THERMOREGULATION IN NEONATAL CARE - CHW

PRACTICE GUIDELINE ©

DOCUMENT SUMMARY/KEY POINTS

- Understanding the physiology of thermoregulation
- Identifying mechanisms of thermoregulation
- Infants need to be nursed in an environment that aids thermoregulation. Ideally this should be according to the infant's neutral thermal zone (see appendix).
- 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
- The four mechanisms of heat loss which place newborns at risk include: conduction, evaporation, radiation and convection.
- Open-care systems are pre-warmed before use
- Refer to the Small Baby protocol for specifics on temperature maintenance for preterm infants <28 weeks or <1000 grams.

Approved by:	SCHN Policy, Procedure and Guideline Committee	
Date Effective:	1st March 2018	**Review Period**: 3 years
Team Leader:	Nurse Educator	**Area/Dept**: Grace Centre for Newborn Care

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CHANGE SUMMARY

- This is revised document of an existing guideline. Changes to the guideline include:
  - Updated references
  - Link to Small Baby policy
  - Inclusion of the management of hypo/hyperthermia flow chart
  - Inclusion of bed type for thermoregulation chart
- **9/07/21**: Minor review. Amended monitoring from 60 minutes to 30 minutes in various places of the document to ensure consistency between small baby policy and thermoregulation policy. Recommend to review the entire document as minor changes are made throughout.

READ ACKNOWLEDGEMENT

- Clinical staff caring for infants admitted into the Grace Centre for Newborn Intensive Care should read this guideline

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Defining Statement

Thermoregulation is a key aspect of neonatal care; it is the ability to balance between heat production and heat loss in order to maintain a body temperature within a normal range. Thermal care is central to reducing morbidity and mortality in newborns. The aim of thermoregulation is to nurse the infant in their neutral thermal zone, so as 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.[3, 14]

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 .[11]

Thermal Management

Temperature Ranges[12,13]

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

- Axillary and abdominal skin temperatures are the preferred sites for measuring skin temperature. Rectal temperature is measured in asphyxiated infants undergoing therapeutic hypothermia with whole-body cooling.
- For neonates on continuous monitoring, the axillary temperature is measured 4–6 hourly, or 30 minutely if it is outside the normal range.[2]
- Continuous skin temperature monitoring is required for neonates nursed on an open-care radiant warmer or in an incubator, and when being weaned from one of these sources to a cribette, to avoid unnecessary cold stress.[1, 2]
- The skin probe is insulated with a reflective probe cover to ensure the infant's body temperature and not an external heat source temperature is being measured.[1]
- The skin probe should be placed on an area that is not between the infant and the mattress. The probe should not be placed over a brown fat area (nape of neck or between the scapulae), where a falsely high temperature may be recorded.[3]

- Observe temperature trends over several hours in an otherwise well infant rather than relying on a single abnormal temperature, particularly if the temperature is close to the normal range.
- Consider possible causes of hypothermia or hyperthermia in relation to the infant's underlying condition.
- Temperature values of <36.0 ºC (unless receiving therapeutic hypothermia) or >37.9 ºC should be conveyed to the NUM and a member of the medical team (doctor or nurse practitioner)

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.

Mechanisms of heat loss

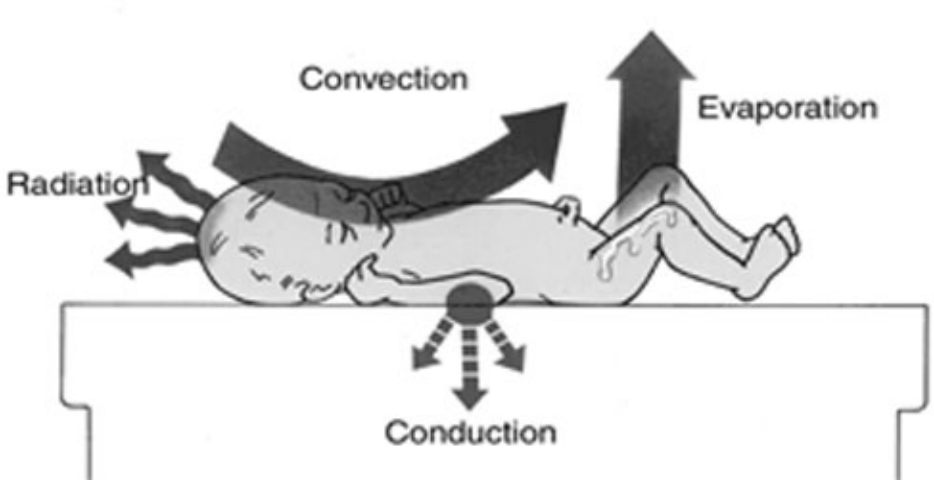


Image 1. Mechanisms of heat loss in neonates (Postnatal Care Module:2012)

