Clinical Guideline

# Thermoregulation in Neonates

| | |
|---|---|
| **Sites where Clinical Guideline applies** | All Newborn Service sites in HNELHD |
| **This Clinical Guideline applies to:** | |
| **1. Adults** | No |
| **2. Children up to 16 years** | No |
| **3. Neonates – less than 29 days** | Yes |
| **Target audience** | Clinicians in neonatal units in HNELHD |
| **Description** | Provides information for neonatal clinicians regarding thermoregulation strategies and management in infants |

Hyperlink to Guideline

| | |
|---|---|
| **Keywords** | Neonate, newborn, NICU, SCU, thermoregulation, hypothermia, cold stress, hyperthermia, re-warming |
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**Related Legislation, Australian Standard, NSW Ministry of Health Policy Directive or Guideline, National Safety and Quality Health Service Standard (NSQHSS) and/or other, HNE Health Document, Professional Guideline, Code of Practice or Ethics:**

- NSW Health Policy Directive 2017_032 Clinical Procedure Safety
- NSW Health Policy Directive PD 2017_013 Infection Prevention and Control Policy
- HNELHD Policy Compliance Procedure PD 2019_020: PCP 1 Clinical Handover - ISBAR

| | |
|---|---|
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## PURPOSE AND RISKS

*This document has been developed to provide support and guidance to the health clinicians to provide high quality, safe and timely care for at-risk neonate's to assist in assessment and management of thermoregulation in the newborn. It ensures that the risks of harm, hypothermia and hyperthermia, are assessed, identified and safely managed.*

*The risks are:*

- *Clinical deterioration of the infant*
- *Inappropriate temperature management of the infant*

*The risks are minimised by:*

- *Comprehensive assessment of the infant*
- *Infants receive appropriate thermoregulatory support as outlined in this document*

*Any unplanned event resulting in, or with the potential for injury, damage or other loss to infants/staff/family as a result of this procedure must be reported through the Incident Management System and managed in accordance with the NSW Health Policy Directive PD2020_020: Incident Management Policy. This would include unintended injury that results in disability, death or prolonged hospital stay.*

*It is mandatory for staff to follow relevant: "Five moments of hand hygiene", infection control, moving safely/safe manual handling, documentation practices and to use HAIDET for patient/carer communication: **H**and hygiene **A**cknowledge, **I**ntroduce, **D**uration, **E**xplanation, **T**hank you or closing comment.*

**Risk Category:** *Clinical Care & Patient Safety*

## CLINICAL PROCEDURE SAFETY LEVEL

Every clinician involved in the procedure is responsible for ensuring the processes for clinical procedure safety are followed. The following level applies to this procedure (click on the link for more information):

**Level 1 procedure**

## CONTENT

## THERMOREGULATION SUMMARY

- Newborn infants are acutely vulnerable to the harmful effects of thermal stress
- Extremely premature infants are at greatest heat loss risk
- Thermal stress has been associated with poor neurological outcome
- Infants can lose heat rapidly if not protected
- Severe hypothermia is associated with increased mortality

## GUIDELINE

*While not requiring mandatory compliance, staff must have sound reasons for not implementing standards or practices set out within guidelines issued by HNE Health, or for measuring consistent variance in practice.*

### Introduction

Survival of at risk infants including the very low birth weight (VLBW) and sick or unwell infants has been shown to be effected by alterations in thermoregulation. Morbidity and mortality of preterm infants remains greater than other newborn infants because of their innate vulnerability and environmental factors they are exposed to. Maintaining a thermo-neutral environment is essential for the survival of newly born premature and unwell infants.

