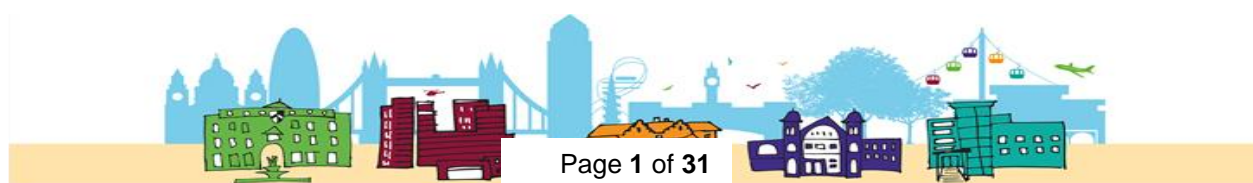


TITLE:	Servo-controlled thermoregulation (SCTR) in an extreme preterm and/or extremely low birth weight infants during Neonatal Transport. (PREMWARM)			
OWNER	London Neonatal Transfer Service, Royal London Hospital, Bart's Health NHS Trust.			
AUTHORS	Pankaj Sakhuja (Consultant), Akif Barlas (ST8 Registrar), Neha Sharma (Senior Clinical Fellow).			
Ratified by: NTS Guideline Committee	1. Dr Pankaj Sakhuja (NTS Guideline Lead)	Date Approved:	June 2020	
	2. Dr Nandiran Ratnavel (NTS Clinical Lead)	Effective From:	June 2020	
	3. Dr Syed Mohinuddin (Neonatal Consultant)	Review date:	June 2022	
STANDARDS Statement of the evidence base of the guideline. (CEBM (oxford) 2011 Level of Evidence and SIGN with some modifications) (Level of Evidence (LOE) and Grades of Evidence (GOE)) *NIG – National and International Guidance	NIG*	NICE Guidance, BAPM Guidance, Royal College Guideline, WHO (please state which source).	Source	REF
	1a	Meta-analysis/Systematic review of the Randomised Controlled Trials.	Grade A (LOE:1a,1b)	7,11
	1b	Randomised Control Trials.		1,12
	2a	Systematic Review of Cohort and Case control studies. (Non-randomised controlled studies)	Grade B (LOE:2a,2b)	9
	2b	High quality Cohort and Case control studies. (Non- randomised controlled trials)		21
	3	Poor quality Cohort and Case control Studies	Grade C(LOE:3)	17,18,22
	4	Systematic review of and/or Non-experimental/ Non- Analytical descriptive studies (i.e. case series, case reports, comparative/ correlation, Surveys etc)	Grade D (LOE:4,5,6)	4, 8, 14, 15,19,23 ,24,25
5	Expert opinions, Quality improvement, expert committee reports, clinical experiences of respected authorities, Literature review, physiology bench research.	2,3,6,13, 16,21,27 ,28		
6	Based on the Local best practise and clinical experience.		5,10,26	
RELATED DOCUMENTS	Thermoregulation in preterm infants, Tecotherm set up guide.			
AUDIT MEASURES:	<ol style="list-style-type: none"> 1. Rate of usage of SCTR in eligible infants transferred by London NTS. 2. Effectiveness (Hypothermia, normothermia and hyperthermia rates; NTS 1st assessment, before starting warming (Prewarming), pre-departure and on arrival at the accepting units). 3. Starting SCTR within 30 mins of arrival at the referring centre. 4. Time taken to achieve normothermia and Temperature homeostasis (Rectal and Surface temp equilibrium (gap of <0.5°C)). 5. Drop in the Mattress and Infants' temperatures and duration for which Tecotherm was switched off during transfer between unit and ambulance. 6. Time spent on Tecotherm mattress and time spent on the road. 7. Safety (Any adverse effects) of using Tecotherm Neo for preterm warming. 			
SCOPE OF APPLICATION AND EXEMPTIONS (Target Users)	<ul style="list-style-type: none"> • All the staff of London Neonatal Transfer Service, without exemption. • NTS service users: All Neonatal Units within and around London (For Information ONLY) • Neonatal Transport Group (NTG) 			
CONSULTATION	Bart's Health	<ul style="list-style-type: none"> • Neonatal Transfer Service Guideline Committee • Neonatal Service Guidelines Group • Children's Hospital guidelines group • Trust Clinical Guidelines committee 		
	External Partner(s)	London ODN, Neonatal Transport Group (UK)		
DISTRIBUTION	London Neonatal Transfer Service website and Q Drive, WeShare (Bart's Health) Intranet, LONDON ODN for distribution across units in London and NTG.			
LOCATION	INTRANET: http:// [file location] , INTERNET: www.london-nts.nhs.uk/			
DISCLAIMER	This Guideline has been registered with Bart's Health NHS trust however it is a guide only. It is the responsibility of the individual clinician for the interpretation and application in context to patient care. They should take full responsibility for the care of their patient. NTS will be happy to advise on the stabilisation and care of any neonate accepted for transfer.			



