

- Switch on warmer 20-30 minutes before delivery
- Warm at least 2 sheets




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## 4. Immediate drying

- Dry skin with linen
- Discard wet linen after wiping
- Wrap in dry towel
- Cover head or put cap on
- Plastic bag/wrap if < 32 weeks




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## 5. Exclusive breastfeeding

- Continue skin-to-skin care
- Breastfeed within 1 hour
- Feed as soon as possible after C-section
- Discourage prelacteal feeds

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## 6. Postpone bathing



- Postpone bathing for 24 hours

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## 7. Appropriate clothing

- Cover head. Use cap, socks, and mittens
- Extra clothing in winter
- Change wet nappies promptly

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## 8. Keep with mother

- Rooming in
- Bedding in
- If not in Kangaroo Mother Care, wrap and place next to mother




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## 9. Warm transportation

- Transport incubator
- Skin-to-skin
- Wrapping
- In-utero transfer for high-risk pregnancies




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## 10. Training & awareness

- Educate all members of team
- Train all members in resuscitation, skin-to-skin, breastfeeding, use of equipment like radiant warmers and incubators
- Ongoing program to train new staff and retrain others

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## Summary

- Increased awareness and a series of simple measures are all that is needed to prevent hypothermia in most neonates.

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What did you learn from this webinar?

1. ....
2. ....
3. ....

What are the queries which come to your mind?

1. ....
2. ....
3. ....



## 2.2: Script

This script shall help you to understand the prevention of hypothermia in preterm infants.

A series of simple measures can prevent hypothermia in most neonates, starting before the baby's birth and continuing in the newborn unit, maternity ward, and home. Together, we refer to these as the "Warm Chain".

Babies become hypothermic when they are kept in cold surroundings. Before the baby is born, we make sure that the delivery room temperature is 26-28°C. Stable babies should be placed on the mother's abdomen for skin-to-skin contact immediately after birth. The baby will move towards the mother's breast using its sense of smell. This is called the breast crawl. The baby can be allowed to do this in the first hour after birth. Routine procedures like Vitamin K injection and weighing can be postponed until this.

Switch on the radiant warmer at least 20-30 minutes before delivery. Use the radiant warmer in manual mode to preheat the mattress and 2 linen sheets with heater output set to 100% initially. To reduce evaporative heat losses in the delivery room, the infant should be dried immediately after birth. This can be done on the mother's abdomen or under the radiant warmer. Wet linen used to wipe the baby must be discarded, and a new warm sheet can be used to wrap the baby. Apply a cap to prevent heat loss from the head. If the infant is less than 32 weeks of gestation, use a plastic bag or wrap. Consider this also for preterm babies above 32 weeks of gestation. Skin-to-skin care can be continued in the maternity ward, Newborn Unit, or Kangaroo Mother Care Ward. Breastfeeds should be given within 1 hour after vaginal delivery. Monitor for activity, colour, cry and breathing difficulty while the baby in skin to skin contact. Babies born by Cesarean section also should be breastfed as early as possible. We should actively discourage prelacteal feeds like tea, honey and cow's milk and encourage exclusive breast feeds.

Bathing the infant should be postponed for at least 24 hours to reduce the risk of hypothermia. The baby should be clothed adequately in the maternity ward and at home. The infant's head should be covered when wrapping. Use a cap to cover the head, and socks and mittens to cover the extremities. Neonates will need extra layers of clothing when compared to adults, especially in winter or in rooms with air conditioning. Wet nappies should be changed promptly to prevent heat loss.

Room in mother and baby to encourage bonding and breastfeeding. The baby should stay with the mother 24 hours a day. Bedding the baby in with the mother will also result in better thermal care. If Kangaroo Mother Care is not being done, the baby can be wrapped in a warm blanket and placed next to the mother.

Warm transport: Babies often become hypothermic when being transported. Whenever possible, use a transport incubator to transfer the neonate. Skin-to-skin contact can be used if a transport incubator is not available. If neither is possible, the baby should be wrapped well and a cap placed on the head. When a high-risk delivery is anticipated, consider in-utero transfer.

Train all team members in thermal care during resuscitation, STS, breastfeeding and in the use of equipment like radiant warmers and incubators.

### 2.3: Key messages

- Prevention of hypothermia in neonates are starting before the baby's birth and continuing in the Newborn unit, maternity ward and home.
- Before the baby is born, we make sure that the delivery room temperature is 25-28°C.
- Stable babies should be placed on the mother's abdomen for skin-to-skin contact immediately after birth.
- Room in mother and baby to encourage bonding and breastfeeding.
- Babies often become hypothermic when being transported. Whenever possible, use a transport incubator to transfer the neonate. Skin-to-skin contact can be used if a transport incubator is not available.





## 2.4: Video

There will be nine short video films on the following:

1. Use of radiant warmer
2. Use of incubator
3. Taking temperature of baby using digital thermometer
4. Use of transport incubator
5. How and when to use skin-to-skin contact for prevention of hypothermia?
6. How to use food grade plastic or bag?
7. Wrapping of baby while at mothers side
8. Harmful practices which can lead to hypothermia
9. How to keep baby warm during transport?

The video demonstration will be followed by discussion.

1. The following aspects of the use of radiant warmer were shown:
  - i. ....
  - ii. ....
  - iii. ....
2. The following aspects of use of incubator were shown:
  - i. ....
  - ii. ....
  - iii. ....
3. The following aspects of taking temperature of baby using digital thermometer were shown:
  - i. ....
  - ii. ....
  - iii. ....
4. The following aspects of use of transport incubator were shown:
  - i. ....
  - ii. ....
  - iii. ....