## Temperature Ranges

Top

Thermoregulation is the ability to maintain a balance between heat production and heat loss in order to maintain body temperature within a normal range with minimal calorie consumption, known as normothermia (see Table 1 for temperature ranges). Both hypothermia and hyperthermia are dangerous for neonates and can have damaging consequences.

| TEMPERATURE | CLASSIFICATION |
|---|---|
| **> 37.5°C** | HYPERTHERMIA |
| **36.5°C - 37.5°C** | **NORMAL RANGE** |
| **36.0°C - 36.5°C** | MILD HYPOTHERMIA *(potential cold stress)* |
| **32.0°C - 36.0°C** | MODERATE HYPOTHERMIA *(cold stress)* |
| **< 32.0°C** | SEVERE HYPOTHERMIA *(risk of death)* |

*Table 1: Temperature Range and Classficiation table (NICU, JHCH)*

## Effects of Prolonged Hypothermia

Top

- Reduced surfactant production
- Increased oxygen consumption
- Respiratory distress
- Apnoea and bradycardia
- Metabolic acidosis
- Hypoxia

- Renal dysfunction
- Cardiac dysfunction
- Static weight or weight loss
- Poor organ growth
- Abdominal distension
- Vomiting
- Dissociation of haemoglobin
- Coagulopathy
- Neurological injury
- Death

### Effects of Prolonged Hyperthermia

Top

- Poor feeding
- Tachycardia
- Tachypnoea
- Irritability
- Hypotonia
- Lethargy
- Increased oxygen consumption
- Static weight or weight loss
- Neurological injury
- Death

## Methods of Heat Loss

Top

There are 4 methods of heat loss described below and seen in Figure 1.

- **Evaporation**: occurs when fluid evaporates from wet skin. Evaporation increases when the baby is under a radiant warmer.
- **Conduction:** occurs when skin comes into direct contact with a cooler surface.
- **Radiation:** occurs when heat is radiated to cooler objects surrounding the infant although there is no skin contact.
- **Convection:** occurs when the air surrounding the infant is lower than body temperature.

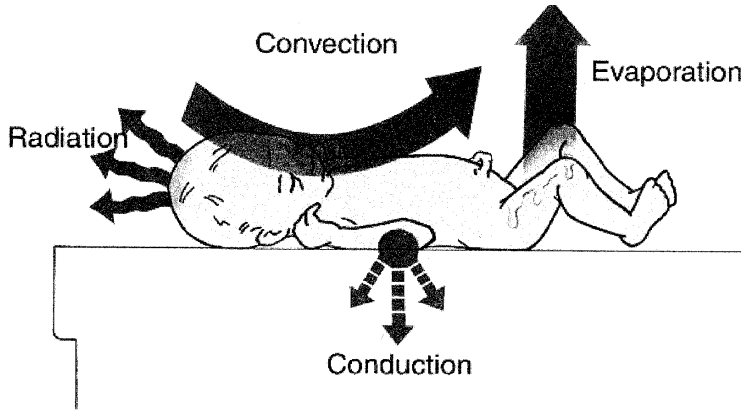


Figure 1: *Methods of Heat Loss (Image from google images)*

## Birthing Environment

Top

The neonate is particularly vulnerable to thermal stress due to immature or absent thermoregulatory mechanisms, increased heat loss, transepidermal water loss (TEWL) and a large body surface area in relation to body mass. At birth heat exchange through the placenta is lost and the infant moves from the warmth of the mother to the external environment, leaving the baby exposed to thermal stress. It is important to follow the warm chain to help to reduce the effects of thermal stress and maintain a neutral thermal environment.

The warm chain is consideration of the following:

- A warm birthing environment
- Immediate drying (in infants ≥30 weeks only)
- Placing in plastic wrap/polyethylene bag (Neohelp™ see Figure 2) and apply hat/beanie (preterm babies <30 weeks only)
- Skin to skin contact and breast feeding (where appropriate)
- Bathing/weighing postponed

- Warm transportation
- Warm resuscitation (warm linen, warm humidified gases as soon as possible, warm equipment etc.)
- Awareness training