EXECUTIVE SUMMARY

The use of Servo-controlled device and mattress (SCDM) in addition to the routine thermal care is aimed to improve the quality of thermoregulatory support to ensure normothermia in extreme preterm and extreme low birth weight (ELBW) infants during neonatal transport.

Aim: This guideline is intended to help NTS staff to use Tecotherm Neo as an adjunct to routine thermal care in an extreme preterm and/or ELBW infant during inter-hospital transfer.

Eligibility criteria:

1. <28/40 Weeks GA.
2. And /OR weight of <1kg
3. And <14 days old

Contraindications:

1. Severe bruising.
2. Extremely fragile and/or broken skin.
3. Imperforate anus.
4. Suspected NEC.
5. Coagulopathy or active bleeding

Risk:

1. Hypothermia or hyperthermia.
2. Burns
3. Rectal perforation or damage.
4. Rectal bleeding.

In Event of Adverse incident:

1. Discontinue the Tecotherm and document the type of complication.
2. Give appropriate medical treatment.
3. Remember Duty of Candour
4. Complete the incident reporting when back at base.

Trouble shooting:

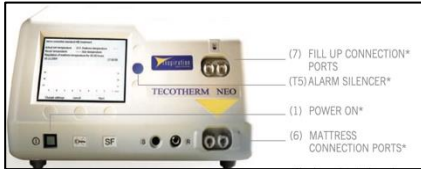
- (persistent Hypothermia and Hyperthermia, failure to achieve temperature homeostasis (Core and Surface temperature equilibrium (gap 0.3-0.5))
1. Check and optimise incubator temperature and humidity
 2. Check axillary temperature.
 3. Check rectal and skin probe position.
 4. Check Tecotherm settings and mattress temperature.
 5. Address any alarms.
 6. If mattress temperature remains lower than 39°C despite persistent hypothermia, use constant mattress mode with mattress temperature set at 39°C.
 7. Reassess every 15 minutes.
 - Temp < 36.5°C: Minimal handling and defer any procedure until temperature improves
 - Temp 36.5°C – 37.5°C: Continue Tecotherm warming and maintain thermo neutral environment
 - Temp > 37.5°C: Turn off Tecotherm Neo, restart if temperature drops < 36.5°C.

- ❖ The Servo-controlled thermoregulation (SCTR) (PREMWARM) monitoring sheet should be completed for all the infants who meet the eligibility criteria irrespective of whether Tecotherm Neo is used or not.
- ❖ Reasons for not using the SCTR, any adverse events and any deviation from the protocol should be documented.



PREMARM FLOW CHART

PRE-ARRIVAL/EN ROUTE TO REFERRING CENTRE:



- Ascertain the eligibility of the infant.
- Plug the Tecotherm to the power supply in the ambulance.
- Set transport incubator temperature at 37 °C
- Place mattress, drape and Neowrap in incubator (to warm)

AT REFERRING CENTRE:

Prewarm Mattress:

- Select "constant mattress temperature" mode.
- Set temperature to 37 °C
- Default maximum upper temperature limit is set at 39°C.
- Press "Apply" and then "Start"

Rectal probe insertion:

- Apply water soluble gel to the rectal probe tip.
- Measure and Insert the rectal probe (1.5-2 cm)
- Fix the probe as per guidelines
- Attach probe to Tecotherm



- Record observations, axillary, skin, and hospital's Incubator temperature on Prem warm monitoring and routine observations Sheet.
- Fill device and mattress as per Tecotherm Neo set up guidelines and start.
- Perform and document thorough assessment of the infant including any contraindications.
- If eligible, start warming as soon as possible (aim within 30 mins)
- Confirm local unit's incubator temperature and set the transport Incubator temp atleast at 37°C (max 38.8 °C)

Place the Tecotherm mattress in the local hospital's incubator

- Confirm mattress has achieved target temperature of 37 °C
- Place a nest made up of prewarmed sheets around the infant
- Place the mattress inside the nest and cover it with a prewarmed drape.
- Place the baby on the Tecotherm Neo mattress.
- Insert rectal probe and attach to the Tecotherm Neo device.
- Change mode to servo-controlled constant rectal temperature mode with target rectal temperature set at 37°C.
- Cover patient with the Neowrap.
- Record rectal, skin, mattress, and incubator temperature every 15 mins.

Move the infant in transport incubator once temperature $\geq 36.5^{\circ}\text{C}$ and Rectal and axillary temperature equilibrium reached (Temp gap $< 0.5^{\circ}\text{C}$)



Ensure rectal and axillary temperature equilibrium (Temp gap < 0.5)
The baby's temperature should be $\geq 36.5^{\circ}\text{C}$ before leaving.