5. The following aspects of how and when to use skin-to-skin contact for prevention of hypothermia were shown:

- i. ....
- ii. ....
- iii. ....

6. The following aspects of use food grade plastic or bag were shown:

- i. ....
- ii. ....
- iii. ....

7. The following aspects of wrapping of baby while at mothers side were shown:

- i. ....
- ii. ....
- iii. ....

8. The following aspects of harmful practices which can lead to hypothermia were shown:

- i. ....
- ii. ....
- iii. ....

9. The following aspects of how to keep baby warm during transport were shown:

- i. ....
- ii. ....
- iii. ....

10. Comments on videos:

Good aspect

Need improvement

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## 2.5: Poster

**The facilitator shall conduct a demonstration session on warm chain**

1. Warm Chain
2. Kangaroo Mother Care Poster
3. Skin-to-skin care contact and breastfeeding in delivery room poster
4. Thermo-Neutral temperature zones for neonates
5. Interpreting thermometer reading
6. Step by step guide for use of radiant warmer
7. Step by step guide to the use of incubator
8. Checklist for transport of newborn

### 1. Warm Chain

<h2 style="color: red;">Warm Chain</h2> <h3 style="color: cyan;">10 steps to prevent neonatal hypothermia</h3>	
<b>1. Warm delivery room</b> <ul style="list-style-type: none"> <li>Delivery room temperature should be 25-28-C</li> </ul>	<b>6. Postpone bathing</b> <ul style="list-style-type: none"> <li>Postpone bathing until after discharge</li> <li>Weigh in Newborn Unit after skin-to-skin contact</li> </ul>
<b>2. Warm resuscitation</b> <ul style="list-style-type: none"> <li>Switch on warmer 20-30 minutes before delivery</li> <li>Prewarm linen (2 sheets)</li> <li>Breast crawl for stable babies</li> </ul>	<b>7. Appropriate clothing</b> <ul style="list-style-type: none"> <li>Cover head. Use cap, socks</li> <li>Extra clothing in winter</li> </ul>
<b>3. Immediate drying</b> <ul style="list-style-type: none"> <li>Dry the skin with linen</li> <li>Discard wet linen after wiping</li> <li>Use another towel to wrap baby</li> <li>Cover head or put cap on</li> <li>Use plastic bag or wrap if gestation is &lt; 32 weeks</li> </ul>	<b>8. Keep with mother</b> <ul style="list-style-type: none"> <li>Room in mother and baby</li> </ul>
<b>4. Skin-to-skin contact</b> <ul style="list-style-type: none"> <li>Start as soon as mother and infant are stable</li> <li>Provide privacy</li> </ul>	<b>9. Warm transportation</b> <ul style="list-style-type: none"> <li>Use transport incubator if baby requires NICU transfer</li> <li>Use skin-to-skin contact if incubator is not available</li> <li>Consider in-utero transfer for high-risk pregnancies</li> </ul>
<b>5. Exclusive breastfeeding</b> <ul style="list-style-type: none"> <li>Discourage prelacteal feeds</li> <li>Encourage skin-to-skin contact</li> </ul>	<b>10. Training &amp; awareness</b> <ul style="list-style-type: none"> <li>Educate all members of team</li> <li>Train in resuscitation and use of equipment</li> <li>Ongoing program to train new staff and retrain others</li> </ul>

## 2. Kangaroo Mother Care Poster

**The facilitator shall conduct a demonstration session on kangaroo mother care.**

### 3. Skin-to-skin care contact and breastfeeding in delivery room poster

The facilitator conducts a demonstration session on skin-to-skin care contact and breastfeeding in delivery room poster. All participants have read all the pages. Facilitator reads one of the components of poster aloud. Then ask participants one after other to read the remaining components on the poster.

**Place stable babies on the mother's abdomen directly after birth**



- Cover baby with a dry sheet and place a cap on the baby's head
- Allow up to an hour for breast crawl and breastfeeding
- Weighing & Vitamin K injection can be done after this

