THERMOREGULATION IN NEONATAL CARE - CHW

PRACTICE GUIDELINE °

DOCUMENT SUMMARY/KEY POINTS

- Infants are nursed in an environment that aids thermoregulation. Ideally this should be according to the infant's neutral thermal zone
- Axillary and abdominal skin temperatures are the usual sites for measuring temperature
- Rectal temperature probes are indicated in specific circumstances (e.g. therapeutic hypothermia).
- Re-warming infants should be done slowly over 1–2 hours to reduce the risk of neurological damage and apnoea
- All beds are pre-warmed before use
- Refer to the Small Baby protocol for specifics on temperature maintenance for preterm infants <28 weeks or <1000 grams.

CHANGE SUMMARY

- Updated content and references
- Included key principles and definitions

READ ACKNOWLEDGEMENT

• Clinical staff caring for infants admitted into the GCNIC

This document reflects what is currently regarded as safe practice. However, as in any clinical situation, there may be factors which cannot be covered by a single set of guidelines. This document does not replace the need for the application of clinical judgement to each individual presentation.

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Key Principles

Neonatal Temperature Ranges

Normal Range is **36.5°C - 37.5°C** for all infants measured per axilla.

- Temperature is monitored per axilla using digital thermometers.
- An infant's core body temperature will generally be higher than the recorded skin temperature, with a difference of ~ 0.5°C in term infants; the difference may be narrower in very preterm or ill infants.
- If the temperature measured is out of the excepted parameters (<36°C or >37.9°C), review the infant to establish if the cause is endogenous or environmental and notify the clinical team (medical and nursing).
- Skin temperature probes may be inaccurate if there is significant peripheral shutdown.
- For neonates on continuous monitoring, the axillary temperature is measured 4–6 hourly, or 30 minutely if it is outside the normal range. For routine temperature monitoring refer to <u>Basic Care of Neonates in the Grace Centre for Newborn Intensive</u> <u>Care – CHW</u> policy.

Key Definitions

- **Thermoregulation:** The ability to regulate one's core body temperature, even when environmental temperature is variable. Assisted thermoregulation is the application of controlled environmental temperature to maintain core body temperature within expected parameters.
- **Cold stress** is a cascade of physiological events caused by the infant's use of chemically mediated thermogenesis in attempt to increase core temperature. Two specific alterations to thermogenesis occur in the infant suffering cold stress; vasoconstriction of the peripheries, which allows heat to be drawn back to the core and metabolism of brown adipose tissue.
- **Brown adipose tissue** (BAT) is a thermogenic tissue that contributes to preventing neonatal hypothermia by generating heat during lipolysis by oxidation because of cold stress. Brown fat is found around the nape of neck, kidneys, between scapulae and axillas. This is activated when neonate's temperature decreases below 36.5°C
- **Heat stress** may also be incurred if an infant is exposed to high environmental temperatures, often associated with increased heart rate, and decreasing stability. It is imperative to ensure frequent observation of probe placement when utilising a thermoregulatory device to avoid a false-low reading if probe becomes detached, that will result in high heater output.
- Incubator: Incubators are utilised to provide a controlled, enclosed heated environment to ensure neutral thermoregulation is provided, enabling the infant to be nursed unwrapped. Incubators are the optimal choice for preterm infants requiring NTE support +/- environmental humidification. Incubators support neurodevelopmental health for



preterm babies, with reduction in noise and light within the enclosed environment. Can be operated in servo or air control settings.

- **Radiant warmer:** Radiant warmers are an open care cot system designed to provide thermal stability to infants while allowing for continuous direct observation and accessibility. As this is not an enclosed system the temperature will fluctuate depending on the surrounding environment.
- **Servo control:** Heat output is automatically and constantly adjusted according to the programmed set skin temperature, which is continuously measured from the skin temperature probe. This is the preferred mode of applying thermoregulatory assistance to *most* neonates but requires close monitoring and assessment of probe site.
- Temperature Probe placement:

Ideal temperature probe placement for central surface monitoring is on the abdomen for a supine infant, ideally over the liver region, or if positioned prone should be placed on the back over the flank region. The probe should *not* be placed on bony prominences due to reduced sensitivity to temperature changes, or areas of brown adipose tissue. It is important to ensure that the probe is not placed between the mattress and the infant, as this will create incorrect readings resulting in inadvertent cooling and create a risk for pressure area. Also, ensure the probe is not in contact with any wound dressings.

