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Nursing Guidelines for Therapeutic Hypothermia in Neonates

Mories sankar

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I. Introduction

Neonatal asphyxia is a major health issue globally. Birth asphyxia, defined as the failure to establish breathing at birth, accounts for an estimated 900 000 deaths each year and is one of the primary causes of early neonatal mortality. According to the National Institutes of Health (NIH), neonatal hypoxic ischemic encephalopathy (HIE) occurs in around 1 to 6 out of every 1,000 births. HIE is defined as lack of oxygen to the brain, and without immediate treatment, infants are at risk not only of severe brain damage, but death as well. In fact, NIH states that around 15-20% of newborns who develop HIE will die.

In developed countries asphyxia affects 3-5 per 1000 live births. Subsequent development of moderate to severe hypoxic-Ischaemic encephalopathy (HIE) occurs in 0.5- 1 per 1000 live births, with up to 60% of these babies dying during the neonatal period and 25% of survivors having major long term neuro developmental problems.

Hypothermia may protect neurons by reducing cerebral metabolic rate. Therapeutic hypothermia aims to lower the temperature of the vulnerable deep brain structures to 33-34°C. Hypothermia is not without risk and thus it is important to manage the patient safely during induction and maintenance of hypothermia and during the rewarming process.

What is therapeutic hypothermia?

Therapeutic hypothermia is also called neonatal cooling therapy, is one of the most effective treatments for HIE when administered properly. Cooling the baby's body and brain temperature in a controlled environment alters chemical processes in the brain, thus reducing the risk of permanent brain damage.

The aim of cooling is to achieve the target temperature within 1 hour of commencement (rectal temperature between 33.0°C – 34.0°C). The total period of cooling and rewarming is for 84 hours, consists of 2 phases:

- Active cooling- for 72 hours from the initiation of cooling
- Rewarming- 12 hours of active gradual rewarming time after completion of 72hrs of cooling. Increase temperature by 0.5ºC every 2 hours until 37°C +/- 0.2. Monitor temperature frequently following rewarming to prevent rebound hyperthermia.

Advantages of therapeutic hypothermia

- Reduce energy depletion and metabolism
- Decrease excitatory transmitter action in the brain
- Reduce ion flux alterations
- Reduce edema, vascular permeability, and blood-brain barrier disruptions

Equipment:

- High cradle
- Radiant warmer with the warmer switched off.
- Rectal temperature probe
- Ice packs
- Temperature cable
- Cerebral function monitor
- Cardio respiratory monitor
- Do not nurse in an incubator
- Nurse the newborn naked on a radiant warmer with the warmer switched off.

Criteria for Therapeutic Hypothermia:

1. ≥ 36 weeks gestational age and more than 2kgs
2. < 6hrs post birth

Evidence of asphyxia as defined by the presence of at least two of the following four criteria:

1. Apgar ≤5 at 10 minutes or continued need for resuscitation with positive pressure ventilation +/- chest compressions at 10 minutes of age
2. Any acute perinatal event that may result in HIE (i.e. abruption placenta, cord prolapse, severe foetal heart rate abnormality.).
3. Cord pH <7.0 or base deficit of 12 or more within 60 minutes of birth
4. Clinically defined moderate or severe HIE (stage 2 or 3 based on modified Sarnat Classification).

Neonate not eligible for cooling

1. Birth weight less than 2000 g
2. Gestational age less than 36 weeks
3. Inability to initiate cooling by 6 hours of age
4. Suspected coagulopathy
5. Life-threatening abnormalities of the cardiovascular or respiratory systems such as complex congenital heart disease and persistent pulmonary hypertension of the newborn (PPHN)
6. Major congenital malformations, imperforate anus, suspected neuromuscular disorders, or presence of known lethal chromosomal anomaly
7. Death appears inevitable