### 4. Thermo-Neutral temperature zones for neonates

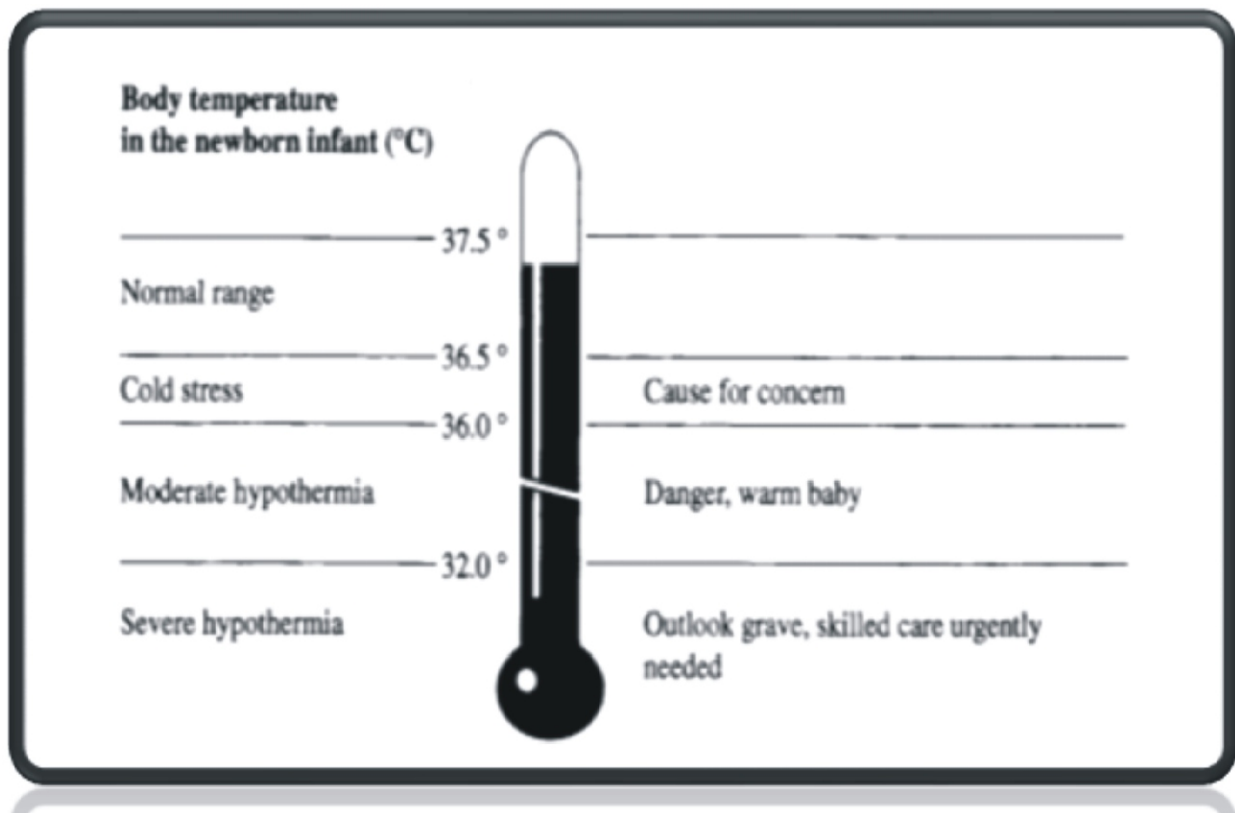
Weight	1 <sup>st</sup> day	2 <sup>nd</sup> day	3 <sup>rd</sup> day	≥ 4 days
<1200 gm	35.0 ± 0.5	34.5 ± 0.5	34.0 ± 0.5	33.5 ± 0.5
1200-1500g	34.3 ± 0.5	33.7 ± 0.5	33.5 ± 0.5	32.8 ± 0.5
1501-2500g	33.4 ± 0.5	32.7 ± 0.5	33.0 ± 0.5	32.2 ± 0.5

\*Temperature range can be used in manual mode in Incubator

\*\*The temperature may vary with skin clothing and sickness

## 5. Interpreting thermometer reading

The facilitator shall conduct a demonstration session on interpreting thermometer reading poster. All participants have to read all the pages. Facilitator reads one of the components of poster aloud. Then ask participants one after other to read the remaining components on the poster.



## 6. Step by step guide for use of radiant warmer

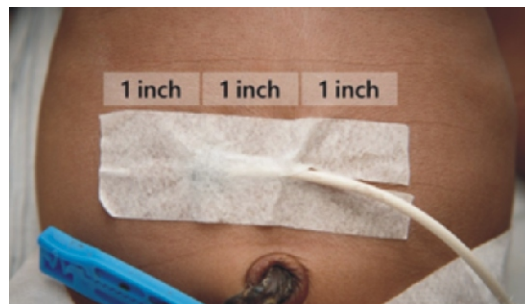
***The facilitator shall conduct a demonstration session on step by step guide for use of radiant warmer poster.***

All participants have to read all the pages Facilitator reads one of the components of poster aloud. Then ask participants one after other to read the remaining components on the job aid.

1. Keep room temperature 25-28°C
2. Place the warmer away from air currents
3. Clean the mattress and platform, and use clean linen sheet to cover the mattress
4. Whenever possible, turn warmer on 20 minutes before receiving the infant (to pre-warm the mattress and the sheets)
5. Use manual mode initially. Once the skin probe is attached and the baby's temperature is between 36.5°C and 37.5°C, switch to servo mode.

6. The skin probe is attached securely to the right upper abdomen as shown in Figure 1. When the baby is prone, the probe can be placed in the loins. If tegaderm or other transparent adhesive is available, place it on the skin and place the probe on top of it; this helps prevent skin injury.
7. Cap, socks and diapers can be used.
8. Record the heater output and the infant's axillary temperature at least once per shift (displayed skin temperature can be documented hourly).
9. If the baby is stable and maintaining body temperature with heater output <20%, consider keeping the baby with the mother.

*Figure 1: Securing the skin temperature sensor ("skin probe")*



#### Manual mode

1. The heater output is displayed as percentage or bars/bulbs. We use this mode only for pre-warming, resuscitation and initial stabilization.
2. 100% heater output is used for rapidly warming the bassinet, and the heater output can be reduced after 10 min. Most radiant warmers alarm after a few minutes if left in manual mode with high heater output, and will automatically switch to lower heat output.
3. The baby's temperature should be recorded every 2-4 hours and the heater output has to be manually adjusted depending on the baby's temperature

#### Servo mode

1. Servo mode is used with desired temperature set at 36.5°C. The warmer will adjust the heater output depending on the baby's skin temperature (as measured by the skin probe).
2. The skin probe is attached securely. If the skin probe gets detached from the baby's skin, the probe will measure a falsely low temperature. This will cause increased heater output and hyperthermia

#### Cleaning and disinfecting

1. Clean front panel daily using damp cloth soaked in soap solution
2. Cot/bassinet can be disinfected daily using damp cloth soaked in soap solution.
3. If not occupied, clean with disinfectant solution like Incidur™