The axilla is a good site for a skin probe as it is not easily affected by changes in environmental temperature. Monitoring the trends in the axilla skin measurements give information on the way the central temperature is changing.

Degrees Celsius	Classification
<32.0 °C	Severe Hypothermia
32.0 - 35.9 °C	Moderate Hypothermia
36.0 - 36.4 °C	Mild Hypothermia
36.5 - 37.5 °C	Normal range
>37.5 °C	Hyperthermia

Temperature Ranges

Effects of Rapid Heating/Cooling

Infants are to be warmed or cooled slowly to prevent rapid metabolic changes, vasodilation/constriction, and shock.

- Aim to raise or lower the infant's temperature by 0.5 -1^o C per hour.
- During cooling or warming the temperature should be monitored continuously with a peripheral temperature probe.



Aim

The aim of thermoregulation is to nurse the infant in their neutral thermal zone, to minimise the amount of energy used and in turn maximise metabolic efficiency, decrease oxygen use and conserve energy for other basic functions and growth.

Newborns are more vulnerable to hypothermia due to their large surface area to body mass ratio, decreased subcutaneous fat, poorly developed metabolic mechanism for responding to thermal stress (inability to shiver) and immature skin leading to increased evaporative water and heat loss.

Patients who may require support with thermoregulation

- Surgery
- \leq 32 weeks gestation OR \leq 1800 grams
- Prolonged procedure
- Sedated and muscle relaxed infants
- Phototherapy
- Temperature instability for any reason
- Parenteral fluids
- Observations requiring exposure of upper and lower body
- Isolation for infection risk or additional precautions

Mechanisms of heat loss



Image 1. Mechanisms of heat loss in neonates (Post Natal care Module:2012)

The four mechanisms of heat loss in the newborn infant are:

- <u>Radiation</u>: Heat transfer without direct contact through absorption and emission of infrared rays, e.g. single wall incubators placed in direct sunlight or a cold nursery.
- <u>Convection:</u> Heat transfers via air currents, e.g. cold draughts
- <u>Conduction:</u> Heat transfer via direct contact, e.g. cold scales, hands, and clothing.
- <u>Evaporation</u>: Heat loss by conversion of liquid into vapour, e.g. wet and dry skin under radiant warmer.



Temperature assessment and maintenance

Temperature Maintenance

The following strategies are recommended to support normothermic temperatures in infants:

Component	Recommendations
	Ensure the infant is nursed away from draughts.
	Pre-warm bed and linen prior to transferring infant.
The	Warm hands and stethoscope prior to contact.
environment	 For infants <1000 grams or <28 weeks, an operating theatre or catheter lab temperature of 25°C is recommended. With the operating theatre temperature documented in the infant's medical record.
	The infant is not bathed in the first 24 hours of life.
Pothing and	Check axillary temperature before bathing and weighing.
weighing	Postpone weight/bathif below 36.5.
	 Ensure that the infant is wrapped to reduce heat loss and stress. Weigh the linen and deduct from the total weight.
Inhaled gases	 Heating and humidifying the inspired gases are necessary for CPAP, Humidified HFNC or mechanical ventilation.¹
	 Use transport bed rather than a cribette when transferring the infant to another department.
Transfer and	 As a minimum, the temperature should be checked prior to departing GCNIC, on arrival at another department and upon return to GCNIC.
transport	 A bair hugger is available in Fluroscopy to assist with thermoregulation in the imaging department.
	 In MRI, /CT, fluoroscopy the temperature should be checked every 30 minutes as the baby may spend considerable time outside the incubator.