DURING TRANSFER



- Ensure infant temperature remains stable.
- Actively watch for any adverse events

AT ACCEPTING CENTRE

- Document observations and all the temperatures.
- Handover including details of temperature control and rectal probe.
- Ensure the local unit's incubator temperature and humidity are set as per the infant's requirement.
- Remove the rectal probe before transferring to receiving cot.
- Observe tip of the probe for any fresh blood or iatrogenic skin lesion.
- Check post warming skin condition and any local injury
- Document all the positive and negative results in the clinical notes.



Evidence Chart:

- ❖ The extremely preterm and extremely low birth weight (ELBW) infants are prone to severe hypothermia during interhospital transfer. **Grade D (LOE:5)**
- ❖ Additional warming techniques along with routine care lead to higher temperatures on admission to NICUs in extremely preterm infants. **Grade A (LOE:1a)**
- ❖ Non thermal controlled warming mattress (gel and water) is successfully combined with other warming techniques for thermoregulation in Preterm infants but due to considerable variability in their warming effects and non-servo-control nature they carry a risk of potential serious burns, hyperthermia and hypothermia. **Grade D (LOE:4,5,6), BAPM**
- ❖ The contact surface temperature above 40°C is considered to be a risk for burns. **Grade D (LOE:5)**
- ❖ Prewarmed thermal controlled mattress at temperature of 37°C along with radiant warmer leads to a quicker improvement of temperature in preterm infants in NICU. **Grade A (LOE:1b)**
- ❖ Servo-control of abdominal skin temperature at 36°C reduces the neonatal death rate among low birth weight infants in NICU. **Grade A (LOE:1a)**
- ❖ Servo-control thermoregulation (**SCTR**) in ELBW infants during transport of infants born at ≤28 weeks via rectal temperature monitoring is feasible and effective for thermoregulation. **Grade D (LOE:6)**
- ❖ Best site for the probe-measured skin temperature is at the right hypochondrium of abdomen. **Grade B (LOE:2b)**
- ❖ Prolonged rewarming in newborn may be associated with adverse neonatal outcomes and rapid rewarming is not harmful. **Grade C(LOE:3)**
- ❖ Hypothermic newborn should be rewarmed as soon as possible. **WHO**
- ❖ The skin temperature is lower than the rectal temperature. Optimal rectal temperature is 36.5-37.5 °C, optimal axillary temperature is 36.5°C–37.3°C and optimal skin temperature is 36.2-37.2 °C. **Grade D (LOE:4)**
- ❖ Optimal skin temperature that should be maintained for normal heart rate is between 36.8°C and 37°C. **Grade D (LOE:4)**
- ❖ Rigid glass mercury rectal thermometer carries a risk of rectal trauma and perforation. **Grade D (LOE: 4)**
- ❖ Rectal catheters inserted up to 1.5 - 2 cm for saline/glycerine enemas in <1000 grams and <28 weeks is not associated with perforation. **Grade D (LOE:5)**
- ❖ The skin and axillary temperatures may read higher than the rectal temperature initially during provision of external heat for thermoregulation in hypothermic infants. It may take some time for heat transfer from skin to the core and to achieve equilibrium between core and surface temperature. **Grade D (LOE:6)**



1. INTRODUCTION / PURPOSE OF THE GUIDELINE:

- 1.1. Thermoregulation can be a major challenge as standard practices and routine thermal care may not be adequate for prevention of hypothermia in preterm and/or low birth weight infants. Additional warming techniques with routine care led to higher temperatures on admission to NICUs with less hypothermia, particularly for extremely preterm infants. [1]
- 1.2. The extremely preterm and extremely low birth weight (ELBW) infants are prone to severe hypothermia during interhospital transfer.[2] Additional warming techniques are therefore needed to provide optimal thermoregulation.
- 1.3. Non thermal controlled warming mattress (water and gel) provide conductive and radiant heat and is often combined with other warming techniques (closed incubators, radiant warmers, hats, blankets and plastic bags).[1,3] These mattresses are successfully used as an adjunct for the temperature control but due to considerable variability in their warming effects and non-servo-control nature they carry a risk of potential serious burns, hyperthermia and hypothermia.[3-6]. A safety warning has also been recently issued by the British Association of Perinatal Medicine (BAPM) about their use alongside other heat sources carrying a significant risk of severe burns [7].
- 1.4. The servo-controlled device with mattress (SCDM) with rectal temperature probes for Therapeutic Hypothermia (TH) is now a standard of care in term infants with Hypoxic-ischemic encephalopathy during neonatal transport.[8] The use of this device to provide heat by setting up at a constant mattress temperature of 37°C in a non-servo-controlled way has shown to improve hypothermia in ELBW infants in the neonatal unit [9]



- 1.5. There is no literature on its use for servo-control thermoregulation (**SCTR**) in ELBW infants either in NICU or during neonatal transport. It can be used effectively for thermoregulation during transport of infants born at ≤ 28 weeks via rectal temperature monitoring. (10)
- 1.6. The aim of this guideline is to aid neonatal transport service to use Tecotherm neo (an SCDM) as an adjunct to routine thermal care in extremely preterm and/or extremely low birth weight (ELBW) infants during inter-hospital transfer.