Protocol for active cooling

1. Nurse the infant naked on a radiant warmer with the warmer switched off. Do not nurse in an incubator.
2. Use cold packs from the refrigerator (around 10°C). Never use frozen packs.
3. Cold packs should be wrapped in cotton cloth. They should never be applied directly to the skin
4. The cold packs can be placed under the shoulders/upper back, under the head, and/or across the chest/body. Use of a fan to continue cooling may be considered
5. Insert rectal thermostat/probe into the anus at 5 cm and fix it to the thigh. It is very important that the probe is inserted to this depth to accurately measure the core temperature
6. Connect rectal probe to cable, temperature module, and monitor
7. Set temperature alarm limits at 33.5°C (low) and 34.5°C (high) during cooling
8. Record time of initiating active cooling and monitor rectal temperatures every 15 min
9. Axillary temperature measurements are used, and then ensure that observations are taken at least every 15 min
10. If rectal or axillary temperature drops below 34.5°C, remove all the cool packs and reassess temperature in 15 min. If the temperature continues to fall, set radiant warmer on manual and gradually adjust the heater output to maintain the temperature at 33.5-34.5°C
11. The aim is to achieve the target temperature range within 1 h, but more importantly, continue to manage airway, breathing, and circulation
12. If nursed using head box oxygen, do not humidify or warm the air/oxygen gas mixture
13. If ventilated, use normal humidifier settings
14. Advise/reassure parents about the baby's appearance and that he/she will feel cool to touch

Reduce active cooling measures (cool packs) in case of the following:

- The rectal temperature falls below 35°C
- Significant FiO_2 requirement, defined as: increment by more than 20% (e.g. from 30 to 50%) after the initiation of procedure. Other pathologies should be excluded first
- The infant is treated with anticonvulsants or muscle relaxants

Stop active cooling measures when:

- the rectal temperature falls below 34.5°C
- the infant has persistent hypoxemia on 100% oxygen
- there is life-threatening coagulopathy
- there is an arrhythmia requiring medical treatment. Use re-warming procedure

Monitor temperature every 30 min after stopping active cooling until it reaches 35°C.
Resume active cooling when the temperature reaches 35°C and the patient is clinically stable.

Nursing Assessment and Management
Monitoring

- Continuous ECG, BP, SaO_2, $ETCO_2$ monitoring

Systemic effects

- Infants usually require ventilator support to maintain adequate oxygenation and ventilation. Hypothermia shifts the oxyhaemoglobin curve and can result in a decreased oxygen delivery, but the metabolic rate is also lowered which decreases oxygen consumption and carbon dioxide production. If the baby is not ventilated then the metabolic rate may be increased without an increase in oxygen delivery.
- Use humidified, heated gas as normal.
- At 33.5°C, the average HR is approximately 80-100 beats per minute (bpm). HR changes by 15 bpm per 1°C change in temperature.
- Monitor BP- hypothermic infants are at risk of hypovolaemia as cold can induce water displacement into tissues. Infants may need filling and inotropes (correct hypovolaemia first).
- Watch for arrhythmias - sinus bradycardia is the most common arrhythmia

Temperature monitoring needs to be continuous throughout treatment

- Insert rectal probe 9FR 5cms into the anus and tape the probe at 10cms to the upper thigh.
- Mark 5cms and 10cms on probe prior to insertion. It is crucial that the probe is correctly inserted as to ensure accurate temperature monitoring.
- Set temperature alarm limits at 33.5°C (low) and 34.5°C (high) during cooling.
- Check rectal probe hourly.
- Monitor skin temperature regularly.

Close neurological observation –

- Commence EEG monitoring (seizures occur in 43-56% of infants with HIE undergoing cooling). Most seizures peak within the first 48 hours. Follow seizure management algorithm.
- Check pupils, evaluate level of consciousness and for signs of raised intracranial pressure
- Will need formal EEG and MRI later (3-7 days after rewarming). Early MRI may be done to assist decision making with regards to palliation.

Access: site lines prior to cooling as perfusion will diminish: Preferably double lumen UVC and UAC peripheral arterial line.
Blood tests: ABG, Electrolytes, LFTS, Glucose, Coagulation.

- Bloods normally taken on admission, prior to commencement of cooling then at 4, 8, 12, 24, and 72 hours
- Infants with HIE are at risk for multiple electrolyte imbalances and need frequent monitoring and correction based on laboratory levels as documented on treatment orders.
- Coagulopathy may be induced by hypothermia because of decreased platelet function
- Minimise risk of cerebral oedema by keeping sodium levels at upper limits of normal
- Magnesium is kept at the upper limits of normal as this has neuroprotective effect.

Fluids: Most infants are fluid restricted to avoid fluid overload and cerebral oedema.