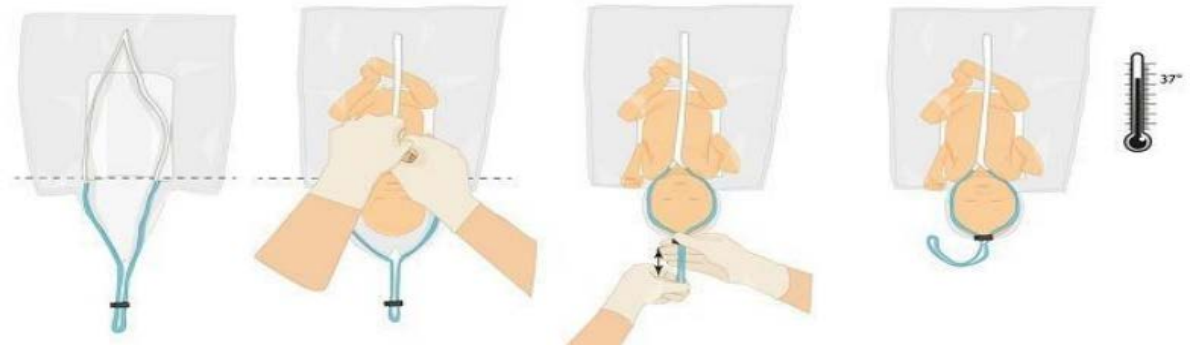

Figure 2: *Neohelp application (Image from WA Thermoregulation CPG)*

## Special Considerations for Preterm Infants Top

Preterm infants are at a higher risk of heat loss via the 4 methods of heat loss. Preterm infants possess a disproportionate body mass-to-surface area ratio, reduced thermal insulation in decreased brown adipose tissue (BAT), a thin epidermis that has increased permeability, poor vasomotor control and a naturally extended position that exposes a greater body surface area to the external environment. For these infants, cold stress will trigger a cascade of physiological responses that further impedes their transition to extra uterine life.

### Cold Stress

Cold Stress is a cascade of physiological events caused by the infant's use of chemically mediated thermogenesis in an attempt to increase core temperature. Two specific alterations to thermogenesis occur in the infant suffering cold stress; vasoconstriction of the peripheries allowing heat to be drawn back to the core and the metabolism of BAT.

### Metabolism of Brown Adipose Tissue

Within the metabolism of BAT during states of cold stress, a cascade of metabolic and chemical reactions are initiated and maintained, which result in a number of detrimental physiological changes.

### Environmental Humidity

Infants born at <30 weeks gestation have an immature epidermis and stratum corneum and are at an increased risk of TEWL. The use of environmental humidity assists to reduce TEWL and in turn supports temperature regulation, fluid and electrolyte management and skin integrity.

## Neonatal Admission Top

An admission bed with a pre-warmed environment and warm bedding should be set-up and ready for use at all times in the neonatal unit. The Neutral Thermal Zone (NTZ) guide should be used to determine the crib setting based on an estimated/or confirmed weight (see Appendix 2).
Any baby requiring humidity, or with respiratory compromise, or is clinically unstable must never be dressed or covered.

## Equipment Top

### Humdicrib

All preterm infants' ≤30 weeks' gestation or ≤1000 grams should be cared for in a humidicrib (i.e. crib that has capacity to provide humidity).

### Non-Humidified Crib

Preterm infants' 30-32 weeks' gestation or ≤1800 grams should be cared for in a crib at admission.
Preterm infants' 32-34 weeks' gestation may require care in crib if hypothermic on admission.

### Open Care Centre/Radiant Warmer

Infants' ≥34 weeks' gestation may be nursed on an open care centre if no hypothermia present and requiring respiratory support, phototherapy or another clinical indication.

### Open Cot

Infants' ≥34 weeks' gestation who are normothermic and clinically stable.
Preterm infants weighing ≥1500 grams with a stable temperature (normothermic for ≥24 hours in a crib temperature of ≤29°C and demonstrated weight gain) may be transferred to an open cot.

## Heating Modes

Top

### Manual Mode

This mode is used for pre-warming of an admission bed and ongoing thermoregulation management. Temperature management is controlled by the clinician, by adjusting the delivered temperature setting according to the infant's temperature assessment. There is no feedback process with this mode, therefore the clinician's careful attention to prevent hypo/hyperthermia is needed. This mode is preferred for more stable infants.

### Servo Mode

This mode aims to control the infant's temperature by adjusting the heating output to achieve the desired pre-set skin probe temperature setting. The infant's skin temperature is continuously monitored via the temperature probe.

