REVIEW ARTICLE

BIRTH RELATED TRAUMATIC BRAIN INJURY - NURSING INTERVENTIONS

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DOI: 10.5281/zenodo.35310

Abstract

Traumatic brain injury is a major cause of serious harm and death in newborn infants. The injury affects not only the infant but also impacts heavily on close relatives. They also will need professional assistance. Caring for infant patients with traumatic brain injury is perhaps the most difficult of many professional challenges for nursing staff, requiring both technical and skills and sensitivity to the needs of the relatives. The purpose of this article is to highlight the most important nursing interventions.

Objective: The aim of this study was to review recent publications specifically addressing nursing intervention in the care of neonates with traumatic brain injury.

Sources and materials: The approach to this article centers on research and review of studies between 2007–2015, from the online sources of Pubmed/Medline, Elsevier, Saunders Medical Center, Lippincott Williams and Wilkins, New England Journal of Medicine, The Journal of Head Trauma Rehabilitation and the Journal of Neuroscience. The literature featured in this article refers to nursing intervention in cases of neonates with traumatic brain injury, identified through key words such as: nursing intervention in neurosurgery, nursing intervention in neonates with cranial trauma, head injuries and nursing care, nursing neurological assessment.

Results: The most recent studies emphasize that nursing interventions in the case of neonates who have sustained traumatic brain injury should be provided by specially trained persons who have acquired the skills and knowledge within this particular speciality area. Essential to successful outcomes of nursing interventions are frequent training and tutoring sessions where the nurse, in conjunction with the doctor, will be able to find, understand and apply scientifically competent solutions to meet the exact needs of the case. The role of the nurse should follow a personalized plan clearly defined as part of the total care and welfare of the neonate.

Conclusions : Successful nursing interventions for the care of neonates with traumatic brain injury include improvement of the neurological status and achieving a better outcome. However, there are few researched facts in the literature that document the detail of the nursing interventions performed. This suggests that further studies of the nature of the nursing interventions are necessary.

Key-words: Nursing intervention- neonates- traumatic brain injury

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Introduction

Birth related traumatic brain injury occurs with the interventions of external forces and can result into tissue and cellular damage of the brain. Such an incident can lead to permanent or temporary impairment of cognitive, physical, psychosocial functions, and a diminished or altered state of consciousness. (1)

Despite efforts to prevent birth related brain trauma, it remains the most common cause of injury and death in neonates. (2,3) Traumatic brain injury most often occurs during labor and leads to a number of conditions such as caput succedaneum, cephalohematoma, subgaleal hemorrhage, subdural hemorrhage, subarachnoid hemorrhage, epidural hemorrhage, cerebellar hemorrhage, intraventricular hemorrhage and skull fractures. Infants with greater risk for birth related injuries include those above the 90th percentile for weight (>3500g), infants that are in an abnormal position during labor and delivery, when the mother's pelvis size or shape is not adequate for vaginal birth, difficult labor or delivery, Braxton Hicks contractions, prolonged labor, fetal anomalies, very low birth weight and extremely premature infants. (2)

Extracranial Hemorrhage

Extracranial hemorrhages are one of the most common complications of instrument-assisted deliveries and are characterized by a bleed that is situated outside the cranium. Risk factors other than instrument-assisted deliveries include primigravidity, hypoxia, cephalopelvic disproportion, difficult and prolonged labor and coagulation disorders. There are three major types of hemorrhages: caput succedaneum, cephalohematoma and subgaleal hemorrhage. These lesions occur in different parts of the tissue between the skin and the cranial bone. (2)

Caput succedaneum

A caput succedaneum is an edema of the scalp caused by a bleed below the scalp and above the periosteum and involves a serosanguinous, subcutaneous, extraperiosteal fluid collection with poorly defined margins caused by the pressure of the presenting part of the scalp against the dilating cervix during labor. (4,5,6) It does not indicate damage of the brain or the bones of the cranium. Although caput succedaneum can occur in the absence of risk factors, incidence increases in difficult or prolonged labor, with premature rupture of the amniotic membranes, in primagravidas and in instrument-assisted deliveries. The risk of such complication during labor is estimated at around 5% and are more common with vacuum extraction delivery than with forceps with a ratio of 14-16% vs 2% respectively. (7)

Caput succedaneum is manifested immediately following delivery and gradually decreases in size thereafter. The scalp edema may cross over the sutures lines and the caput is generally 1-2 cm in depth and varies in circumference. (6) The most common presentation of caput succedaneum is symptomatic with findings such as soft or puffy swelling on the scalp, bruising or color change on the scalp and swelling that extends across the midline and over the sutures lines. The edema usually heals in hours to days and rarely has any complications. (8) In order to diagnose a caput succedaneum there is no need to perform a formal test. Diagnosis is usually made with a physical examination and inspection of the scalp. The condition almost always resolves itself in a couple of days, and there is rarely any long-term complications.