The four mechanisms of heat loss in the newborn infant are:[2, 8, 14]

Mechanism	Definition
Radiation	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.
Convection	Heat transfers via air currents, e.g. cold draughts
Conduction	Heat transfer via direct contact, e.g. cold scales, hands and clothing.
Evaporation	Heat loss by conversion of liquid into vapour, e.g. wet and dry skin under radiant warmer.

Mechanisms of heat production[1, 11, 12, 14, 15]

MECHANISM	SOURCE
Increased metabolic activity	• The brain, heart and liver produce the most metabolic energy by oxidative metabolism of glucose, fat and protein. • The hypothermic infant is at risk for respiratory distress, hypoxia and hypoglycaemia - respiration and blood glucose should be monitored closely
Peripheral vasoconstriction	• In response to cooling, peripheral vasoconstriction reduces blood flow to the skin and decreases loss of heat from the skin surface. Superficial vasoconstriction causes the mottled appearance of the skin. • Preterm infants have poor vasomotor control, limiting their ability to control vasoconstriction.
Shivering and non-shivering thermogenesis.	• Due to immature neonatal muscles, preterm infants do not shiver in response to the cold. Term babies will shiver at a temperature of 32-34 ºC and lower • Non-shivering thermogenesis is the production of heat by metabolism of brown adipose tissue and is the primary source of heat production in neonates. Brown adipose tissue is evident after 26 weeks of gestation and is predominant around the kidneys, scapular region, adrenals and neck.