2. IMPLEMENTATION:

- 2.1. The guideline will be disseminated to the NTS team via an email and will be presented in the guidelines meeting. It will be available in the guideline folder on the shared drive and will also be placed on the hospital Intranet and NTS website.
- 2.2. The guideline will be sent to the London ODN for dissemination to all the London Neonatal units and shared with Neonatal transport group (NTG).

3. ROLES AND RESPONSIBILITIES

- 3.1. The whole team (doctor, nurse, and ambulance technician) is expected to work together to ensure normothermia in extreme preterm infants during inter-hospital transfer. The decision to use the Tecotherm Neo for thermoregulation remains the responsibility of the transport doctor along with the nursing staff.
- 3.2. It is important that the infant is placed on the servo-controlled warming mattress set to rectal temperature of 37°C within 30 mins of arrival at the referring hospital.
- 3.3. When mattress is used in the incubator of the referring hospital it important to ensure that the incubator is on skin servo-control mode set to infant's skin temperature of 36.8°C with skin temperature probe properly placed on the infant abdomen as it is considered to be most reliable. [11-16]



3.4. Transport doctor

- 3.4.1. Will ensure patient's eligibility as per the protocol and look for any contraindications and risks.
- 3.4.2. Will be responsible for a thorough assessment of the infant including physical examination, documenting the condition of the skin, patency of anus and abdominal examination.
- 3.4.3. Will discuss his assessment about the eligibility and contraindications or any other concerns with the nursing staff and the duty consultant. If no concerns found, every attempt should be made to start SCTR as soon as possible (aim to start within 30 mins of arrival)
- 3.4.4. Will complete the SCTR monitoring sheet for all infants who fulfil the eligibility criteria irrespective of whether it was started or not. The reasons for not using Tecotherm Neo for thermoregulation should be clearly documented. It is important to complete the temperature summary and document any adverse event or if there was any deviation from the protocol.
- 3.4.5. Will monitor for and address any potential adverse event but not limited to rectal perforation, rectal bleeding, skin damage from probe dressings, hypothermia, hyperthermia and burns from the mattress.
- 3.4.6. Will check full-body skin condition and annotate the body map if required at the end of the transfer.
- 3.4.7. Complete and file the SCTR monitoring sheet into the study folder on returned to base.

3.5. Nursing staff

- 3.5.1. They, along with the transport doctor, will assess infant's eligibility and contraindications and contribute in decision making.



- 3.5.2.** If no concerns found and decision is made to initiate SCTR then they will ensure to start Tecotherm Neo as soon as possible (aim to start within 30 mins of arrival)
- 3.5.3.** They are responsible for preparing and starting of Tecotherm Neo which include setting up the Tecotherm unit and mattress as per the set up guide, inserting and securing rectal probe and regularly checking and documenting infant's temperature (axillary, skin, incubator and rectal) on the SCTR monitoring sheet at 15 minutes interval.
- 3.5.4.** They will monitor for and address any potential adverse event but not limited to rectal perforation, rectal bleeding, skin damage from probe dressings, hypothermia, hyperthermia and burns from mattress.
- 3.5.5.** They will be responsible for the full body skin assessment pre and post warming.
- 3.5.6.** Will ensure that the SCTR monitoring sheet is complete and then photocopied and filed in the study folder on return at the base.

3.6. Ambulance Technician

- 3.6.1.** Will assist the medical and nursing staff in setting up and ensuring the Tecotherm equipment is functional during the stabilisation of the infant and for the transfer.
- 3.6.2.** Timekeeping and note taking is also of importance and they may assist with recording the observations and supporting families when needed.

4. GUIDELINE

- 4.1.** The philosophy of neonatal transport is to keep the baby stable, aim to improve the clinical status and ensure safe transfer of the infant to an appropriate neonatal unit.



- 4.2.** The use of Tecotherm in addition to the routine thermal care is aimed to improve the quality of thermoregulatory support to ensure normothermia in extreme preterm and extreme low birth weight (ELBW) infants during neonatal transport.
- 4.3.** It is important that the temperature in a hypothermic infant is brought to normothermia quickly. Prolonged rewarming may be associated with adverse neonatal outcomes and rapid rewarming is not harmful. [17,18] WHO also recommends that a hypothermic newborn should be rewarmed as soon as possible. [11]
- 4.4. Servo-control device and mattress (Tecotherm Neo):** The Tecotherm Neo is a servo-controlled thermoregulation mattress designed for controlled cold and heat treatment procedures. The mattress, which was previously filled with alcohol-based fluid and now sterilised water, is either cooled down or warmed up in the Tecotherm Neo device and continuously flows through the mattress. The patient is provided with cold or heat therapy in a fully controlled and targeted way by this circulating fluid. The patient's temperature is continuously monitored with a rectal probe connected to the machines microcomputer that will adjust the mattress temperature in order to maintain baby's core (rectal) temperature at 37°C.