Alarm	Problem	Response
"Power alarm"	This alarms if the mains power fails	Find alternative means for heating if power cannot be fixed e.g. (KMC). Check the fuse
"System alarm"	This alarms if there is an error in the electrical/electronic circuit	Change WARMER, as it needs repair
"Skin Probe failure alarm"	This alarm sounds if the temperature probe sensor is not connected properly or if it is not functioning properly	Try to re-connect the sensor correctly. If this does not work, change it
"Skin temperature alarm High or Low"	This alarm operates in servo mode only. It sounds when the patient temperature differs from the SET temperature by $>0.5^{\circ}\text{C}$	<ul style="list-style-type: none"> <li>• Change to manual mode with maximum output if baby is having low temperature and adjust the temperature to try and normalize the baby's Temperature.</li> <li>• If baby is having fever, shift to manual mode and set appropriate heater output.</li> <li>• Check for signs of infection.</li> </ul>
"Heater failure"	Indicates heater is not working	Change warmer, needs repair

## 7. Step by step guide for use of incubator

***The facilitator shall conduct a demonstration session on step by step guide for use of incubator poster.***

All participants have to read all the pages. Facilitator reads one of the components of poster aloud. Then ask participants one after other to read the remaining components on the job aid.

Keep room temperature  $25-28^{\circ}\text{C}$

1. Position incubator perpendicular to the wall for better air circulation and decreased heat loss by radiation
2. Consider incubator for VLBW (birth weight  $< 1.5$  kg) or preterm infants  $< 34$  weeks of gestation.
3. Humidification may be used for infants  $< 1$  kg birth weight. Use distilled water for humidification
4. If humidification is used, change water daily.
5. Turn incubator on at least 30 minutes before receiving the infant (to pre-warm the mattress, the hood and the sheets)
6. The baby can be clothed inside the incubator if stable and if any procedures are not being planned. Cap, socks and diapers can be used.
7. Use elbows to operate the access ports. Take care to ensure that they do not bang against the sides when opening, startling the infant.



8. Do not use the top of the incubator as storage space for keeping feed or any equipment.
9. Position phototherapy units carefully so that the top of the hood is not scratched.
10. Record the heater output and the infant's axillary temperature at least once per shift (displayed skin temperature can be documented hourly).
11. If the baby is stable and maintaining body temperature with heater output <25% or air temperature <30°C, consider moving the baby out of the incubator. This is usually after 2 weeks for ELBW infants, when the skin is mature and the infant is starting to gain weight on full feeds.

#### Air mode

1. Air mode can be used for initial stabilization, for procedures, and for stable infants.
2. If air mode is used for continuous thermal care, use the thermoneutral temperature chart (Table 1) to set the air temperature.
3. The baby's temperature should be recorded every 2-4 hours and the set air temperature may have to be manually adjusted depending on the baby's temperature.

#### Skin mode

1. Skin mode is used with desired temperature set at 36.5°C.
2. The skin probe is attached securely to the right upper abdomen. When the baby is prone, the probe can be placed in the flanks/loins. If tegaderm or other transparent adhesive is available, place it on the skin and place the probe on top of it; this helps prevent skin injury.
3. If the skin probe gets detached from the baby's skin, the probe will measure a falsely low temperature. This will cause increased heater output and hyperthermia

#### Cleaning and disinfecting

1. Clean front panel daily using damp cloth soaked in soap solution
2. Accessible areas of the incubator can be cleaned daily using damp cloth soaked in soap solution.
3. If not occupied, clean with disinfectant solution



Alarm	Problem	Response
<b>"Power alarm"</b>	This alarms if the mains power fails	Find alternative means for heating if power cannot be fixed e.g. (KMC). Check the fuse
<b>"System alarm"</b>	This alarms if there is an error in the electrical/electronic circuit	Change incubator, as it needs repair
<b>"Skin Probe failure alarm"</b>	This alarm sounds if the temperature probe sensor is not connected properly or if it is not functioning properly	Try to re-connect the sensor correctly. If this does not work, change it
<b>"Skin temperature alarm High or Low"</b>	This alarm operates in skin mode only. It sounds when the patient temperature differs from the SET temperature by $>0.5^{\circ}\text{C}$	<ul style="list-style-type: none"> <li>• Make sure that the temperature probe is not detached or entrapped between the infant and the mattress.</li> <li>• Confirm the baby's axillary temperature using a digital thermometer.</li> <li>• Change to air mode, if the infant is hypothermic or hyperthermic.</li> <li>• Check for signs of infection if temperature abnormalities persist.</li> </ul>
<b>"Heater failure"</b>	Indicates heater is not working	Change incubator, needs repair

### 8. Checklist at transport of newborn

**The facilitator shall conduct a demonstration session on checklist at transport of newborn poster.**

All participants have to read all the pages. Facilitator reads one of the step of checklist aloud. Then ask participants one after other to read the remaining steps in the checklist.

Equipment check list for thermal support

Basic details of the neonate	
<b>Name of the baby: (labelling to be There on one of the limb by using bands)</b>	Sex:
<b>Mother's name:</b>	Father's name:
<b>Address:</b>	Accompanying person
<b>Date of birth:</b>	Time of birth:
<b>Gestation: (wk)</b>	Birth weight (g):

Thermal support equipment and supplies (kept ready)	Yes	No
Transport incubator		
Thermometer and/ or temperature monitor and probes		
Plastic wrap/Insulating blankets/Heat shield		
Caps of different sizes, socks and gloves		
During transport		
Temperature checked at the start and end		
Baby is well covered with caps, socks and gloves		
Modality used for thermal support		
<ul style="list-style-type: none"> <li>• Skin to skin contact</li> <li>• Warm blanket (wrapped)</li> <li>• Transport incubator</li> <li>• Others</li> </ul>		
Blood sugar monitoring done		

Signature of the doctor/Nurse  
(accompanying the transfer team)

Signature of the doctor/Nurse  
(at receiving hospital)