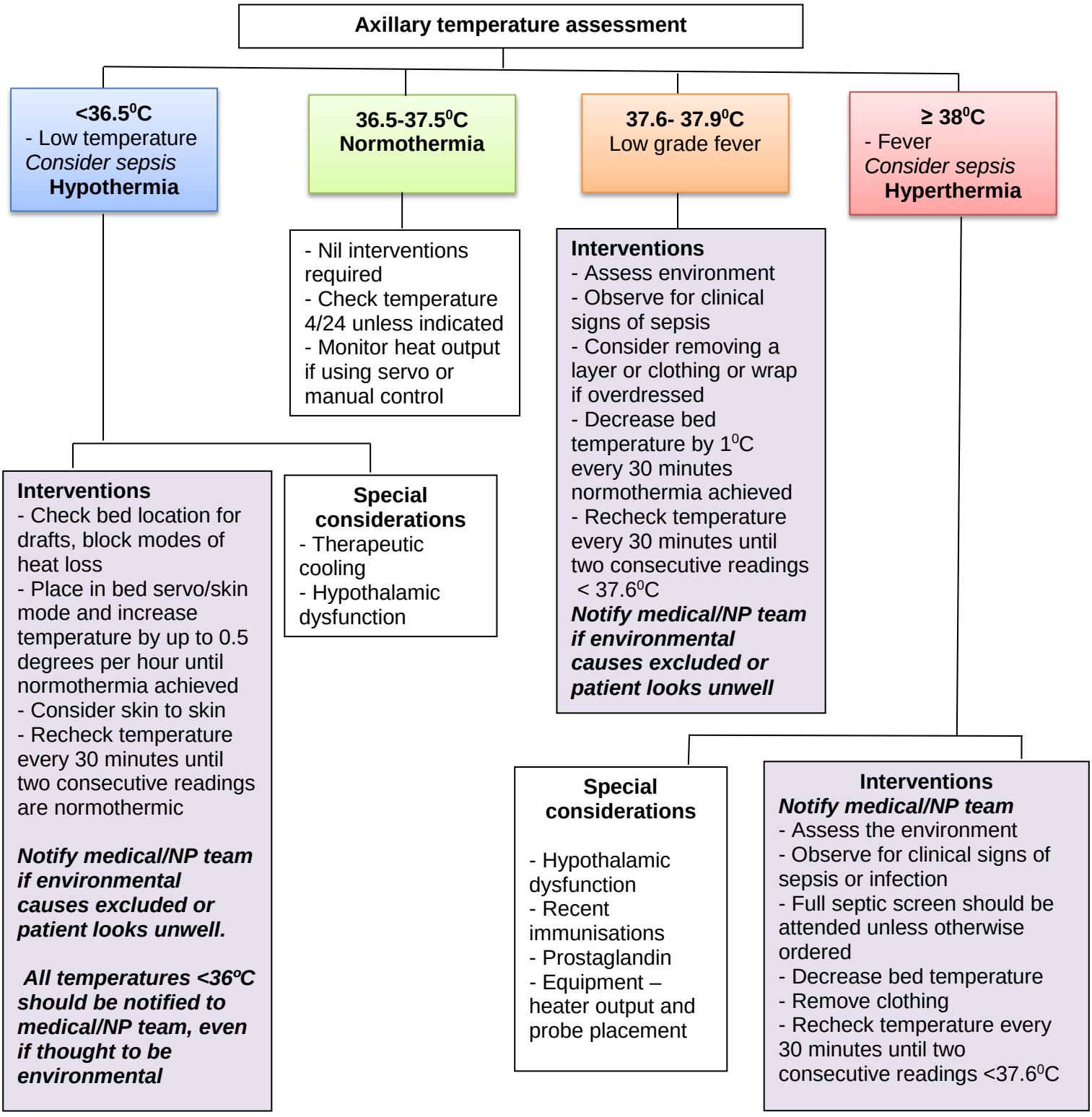
Temperature assessment and maintenance

Temperature Maintenance

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

Component	Recommendations
The environment	• Ensure the infant is nursed away from draughts.[2] • Pre-warm heating source and linen prior to transferring infant to the bed. • Warm hands and stethoscope prior to contact.[3] • For infants <1000 grams or <28 weeks, an operating theatre or catheter lab temperature of 25ºC is recommended. With the operating theatre temperature documented in the infant's medical record.
Bathing and weighing	• The infant is not bathed in the first 24 hours of life. • Check axillary temperature before bathing and weighing.[2] • Postpone weight/bath until temperature is normal/stable.[2] • Ensure that the infant is wrapped for the procedure to reduce heat loss and stress. Weigh the blanket and deduct from the total weight to obtain the infant's weight.
Inhaled gases	• Heating and humidifying the inspired gases is necessary for infants receiving CPAP, Humidified HFNC or mechanical ventilation.[1]
Transfer and transport	• Use transport bed rather than a cribette when transferring the infant to another department. • As a minimum, the temperature should be checked prior to departing GCNIC, on arrival at another department and upon return to GCNIC. • A bair hugger is available in Fluroscopy to assist with thermoregulation in the imaging department • The temperature should be checked every 30 minutes when in the Medical Imaging Department (e.g. MRI), as the environmental temperature may be lower and the baby may spend considerable time outside the transport incubator.

Temperature assessment



Modified from RCH (2020)[17]

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

Hypothermia

Hypothermia in the newborn period 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.[12]

Signs and symptoms of Hypothermia[12, 13]

- 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.[2] • Increase heat source by 0.5 degrees every 30 minutes • Apply beanie/bonnet to head. • Add a layer of clothing or extra blanket (within SIDS guidelines).
Moderate Hypothermia (32 - 35.9 ºC)	• 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 neonate's axilla temperature every **half hour** after each intervention.
- Rewarming the infant may take several hours; rapid rewarming may cause apnoea and possible neurological injury [11]

- 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. [2]
- The hypothermic infant is at risk for respiratory distress, hypoxia and hypoglycaemia, therefore respiration and blood glucose should be monitored closely [11]

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. Regardless of the cause, hyperthermia can have damaging consequences. [12, 14]

Signs and symptoms of Hyperthermia[1, 12,14]

- 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 ≥38ºC notify Doctor/NP, 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