 ISSN:2241-0481, E-ISSN:2241-3634

However in rare cases if left untreated, the swelling caused by a caput succedaneum can break down into bilirubin and the neonate may develop jaundice which can posses a threat if not treated (kernicterus). (9,10)

Nursing care most often involves parent education which includes the cause of the tissue swelling and complications that might present. (2) It is very important to measure the head circumference every 24 hours and to record and report any possible defects of the scalp. As the edema withdrawals it is necessary to perform a physical exam of the scalp in order to diagnose any abnormalities. (2,11)

Cephalohematoma

A cephalohematoma is a traumatic subperiosteal hemorrhage of blood that occurs between the periosteum and the skull of a newborn baby secondary to the rupture of a blood vessel crossing the periosteum. It is typically over the parietal bone and can be seen unilateral (most often) or bilaterally. (2) Birth related cephalohematoma is a medical condition that occurs in 1-2% of all live births. A prospectively study that was performed on live babes, indicates that the condition is more common than any other head trauma and is estimated around 57,2% out of a population of 7154 live babes. (4) Cephalohematoma is seen most often in male infants than female. (2) Also, the condition is more likely to occur in instrument-assisted deliveries (forceps) and after prolonged and difficult deliveries. (2,4) Additionally, vitamin C deficiency has been reported to be associated with this condition. (12)

Cephalohematomas are mostly internal with characteristic findings of a firm and tense mass that does not cross the suture line. The mass may become more extensive by 2-3 days of age. (2) In rare occasions complications such as anemia, infection, unnatural bulges and jaundice can be noticed, although it is unlikely for a hematoma to contain enough blood to affect hemoglobin and bilirubin levels. The condition can also be accompanied with intracranial lesions that can lead to death. (13) Apart of a physical exam which can lead to a diagnosis, a computed tomography scan is an important means of detecting the hematoma. A computed tomography can also detect linear skull fractures which can be accompanied with cephalohematomas at around 10-25% of times. One must not forget that cephalohematomas are internal and

sometimes can not be detected with just a physical exam. (14,15)

The condition resolves in time period of a week to two months, occasionally with residual calcification. The calcifications gradually withdrawal as the bones grow and reform. Generally, there are no long-term sequelae from a cephalohematoma. (2)

Nursing interventions include monitoring the newborn. The vital signs of the infant should be recorded frequently and the head circumference should be measured every 12-24 hours if necessary. Nurses must detect early signs of complications including high bilirubin levels, loss of appetite, fever, anaemia and hypotension. A physical exam of the head should be performed twice a day. Abnormalities and changes of the size and place of the mass must be recorded and reported to the attending physician. Parent education is also part of the nursing role. Parents must be informed about the cause, the complications and the treatment options. (2,16)

Subgaleal hemorrhage

A subgaleal hemorrhage is the most serious extracranial hemorrhage and results in the accumulation of blood between the skull periosteum and the galea aponeurotica, due to the rupture of large emmisary veins. (17) The hemorrhage may be from suture separation, linear skull fracture or fragmentation of the superior margin of the parietal bone with the bleed spreading beneath the entire scalp and down the subcutaneous tissue in the neck. Blood loss can be significant up to 260 ml which can exceed the total volume of blood in a newborn. (2) Birth related subgaleal hemorrhage has an incidence of 0,2-3 per 1000 live births. (17) It is a condition that is more likely to occur in instrument-assisted deliveries and more specific when vacuum extraction is used (90%), but can happen spontaneously. (18) The condition is rare but really serious advert event that when left undetected can result in to poor neonatal outcome or even death. (17)

The hemorrhage usually presents as a firm fluctuant mass developing over the scalp (occiput) with superficial skin bruising and spreads across the suture lines. The swelling may increase in size after birth (12-72 hours after delivery). (2) Rupture of large emissary veins connecting the dural sinuses and scalp veins into a large potential space can result into hemorrhage of 20-40% of total circulating blood volume, resulting in hypovolemic shock and may contribute to hyperbilirubinemia. (17) Infection of the blood clot is a complication that can potentially occur in a subgaleal hemorrhage and can lead to a numerous of disorders if left untreated. Diagnosis is made by history taking and physical examination of the head, including measuring the circumference of the head and assessment of the location and characteristics of any swelling. The presence of fluctuance early on, whether or not the swelling is progressive, is an important distinguishing feature of subgaleal hemorrhage. Because the hemorrhage spreads through a large tissue plane, blood loss may be massive before hypovolemia becomes evident. When a subgaleal hemorrhage is suspected, hemoglobin measurement should be performed as soon as possible and should be monitored every 4–8 hours, as should coagulation studies. Clinical diagnosis with the use of a computed tomography scan can identify the hemorrhage and any underlying skull fractures. (19) Early detection of this clinical emergency is vital. Due to the loss of blood, transfusions are necessary in order to avert hypovolemia. If the bleed has progressed to