## 2.6: Self-check MCQs

1. The preferred site for attaching the skin temperature sensor (probe) is:
  - a) Right lower abdomen
  - b) Chest wall
  - c) Right upper abdomen
  - d) Back of abdomen
2. If the temperature probe gets detached from the infant's skin while using a radiant warmer in Servo mode, what usually results?
  - a) Infant becomes hyperthermic
  - b) Infant becomes hypothermic
  - c) No change in infant's temperature
  - d) Warmer shuts down
3. To measure a neonate's temperature, a digital thermometer should be placed in the axilla
  - a) Until a beep is heard
  - b) For 2 minutes
  - c) For 3 minutes
  - d) For 5 minutes
4. Which of the following can be used for thermal care in infants <32 weeks of gestation?
  - a) Food-grade plastic bag
  - b) Plastic food wrap
  - c) Plastic surgical bag
  - d) Any of the above
5. Which of the following can be used for neonatal transport?
  - a) Transport incubator
  - b) Exothermic mattress
  - c) Skin-to-skin contact
  - d) Any of the above

### Learning objective 3

#### **Identify and manage neonates with hypothermia and hyperthermia.**

This objective covers the concept of identifying and managing neonates with hypothermia and hyperthermia and is delivered as:

- Video
- Posters
- Key Messages

After seeing the videos, posters and reading the script and the key messages you shall undergo a self- evaluation based on what have you already learnt.



### 3.1: Video

There will be video demonstration by your facilitator on:

- Management of a neonate with cold stress and moderate hypothermia,
- Severe hypothermia,
- Hyperthermia and differentiating fever and overheating

The video demonstration will be followed by discussion.

1. The following aspects of management of a neonate with cold stress and moderate hypothermia were shown:
  - i. ....
  - ii. ....
  - iii. ....
2. The following aspects of severe hypothermia were shown:
  - i. ....
  - ii. ....
  - iii. ....
3. The following aspects of hyperthermia and differentiating fever and overheating were shown:
  - i. ....
  - ii. ....
  - iii. ....

4. Comments on videos:

Good aspect

Need improvement

.....  
 .....  
 .....

.....  
 .....  
 .....



### 3.2: Poster

The facilitator shall conduct a demonstration session on hypothermia in newborns.

# Hypothermia in Newborns

#### What is hypothermia?

Hypothermia is defined when baby's body temperature falls below 36.5°C

You can measure temperature of a baby by keeping thermometer in roof of axilla for three minutes

#### Why it is important ?

1. Hypothermia decreases chances of survival of a low birth weight baby
2. Hypothermia aggravates the illness severity in a sick baby
3. Hypothermia decreases growth of a low birth weight baby

#### Severity of hypothermia

Normal range (36.5°C to 37.5°C)
Cold stress (36.1°C to 36.4°C)
Moderate hypothermia (32.0°C to 36.0°C)
Severe hypothermia (<32.0°C)

#### Why does it occur?

1. When delivery room is too cold
2. Baby is not dried immediately after birth
3. Baby is kept away from mother
4. Baby has inadequate clothing
5. Exposure during bathing

#### Which babies are at highest risk?

1. Low birth weight babies
2. Sick babies
3. Babies immediately after birth

#### Prevent heat loss: The warm chain

- **Prevent heat loss at birth**
  - Keep delivery room temperature at least 25°C
  - Dry immediately; wrap in a warm towel
  - Provide skin-to-skin contact, initiate breastfeeding
- **Bathing the infant**
  - Postpone till next day
  - Do not bathe a sick baby
  - Avoid till cord falls in LBW baby
  - Bathe using warm water in a warm room. Dry immediately. Wrap in dry warm towel, cover head. Place near mother.
- **Dress newborns with several layers of loose clothing and monitor temperature**
- **Keep mother and newborn together in a warm room**

#### How to keep a LBW baby warm at home

Keep the room warm

Keep baby wrapped in warm clothes

Provide Kangaroo Mother Care

Keep baby on exclusive breast feeding

#### How to keep a sick/LBW baby warm in facility

1. Keep baby under radiant warmer or inside an incubator
2. Provide Kangaroo Mother Care
3. If radiant warmer/incubator not available keep the nursery warm

Birth weight (kg)	Ideal nursery temperature
1.0-1.5	30-33°C
1.5-2.0	28-30°C
2.0-2.5	26-28°C

#### How to rewarm a hypothermic baby

- **Ensure a warm room**
- **Remove wet cold clothes, 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**
- **Monitor temperature at regular intervals**
- **Assess for infection if hypothermia persists**

## Hypothermia in Newborns

The facilitator shall conduct a demonstration session on standard treatment protocol (STP) on management of baby with hypothermia.



### Standard Treatment Protocol for Management of Common Newborn Conditions in Small Hospitals (Adapted from WHO Guideline)



## Hypothermia

Axillary temperature  $<36.5^{\circ}\text{C}$

- Look for possible cause of hypothermia
- Check room temperature

### Hypothermia

#### Mild hypothermia $36^{\circ}\text{C} - 36.4^{\circ}\text{C}$

- Ensure room is warm (maintain at  $25^{\circ}\text{C} - 28^{\circ}\text{C}$ )
- Position baby skin-to-skin with mother
- Continue breast feeding
- Recheck temperature in 1 hour;
  - ✓ If temperature is normal, cover the baby adequately including head, hands and feet
  - ✓ If no improvement, treat as Moderate Hypothermia

#### Moderate hypothermia $32^{\circ}\text{C} - 35.9^{\circ}\text{C}$

- Provide warmth using a warmer
- If no warmer is available, start skin to skin with mother (KMC). Cover mother and baby together optimally using pre-warmed clothes
- Ensure room is warm (maintain at  $25^{\circ}\text{C} - 28^{\circ}\text{C}$ )
- Continue breast feeding
- Measure blood glucose, if  $<45\text{mg/dL}$ , treat for hypoglycemia (See STP for Hypoglycemia)
- Reassess every 15 minute; if temperature does not improve, increase setting of warmer - Reassess
- If no improvement or no warmer, REFER

