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Pre-hospital Care of the Neonate

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Objectives

Objective #1 – Discuss the Neonate

Objective #2 – Assist the Birth of the Neonate

Objective #3 -- Observe Neonatal Distress

Objective #4 – Assess Risk Factors for the Neonate

Objective #5 – Evaluate the Neonatal Infant

Objective #6 -- Stabilize the Neonatal Infant

Objective #7 – Appraise the Jaundice Factor in the Neonate

Objective #8 – Examine the Neonate Infant in a Major Catastrophe

Objective #9 -- Recognize Neonatal Injuries in Child Abuse

Objective #1

Discussing the Neonate

Neonatal care refers to the care of an infant in the first 28 days of life vs. a newborn which embraces the period of the first few hours of life after birth. Approximately 90% of newborn neonate babies begin life without any difficulty. However, the remaining 10% will require varying degrees of assistance with breathing. 1% to 6% of this 10% just referred to will require invasive resuscitation measures in order to survive.

The Premature Neonate

A baby born before 34 weeks is considered to be a premature neonate. The weight of a premature baby is normally between 1.5 pounds to 5 pounds. The routine newborn assessment should include an examination for size, macrocephaly or microcephaly, changes in skin color, signs of birth trauma, malformations, evidence of respiratory distress, level of arousal, posture, tone, presence of spontaneous movements, and symmetry of movements.⁸ A premature infant's health at birth is influenced by many factors, including:

- Gestational age;
- Weight;
- Maternal illness and medical treatment during pregnancy;
- Congenital birth defects.⁶

Most infants born at 36 and 37 weeks' gestation do not need additional medical intervention. But many premature infants are too immature to survive without medical care in the neonatal intensive care unit (NICU). Symptoms of prematurity that require extensive emergency medical intervention include:

- Inability to breathe continuously;
- Inability to feed orally;
- Inability to maintain body heat;
- Underdeveloped lungs.¹

Physical Assessment

A thorough physical examination should be done within 24 hours of birth. The following are the areas of the body which the EMS Personnel should evaluate in any environment where a neonatal baby is involved.

Cardio-Respiratory System

Skin color is considered the single most important index of cardio-respiratory function in the neonate. Good color in white infants means an overall reddish pink hue. The only exception to this color is for possible cyanosis of the hands, feet, and perhaps the lips. In the dark-skinned neonate, the mucous membranes are a more reliable indicator of cyanosis than the skin. The post-mature neonate baby skin is paler than full term. The neonate infant respiratory rate is normally 40 to 60 breaths per minute. However, the neonate infant often is a periodic breather rather than a regular breather.⁷

Head and Neck

It is important to note the head and neck area of the neonatal newborn because there is a lot of pressure on this area of the body during the birthing process. The head of the infant born by vaginal delivery often shows some degree of molding unless they deliver by cesarean section or breech. Molding is when the skull bones shift and overlap, making the top of the infant's head look elongated, stretched out, or even pointed at birth. The newborn's skull is made up of several separate bones that will eventually fuse together. Normal term newborn head circumference is 33 to 38 cm. The technique to take this measure is to place a measuring tape around frontal forehead and occiput.⁹

Abdomen and Pelvis

The abdomen should be round and symmetric for the healthy neonatal infant.⁸ It's normal for a baby's abdomen to appear somewhat full and rounded. When the baby cries or strains, the skin over the central area of the abdomen may protrude between the strips of muscle tissue making up the abdominal wall on either side. This almost always disappears during the next several months as the infant grows.

Musculoskeletal System

The musculoskeletal system includes the muscles; connective tissue; cartilage and bones in the body. The musculoskeletal system provides structure and movement. Abnormalities of the neonatal musculoskeletal system range from a subtle brachydactyly to a fatal form of osteogenesis. Assessment of the musculoskeletal system can have multiple normal variants so the knowledge of pathogenesis, treatment, and prognoses for deformities of the musculoskeletal system is imperative.

Neurologic System

A careful examination at delivery helps detect anomalies, birth injuries, and cardio-respiratory disorders that may compromise a newborn's successful adaptation to extra-uterine life. A detailed examination should also be performed after the newborn has completed the transition from fetal to neonatal life. The examination may begin with an evaluation of neonatal size

Objective #2

Assisting the Birth of the Neonate

Most births progress through a predictable set of steps without incident. In most incidents the newborn does not need much help because the breathing process begins at the moment of birth. However, should there be an issue with the infant, resuscitative efforts can save precious time and make a critical difference for a variety of complications.