 ISSN:2241-0481, E-ISSN:2241-3634

hypovolemic shock, ventilation is required as an aggressive treatment of the resulting metabolic acidosis. Support with inotropic medication may be needed to increase blood pressure and improve cardiac output. Seizure activity is usually treated by using phenobarbital. (20) Phototherapy can be used to treat jaundice through the isomerization of the bilirubin and consequently transformation into compounds that the newborn can excrete via urine and stools. (21)

As the subgaleal hemorrhage possesses a real threat to the newborn, nurses have to be alerted in order to detect any symptoms that could lead to evidence of such condition. Symptoms such as anaemia, loss of appetite, prolonged crying, bruising that crosses over the suture lines, poor vital signs and loss of consciousness are indicative of a hemorrhage between the skull periosteum and the galea aponeurotica. Nursing intervention in newborns with increased potential of a subgaleal hemorrhage include measuring the head circumference every 4-8 hours, inspection of the edema and the ears on a hourly basis, monitoring the vital signs (especially the heart rate and the blood pressure) and measuring the arterial blood gasses (hematocrit or hemoglobin, levels of oxygen and the blood acidity). (2,16) The use of the Glasgow Coma Scale every hour is crucial in order to detect any loss of consciousness. Anemia in collaboration with loss of consciousness can be indicative of a hypovolemic shock which has to be treated aggressively. An intravenous line should be inserted in order to administer fluids (saline or blood components) and drugs (inotropic and other) as prescribed from the attending physician. Oxygen administration can be prognostic in order to counteract the blood acidity. (16) Newborns with increased risk of a subgaleal hemorrhage must always be transferred to the neonatal intensive care unit for additional observation. Last but not least, nurses must engage with the parents preparing them for the likelihood of any complications that it may present due to the underlying condition. Newborns with moderate to severe lesions may require aggressive therapy and up to 25% can die mainly due to hypovolemic shock. Lesser lesions in newborns will dissolve in 2-3 weeks. (2)

Neonatal skull fractures

A skull fracture is any break or indention in the cranial bone known also as the skull. They are quite a rare occurrence that constitute 2,9% of all neonatal head injuries. Studies have shown that fractures occur more less in vaginal deliveries but the risk increases with instrument-assisted deliveries. Other risk factors that contribute to skull fractures include primiparity, macrosomia, male sex and difficult or prolonged labor. Depressed and linear fractures have been detected sporadically in the newborns, with depressed fractures occurring more frequently than linear. (22) The infants skull can be very flexible but due to its poor ossification it can hardly tolerate any mechanical stressors in comparison to an adult that has a mature skull. Some studies suggest that an impact force equivalent to 280 N can result in a 50% probability of fracture in any part of the cranial bone. In conclusion, due to the immaturity of the infants skull there are indications of lower thresholds for fractures in comparison with an adults skull that need nearly five to eight times the force (1400-2240 N or more) in order to sustain a fracture. (23)

Depressed skull fractures

Depressed skull fractures are fractures or indentions of the skull that result in bone

fragments depressed into the underlying brain tissue. (24) A depressed skull fracture is most often seen (approximately 75% of the time) in the front or parietal region, as the bone is thiner and it is more prone to injury, but does not cross the suture lines. (25) These kind of fractures are almost entirely seen after instrument-assisted deliveries, prolonged or difficult labor and by compressing the fetal skull against the maternal ischial spine, sacral promontory or the symphysis of the pubis but also can be seen in very rare conditions as a spontaneous fracture in uncomplicated deliveries. (2,22) A depressed skull fracture has an incidence approximately 1 out of 1.000 deliveries. (26)

The characteristic ping pong skull fracture occurs when the bones are soft and resilient, causing a depression deformity of the bone (like a dent in a ping pong ball). The condition may be symptom free, but signs such as skull deformity, neurological deterioration, bruising, seizures, loss of consciousness, loss of appetite and prolonged crying can be detected as a result of an underlying cerebral contusion or hematoma. Other complications that might be noticed are infections, especially if there is a cerebral fluid leakage or when cysts form which are also called leptomeningeal or growing skull fractures. Diagnosis can be made when overviewing and palpating the skull during a physical examination. The dents which are frequently seen over the right parietal bone of the fractured skull can easily be identified. A computed tomography can also confirm the diagnosis and rule out any underlying brain injury. Treatment options vary depending on the place (frontal, parietal) of the injury and the method used to elevate the skull (manual elevation or surgical operation) if the skull has not recovered spontaneously on its own in the first week. (2,27) Recent studies indicate that early surgery does not improve prognosis of victims, although nearly 72% showed good recovery but some senses such as smell and taste are compromised in 50% of patients which will affect their quality of life. (28) Other methods of elevating the depressed skull is the usage of breast pumps, vacuum extractors, gentle pressure and elevation via a percutaneous micro-screw. (29) In the presence of cerebral fluid leakage or hemorrhage, antibiotics and fluids must be administered in order to prevent infections and shock. Studies in rat models with ex-vivo evidence have shown that Ceftriaxone, which is a beta-lactam antibiotic improves cognitive function and relieves brain edema mainly due to the scale down of the excitotoxicity and inflammation after brain injury. (30)