Temperature assessment



Modified from RCH (2020)

**Refer to the small baby policy for thermoregulation management via an incubator



Hypothermia

Hypothermia can lead to serious and potentially life-threatening complications. Hypothermia can occur at birth, during transfer of infants to neonatal units, during routine care and in operating theatres.

Clinical Indicators of Hypothermia

- Vasoconstriction cold/pale or mottled skin
- Lethargy
- Feed intolerance/vomiting/increased gastric aspirates
- Increased oxygen requirement
- Respiratory distress
- Apnoea /bradycardia
- Hypotonia
- Hypoglycaemia

Rewarming hypothermic infants

Severity of Hypothermia	Method							
Mild Hypothermia (36 - 36.4 ºC)	 Kangaroo (skin–to–skin) care can effectively rewarm hypothermic infants but may require consideration in small or unstable infants. 							
	 Increase heat source by 0.5 degrees every 60minutes. 							
	Apply beanie/bonnet to head.							
	 Add a layer of clothing or extra blanket (within SIDS guidelines). 							
Moderate Hypothermia (32 - 35.9 °C)	 Re-warm in an incubator or on an open-care radiant heater warmer, depending on gestation. 							
	 Rewarm at a maximum of 0.5 degrees every 30 minutes. 							

- Re-measure axilla temperature every half hour after each intervention.
- Rewarming the infant may take several hours



- Infants rewarmed on an open-care radiant warmer should have their clothes and wraps removed to expose their skin to the radiant heat source and prevent cold air trapping.
- The hypothermic infant is at risk for respiratory distress, hypoxia and hypoglycaemia, therefore respiration and blood glucose should be monitored closely.

Hyperthermia

Hyperthermia is usually secondary to overheating due to external or environmental factors that cause overheating. However, it can be secondary to other factors including sepsis.

Clinical Indicators of Hyperthermia

- Vasodilation flushing of skin, warm extremities
- Lethargy
- Hypotension
- Tachycardia
- Tachypnoea/apnoea
- Poor feeding
- Irritability
- Feed intolerance/vomiting
- Seizures

The treatment of hyperthermia is to adjust environmental condition if considered a contributing factor and/or treat cause:

- Remove layer of clothing or blankets if baby is overdressed or overwrapped.
- If temperature remains high despite appropriate environmental temperature, consider other causes including sepsis.
- If temperature is ≥38°C notify clinical team, consider sepsis/infection, and prepare for a septic work up if ordered by team.
- Monitor axilla temperature hourly until back within normal range for two consecutive measurements.
- In the event of sepsis, the infant may remain hyperthermic.



Modes of temperature control

Mode of heating	Information							
	 Used for infants nursed on an open-care radiant warmer and is the preferred mode for patients nursed in an incubator 							
	 Controls the infant's temperature in a specific range by adjusting the radiant heater output to achieve the desired pre-set skin probe temperature 							
Servo-controlled/skin mode	 Useful in rewarming a hypothermic infant, as the probe temperature can be set 1.0 – 1.5°C higher than the infant's axillary temperature 							
	 If an infant becomes overheated, decrease set temperature by 1.0 degrees every 30 minutes until the baby's temperature normalises 							
	• If this does not work, in an incubator switch to air mode and decrease temperature by 1.0 degree every 30 minutes until axilla normalises, then switch back to skin mode							
	 Used for short-term pre-warming of the bed for expected admissions or during skin-to-skin or when the skin temp probe needs to be removed for a procedure. 							
Manual manda an a nadiant	 Allows the infant to be assessed and stabilised without the risk of hypothermia 							
warmer	 Pay careful attention to prevent hyperthermia or hypothermia as manual mode does not have feedback system 							
	 If the bed has a non-functioning skin temperature probe, continuous skin temperature monitoring should be implemented via the bedside monitor. 							
	 Air mode is generally only used to preheat the incubator prior to the baby being placed into the bed. 							
Air mode (incubator)	• Air mode may also be used during a procedure; however, skin probe must be used while baby nursed in air mode							
Humidity	• Humidity is utilised in preterm infants to reduce the incidence of trans-epidermal water loss and support the maturation of their skin.							