#### Severe hypothermia $<32^{\circ}\text{C}$

- Provide warmth using a warmer
- Rapid re-warming till baby is  $34^{\circ}\text{C}$  and then slow re-warming\*
- Start oxygen and maintenance IV fluids
- Give Inj Vitamin K, if not given or status unknown
- Ensure room is warm (maintain at  $25^{\circ}\text{C} - 28^{\circ}\text{C}$ )
- Measure blood glucose, if  $<45\text{mg/dL}$ , treat for hypoglycemia (See STP for Hypoglycemia)
- Reassess every 15 minutes, if temperature does not improve increase setting of warmer - Reassess
- If no improvement, REFER

### ❖ Hypothermia can be a sign of infection

\*Initially use high setting of the warmer and if the baby's temperature has been increasing atleast  $0.5^{\circ}\text{C}$  per hour in last three hours, rewarming is successful, shift to lower setting of warmer and continue measuring the baby's temperature every two hour s

For additional / next level management please refer to WHO Guidelines (Managing Newborn Problems and Pocket Book of Hospital Care of Children), <http://www.ontop-in.org/sick-newborn/>, <http://www.newbornwhocc.org/>

## Hyperthermia in Newborns

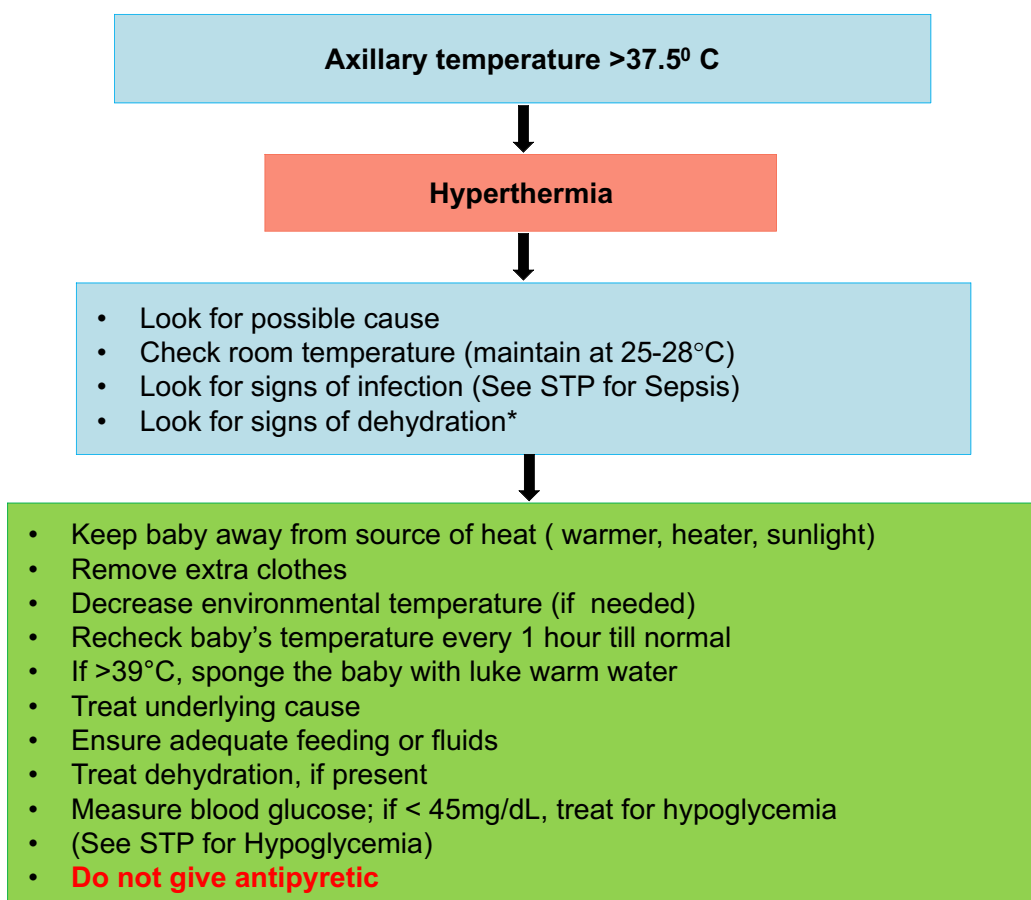
The facilitator shall conduct a demonstration session on standard treatment protocol (STP) on management of baby with hyperthermia.



### Standard Treatment Protocol for Management of Common Newborn Conditions in Small Hospitals (Adapted from WHO Guideline)



## Hyperthermia



#### \* Signs of dehydration in a newborn

- Sunken eyes, or
- Depressed fontanelle, or
- Loss of skin elasticity, or
- Dry tongue and mucous membrane

**Note: Hyperthermia can be a sign of infection**

For additional / next level management please refer to WHO Guidelines (Managing Newborn Problems and Pocket Book of Hospital Care of Children), <http://www.ontop-in.org/sick-newborn/>, <http://www.newbornwhocc.org/>



### **3.2: Key messages**

- Neonates with temperatures between 36-36.4°C are considered to be in cold stress.
- The neonate with temperature is between 32-35.9°C is considered to be having moderate hypothermia.
- Neonates with temperatures < 32 °C are considered to be in severe hypothermia and it's a neonatal emergency which can lead to multiorgan failure.
- Encouraging breast feeding during immediate neonatal period not only ensures sufficient nutrition and also prevent cold stress as it will prevent heat loss.
- Measuring blood glucose, treat it as having hypoglycemia if it is < 45 mg/dL, give Inj. Vitamin K if the neonate has not received it after delivery.
- Ensure room temperatures around 25 - 28°C
- Neonates with temperatures > 37.5°C are considered to have hyperthermia.