Nursing intervention is required from early on. Nurses should be able to successfully provide a physical exam and determine the fracture and also eliminate any underlying conditions such as a hemorrhage. A physical examination must be performed at least once every four hours if the condition is declared as high alert. The neonates vital signs must be monitored and recorded at least every four hours. An assessment with the inclusion of the measurement of the head circumference and the Glasgow Coma Scale must be conducted in order to exclude any neurological deterioration. If possible, monitoring the intracranial pressure or any signs that could suggest high intracranial pressure (hypersomnolence, loss of appetite, vomiting) should be performed. Pupil inspection can also provide evidence of elevated pressure. Seizure activity could be prognostic and it is important to record the attacks and report them to the attending physician. Last but not least a nurse should inform the parents about the potential damage to the brain, the cause and the complications that might occur during

 ISSN:2241-0481, E-ISSN:2241-3634

recovery. Part of the nursing care is to educate parents in detecting signs of increased intracranial pressure or growing skull fractures (leptomeningeal cysts). (2,16,31)

Linear skull fractures

A linear skull fracture is a break in the bone of the skull that simulates a thin line with the absence of any depression, splintering and distortion of the bone. (32) These kind of fractures are generally seen in the parietal and frontal region as the bone is thiner, but can be seen in the occipital region also. Linear fractures can too be accompanied by cephalohematomas at around 10-25% of times, subdural hemorrhage and in rare cases with intracranial complications. The main cause of this fracture is instrument-assisted deliveries, prolonged or difficult labor, when the fetal is in utero and in rare occasions in uncomplicated vaginal and cesarean birth. (2,33) The incidence of linear fractures are uncharted due to the fact that identification of the lesion depends on the radiographic studies and the physical examination, which means that some fractures remain undiagnosed. (15)

The condition is more difficult to detect as there is no deformation of the skull and the newborn may not have any symptoms. It is usually diagnosed while undergoing a routine radiographic study. Although it is a symptom free condition, it can manifest some times in ways such as bruising and edema of the scalp, pathologic changes of the head circumference, seizures, irritability, loss of appetite or more severe loss of consciousness and hydrocephalous (if craniocerebral erosion occurs). Complications are rare and include extracranial or intracranial hemorrhage and leptomeningeal cysts (growing fractures). These cysts are quite a rarity in an occurrence of lower than 1% of linear fractures, and happen due to the arachnoid membrane trapped between the edges of the fracture, which results in the erosion of the skull caused by throbbing of the arteries. (2) Health providers more often categorize complications of a linear fracture as acute (hemorrhage) or chronic (leptomeningeal cysts and hydrocephalous). As mentioned earlier on, diagnosis is made through radiographic studies, usually with a plain x-ray and not with a physical examination as there might not be any evidence of a fracture. A computed tomography can be necessary to exclude any complications. Neonates with uncomplicated linear fractures generally do not require any treatment or special management as the fracture heals spontaneously on its own in a time period of four weeks to six months depending on the injury and region. Neurosurgical intervention is necessary if complications develop. (33)

Nursing care involves monitoring the vital signs and recording them every four hours, measuring the head circumference at least once daily, a physical examination of the head to rule out any bruising or edema, and the evaluation of the Glasgow Coma Scale in order to determine the level of consciousness. Assessment of the intracranial pressure is not necessary if there is no evidence of complications. Furthermore, a nurse has to engage with the parents and inform them about the cause and the doubtfulness of any complications that might develop. Lastly, parents must be educated in measuring their babes head circumference at least once a week at home and also performing a physical exam of the head at least twice a week to exclude a growing fracture. While visiting their practitioner or pediatrician there are

instructed to inform them about the linear fracture in order for a more experience evaluation. (2,33)

Intracranial hemorrhage

A intracranial hemorrhage can occur due to the immaturity of the structure or the hemodynamic instability, and also secondary to trauma or hypoxia. There are five major types of hemorrhages according to the site of origin: epidural, subarachnoid, subdural, intraventricular and cerebellar. Neonatal intracranial hemorrhage is a considerable source of mortality and morbidity. There are many causes and risk factors that could reinforce the condition such as maternal disease (hypertension etc), history of infertility drugs, preeclampsia, ventilator therapy, pneumothorax, difficult and prolonged labor, premature infants, low weight infants (<1500 g), instrument-assisted deliveries, hypoxia and hemodynamic instability are some of them. The etiology is usually identified with the infants age of birth. Specifically, full term infants more often develop intracranial hemorrhage due to labor (mechanical factors) in comparison to preterm infants that develop such a condition due to hemodynamic instability. The location, neurological outcome and symptoms also differ in full and preterm infants. (15,34)

