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The Nurse's Role in Neonatal Therapeutic Hypothermia

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The Nurse's Role in Neonatal Therapeutic Hypothermia

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Abstract

The registered nurse (RN) plays a vital role in the induction and maintenance of therapeutic hypothermia in neonatal patients. During a difficult labor and delivery, the nurse needs to recognize the risk factors for neonatal asphyxiation and signs thereof. It may be necessary for the nurse to draw attention to such a situation so that interventions and treatment can begin. Therapeutic hypothermia is the treatment of choice for instances of hypoxic ischemic encephalopathy (HIE). This requires the RN to have a clear understanding of the treatment and interventions associated with HIE. The RN in the neonatal intensive care unit (NICU) is then responsible for maintaining such treatment. The nurse needs to keep a vigilant watch of blood pressure, heart rate, blood glucose, electrolyte balance, serial arterial blood gases, skin, and level of sedation in the neonate. The nurse needs to have the skill set to maintain the treatment effectively and ensure the neonate is safe while under such conditions. While the data is there to support the use of such treatment for HIE, adverse outcomes are still present in about half of all cases. This requires the nurse to provide consistent, compassionate care in the instance of a palliative care choice. The nurse needs to understand interventions for the use of therapeutic hypothermia while forming a therapeutic relationship with the parents and family.

Introduction

It has been discovered that cooling of the brain and body has immense benefits in preserving brain function in instances of reduced oxygen and perfusion. It is important to identify infants at risk for moderate to severe brain damage as early as possible to initiate therapeutic hypothermia to preserve brain function. The healthcare team must work together to identify candidates for such treatment, implement treatment quickly, and monitor for signs of improvement.

The RN plays a vital role in the induction, maintenance, and rewarming phases of therapeutic hypothermia. The labor and delivery nurse recognizes risk factors and scenarios that may require use of therapeutic hypothermia. The neonatal intensive care unit nurse is proficient in monitoring cooled infants while looking for signs of improvement or declining condition. The postpartum nurse supports and helps the mother and family with what may be the most difficult time of their lives. The healthcare team must work together to ensure the proper treatment for the infant. The RNs are the members of that team that have many roles to play, but their most important role is assessing and watching for signs of impending issues in order to catch problems as early as possible.

It is important for nurses to be informed on the proper treatment of hypoxic-ischemic encephalopathy with therapeutic hypothermia, as well as what specific interventions are needed to ensure that the infant has the best chance of recovery.

Hypoxic-Ischemic Encephalopathy (HIE)

HIE is a disorder that occurs in a neonate when the organs do not receive enough oxygen. This can occur during the pregnancy, labor and delivery, or the postnatal period. This disorder is

a type of brain dysfunction due to a lack of oxygen (hypoxic) and blood flow (ischemic). The effects of HIE vary greatly. Some neonates have little to none, but others suffer severely with developmental delays, cerebral palsy, epilepsy, or cognitive impairments (UCSF Benioff Children's Hospital). Additionally, HIE may disrupt blood flow and oxygen delivery to other organs within the body such as the heart, liver, kidney, or bowels. These organs typically heal and recover any loss of function on their own, but the brain is not equipped with such recovery abilities. The duration of hypoxia and ischemia typically correlates with the severity of damage, signs, and symptoms (UCSF Benioff Children's Hospital).

Some signs of HIE include floppiness and hypo reactivity to sights or sounds, but some may be more tense and hyperreactive in response to stimulation than is typical of a healthy newborn. Other signs include seizures, feeding problems due to weak muscles, weak cry, and signs of organ dysfunction related to the heart, lungs, kidneys, liver, and blood (UCSF Benioff Children's Hospital).

HIE is suspected if the labor and delivery was long and difficult, prolonged deceleration is present, or if the baby is delivered with low heart rate and respiratory distress (UCSF Benioff Children's Hospital). A neurologist will ultimately diagnose HIE through a series of tests that include an electroencephalogram (EEG) for seizures and magnetic resonance imaging for signs of brain damage.

In instances of HIE, therapeutic hypothermia of the brain and body to preserve and protect brain function is often the treatment of choice. The patient is typically cooled for three days. During that time, nurses administer medications to support other organs that may be dysfunctioning and keep the newborn breathing and perfusing normally (UCSF Benioff Children's Hospital).

The Efficacy of Therapeutic Hypothermia

The positive effects of hypothermia on the brain and body have been known for centuries. As far back as 400 BC, Hippocrates mentioned the use of snow and ice to reduce hemorrhage in patients (Song & Lyden, 2012). There are multiple documented cases of the environment providing hypothermic effects on the body of a patient who has suffered a brain injury. This hypothermic effect sometimes results in little to no brain damage in the patient. The efficacy of such a treatment has been widely studied and has proven to be an effective treatment to reduce permanent brain damage in cases of HIE.