### 3.5: Self-check MCQs

1. All the following can cause hyperthermia except
  - a. Wrapping the baby in too many layer of clothes
  - b. Leaving baby in direct sunlight
  - c. Kangaroo Mother Care
  - d. Baby placed too close to heater
2. Appropriate statement regarding hyperthermia include
  - a. Is as dangerous as hypothermia
  - b. Neurological damage will not occur
  - c. No harm to keep baby well wrapped in direct sun light
  - d. Infection need not be ruled out
3. Treatment of hyperthermia include all except
  - a. Continue breast feeding
  - b. Unwrap the baby
  - c. Move baby away from heat source
  - d. Give bath with cool water to decrease temperature
4. Hyperthermia is temperature more than
  - a.  $36.5^{\circ}\text{C}$
  - b.  $37^{\circ}\text{C}$
  - c.  $37.5^{\circ}\text{C}$
  - d.  $38^{\circ}\text{C}$
5. All are common association with hyperthermia except
  - a. Sepsis
  - b. Dehydration
  - c. Congestive cardiac failure
  - d. Hypernatraemia
6. Moderate Hypothermia in a neonate is defined as an axillary temperature
  - a.  $< 34^{\circ}\text{C}$
  - b.  $< 32^{\circ}\text{C}$
  - c.  $36-36.4^{\circ}\text{C}$
  - d.  $32-35.9^{\circ}\text{C}$
7. The recommended room temperature for maintaining warmth for neonates is
  - a.  $28 - 30^{\circ}\text{C}$
  - b.  $32 - 34^{\circ}\text{C}$
  - c.  $25-28^{\circ}\text{C}$
  - d.  $22-24^{\circ}\text{C}$

8. Prevention of hypothermia in the community should focus on
  - a. Kangaroo mother care
  - b. Keeping the room warm (26-28°C)
  - c. Ensure adequate breastfeeding
  - d. All of the above
9. All the methods can be used for rewarming the baby except
  - a. Radiant warmer
  - b. Placing in an incubator
  - c. Over a cloth placed on hot water bottle
  - d. Skin to skin contact with mother
10. Baby with normal temperature will have
  - a. Cold abdomen and cold peripheries
  - b. Warm abdomen and cold peripheries
  - c. Cold abdomen and warm peripheries
  - d. Warm abdomen and warm peripheries
11. Manifestations of severe hypothermia include all except
  - a. Hypoglycemia
  - b. Metabolic acidosis
  - c. Warm peripheries and abdomen
  - d. Bleeding manifestations
12. In severe hypothermia rapid rewarming done till....
  - a. 34°C
  - b. 35°C
  - c. 36°C
  - d. 36.5°C
13. All are part of treatment of severe hypothermia except....
  - a. Rewarming by keeping the baby under radiant warmer
  - b. Inj Vitamin K
  - c. Oxygen inhalation
  - d. Phototherapy
14. The causes of severe hypothermia include all except..
  - a. Asphyxia
  - b. Sepsis
  - c. Hypoglycemia
  - d. Kangaroo mother care
15. After the baby is re-warmed to 36.5°C, the management includes
  - a. Continued monitoring vitals and temperature
  - b. Shifting the baby to postnatal ward
  - c. Sending the baby to bath with warm water
  - d. Start IV antibiotics to all



### Skill check

After you have read through the scripts, seen the videos and the webinars, you shall be asked to undergo a skill check on task trainers. The facilitator shall assess you and provide feedback. This shall include assessment of skill of:

S. No.	OSCE
1	Using radiant warmer
2	Measuring axillary temperature
3	Thermal care in delivery room
4	Wrapping the Baby
5	Skin to skin contact
6	Thermal care at home
7	Using Plastic wrap
8	Assessing baby temperature Observation / Palpation

#### 1. Using a radiant warmer

You have just received a stable newborn infant in the SNCU. A radiant warmer is provided. Demonstrate the necessary steps to ensure thermal care of the infant using the radiant warmer.

S. No.	Correct Action	Yes	No
1	Cleans hands with hand rub		
2	Switches on warmer in manual mode		
3	Applies cleaned temperature probe to right upper abdomen		
4	Secures probe correctly using adhesive strip		
5	Switches to Servo/Skin mode		
6	Records axillary temperature		
7	Cleans the hands with hand rub		
8	Puts socks, mittens on the infant		
9	Places a cap on the infant's head		

#### Total Score

Score: (Maximum Score 9): \_\_\_\_\_

## 2. Measuring axillary temperature

You have just received a stable newborn infant in the SNCU. Measure the axillary temperature of this infant using the thermometer provided.