Epidural hemorrhage

Epidural hemorrhages are rare extra-axial (occurring outside the brain tissue) head injuries that represent less than 2% of all head injuries in newborns. It is a condition where blood accumulates between the dura and the calvarial bone. (35) The main cause of the particular condition is due to the rupture of the middle meningeal artery in the temporal-parietal region in approximately 70% of occurrences. Linear fractures can be at fault in a rupture of the middle meningeal artery. Another cause is torn venous sinuses mainly due to depressed skull fractures which tear the dura of the bone in the parietal-occipital region or the posterior fossa in around 30% of occurrences. Nearly all infants with epidural hemorrhages have been associated with difficult or prolonged labor and instrument-assisted deliveries. (2,35)

Epidural hematoma is a rare clinical and pathological occurrence with a difficult symptomatology. Health care providers have to think out of the box in order to successfully diagnose the condition as it is a limited phenomenon with less than 20% of patients manifesting the classic presentation sequel. Following injury, neonates may or may not present loss of consciousness, hypertension, bradycardia, vomiting, seizures, apnea, fixed pupils and coma which can lead to death. (2) As the hematoma grows, symptoms become more rigorous as the pressure on the brain increases, resulting in high intracranial pressure and inevitably brain herniation if not treated early. Diagnosing a epidural hematoma can be challenging. If there is a skull fracture then a computed tomography can rule out any underlying brain damage. On the other hand, in the absence of a skull fracture the condition can be diagnosed with the help of a detailed history (delivery method, weight of the infant, weeks of gestation etc), a physical examination, routine radiographic studies and clinical presentation. Within the first hours of an infant life, evidence of increased intracranial pressure and bulging of the fontanel can be presence. In order to confirm the diagnosis a computed tomography should be performed within the first three hours, as it the most definitive test for diagnosis.(36) Treatment is compulsory since untreated epidural hemorrhages may lead to death in a margin of 48 hours.

 ISSN:2241-0481, E-ISSN:2241-3634

Treatment comes in three stages. First of all the patient has to be stabilized. The vital organs must be supported adequately with a combination of fluids and drugs in order to maintain euvolemia and cerebral profusion pressure. To avoid the inadvertent effect of a potential increased intracranial pressure, osmotic diuretics, hyperventilation and a phenobarbital induced coma might be necessary. Secondly, in order to stop the hemorrhage vitamin K, platelet transfusion, protamine sulfate (to counteract the effects of heparin) and clotting factors can be administered. Last but not least, when the patient is hemodynamically stable and the hemorrhage has been successfully stopped, surgical evacuation of the hematoma may be necessary with methods such as decompression craniotomy, laminectomy, burr holes or negative pressure drainage. (36,37,38) Although complications range from none to permanent neurologic deficits, aggressive treatment has shown to have a positive input in the infants prognosis. (2,39)

Nursing care involves early detection and immediate referral to the attending physician, as early treatment is vital for a positive outcome. A nurse must have the ability to schedule all the necessary exams in a short period of time, prepare the patient for the evacuation of the hematoma while supporting the vital organs via oxygenation, thermoregulation and administration of fluids and medications. After the hematoma has successfully been evacuated, the patient must be transferred to the intensive care unit for further observation. Whilst being in the intensive care unit, nurses should always monitor the infants vital signs and the intracranial pressure every hour. Adequate fluids should be administered in combination with drugs in order to maintain euvolemia and cerebral profusion pressure. (40) Last of all, nurses should always inform the parents about the cause, the management and the outcome of the condition. In more advanced facilities parents are allowed to participate in the caring plan, which allows them to come closer to their baby more often. It is also very important to support parents and make them understand the potential complications, acute or chronic, that might follow from a epidural hemorrhage which can vary from none to permanent neurological defects. (2,15,40)

Subarachnoid hemorrhage

A subarachnoid hemorrhage is a bleed between the arachnoid membrane and the pia mater which surrounds the brain. This condition is the most common intracranial hemorrhage that occurs in infants with an incidence of approximately 20-30% of live births. A subarachnoid hemorrhage is a product of a rupture of bridging blood vessels or dural sinuses during labor or when forces (acceleration, deceleration) push the brain against the skull (shaken baby syndrome) causing venous bleeding in the subarachnoid space. (2,41) The main region that appears to be affected by the hemorrhage is over the cerebral convexities and almost exclusively in the posterior fossa. (15) There are many predisposed risk factors that have been found to cause the condition, some of which are prolonged and difficult labor, prenatal asphyxia, instrument-assisted deliveries, low gestational age, low birth weight, pregnancy induced hypertension and platelet alloimmunization all of which can contribute in the development of a subarachnoid hemorrhage. (42,43,44)