In randomized controlled trials that compared therapeutic hypothermia to normothermia for newborns with HIE, it was determined that hypothermia improved survival and neurodevelopment in newborns with moderate to severe HIE. According to the study,

> "Therapeutic hypothermia resulted in a reduction in the risk of death or major neurodevelopmental disability and increase in the rate of survival with normal neurological function at age 18 months. Hypothermia reduced the risk of death or major neurodevelopmental disability at age 18 months in newborns with moderate HIE and in newborns with severe HIE. Both total body cooling and selective head cooling resulted in reduction in the risk of death or major neurodevelopmental disability" (Tagin et al, 2012).

In another study, the effectiveness of whole body hypothermia was measured. This article found that therapeutic hypothermia reduced the risk of death or major sensorineural disability at 2 years of age while the adverse effects of hypothermia were minimal (Jacobs et al, 2011).

A study out of the United Kingdom evaluated the effects therapeutic hypothermia had into middle childhood by evaluating IQ scores (Azzopardi et al, 2014). The study found that 52% of children in the hypothermia group vs only 39% in the control group survived neonatal

asphyxiation with an IQ score of 85 or more. It also found that more children in the hypothermia group than in the control group survived without neurologic abnormalities. The study made further important discoveries on the wellbeing of the children that received therapeutic hypothermia to treat HIE. The study found that among survivors, children in the hypothermia group had significant reductions in the risk of cerebral palsy and the risk of moderate to severe disability. The study also found that they had significantly better motor-function scores (Azzopardi et al, 2014).

These studies aim to discover the physical and mental abilities of these neonates later on in life after receiving therapeutic hypothermia as treatment, but what about signs of damage to the brain itself? Magnetic resonance imaging (MRI) produces an image of damage within the brain. A group of researchers out of California aimed to compare MRI scans of infants with HIE treated with therapeutic hypothermia and without (Bonifacio et al, 2011). They had a group of 35 treated and 25 non treated neonates who received MRI scans. The study differentiated between normal, watershed, or basal ganglia/thalamus-predominant along with moderate-to-severe versus mild-to-no injury to categorize the brain scans. The results were not surprising as they confirmed what the tests of ability proved: that those treated with therapeutic hypothermia had less brain damage. Specifically, the results showed that neonates with hypothermia had less extensive watershed and basal ganglia/thalamus injuries and greater proportion of normal imaging. Neonates that suffered from sentinel events such as ruptured uterus, placental abruption, and prolapsed cord, but received hypothermia treatment, showed a decrease in basal ganglia/thalamus-predominant injury and an increase in normal imaging. The study did discover an important factor in how a neonate will respond to treatment: perinatal factors are important

indicators of response to treatment. Independent of therapeutic hypothermia, all neonates with decreased fetal movement had injury, predominantly watershed (Bonifacio et al, 2011).

The studies prove that therapeutic hypothermia is a remedy of great efficacy. In the right scenario, cooling the brain and the body stops further brain damage while preserving brain function. It has been proven multiple times that neonates suffering from asphyxiation during any stage of pregnancy or delivery will suffer less brain damage if treated with therapeutic hypothermia.

As the study out of California discovered, there may be instances in which the time without oxygen and perfusion was so long, and the damage so severe, that the efficacy of therapeutic hypothermia is greatly reduced. There are clear indications of whether a neurologist is going to recommend and induce therapeutic hypothermia on a neonate. There are many factors that contribute to deciding on this treatment option such as the pregnancy, duration and characteristics of the labor and delivery, APGAR score of the baby upon delivery, and MRI scans indicating brain damage.

The RNs on the NICU team are often the first to assess the baby and determine if something is wrong. They may ultimately be responsible for calling the pediatric code team and neurologist, who will decide if therapeutic hypothermia is an appropriate course of action when extensive brain damage is suspected.

Induction

It is important that the appropriate neonates are selected for treatment with therapeutic hypothermia. There must be biological evidence of hypoxia-ischemia followed by progressive moderate or severe encephalopathy. In trials testing the efficacy of therapeutic hypothermia, acidosis was required at birth on cord pH or the first blood gas within one hour of age (Natarajan

et al, 2018). If blood pH could not be gathered, treatment required presence of additional criteria. The first criterion to be met was history of an acute perinatal event in combination with either a 10-minute APGAR score of greater than or equal to five or assisted ventilation initiated at birth and continued for at least 10 minutes. The second criterion to be met was evidence of moderate or severe encephalopathy on neurological examination (Natarajan et al, 2018).