To help maintain a newborn in their neutral thermal zone, incubators or over-head radiant warmer beds are used. Open-care systems with radiant warmers are used for late preterm and term infants with more mature thermoregulatory systems.[8] The open-care system permits better observation, and makes procedures such as vascular cannulation, mechanical ventilation, surgical wound care and parent contact easier. [14]

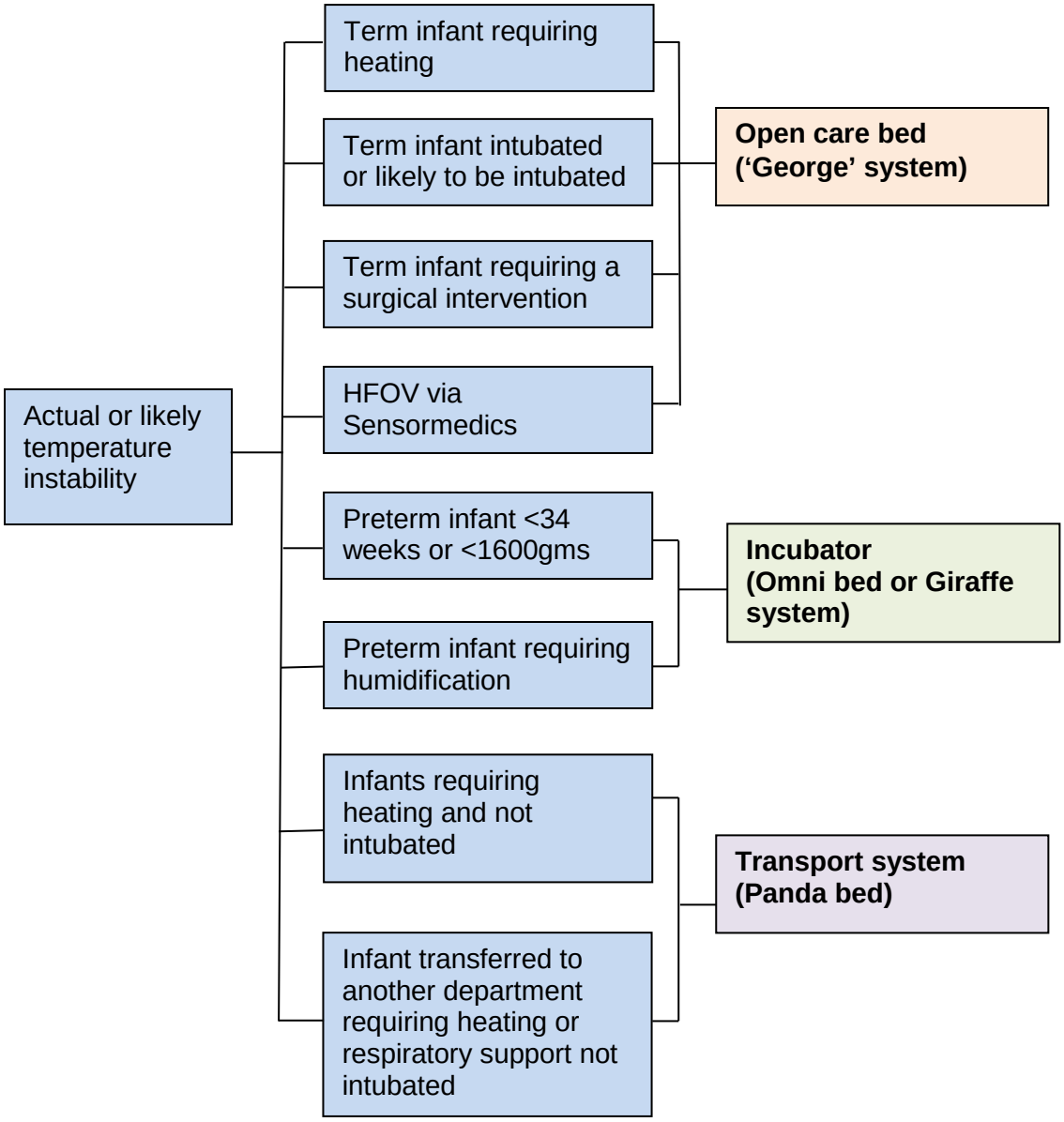
Mode of heating	Information
Servo-controlled/skin mode[2,9]	• Used for infants nursed on an open-care radiant warmer and is the preferred mode for patients nursed in an incubator • Controls the infant's temperature in a specific range by adjusting the radiant heater output to achieve the desired pre-set skin probe temperature • Useful in rewarming a hypothermic infant, as the probe temperature can be set 1.0 – 1.5ºC higher than the infant's axillary temperature • *If an infant becomes overheated, reduce 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 reduce temperature by 1.0 degree every 30 minutes until axilla normalises, then switch back to skin mode*
Manual mode on a radiant warmer[9]	• Used for short-term pre-warming of the bed for expected admissions or during skin-to-skin • Allows the infant to be assessed and stabilised without the risk of hypothermia • *Pay careful attention to prevent hyperthermia or hypothermia as manual mode does not have a 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 (incubator)	• Air mode is generally only used to preheat the incubator prior to the baby being placed into the bed. • Air mode may also be used during a procedure where the skin probe needs to be removed.
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 Small Baby Protocol for additional information on humidity and air mode.