There are different ways in which a subarachnoid hemorrhage can present. The most common presentation is the asymptomatic where the hemorrhage is found by accident during a routine

radiographic study or during a lumbar puncture for studies to exclude sepsis. In some occasions the bleeding can be detected during ultrasonography, which is done as a routine check to rule out any intraventricular hemorrhages. (2) The asymptomatic presentation is almost entirely seen in premature infants. A subarachnoid hemorrhage can also present with symptoms, and it is seen more often in full term infants. Symptoms include convulsive activity (69%), apnea (23%), bradycardia and seizures at 2-4 days of age. (2,45) Studies suggest that massive hemorrhages occur in rare occasions and are mainly due to severe asphyxia or instrument-assisted deliveries with around 100% mortality rate. (46) Besides the obvious symptoms mentioned further up, irritability, vomiting, loss of consciousness and stroke-like symptoms can also exist. Diagnosis can easily be confirmed with the help of a computed tomography or an ultrasonography study where the bleed can be detected in the subarachnoid space. In most cases the hemorrhage is identified during a lumbar puncture, where traces of blood are found in the cerebral fluid. The initial treatment of the condition is the management of life threatening symptoms such as cardiovascular instability, shock and brain herniation whilst maintaining the vital signs. Craniotomy is not the first line of treatment, although can be required if the bleed is extensive and herniation is presence. Sedation especially with barbiturates must be used judiciously as they affect the intracranial pressure. (45,47) Multiple studies have shown that barbiturates can decrease the intracranial pressure. (48,49) In most cases a subarachnoid hemorrhage is treated supportively in the first days in order to give time for the brain to stabilize and in a second phase a neurosurgical intervention may be required to remove the clot from the space. (47) Patients with the asymptomatic presentation usually have good outcomes with minor neurological defects (mainly chronic seizures). Up to 50% of infants with symptomatic presentation will have neurologic defects such as seizures and hydrocephalous due to the obstruction of the

 ISSN:2241-0481, E-ISSN:2241-3634

cerebral fluid at the level of the arachnoid villi. (2,45)

Nursing interventions in a subarachnoid hemorrhage involves immediate detection of the condition and referral to the attending physician in order for the treatment to be initiated as soon as possible. Seizures must be observed and documented in the nursing notes. The frequency and severity must also be recorded. Even if a health provider is not present during an episode, parents should give a history of the seizure indicating time, severity and other presentations. Certain medical facilities have protocols in order to treat seizures that are life threatening. Apart from seizure attacks other neurological functions must be assessed with the Glasgow Coma Scale. A pupil inspection every hour is crucial in order to detect a brain herniation. Measuring the head circumference is really important from early on as hydrocephalous is a real threat. Nurses should always support the parents needs and inform them about the condition and the possible outcome. It is important that parents know about the likelihood of a neurosurgical intervention. Some facilities have the liberty to allow relatives in the caring plan by giving advice and helping out when conducted. If necessary, the nursing team can refer the parents to other health providers (social workers etc) for more advanced assistance. Last but not least, when the patient is discharged from hospital it is important to schedule appointments in order to monitor the ventricular size and the rehabilitation progress. (2,15,47,48)

Subdural Hemorrhage

A subdural hemorrhage is when the blood is gathered between the dura mater and the brain. (15) The condition is caused due to the rupture of bridging veins (great vein of Galen) that cross the subdural space. (50) It is seen quite frequently after uncomplicated vaginal delivery and the location of the bleed is more often seen over the cerebral hemispheres and posterior fossa. Factors such as instrument-assisted deliveries, perinatal asphyxia, prolonged and difficult deliveries, cephalopelvic disproportion, large and full term infants can increase the possibility of a subdural hemorrhage. (15,50) A UK based study suggests that the incidence is approximately 24 cases per 100.000. (51)

Recent literature indicates that there are three major patterns which a bleed over the cerebral hemispheres can present. A minor hemorrhage with the infant being asymptomatic or showing signs of irritability and excessive alertness is the most frequent presentation. A second presentation involves convulsive action (focal seizures), hyper alertness and irritability in the first 2-3 days of life. Other neurological signs might or not be present such as hemiparesis irregular respiration, bradycardia and abnormal pupils reaction. The third presentation is seen after a period of 4 weeks to 6 months of age and includes altered loss of consciousness, increases head circumference, convulsive action, failure to thrive and poor feeding. (2) Bleeding in the posterior fossa can present in different ways depending on the volume of blood in the space. Small bleeds can take up to 4 days to show any signs. A larger bleed can cause elevation of the intracranial pressure and other neurological defects including coma, asymmetrical pupil size, irregular respiration, bradycardia and opisthotomos. If the bleed is large enough to interact with vital parts of the brain (brain stem etc) then the symptoms can be more life threatening. Symptoms of extensive bleeding in the posterior fossa include shock, coma, fixed and dilated pupils irregular respirations and finally cardiac or respiratory