- Total fluid intake is usually 40-60ml/kg/day.
- Commencing enteral feeds in infants during therapeutic hypothermia should be considered on an individualized basis taking into account the overall clinical status.
- Site urinary catheter. Strict fluid balance is required.

Sedation - Infants may require a low dose morphine infusion to optimize comfort and efficacy of the cooling process. Monitor comfort using modified pain assessment tool (mPAT).

- Inadequate sedation can result in increased metabolic rate which decreases the effectiveness of the cooling strategy.
- At 48 hours, the weaning of morphine should be considered to reduce the risk of accumulation and toxicity.
- Monitor for signs of inadequate sedation: increased HR, shivering, difficulty ventilating.

Infection control

- Hypothermia can cause immune dysfunctions so cooled infants are often covered prophylactically with IV antibiotics
- Strict infection control
- Daily review for evidence of infection

Skin

- Need frequent inspections of skin and repositioning – as per Pressure Injury guideline
- Infant can be nursed supine and 30° tilt to right or left. To avoid impairment to cerebral blood flow return, keep head in alignment with spine (nose in body midline)
- Monitor skin for colour, perfusion, skin breakdown and for signs of subcutaneous fat necrosis
- Although rare, subcutaneous fat necrosis is characterised by induration erythemateous nodules and plaques over bony prominences such as back, arms, buttocks, thighs and chest. It is rare, thought to be because brown fat is more sensitive to hypoxia and made worse by cooling. It can also lead to hypercalcaemia, hyperlipidaemia and thrombocytopenia

Feeding

- Due to an increased risk of necrotizing enterocolitis, feeds should be withholded and introduced cautiously at the rewarming phase and Total parenteral nutrition (TPN) should be commenced till full enteral intake is established.

Rewarming procedure

- After completion of 72 hrs of total body cooling, the goal is to increase the rectal temperature to 36.5-37°C at a rate not to exceed 0.5°C per hour
- Re-warm by stopping any active cooling strategies and increasing the temperature by 1°C per hour or increasing the radiant heat source temperature setting by 0.5°C per hour
- The final temperature goal is 36.5°C and should take about 7 hours to achieve.

Monitoring during re-warming phases

- Record rectal temperatures every 30 min until temperature goal is achieved
- Record HR, respiratory rate (RR), oxygen saturation, and BP (every 15 min for the first 2 h, then hourly until re-warmed)
- Document vital signs every 3 h once the temperature goal is achieved and continue rectal temperature monitoring for another 24 h
- Obtain the following laboratory results once the temperature goal is achieved:
- Glucose
- Coagulation profile (INR, PTT, fibrinogen)
- Complete blood counts (CBC)
- Arterial blood gas (ABG)with lactate

What to expect during re-warming?

- Increase in HR
- Decrease in BP due to decrease in peripheral vascular resistance
- Decrease in urine output
- Electrolyte imbalance, as renal clearance rates change
- Complications are more likely to occur or worsen with lower temperatures. Avoid overcooling the neonate

Complications

- Cardiovascular complications – (bradycardia, Prolonged QT interval, ventricular arrhythmias, reduced cardiac output, hypotension)
- Reduction in surfactant production, increased pulmonary vascular resistance, increased oxygen consumption and oxygen requirement
- Electrolyte imbalance: hypokalaemia, hypo magnesia, hypophosphatemia
- Coagulopathy, particularly platelet function
- Infection risk increases due to inhibition of pro-inflammatory response (Increased incidence of sepsis, line & wound infections)
- Pharmacokinetics alter due to changes in liver & renal function Prolongs the action and increases the blood concentration of many drugs including opiates and sedatives when standard doses and dose intervals are used
- Delayed gastric emptying and elevated serum amylase
- Tolerance of enteral feeds may be poor and they are usually ceased during feeding
- Consider nutritional plan and the need for parenteral nutrition

Documentation

- Record time of initiating active cooling. Document programmed temperature and actual temperature

Family centered care

- Explain to family the reasoning for using hypothermia and the expected length of treatment.
- Explain to family that their baby will feel cold for the duration of the treatment
- Reassure them that their baby will be kept comfortable during the treatment. Encourage bonding by allowing parents to touch their baby, do nappy changes etc.

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