Figure 1: Servo-control device and mattress (Tecotherm Neo)

4.5. Eligibility criteria

- $\leq 28/40$
- And / or ≤ 1 kg.
- And < 14 days old at the time of referral.

4.6. Exclusion criteria (Contraindications)

- Infants with severe bruising
- Infants with extremely fragile skin and/or broken areas
- Imperforate anus.
- Suspected Necrotising Enterocolitis
- Other gastrointestinal pathology
- Known coagulopathy, active bleeding, or bleeding tendency

4.7. Risk:

- Hypothermia or hyperthermia.
- Burns
- Theoretical risk of conflict between 2 different servo-controlled devices (incubator and mattress) used with each other and being controlled by 2 different temperatures (Skin and Rectal)
- Rectal perforation or damage.
- Rectal bleeding.

4.7.1. Hypothermia, Hyperthermia and Skin burns:

4.7.1.1. Clinical studies and case reports of water and gel warming mattresses have reported hypothermia, hyperthermia, and serious burns. [3-6,9,19]



- 4.7.1.2.** Hypothermia was noted in a study on term infants where the water filled mattress temperature was kept constant at 37°C in a nursing cot in an environment at a room air temperature of 20°C.
- 4.7.1.3.** Hyperthermia has been documented with use of mattress along with other heat sources. It is also noted that there is a considerable variability in their warming effects of gel mattress depending upon the temperature at which they are activated. [3-6,9,19]
- 4.7.1.4.** Various authors have suggested the contact surface temperature above 42°C to be a risk for burns [4,7,19] This data is based on experiments in adult subjects with mature healthy skin [4,19] and from experience using transcutaneous oxygen monitoring in neonates.[7] One case report on severe burns from warming mattress mentioned the water temperature of around 40°C in their case although in their discussion and conclusion suggested to keep the mattress temperature less than 42 °C. [4] A literature review on effectiveness and risks of warming mattresses in Newborn stated that no cases of burns have been reported between the temperatures of 35°C-40°C. [3]
- 4.7.1.5.** The default upper limit of the Tecotherm Neo mattress temperature is set at 39 °C. [20] This mitigates the risk of burns with temperature above 40 °C
- 4.7.2. Risk of conflict between two different servo-controlled devices:**
- 4.7.2.1.** The manikin studies representing extremely low birth weight infants, having an internal temperature (representing core temperature) of 37°C and surface temperature (representing skin temperature) of 36.8°C have shown that the warming mattress in a closed **Air servo controlled** double walled incubator (set to air temperature of 35.6°C)



can generate a microclimate by increasing the temperature of an air above the infant, which reduces radiant, convective and evaporative heat loss.

- 4.7.2.2.** The incubator was not **Skin servo controlled** and the incubator heating system was turned off for 30 minutes as a precautionary measure after the warming mattress had been activated to avoid excessively rapid increase in the manikin's core temperature.
- 4.7.2.3.** Turning off the incubator led to the drop in the air temperature in the incubator and later the drop in the skin (surface) temperature of the manikin while maintaining its core temperature. Having the manikin's in a skin servo-controlled incubator would have mitigated this drop in the skin temperature and incubator would not need to be switched off. Subsequently only 2/3rd of the incubator's heater output was required and adjusted manually in order to provide required air temperature in the incubator (3°C reduction from the previous incubator temperature) to maintain the manikin's core temperature. [3,21]
- 4.7.2.4.** The use of warming mattress whose surface temperature did not exceed 40°C add heat to the system that enabled a 3-5% reduction in the incubator's heating power. They suggested that the use of an incubator with a skin servo control operating mode is preferable when a warming mattress is employed in an incubator to stabilise the body temperature. [3,21]
- 4.7.2.5.** In manikin studies, the mattress temperature was not servo controlled by manikin's core temperature neither was the incubator air temperature by manikin's surface temperature.



- 4.7.2.6.** In clinical studies as in section 4.6 above the mattress was either at a constant temperature or had a considerable variability in their heat generation.
- 4.7.2.7.** To avoid the risk of hypothermia and hyperthermia continuous measurement of the rectal and abdominal skin or axillary temperature is vital and it is preferable to use an incubator in a skin servo control operating mode when a mattress is employed in an incubator. [3]
- 4.7.2.8.** The skin temperature is normally lower than the rectal temperature. Neonatal texts suggest that rectal temperature should be 36.5-37.5 °C, axillary temperature should be 36.5°C–37.3°C, skin temperature should be 36.2-37.2 °C and targeting the abdominal skin temperature between 36.8-36.9 °C is optimal and maintains HR within normal limits. [15,16]
- 4.7.2.9.** Extrapolating these observations, the use of servo-controlled mattress to rectal temperature of 37 °C in a servo-controlled incubator to abdominal skin temperature of 36.8 °C would be optimal
- 4.7.3. Rectal Trauma/Perforation:**
- 4.7.3.1.** Rectal probe provides constant temperature monitoring which is vital for feeding back data to the Tecotherm machine for servo control, facilitating dynamic adjustment of the mattress temperature for TH treatment in infants with HIE during Neonatal transport. [22]
- 4.7.3.2.** Rectal probes carry a potential risk of rectal trauma and perforation.
- 4.7.3.3.** Rectal perforation following the insertion of older rigid glass mercury rectal thermometer has been reported in the literature. [23-25]
- 4.7.3.4.** Insertion of rectal probes is an established practice for various surgical procedures such as rectal washouts whereby it is standard