In order to determine categorization of moderate to severe HIE, a comprehensive neurological examination called the Sarnat classification is used. This exam assesses level of consciousness, spontaneous activity, posture, tone, primitive reflexes (suck and moro), and autonomic nervous system including the pupils, heart rate, and respirations (Blyth, 2018).

While those are the criteria for some of the studies on HIE and therapeutic hypothermia, there are different criteria for hypothermia in use. This may vary slightly from hospital to hospital, but according to the Royal Children's Hospital Melbourne, the criteria for initiating therapeutic hypothermia is as follows:

1. ≥ 35 weeks gestational age and more than 1.8kgs.
2. < 6 hrs. post birth
3. Evidence of asphyxia as defined by the presence of at least two of the following four criteria:
    a. APGAR ≤5 at 10 minutes or continued need for resuscitation with positive pressure ventilation +/- chest compressions at 10 minutes of age
    b. Any acute perinatal event that may result in HIE (i.e., abruption placenta, cord prolapse, severe fetal heart rate abnormality.).
    c. Cord pH <7.0 or base deficit of 12 or more within 60 minutes of birth

   d. If cord pH is not available, arterial pH <7.0 or BE >12 mmol/L within 60 minutes of birth (if available).

4. Assessment of relative contraindications/not moribund and with plans for full care. For example: uncontrolled pulmonary hypertension, uncontrolled clinical coagulopathy (i.e., active bleeding), major congenital abnormalities, survival appears unlikely (this should be discussed with a tertiary neonatologist or a PIPER Consultant). PPHN should not be considered a contraindication to commencing therapeutic hypothermia for HIE.
5. Clinically defined moderate or severe HIE (stage 2 or 3 based on modified Sarnat Classification).
6. Moderate to severely abnormal background activity on amplitude-integrated EEG i.e., discontinuous, burst suppression or low voltage +/-
7. At the neonatal consultant's discretion to commence therapeutic cooling (Blyth, 2018).

When it is decided that an infant will be therapeutically cooled, the goal is to reach a rectal temperature between 33.0-34.0 degrees Celsius. This must be done within one hour. The total period of cooling and rewarming is 84 hours and consists of two phases of active cooling for 72 hours and 12 hours of gradual rewarming (Blyth, 2018).

The optimal choice for inducing therapeutic hypothermia is active cooling, versus passive cooling. Active cooling is accomplished through the use of ice packs and cooling blankets to gradually bring the infant's temperature down to between 33.0-34.0 degrees Celsius over an hour. The method of cooling the infant may vary from hospital to hospital. Some sites may only cool the head by using a cooling cap that circulates with cold water. Some sites may systematically cool the entire body with either a blanket or cold packs placed under and around the baby (Chirinian & Mann, 2011). It has been determined that 72 hours of hypothermia

followed by 12 hours of rewarming is optimal. In studies involving animals, a greater duration and colder temperature than those parameters caused no further or decreased neuronal protection with an increased risk of death in instances of deeper cooling to 8.5 degrees Celsius below control values (Davidson et al, 2015). A large randomized controlled trial comparing 72 hours of hypothermia to 33.5 degrees Celsius with either prolonged hypothermia for 120 hours or deeper cooling to 32 degrees Celsius had to be stopped early because longer duration, lower temperature, or the combination of the two were associated with a trend toward a higher risk of death in the neonatal period (Davidson et al, 2015).

The parameters for therapeutic hypothermia have been established through many tests and studies. If criteria for induction of therapeutic hypothermia are met, the infant will be cooled over a period of one hour, kept cool for 72 hours, and rewarmed over a 12 hour period. During maintenance of this treatment, the nurse's role is vitally important.

Nursing Interventions During Maintenance of Treatment

The nurse's role is incredibly important in a case of induced therapeutic hypothermia. The nurse is responsible for monitoring the infant and catching signs of negative side effects and making adjustments. The infant will be on continuous electrocardiogram (EKG), blood pressure, oxygen saturation, and end tidal carbon dioxide monitoring (Blyth, 2018). Hypothermia can decrease oxygen delivery and not meet metabolic demands, thus a ventilator is often required. However, not all neonates will require mechanical ventilation. If a ventilator is required, the air used should be humidified and heated. At a temperature of 33.5 degrees Celsius, the baby's heart rate should be between 80-100 beats per minute. The heart rate should decrease by 15 beats per minute per one degree Celsius change in temperature. Hypothermia can cause water to displace into the tissues causing hypovolemia and subsequent hypotension. The most common arrhythmia

with hypothermia is sinus bradycardia but because other, more serious arrhythmias can occur, monitoring the EKG is very important. The nurse needs to monitor heart rate and rhythm, blood pressure, and ventilator alarms to ensure the baby is responding well to the treatment and is comfortable (Blyth, 2018).