**This is the preferred mode for:**

- Infants' ≤1000 grams
- Infants requiring environmental humidity
- Infants with temperature outside of normal range
- Unwell/unstable infants
- Infants undergoing procedures in the unit
- Any other infant deemed to be at risk of hypo/hyperthermia

**Cessation of servo mode can be considered when the infant:**

- Weighs >1000 grams
- No longer requires environmental humidity
- Is stable in a consistent crib temperature of ≤34°C

When transferring the infant from servo to manual control, set the air temperature at the same temperature that was consistently delivered over the previous 24 hours. If the infant has had significant fluctuations, consider if the infant is ready to transition to manual control.

## Humidity

Top

Humidity should start at 80% (>85% results in excess rainout and temperature instability).
Humidity should be reduced with respect to gestation and temperature stability:

### Infants of 28 - 30 weeks gestation

- If the infant's temperature is stable after 24 hours humidity can be reduced by 5% each day

### Infants <28 weeks gestation

- Maintain humidity at 70-80% for the first 7 days of life, and then reduce by 5% daily if infant's temperature stability is maintained

Humidity should be discontinued when a level of 50% is reached and temperature stability is maintained. Consideration of the infant's skin integrity is vital, if the neonate has compromised skin integrity consultation with the medical team should occur prior to cessation of humidity. In this instance, consider continuing 50% humidity until the infant is 28 days old or skin integrity improves (whichever is reached first).

In order to reduce rain out in the humdicrib, place a cover and bubble wrap over the humdicrib. Ensure the bubble wrap is bubble side down to trap air.
Always record humidity level hourly on observation flow chart and check the water level regularly and refill with distilled sterile water as required/or when humdicrib alarms.

## Temperature Assessment Top

**Hourly until stable in normal range, including:**

- On admission
- Transfer to humdicrib/crib or radiant warmer
- Commencement or cessation of humidity
- Commencement or cessation of phototherapy
- Commencement or cessation of humidified respiratory support
- Commencement or cessation of servo control
- Commencement or cessation of a clinical procedure

**Thereafter, temperature assessment must be completed at a minimum requirement of 4$^{th}$ hourly on all infants admitted to neonatal units.**

*If a temperature records outside of the normal range, commence hourly temperatures until 2 consecutive normothermic measurements*

### Methods of Temperature Assessment Top

#### Axilla Temperature

This is the most common approach to temperature measurement. Position the tip of the thermometer in the middle of axilla prior to commencing the reading. Always clean the thermometer before and after use. When attending to cares, the axilla temperature should be recorded first as to attain the most accurate recording.

#### Skin Temperature

Skin temperature is measured when utilising servo control. Position the probe on clean, dry skin over soft tissue of the abdomen or back (avoid bony prominences to reduce risk of pressure injury). The skin probe position must be re-sited 8$^{th}$ hourly, at a minimum. For skin protection for all infants, always use a silicone tape between the skin probe and the adhesive disc.

## Special Considerations (*for neonates requiring heating support*) Top

All infants in cribs should be monitored either by electrocardiography (ECG) monitoring or oxygen saturation monitoring and this should be recorded hourly. Do not block the circulated flow of heat from the crib, therefore no equipment should be left at either end the crib. No toys should ever be left inside the crib.

**Dressing/Clothing**

- If the infant is dressed ensure the clothing is pre-warmed prior to changing and clothing on the infant is not left wet. Remove any wet linen from the infant immediately.
- If an infant requires observation of respiratory effort, nurse with a nappy only.

**Bathing/Sponging**

- Infants in cribs are not immersed in water due to their incapacity to maintain normothermia, instead the infant should be sponged and dried in small sections within the crib. For example the face and head are washed and dried before the arms and trunk of the body.
- Clothing and bedding that is changed is pre-warmed to ensure a reduction in heat loss.