practice to insert a rectal catheter at a depth of 2-3 cm in a preterm infant. [26]

- 4.7.3.5. Various studies have used rectal catheters in <1000 grams and <28 weeks up to 1.5 - 2 cm for saline/glycerine enemas with no reported cases of perforation. [27,28]
 - 4.7.3.6. Locally, we uses Measurement Specialities 4491 (MEAS 4400 Series Temperature probe) which is a 9 French (3mm diameter), 76 cm long, which is very soft and highly flexible and has a white PVC sleeve encasing a lead wire with a smooth rounded tip for non-traumatic insertion.
 - 4.7.3.7. Based on this and in conjunction with general advice from local paediatric surgeons we insert the rectal probe at 1.5-2 cm, to minimise the risk of rectal perforation.
 - 4.7.3.8. Other precautions include avoiding its use if there are already concerns of necrotizing enterocolitis, gut perforation, imperforate anus, or severe localised bruising.
- 4.8. At the time of referral**

- 4.8.1. Ask for the current temperature in all preterm infants and advise about providing optimal thermal care as per our thermoregulation guidelines in preterm infants including optimising the incubator temperature and humidity, using plastic sheets, warm blankets if needed, keep the incubator doors closed and avoiding all procedure other than emergency procedures in a hypothermic infant.

4.9. Pre-arrival/ En route to referring centre

- 4.9.1. Ascertain the eligibility of the infant.
- 4.9.2. Set transport Incubator temperature to 37°C.



4.9.3. Keep the Tecotherm mattress, Neowrap plastic and drapes/sheets inside the incubator, so that it can be pre-warmed

4.10. At the referring centre

4.10.1. Confirm the patient's eligibility for Tecotherm warming.

4.10.2. Set up the SCDM (Tecotherm Neo) for Preterm warming:

- Fill device and mattress with sterile water as per manufacturer's instruction.
- Set Tecotherm mattress to run in constant mattress mode and set the temperature to 37°C.
- The default upper maximum temperature limit of the mattress is 39°C as set by the manufacturer. This mitigates the risk of burns.

4.10.3. Record and document on arrival assessment on the SCTR sheet:

- Vitals (HR, Spo2, and Blood Pressure)
- Ventilatory parameters (MAP, Fio2)
- Blood gas and blood sugar.
- Cranial USG findings if available.
- Medications (eg Inotropes)
- Temperatures: Axillary, Skin, and local hospital's Incubator temperature

4.10.4. Perform a thorough assessment of the infant including physical examination, documenting the condition of the skin, patent anus and abdominal exam and look for any contraindications and risks.



- 4.10.5.** If the infant meets the eligibility criteria and there is no contraindication, then start Tecotherm warming as soon as possible (aim to start within 30 mins of arrival)
- 4.10.6.** Record and document Prewarming assessment on the SCTR sheet
- Skin assessment.
 - Set of vitals (HR, Spo2, and Blood Pressure)
 - Ventilatory parameters (MAP, Fio2)
 - Blood gas and blood sugar.
 - Cranial USG findings if available.
 - Medications (eg Inotropes)
 - Temperatures: Axillary, Skin, Rectal, Mattress and local hospital's Incubator temperature.
- 4.10.7.** Place the SCDM (Tecotherm Neo) in the local hospital's incubator:
- Place a Nest made up of prewarmed sheets around the infant or use the same Nest if the infant is in one, in the local hospital incubator.
 - Confirm mattress has achieved target temperature of 37 °C and then place the prewarmed mattress in the nest and cover it with a prewarmed drape.
 - Placing the mattress in the nest and placing the infant over it will provide the maximum contact surface.
- 4.10.8.** Place the baby on the prewarmed mattress (37 °C) and insert the rectal probe.
- 4.10.9.** Rectal probe insertion:
- Apply water-soluble gel to the rectal probe tip.