arrest. (52) Diagnosis is usually made with a computed tomography. Ultrasonography in this case is not used as it is not very reliable. (2,53) Treatment varies depending on the volume and the place of the hemorrhage. Supporting the vital organs with oxygen and fluids is necessary as also maintaining thermal balance and nutrition. If the bleed is still persistent, coagulating factors can be administered. Needle aspirations in the infants fontanel can relieve the intracranial pressure. Neurosurgical intervention is required if the patient can't be stabilized with other resources (medication etc). (52) Prognosis differs depending on the size of the bleed and presentation. Infants that are asymptomatic usually have good outcome if there is no cerebral injury. Early diagnosis and treatment of greater hemorrhages can improve outcome. Infants with extensive bleeding over the tentorium or falx cerebri usually have chronic neurological sequelae or die. (2)

Nursing interventions basically involve supportive care. A close monitor of the infants neurological function with the help of the Glasgow Coma Scale is necessary. Observations of the vital signs must be done hourly. In rare cases and when vital parts of the brain are influenced, signs of respiratory depression can be present as also can bradycardia (Cushing's triad), so observing the vital signs is pivotal. PERRLA (pupils, equal, round, reactive, light, accommodation) is a simple test of the pupils and can detect major problems such as cerebral edema and brain stem herniation, so it is important to be done whilst doing the observations of the vital signs. If seizures are present, nurses must monitor the attacks and record them (time, frequency etc). (2,16) Some facilities monitor the seizures in a 24 hour bases by connecting the patients to an EEG telemetry, and have protocols to manage life threatening convulsive activities. (16) Infants with symptomatic subdural hemorrhages tend to be hyperpyrexic or hypothermic, so maintaining a temperature of 36,6 o C is crucial. Part of the nursing role is to support the parents. (15) It is a delicate mission that involves explaining the reason, the complications and the outcome of the condition. Some facilities even allow parents to help with the nursing plan. By doing so, it gives an opportunity to the parents to come closer to their child. The nursing plan should always have a discharge plan indicating the assistant that the infant and the parents might require whilst at home. Last but not least nurses must educate the parents in recording any seizure activity and measuring the head circumference at home. A follow-up should also be scheduled by the nurse according on the patients condition. (2,16)

Intraventricular Hemorrhage

A intraventricular hemorrhage is a bleed in one of the four ventricular's inside the infants brain. The condition is caused by the inherent fragility of the germinal matrix vasculature, the disturbance in the cerebral blood flow and because of a platelet or coagulation disorders. (54) Risk factors such as prolonged and difficult deliveries, low apgar score, severe distress syndrome, perinatal asphyxia, seizures, patent ductus arteriosus, thrombocytopenia, extracorporeal membrane oxygenation, low birth weight, infections and premature infants can increase the possibility of a bleed in the ventricular's. (55) Studies suggest that a intraventricular hemorrhage is a major complication of prematurity. In the USA approximately 12.000 premature infants develop the condition every year. (54,56)

The majority occur within the first 72 hours of life. The volume of hemorrhage varies depending on the grade. There are

 ISSN:2241-0481, E-ISSN:2241-3634

four grades depending on the volume of the bleed and the ventricle involvement:

Grade I: Is the most frequent type and involves the germinal matrix. The bleed is located in the subependymal germinal matrix and often affects the lateral ventricles.

Grade II: Is the second most frequent type and involves bleeding in the ventricles, without the dilation of the ventricles.

Grade III: This type is not very often and involves bleeding into the ventricles with dilation of the infected ventricles. The hemorrhage is maintained in the ventricle and does not extend to the brain tissue.

Grade IV: This type is rare. Due to the volume of the bleed the ventricles can't sustain the pressure, resulting in the rupture of the ventricle and bleeding in the surrounding brain tissues. (15,57)

Symptoms such as apnea, loss of consciousness, seizures, lethargy, decreased flexes and coma can present. (15) Diagnosis is primary made with a computed tomography, but a magnetic resonance imaging can be used to identify very small hemorrhages as it is a more sensitive scan. Treatment option varies depending on the grade. Stopping a intraventricular hemorrhage is very difficult and in some case impossible, therefore supportive treatment is crucial with multiple transfusions to maintain blood pressure and drugs in order to decrease the intracranial pressure. A lumbar puncture can also relieve the pressure by draining any excessive fluids. Neurosurgical intervention is necessary if all other methods fail. In most cases, if the pressure builds up an external ventricular drainage is inserted to relieve the pressure. Prognosis is usually good in grades I and II with small neurological sequelae, but in grade III and IV the outcome is poor with 1 in 5 infants dying due to herniation of the brain stem or other complications. Hydrocephalus is likely to occur as a result of the condition, because of a clot that obstructs the normal flow of the cerebral fluid. Hydrocephalus can also occur due to an inflammation response when the clot brakes down, affecting the arachnoid granulations which results in the abnormal reabsorption of cerebral fluid. (15,57,58,59)