For additional information on management of normothermia or hypothermia of an infant in an incubator or open care system click on the break out links.

Equipment

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



Modified from RCH 2020[17]

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 abdominal skin temperature should be maintained at 36-37°C.[3] Once the infant is transferred into a bassinette/cribette, the axillary temperature is recorded every 4 hours.

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.[11]

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

- When transferring from an open-care system to a cribette, ensure that wraps and clothes are comfortably warm.
- Before transferring an infant from an open-care system to a bassinette, 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 for at least four hours after transfer to a bassinette and thereafter the axillary temperature is measured every four hours.
- The infant should not be bathed prior to transferring to a cribette.

Appendix

Neutral Thermal Zone Chart[17]

Age	Weight (grams)	Starting Temperature (°C)	Range of Temperature (°C)
0 – 6 Hours	< 1200	35.0	34.0 – 35.4
	1200 – 1500	34.1	33.9– 34.4
	1501 – 2500	33.4	32.8 – 33.8
	> 2500	32.9	32.0 – 33.8
6 - 12 Hours	< 1200	35.0	34.0 – 35.4
	1200 – 1500	34.0	33.5 – 34.4
	1500 – 2500	33.1	32.2 – 33.8
	> 2500	32.8	31.4 – 33.8
12 - 24 Hours	< 1200	34.0	34.0 – 35.4
	1200 – 1500	33.8	33.3 – 34.3
	1501 – 2500	32.8	31.8 – 33.8
	> 2500	32.4	31 – 33.7
24 – 36 Hours	< 1200	34.0	34.0 – 35.0
	1200 – 1500	33.6	33.1 – 34.2
	1501 – 2500	32.6	31.6 – 33.6
	> 2500	32.1	30.7 – 33.5
36 – 48 Hours	< 1200	34.0	34.0 – 35.0
	1200 – 1500	33.5	33.0 – 34.1
	1501 – 2500	32.5	31.4 – 33.5
	> 2500	31.9	30.5 – 33.3
72 – 96 Hours	< 1200	34.0	34.0 – 35.0
	1200 – 1500	33.5	33.0 – 34.0
	1501 – 2500	32.2	31.1 – 33.2
	> 2500	31.3	29.8 – 32.8

Age	Weight (grams)	Starting Temperature (°C)	Range of Temperature (°C)
4 – 12 Days	< 1500	33.5	33.0 – 34.0
	1501 - 2500	32.1	31. – 33.2
	> 2500	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	30.5 – 32.6 29.4 – 32.3 29.0 – 32.2 29.0 – 31.4 29.0 – 31.4
12 -14 Days	< 1500	33.5	32.6 – 34.0
	1501 - 2500	32.1	31.0 – 33.2
	Over 2500	32.8	31.8 – 33.8
	> 2500	29.8	29.0 – 30.8
2-3 weeks	< 1500	33.1	32.2 – 34.0
	1501 - 2500	31.7	30.5 – 33.0
3-4 weeks	< 1500	32.6	31.6 – 33.6
	1501 – 2500	31.4	30.0 – 32.7
4-5 weeks	< 1500	32.0	31.2 – 33.0
	1501 – 2500	30.9	29.5 – 35.2
5-6 weeks	< 1500	31.4	30.6 – 32.3
	1501 – 2500	30.4	29.0 – 31.8

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