- Measure and gently insert rectal probe 1.5-2 cm maximum.
- Secure as shown in the diagram below

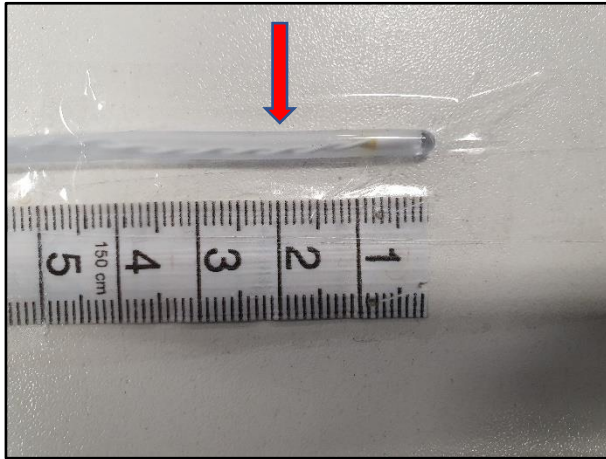


Figure 2: a) Rectal probe



b) Securing of rectal probe

4.10.10. Change mode to servo-controlled constant rectal temperature mode with target rectal temperature set at 37°C.

4.10.11. Set up Tecotherm for servo control

- Select “details” and then “options” on Tecotherm device screen.
- Select “end mode and save data”
- Select “servo control mode (Constant rectal temperature mode)”
- Once confirmed - Press “select” and “confirm” a rectal probe is inserted
- Press “select” and adjust set temperature point to 37 °C
- Press “apply” and then “start” and then “Confirm”

4.10.12. Cover patient with the Neowrap, do not block the airflow around the mattress and tray



Figure 3: a) Tecotherm mattress inside the Nest to maximise the contact surface
b) Patient covered with Neowrap.

4.10.13. Actively watch and document any adverse events on the SCTR monitoring sheet.

4.10.14. Record and document the following during the stabilisation phase:

- Rectal, Skin, Mattress, and Incubator temperature every 15 mins.
- Check the Rectal probe when in doubt based on rectal temperature reading.
- Check the axillary temperature on arrival and when in doubt during stabilisation.
- Set of vitals (HR, Spo2, and Blood Pressure) and ventilatory parameters (MAP, Fio2) at least every 30 mins in the observation sheet
- Blood gas and blood sugar when taken in observation sheet
- Medications (eg Inotropes) in medication sheet

4.10.15. Confirm the transport Incubator is heated to 37°C unless the referring unit's set incubator temperature is higher than 37°C with the aim to maintain consistency and minimal changes to the environment. The

maximum temperature that the transport incubator can be set is 38.8 after which it switches off.

4.10.16. The skin and axillary temperatures may read higher than the rectal temperature initially, because of external heat in hypothermic infants. It may take some time for heat transfer from skin to the core and to achieve temperature homeostasis. (Equilibrium between core and surface temperature: temp gap 0.3-0.5°C)

4.10.17. Stabilise the infant and move baby in transport incubator only when temperature $\geq 36.5^{\circ}\text{C}$ and temperature homeostasis is achieved.

4.11. Predeparture from referring centre:

4.11.1. Ensure infant is stable and temperatures (rectal/skin/axillary) is $> 36.5^{\circ}\text{C}$ and within the normal range. (36.5-37.5).

4.11.2. Transport incubator is not skin servo control and there is no humidity. It is important to check the local unit's incubator temperature on which the normothermia in infant is achieved and set the same or higher (max 38.8) transport incubators temperature.

4.11.3. Tecotherm does not have a battery and will be switched off during the transfer of the infant from the unit to the ambulance. This will lead to drop of the mattress temperature by 2-3 degrees as per our experience.

4.11.4. To mitigate the effects of this mattress temperature drop (contact with a cooler mattress leading to conductive heat loss) ensure the mattress temperature of 39°C is achieved before it is disconnected from the mains and minimal time is taken to transport the infant to the ambulance.

4.11.5. Record and document Predeparture

- Skin assessment.
- Set of vitals (HR, Spo2, and Blood Pressure)
- Ventilatory parameters (MAP, Fio2)
- Blood gas and blood sugar.



- Cranial USG findings if available.
- Medications (e.g. Inotropes)
- Temperatures: Axillary, Skin Rectal, Mattress and Incubator temperature.

4.12. En route to the accepting centre:

4.12.1. Record the 1st set of temperatures in the ambulance as soon as the Tecotherm is connected to the mains and switched on.

4.12.1. Ensure infant temperature remains stable

4.12.2. Actively watch for any adverse events.

4.12.3. Record and document

- Temperatures every 15 mins: Rectal, Skin, Mattress, and Incubator temperature.
- Check the Rectal probe when in doubt based on rectal temperature reading.
- Check the axillary temperature when needed.
- Set of vitals (HR, Spo2, and Blood Pressure) at least every 30 mins
- Ventilatory parameters (MAP, Fio2) at least every 30 mins
- Use standard procedures for stopping the ambulance if intervention required and document.