Refer to the <u>Small Baby Protocol</u> for additional information on humidity and air mode.



Equipment

There are numerous infant beds with different heating capabilities. The following flow chart provides a guide for which device to choose. For additional information refer to the NUM/NP/CNC or education team.



Modified from RCH 2020



Grading infants from heating source

Infants to be transferred from an open care system to a cribette are clothed and wrapped in a light wrap for 2-4 hours prior to transfer. During this time the overhead radiant warmer is turned off, but the mattress heating remains on and set at the lowest setting. The skin temperature should be maintained at 36-37°C. Once the infant is transferred into a bassinette/cribette, the axillary temperature is recorded every 4 hours (for weaning from an incubator, please refer to <u>Small Baby Protocol).</u>

Infants who are unable to maintain their temperature in the absence of an external heat source may have increased energy consumption and slow weight gain.

The need to return an infant from a cribette to an incubator or radiant heater should be discussed with families prior to implementation.

Patient/carer safety considerations

- Before transferring an infant from an open-care system, the gel mattress temperature is reduced to the lowest setting and the overhead heating is reduced and then turned off.
- The infant's skin temperature is monitored hourly for at least four hours then every four hours.
- The infant should not be bathed prior to transferring to a cribette.



Appendix

Neutral Thermal Zone Chart

Age	sınoң sıno 9 — 0 — 7 -						noj [-{	4		su trZ	noH :- ZT		Hours 24 – 36				sınoµ 87 - 98				sınoң 96-7 <u>7</u>			
Weight (grams)	< 1200	1200-1500	1501-2500	> 2500	< 1200	1200-1500	1500-2500	> 2500	< 1200	1200-1500	1501-2500	> 2500	< 1200	1200-1500	1501-2500	> 2500	< 1200	1200-1500	1501-2500	> 2500	< 1200	1200 - 1500	1501-2500	> 2500
Starting Temperature (°C)	35.0	34.1	33.4	32.9	35.0	34.0	33.1	32.8	34.0	33.8	32.8	32.4	34.0	33.6	32.6	32.1	34.0	33.5	32.5	31.9	34.0	33.5	32.2	31.3
Range of Temperature (°C)	34.0-35.4	33.9-34.4	32.8 - 33.8	32.0-33.8	34.0-35.4	33.5 - 34.4	32.2 - 33.8	31.4 - 33.8	34.0-35.4	33.3 - 34.3	31.8 - 33.8	31-33.7	34.0-35.0	33.1-34.2	31.6-33.6	30.7 - 33.5	34.0-35.0	33.0-34.1	31.4 - 33.5	30.5 - 33.3	34.0-35.0	33.0 - 34.0	31.1-33.2	29.8-32.8
Age		s	4 - 15 D9A				sved 41 - 21				عامع الح	ୟାଚଚନ୍ଦ ସ୍ଥାବ ସ ସ-ସ ସ			əəm sqa ⊶€ S			aan t	-17		saleew 8-2			
Weight (grams)	< 1500	1501 - 2500	> 2500					< 1500	1501 - 2500	Over 2500	> 2500		< 1500	1501 - 2500	< 1500		1501 – 2500		0041 >	1501-2500		< 1500	< 1500 1501 - 2500	
Starting Temperature (*C)	33.5	32.1	Day 4-5: 31.0	Day 5-6: 30.9	Day 6-8: 30.6	Day 8-10: 30.3	Day 10-12: 30.1	33.5	32.1	32.1 32.8 29.8			33.1	31.7	31./ 32.6		31.4		32.0	30.9		31.4		
Range of Temperature ('C)	33.0 - 34.0	31. – 33.2	30.5 - 32.6	29.4 – 32.3	29.0 - 32.2	29.0 - 32.2 29.0 - 31.4 29.0 - 31.4			31.0 - 33.2	31.8 - 33.8	29.0 - 30.8		32.2 - 34.0	30.5 - 33.0	316-336	0.00 0.40	30.0-32.7	000 000	31.2 - 33.0	29.5 - 35.2		30.6 - 32.3	30.6 - 32.3 29.0 - 31.8	



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