Observing and maintaining the vital signs in normal range is a responsibility of the nurses, therefore it is crucial to monitor the patient hourly. Adequate fluids and blood transfusions should be administered to maintain the blood pressure. A fluid chart should be filled in order to monitor the fluid balance. If apnea is present, oxygen therapy or even ventilation can be necessary. Carers must detect any respiratory depression and treat it immediately. If an external ventricular drain is inserted, nurses should closely monitor the rate of drainage and record the volume hourly. The site of insertion should be inspected every 2 to 4 hours for cerebral fluid leakage and infections. The Glasgow Coma Scale should be done whilst doing the observations as well as an inspection of the pupils (PERRLA), as early detection of any complication is vital. Hydrocephalus is common in patients with intraventricular hemorrhages and therefore daily measurement of the head circumference is important. Part of the nursing role is providing support to the parents by explaining the cause and the possible outcome. Infants with such condition are more likely to be nursed in the neonatal intensive care unit. Parents have limited time to be with their child, so it is important for them to feel that they are part of the care. Some medical facilities have the liberty to allow relatives in helping out with the nursing

care, and by doing so gives them a chance to get closer with the patient. (16,58,59)

Cerebellar Hemorrhage

A cerebellar hemorrhage is seen more often in premature infants than in full term and occurs during the developmental period, when the cerebellum undergoes rapid growth and many other complex developmental processes. Because all of these events occur within a time frame, it is considered to represent a critical period of cerebellar development where the cerebellum is most vulnerable to injury. Injuries could have consequences beyond the direct impact of the damaged cerebellar tissue if the injury impairs or arrests later developmental processes and takes the cerebellum off its developmental trajectory. The bleed is detected in the inferior aspect of the posterior lobe of the cerebellum but can also extend to other areas with involvement of the posterior inferior cerebellar artery. (60) The actual incidence is not accurately known because the condition is under diagnosed. Studies suggest that the incidence is approximately 10-25%. Other than prematurity, low birth weight, hypoxia, vitamin K deficiency, thrombocytopenia, instrument-assisted deliveries, hypertensive spikes, rapid intravenous colloid infusion and constrictive bands can increase the risk of such condition. (15,50,60)

Infants with a cerebellar hemorrhage can either present with life threatening symptoms or with non life threatening symptoms. The usual findings in critical ill patients are apnea, anemia, bradycardia, seizures, facial paralysis, opisthotonos, absent Moro reflex, coma and death in a time period of 24-36 hours. In less critical ill patients the findings may include the above as well as hydrocephalous but in a time period of 2-3 weeks of age. Diagnosis can be made by ultrasonography or computed tomography, although the condition is more frequently diagnosed during autopsy. Treatment is primarily supportive but neurosurgical intervention may be required in order to evacuate the hematoma. In some cases a shunt is inserted to prevent a cerebral fluid obstruction. Prognosis unfortunately is very poor in survivors, with serious neurological defects and hydrocephalous occurring in more than 50% of patients. Motor and variable involvement of intellect are affected more than anything else. (15)

Nursing care is primarily supportive. Patients with such condition are usually admitted in the neonatal intensive care unit for closer monitoring. Observations must be done hourly as well as the Glasgow Coma Scale and the inspection of the pupils (PERRLA). A measurement of the head circumference should be performed once daily as hydrocephalous can occur. Adequate fluids and blood transfusions should be administered in order to maintain the blood pressure and to prevent the declining of the hematocrit. It is the nurses responsibility to support the relatives. It is crucial to inform the parents about the cause and the possible outcome since prognosis is very poor. Social carers have to be informed as parents will need assistance when the infant is discharged. (2,15,60)

Conclusion :

Birth related traumatic brain injury causes serious complications and death in newborn infants. The condition also impacts the close relatives. There are three major categories, extracranial hemorrhages, skull fractures and intracranial hemorrhages, that relate to traumatic brain injury. Depending on the region and the extent of the damage, symptoms differ and treatment varies. Caring infant patients with brain injury, involves

 ISSN:2241-0481, E-ISSN:2241-3634

support of their needs, treatment and early recognition of complications. Any suspicious neurological sign should be evaluated immediately, as early detection and treatment can improve outcome. Nurses have the responsibility in providing support and education to the close relatives as well. Early discharge planning and rehabilitation should be incorporated in the nursing plan, as care should be provided even when the patient leaves the hospital.

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