4.13. On arrival at the accepting center:

4.13.1. At the parking bay the Tecotherm will be disconnected from the mains and mattress will lose heat. To mitigate the effects of the mattress temperature drop (contact with a cooler mattress leading to conductive heat loss) ensure the mattress temperature of 39°C is achieved before it is disconnected from the mains and minimal time is taken to transport the infant to the unit.



4.13.2. In the accepting NICU, record and document

- Skin assessment.
- Set of vitals (HR, Spo2, and Blood Pressure)
- Ventilatory parameters (MAP, Fio2)
- Blood gas and blood sugar.
- Medications (eg Inotropes)
- Temperatures: Axillary, Skin, Rectal, Mattress and Incubator temperature

4.13.3. Handover all aspects of baby's management to receiving team before moving the baby, including details of temperature control and rectal probe.

4.13.4. Ensure all preparations for baby's transfer including setting up the local unit incubator temperature and humidity are made before opening the transport incubator doors.

4.13.5. Remove the rectal probe before transferring to receiving cot. Observe tip of the probe for any fresh blood or iatrogenic skin lesion.

4.13.6. Take assistance from the local unit staff while moving the baby. NTS team should be moving the baby not the unit staff to coordinate the process and reduce the risks.

4.13.7. Check post warming skin condition and document all the positive and negative results in the clinical notes.

4.13.8. Complete the "Transfer completion", "Temperature summary" and "Any Adverse event/Any deviation from the protocol/Comments" sections.



4.14. Monitoring and Documentation:

4.14.1. The SCTR monitoring sheet should be filled in for all preterm infants who meet the eligibility criteria (≤ 28 weeks and/or ≤ 1 kg and <14 days old.)

4.14.2. In Event of Adverse incident:

- Discontinue the Tecotherm and document the type of complication.
- Document all the interventions that were required during transfer.
- Give appropriate medical treatment.
- Remember Duty of Candour.
- Complete the incident reporting form when back at base.

4.14.3. Trouble shooting: (persistent Hypothermia and Hyperthermia and failure to achieve temperature homeostasis (core temperature remains lower than the surface temperatures)

- Check and optimise incubator temperature and humidity.
- Check axillary temperature.
- Check rectal and skin probe position.
- Check Tecotherm settings and mattress temperature.
- Address any alarms.
- If mattress temperature remains lower than 39°C and baby is hypothermic, use constant mattress mode with set the mattress temperature at 39°C .
- Reassess every 15 minutes.
 - Temp $< 36.5^{\circ}\text{C}$: Minimal handling and defer any procedure until temperature improves



- Temp 36.5°C – 37.5°C: Continue Tecotherm warming and maintain thermo neutral environment
- Temp > 37.5°C: Turn off Tecotherm Neo, restart if temperature drops < 36.5°C

Ensure temperature homeostasis (0.3-0.5°C) and the baby's temperature should be ≥ 36.5°C before leaving (Target temperature: 36.5 -37.5)

5. BREACH OF GUIDELINES/POLICIES

5.1 This guideline is to ensure that SCDM (Tecotherm Neo) is used safely and effectively for optimal thermoregulation in an extreme preterm and ELBW infants. It is intended to improve thermal care and maintain normothermia throughout the transfer for extreme preterm infants.

5.2 Each transfer and baby should be considered individually. It may be felt that this therapy or any aspect of this guideline may not be appropriate in a circumstance.

5.3 Noncompliance and deviation from the protocol should be recorded, and the reasons should be clearly documented.

3. MONITORING COMPLIANCE, GOVERNANCE AND EFFECTIVNESS

6.1 Compliance will be monitored during morning team briefing and case discussions by the NTS consultants and feed back to all team members. The importance of thermal control in extreme preterm infants during transport will be emphasised.

6.2 A governance folder will be maintained for all the eligible cases which include a governance checklist, case notes and download from the Tecotherm machine.

6.3 The cases will be reviewed by a consultant/lead nurse/PDN within a week of transfer as per the governance check list along with the Tecotherm download and case notes for eligibility, contraindications, any adverse outcome, if all the



processes for optimal use are followed, any issues noted and completion of Premwarm documentation.

- 6.4** Effectiveness will be measured through departmental audit. All the proformas will be reviewed.



NEONATAL TRANSFER SERVICES GUIDELINE CHECKLIST

	YES	NO
Guideline development/review approved by committee		
Guideline submitted as per agreed deadline		
Guideline submitted using agreed template		
Guideline contains agreed headings		
Title and Headings in Arial font and 14 point		
Sub-headings in Arial 12 point uppercase bold		
All paragraphs are numbered as per agreed convention		
Pages numbered		
Harvard referencing system used and accurate		
Guideline not approved, to be presented at next meeting		
Comments:		



	Date of Approval	Date of next review	Reference number
Guideline approved within neonatal TRANSFER service.			
Guideline submitted to Children's Hospital Guideline Review Board paedclinicalguidelines@bartshealth.nhs.uk			
Final submission to be placed on intranet to: ClinicalGuidelineSubmission@bartshealth.nhs.uk			



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