## Temperature Outside of Normothermic Range

Top

**If the infants' temperature <36.5°C (not including actively cooled infants) initiate the following:**

- Assess and remove any wet/soiled linen or clothing
- Consider skin to skin care for a minimum of an hour
- Consider adding additional layers, ideally pre-warmed (clothing/wraps where suitable)
- Increase crib temperature by 0.5°C
- Assess temperature setting in line with NTZ
- Reassess axilla temperature hourly until 2 consecutive temperatures ≥36.5°C
- If ongoing issue, consideration for servo mode temperature management should be considered

*If an infant nursed in an open cot has a pattern of temperature instability, transitioning care to a crib must be considered and discussed with the Team Leader, Neonatal Nurse Practitioner (NNP) or Medical Team*

**If the infants' temperature >37.5°C initiate the following:**

- Assess environmental factors
- Asses physiological factors
- Consider removing additional layers (clothing/wraps where able)
- Decrease crib temperature by 0.5°C
- Assess temperature setting in line with NTZ
- Reassess axilla temperature hourly until 2 consecutive temperatures <37.5°C
- If ongoing issue, consideration for servo mode temperature management should be considered

**Considerations:**

- Only ever alter crib temperature by 0.5C at any one time and allow a minimum of an hour for the infant's temperature to stabilise before making any further changes
- Manipulation of crib temperatures may obscure temperature instability associated with physiological features rather than environmental i.e. infection
- Inform NNP and/or Medical Team of any significant changes or concerns about the infant

## Transitioning to an Open Cot

Top

Infants can be transferred to an open cot in line with the following criteria:

- Weight ≥1500 grams
- Normothermia for ≥24 hours in crib temperature ≤29°C
- Demonstrated consistent weight gain
- Medically stable condition

- No longer requiring observation or care necessitating exposure of large surface area

Once the described criteria are met, the infant may be transferred to an open cot and the steps below followed:

- Assess the infants temperature prior
- Dress the infant in pre-warmed clothing and hat/beanie (must be monitored if hat/beanie used)
- Wrap the infant in pre-warmed blanket/s
- Do not plan a bath for this day
- Assess temperature at each subsequent care times

*Note: some Special Care Units use warming mattresses to support the transition to an open cot, please refer to own local unit practice and manufacturer instructions for use*

## Infection Control

Top

- All cribs require changing every 7 days and should be wiped over daily with suitable neutral wipes
- Open care centres require changing every 14 days and should be wiped over daily with suitable neutral wipes
- Open cots do not require changing but should be wiped over daily with suitable neutral wipes
- If humidity is ceased, the water chamber must be emptied and dried before returning to the humidicrib

## IMPLEMENTATION PLAN

The clinical guideline will be:

- Circulated to General Managers and Cluster Managers.
- Circulated to the clinicians via the Tiered Neonatal Network/Newborn Services, Children, Young People and Families Services and the Women's Health and Maternity Network.
- Made available on the intranet (PPG) and HNEKids website.
- Presented at facility/unit meetings and tabled for staff to action.

## MONITORING AND AUDITING PLAN

- The person or leadership team who has approved the clinical guideline is responsible for ensuring timely and effective review of the guideline.
- Evaluation will require a review of the most current evidence as well as consideration of the experience of HNELHD staff in the implementation of the clinical guideline.
- Data derived from incidents, monitoring and evaluation should inform the review of the clinical guideline either as required or scheduled.
- Implementation, education support and monitoring compliance be completed by local Clinical Educators and Managers.
- Amendments to the guideline will be ratified by the Manager and Head of Newborn Services & WHaM Network (where applicable) prior to final sign off by Children, Young People and Families Services.

## CONSULTATION WITH KEY STAKEHOLDERS

| | |
|---|---|
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## APPENDICES

1. Glossary & Abbreviations
2. Neutral Thermal Zone Guide

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## FEEDBACK

Any feedback on this document should be sent to the Contact Officer listed on the front page.

## APPENDIX 1

## GLOSSARY & ABBREVIATIONS

| Acronym or Term | Definition |
|---|---|
| BAT | Brown Adipose Tissue |
| ECG | Electrocardiography |
| HNELHD | Hunter New England Local Health District |
| JHCH | John Hunter Children's Hospital |
| MBH | Manning Base Hospital |
| NICU | Neonatal Intensive Care Unit |
| NNP | Neonatal Nurse Practitioner |
| NTZ | Neutral Thermal Zone |
| SCU | Special Care Unit |
| TEWL | Transepidermal Water Loss |
| TMH | The Maitland Hospital |
| VLBW | Very Low Birth Weight |