The temperature of the infant needs to be constantly monitored. It is very important that the temperature probe is inserted properly into the anus and maintained to ensure accurate temperature readings. The rectal probe should be inserted five centimeters into the anus and taped at 10 cm to the thigh. The temperature should be checked hourly by the nurse while also assessing the temperature of the skin. The low temperature alarm should be set at 33.5 degrees Celsius and the high temperature alarm set at 34.5 degrees Celsius (Blyth, 2018).

Seizures occur in roughly half of infants with HIE undergoing hypothermic treatment. These seizures typically peak within the first 48 hours. Continuous EEG monitoring is an important intervention to watch for seizure activity during treatment. The infant will require a formal EEG and MRI approximately three to seven days after rewarming. The nurse will need to monitor for such seizures and report to the doctor (Blyth, 2018). If seizure activity is present the nurse needs to notify the doctor in order to get anticonvulsant treatment administered in a timely manner (Chirinian & Mann, 2011).

The infant is likely to have a peripheral arterial line to obtain blood throughout the duration of the hypothermia treatment. Infants under this treatment often develop electrolyte imbalances that need swift correction. Blood is typically taken at 4, 8, 12, 24, and 72 hours. Sodium levels are kept on the high level of normal to reduce the risk of cerebral edema while magnesium levels are kept on the high end of normal as it has a neuroprotective effect. The nurse

needs to be monitoring these lab values as they result, informing the doctor, and possibly treating an imbalance with medication (Blyth, 2018).

Strict intake and output are monitored with babies being treated for HIE. The baby is at risk for fluid overload and further brain injury with cerebral edema, therefore fluids are restricted. Total fluid intake should not exceed 40-60 mL/kg/day. A urinary catheter is also required for strict urinary output measurement. An infant may or may not be on enteral feedings during therapeutic hypothermia as it depends on the individualized case (Blyth, 2018).

The infant will likely be sedated for the treatment and ventilation support. The sedation is used to reduce as much agitation as possible as it can increase body temperature and brain metabolism. If the sedation is not adequate, metabolic rate will increase, which goes against the aim of the hypothermia treatment. The nurse needs to assess the infant for signs of inadequate sedation using the modified pain assessment tool, increased heart rate, shivering, and difficulty ventilating (Blyth, 2018). The nurse needs to be aware of subtle clues that can indicate pain and if these are present, must advocate for an appropriate intervention (Chirinian & Mann, 2011).

It is imperative that strict infection control is followed as the immune system of a hypothermic infant is reduced on top of an infant having an immature immune system. Strict sterile technique needs to be followed when inserting the catheter and arterial line. Strict catheter and line care needs to be completed (Blyth, 2018).

Finally, the skin of the infant needs to be frequently assessed by the nurse. The infant is not moving and is therefore at risk for skin breakdown. The infant needs to be repositioned frequently. The skin needs to be monitored for color, perfusion, temperature, and signs of breakdown (Blyth, 2018).

One of the most important aspects of hypothermic treatment is maintaining the parental bond with the baby. It will often be very emotionally difficult for parents to see their infant a dusky color and cool to the touch. It is important that the nurse recognize this barrier to the parent-child relationship and intervene when necessary. Explaining the treatment process to parents and answering any and all questions is important to keep parents informed and can alleviate fears. The nurse can keep family members updated with the plan for each day. The nurse should encourage breast pumping and even allow the parents to carefully change diapers of the baby (Chirinian & Mann, 2011). These are all interventions to promote the bond between parents and baby.

The role of a neuro-intensive NICU nurse is strongly suggested in situations of HIE and therapeutic hypothermia. A neuro-intensive NICU nurse is differentiated from a general NICU nurse by specialized training in neurological conditions (Glass & Rowitch, 2016). They have didactic and hands-on training with these scenarios and are specially trained to watch for declining brain function. This nurse can interpret EEG so that the physician can be alerted as soon as possible of a seizure and worsening encephalopathy. This role can also prepare for therapeutic hypothermia and escort critically ill neonates to the MRI machine for scans. They are also capable and trained to communicate with the family about their child's treatment for HIE (Glass & Rowitch, 2016).