S. No.	Correct action	Yes	No
1	Cleans the hands with hand rub		
2	Cleans thermometer with spirit/chlorhexidine from the tip to base		
3	Position tip correctly in the apex of the axilla		
4	Holds infant's arm gently by the side		
5	Waits until the thermometer beeps		
6	Records temperature		
7	Cleans thermometer with spirit/chlorhexidine from base to tip before putting it away		
	<i>Temperature is 36.2°C</i>		
8	Correctly interprets the reading as mild hypothermia/ cold stress		
<b>Total Score</b>			

Score: (Maximum Score 8): \_\_\_\_\_

## 3. Thermal care in delivery room

An infant is about to be born at 36 weeks of gestation. Ensure thermal care of the newborn in the labor room. You can assume that the infant is vigorous

S. No.	Correct action	Yes	No
1	Cleans the hands with hand rub		
2	Switches on the radiant warmer ASAP		
3	Sets warmer in manual mode with 100% heater output		
4	Checks delivery room temperature (or requests to increase it to 25-28°C)		
5	Places at least 2 clean sheets or towels under the warmer		
6	Wipes the infant when received while the infant is on mother's abdomen		
7	Discards wet linen		
8	Wraps the infant in new sheet		
9	Covers head or applies cap		
10	Helps initiate breast feeding		
<b>Total Score</b>			

Score: (Maximum Score 10): \_\_\_\_\_

#### 4. Wrapping the Baby

A 35 week neonate with a birth weight of 1.9 kg is found to be in cold stress in the post natal ward. The doctor identified that she was not covered well. Mother of the neonate is in ICU for her sickness. Advise the attendant regarding wrapping the baby....

S. No.	Steps	Yes	No
1	Cleans the hands with rub or by hand wash		
2	Takes a sufficient size warm clean rectangular cloth		
3	Folds at the top to suit the head		
4	First wrap to the right with the cloth from left side		
5	Wrapping was done so that body is tugged well without hurting the baby		
6	One more fold taken from down to tug into the previous fold		
7	Folds back the left wrap		
8	Adjusts the wrap to show the face and it is not obscuring the nose and mouth		
9	Places the infant back onto the mother's lap or on the baby's bed		
10	Explains the mother/attendant about its importance		
	<b>Total Score</b>		

Score: (Maximum Score 10): \_\_\_\_\_

#### 5. Skin to skin contact

A preterm neonate born at 33 weeks of gestation with birth weight of 1.9 kg is being shifted to referral unit. Explain the mother about skin to skin contact to provide thermal support.

S. No.	Steps	Yes	No
1	Cleans hands by hand rub or hand was		
2	Counsels the mother about SSC		
3	Asks the mother to wear a front open dress		
4	Undressing the baby except cap, socks and mittens		
5	Puts the baby on mother's chest with skin to skin contact		
6	Explains and ensures slightly extended neck position		
7	Secures the mother and baby in safe way in SSC position		
8	Explains the mother about danger signs which she need to Watch		
9	Praises the mother after completion of session		
	<b>Total Score</b>		

Score: (Maximum Score 9): \_\_\_\_\_

## 6. Thermal care at home

A baby born at 34 weeks of gestation with birth weight of 1.8 kgs is getting discharged. Demonstrate "How to ensure warmth by adequate clothing."

S. No.	Steps	Yes	No
1	Cleans hands by hand rub or hand wash		
2	Explains the mother about rooming in practice		
3	Advices about multi layered dress covering major part of chest, upper and lower limbs		
4	Tells about the mother to choose cotton clothes		
5	Shows how to put caps, socks and mitten		
6	Wraps the baby again with the cloth		
7	Keeps the baby along with the mother		
8	Asks the mother to use a warm blanket in between dressing and undressing		
9	Advices frequent Breast feeding		
10	Advices to keep the room temperature around (25°C - 28°C)		
	<b>Total Score</b>		

Score: (Maximum Score 10): \_\_\_\_\_

## 7. Using Plastic wrap

A 28 week old, 1200 gms (as per the USG measurement) neonate is getting delivered in your hospital. You have been asked to help in the delivery. Demonstrate how to use cling-wrap in this baby.

S. No.	Steps	Yes	No
1	Cleans the hands by hand wash		
2	Arranges linen, food grade plastic wrap		
3	Keeps the pre warmed linen ready		
4	Switches on the radiant warmer and keeps it in manual mode		
5	Receives the baby on plastic wrap/bag without drying		
6	Wraps the plastic wrap completely around the baby		
7	Makes provision in the wrap for resuscitation purposes		
8	Assesses the cry, respiratory efforts and heart rate and asks for vitals		
9	Shifts the baby in the transport incubator		
10	Shifts the baby to radiant warmer/incubator in NICU and removes the wrap		
	<b>Total Score</b>		

Score: (Maximum Score 10): \_\_\_\_\_

### 8. Assessing baby temperature by observation / palpation

A neonate who was born at 34 weeks of gestation with a birth weight of 1800 gms is currently being cared in postnatal ward and brought to triage room with complaints of the baby being cold to touch. How do you assess the thermal well being of the child on clinical examination?

S. No.	Steps	Yes	No
1	Does hand hygiene		
2	Observes for dull activity, seizures, altered sensorium by stimulation and cry		
3	Looks for altered behavior during feeding		
4	Assess for any signs of respiratory distress like increase in respiratory rate and retractions		
5	Looks at the alteration in color of the peripheries, mottling and reports whether they are blue/ pallor or pink		
6	Uses the dorsum of the hand to compare the temperature difference between central parts like abdomen and chest with extremities and interpret		
7	Checks axillary temperature using digital thermometer		
8	Checks HR, RR, BP (if available), SpO <sub>2</sub> , CFT and reports any abnormality		
9	Looks for sources of infection like umbilical discharge, pustules over the body		

#### Total Score

Score: (Maximum Score 9): \_\_\_\_\_





## Simulation

An essential pre-requisite before reaching this stage in each module is that the learner should have undergone the entire module, seen the videos and webinars facilitated by the facilitator, attempted the evaluation questionnaire, and demonstrated the skill check.

This session brings out learning and practice in a realistic environment for thermoregulation. The emphasis is on working together as a team and not on individual skills.

You shall be asked by the facilitator to participate as a team for the management of the following conditions.

- Baby with hyperthermia
- Baby with severe hypothermia
- Transport of a preterm neonate
- Skin to skin contact in delivery room
- Thermal support during resuscitation

This shall be followed by feedback and debriefing.