## APPENDIX 2

### NEUTRAL THERMAL ZONE GUIDE

# Neutral Thermal Zone Guide

| Age and Weight | Starting Temperature (°C) | Range of Temperature (°C) |
|---|---|---|
| **0-6 Hours** | | |
| 500-800g | 36.5 | |
| 801-1200g | 35.0 – 36.0 | |
| Under 1200g | 35.0 | 34.0 – 35.4 |
| 1200-1500g | 34.1 | 33.9 – 34.4 |
| 1501-2500g | 33.4 | 32.8 – 33.8 |
| Over 2500g (and >36weeks) | 32.9 | 32.8 – 33.8 |
| **6-12 Hours** | | |
| Under 1200g | 35.0 | 34.0 – 35.4 |
| 1200-1500g | 34.0 | 33.5 – 34.4 |
| 1501-2500g | 33.1 | 32.2 –33.8 |
| Over 2500g (and >36weeks) | 32.8 | 31.4 – 33.8 |
| **12-24 Hours** | | |
| Under 1200g | 34.0 | 34.0 – 35.4 |
| 1200-1500g | 33.8 | 33.3 – 34.3 |
| 1501-2500g | 32.8 | 31.8 – 33.8 |
| Over 2500g (and >36weeks) | 32.4 | |
| **24-36 Hours** | | |
| Under 1200g | 34.0 | 34.0 – 35.0 |
| 1200-1500g | 33.6 | 33.1 – 34.2 |
| 1501-2500g | 32.6 | 31.6 – 33.6 |
| Over 2500g (and >36weeks) | 32.1 | 30.7 – 33.5 |
| **36-48 Hours** | | |
| Under 1200g | 34.0 | 34.0 – 35.0 |
| 1200-1500g | 33.5 | 33.0 – 34.1 |
| 1501-2500g | 32.5 | 31.4 – 33.5 |
| Over 2500g (and >36weeks) | 31.9 | 30.5 – 33.3 |
| **48-72 Hours** | | |
| Under 1200g | 34.0 | 34.0 – 35.0 |
| 1200-1500g | 33.5 | 33.0 – 34.0 |
| 1501-2500g | 32.3 | 31.2 – 33.4 |
| Over 2500g (and >36weeks) | 31.7 | 30.1 – 33.2 |

| Age and Weight | Starting Temperature (°C) | Range of Temperature (°C) |
|---|---|---|
| **72-96 Hours** | | |
| Under 1200g | 34.0 | 34.0 – 35.0 |
| 1200-1500g | 33.5 | 33.0 – 34.0 |
| 1501-2500g | 32.2 | 31.1 – 33.2 |
| Over 2500g (and >36weeks) | 31.3 | 29.8 – 32.8 |
| **4-12 Days** | | |
| Under 1500g | 33.5 | 33.0 – 34.0 |
| 1501-2500g | 32.1 | 31.0 – 33.2 |
| Over 2500g (and >36weeks) | | |
| 4-5 Days | 31.0 | 29.5 – 32.6 |
| 5-6 Days | 30.9 | 29.4 – 32.3 |
| 6-8 Days | 30.6 | 29.0 – 32.2 |
| 8-10 Days | 30.3 | 29.0 – 31.8 |
| 10-12 Days | 30.1 | 29.0 – 31.4 |
| **12-14 Days** | | |
| Under 1500g | 33.5 | 32.6 – 34.0 |
| 1501-2500g | 32.1 | 31.0 – 33.2 |
| Over 2500g (and >36weeks) | 29.8 | 29.0 – 30.8 |
| **2-3 Weeks** | | |
| Under 1500g | 33.1 | 32.2 – 34.0 |
| 1501-2500g | 31.7 | 30.5 – 33.0 |
| **3-4 Weeks** | | |
| Under 1500g | 32.6 | 31.6 – 33.6 |
| 1501-2500g | 31.4 | 30.0 – 32.7 |
| **4-5 Weeks** | | |
| Under 1500g | 32.0 | 31.2 – 33.0 |
| 1501-2500g | 30.9 | 29.5 – 32.2 |
| **5-6 Weeks** | | |
| Under 1500g | 31.4 | 30.6 – 32.3 |
| 1501-2500g | 30.4 | 29.0 – 31.8 |

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