Neonatal HIE puts the infant at risk for end organ failure as the organs may be without oxygen for some time. End organ failure can lead to cardiopulmonary issues, inadequate brain perfusion, and hypoglycemia (Glass & Rowitch, 2016). End organ failure can result in hypotension, hypoxemia, hypocarbia, hyperthermia, and hypo/hyperglycemia, which can all

make brain injuries worse (Glass & Rowitch, 2016). These parameters must be monitored very closely by a nurse to ensure they are managed to reduce the risk of worsening the brain injury.

It is important that all labor and delivery, postpartum, newborn, and NICU nurses be trained on the identification of symptoms of asphyxia, presence of seizures, and criteria for hypothermia even if the hospital does not provide therapeutic hypothermia. It is important that the neonate, if suffering from HIE, be transferred out and cooled within six hours for the highest chance of preserving brain function (Selway, 2010).

Outcomes

If therapeutic hypothermia is successful, the goal of the neurocritical team will be to begin oral feedings. Often, these neonates need help with positioning and feeding as they recover from the treatment. An occupational therapist will often help show parents stage specific exercises and provide the infant with an enriched environment. Survivors of HIE are still at a high risk for long-term disabilities such as epilepsy, cerebral palsy, and intellectual or physical disabilities. These neonates will be under the care of a neurologist to monitor and care for these developments should they arise. The American Academy of Pediatrics recommends that "longitudinal neurodevelopmental outcome be monitored in all neonates that undergo hypothermia" (Glass & Rowitch, 2016). In practice, this often means follow up until about two years of age. Ideally, follow up should be considered until at least six years of age to fully evaluate the neurodevelopment of an infant who suffered HIE and was treated with hypothermia (Glass & Rowitch, 2016).

The long term effects of therapeutic hypothermia as a treatment for HIE were evaluated by the Neonatal Research Network. They evaluated various aspects of cognitive and physical abilities. The results were as follows, "primary outcome of death or IQ<70 was noted among

47% hypothermia and 62% control group children. Secondary outcomes included the mortality rate of 28% and 44%, death or CP of 41% and 60%, and death and severe disability of 41% and 60% in the hypothermia and control groups, respectively" (Glass & Rowitch, 2016). This data greatly supports therapeutic hypothermia as a valid and effective treatment option for neonates who suffer from HIE.

Unfortunately, therapeutic hypothermia does not prevent death or serious brain injuries in all neonates with HIE. While therapeutic hypothermia remains a common treatment option for neonates with HIE, about 50% of patients still have adverse outcomes (Glass & Rowitch, 2016). Sometimes, the multi organ failure is so extensive that the infant is not compatible with life and no amount of cooling will change that. Once it becomes clear that the brain damage is extensive and permanent or the organs are continuing to fail, the healthcare team needs to discuss the option of switching to palliative care with the parents and family. The team needs to work together to be consistent with compassion. It is very important that compassion fatigue is addressed in a field in which adverse outcomes are common (Glass & Rowitch, 2016). Nurses need to have the option to debrief safely over difficult cases. Frequent breaks and psychiatric help must also be made available to nurses.

Conclusion

Therapeutic hypothermia is the treatment of choice, along with other medications, for hypoxic ischemic encephalopathy. It has shown to reduce the incidence of long term moderate to severe brain damage in neonates. It is a treatment that requires the vigilant eyes of a dedicated neurocritical team. The individual that is consistently at the bedside is the RN. The nurse spends the most time with the patient and needs to constantly monitor the infant for declining status to

make the doctor aware as soon as possible. The nurse needs to be monitoring blood pressure, heart rate, blood glucose, electrolyte balance, arterial blood gases, and sedative effects.

Once treatment is complete the infant will still need long term interventions as they are at high risk for cognitive and physical disabilities. The nurse is an integral part of the neurocritical team, providing critical care, education, compassion, a listening ear, professional advice, and encouraging the relationship between infant and parents. In the unfortunate cases of palliative care and death of a newborn, the nurse can provide crucial bonding time for the parents to say their goodbyes and grieve. It is important that the nurse receives time to discuss, debrief, and destress following a situation in which a baby was lost.

The nurse's role is one that is broad in scope and requires a never-ending set of skills and abilities. Nurses provide life saving care to patients while standing as a pillar of professional advice and alleviator of fears. They are an important aspect ensuring the effectiveness of therapeutic hypothermia as they will recognize the risk factors of HIE and recommend such a treatment. The nurse will also be the one to monitor and implement interventions. In the end, the nurse either sends the infant off with the family with education or provides the compassion a grieving family needs. No matter what the role, the RN can adapt to it. More information comes out yearly about the use of therapeutic hypothermia. As it stands today, it is the most effective treatment option to preserve and protect brain function in the case of HIE, and the nurse is an integral part of the induction and maintenance of such treatment.

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