APGAR Score

The Apgar score has been used for many years in evaluating the prognosis of a newborn. Recent studies have used the pH in the umbilical-artery as a more accurate assessment of newborn prognosis. The APGAR score has weathered the storm and still remains a viable way to assess newborn prognosis. This is especially true in the pre-hospital delivery, when lab testing is unavailable

Inverted Triangle Guide

There is a reference to an inverted triangle which will guide the EMS Personnel in caring for the neonatal newborn. The points to observe and prioritize from the top of the inverted triangle downward are as follows:

- Dry, Warm, Position, Suction, Stimulate;
- Supplemental Oxygen;
- Establish Effective Ventilation;
- Chest Compressions;
- Advanced Life Support Intervention.⁵⁵

As the head emerges from the birth canal there are three particular things that the EMS Personnel must be observing. Here are three areas that need tending to immediately:

- Umbilical Cord;
- Mouth;
- Nose.

Umbilical Cord

If the umbilical cord is not around the infant's neck, the normal procedures to follow are to tightly clamp or tie the cord in two places and make the cut between. The first clamp can be

placed 8" to 10" from the baby and the second clamp should be placed four finger widths from the baby. Then the next procedure is to cut between when pulsations cease.

When the umbilical cord is wrapped around the neck of the infant, observe if it is possible to unwrap the cord and then clamp it according to procedures above. If the cord cannot be unwrapped, it may be necessary to cut the cord quickly in order to release the airways.⁵⁵

Mouth

Following birth, for the lungs to operate as a functional respiratory unit providing adequate gas exchange, the airways and the alveoli must be cleared of fetal lung fluid; pulmonary blood flow must increase, and spontaneous respirations must be established.⁵⁷ So the mouth must be suctioned with a bulb syringe, 2 to 3 times.

Nose

Follow the mouth suctioning with suctioning of the nose. For most births, it is a routine procedure to suction the baby's mouth and nose as soon as the head emerges on the perineum, in advance of its full birth. Either a deep suction hose will be used or a bulb syringe to extract any mucus or meconium that may be present.

While it may seem wise to suction as soon as possible, the reality is that the baby is not at great risk of breathing difficulties until it takes its first breath after the umbilical cord has been cut. If the cord is still pulsating and is not clamped the baby will continue to receive oxygen via the placenta until after it has been fully birthed.⁵⁹

Cardiovascular Adaption from Fetal to Neonatal

For successful fetal circulation to take place many changes occur in the neonate's body. What we see in the normal adult circulation is dramatically different in the fetal circulation. The fetal circulation allows the baby to get all its nutrients and oxygen from the mother. Since the baby cannot eat or breathe inside the uterus, all the essential elements for growth need to come through maternal circulation.

The cardiovascular fetal circulation could be explained as follows. The more highly oxygenated blood bypasses the liver, streams into the inferior vena cava to pass through the foramen ovale into the left atrium. The desaturated blood streams into the inferior vena cava to the right atrium. In the right atrium, it mixes with blood returning from the coronary sinus and superior vena cava and flows into the right ventricle. The more highly oxygenated blood crossing the foramen ovale mixes with the small amount of pulmonary venous return to cross the mitral valve into the left ventricle.

The output from the left ventricle passes into the ascending aorta to the heart, brain, head, and upper torso. From the right ventricle, the less saturated blood passes into the pulmonary arteries. Because the pulmonary vessels are constricted and highly resistant to flow, only about 12% of this blood enters the lungs. The remainder of the blood takes the path of least resistance through the patent ductus arteriosus into the descending aorta. Approximately one third of this blood is carried to the trunk, abdomen, and lower extremities, with the remainder entering the umbilical artery and returned to the placenta for re-oxygenation.

Neonatal Circulation

The aeration of the lung results in an increase in arterial oxygenation and pH that consequentially dilates the pulmonary vessels. A decompression of the capillary lung along with a corresponding decrease in right ventricular and pulmonary artery pressures occurs to increase the blood flow to the lungs and in pulmonary venous return.⁵⁷

The clamping of the umbilical cord removes the low resistance placental vascular circuit and causes an increase of the total systemic vascular resistance. This results in an increase in left ventricular and aortic pressures. The both of these factors reverses the shunt through the ductus arteriosus until the ductus completely closes.⁵⁷

With the decrease in right atrial pressure and the increase in left atrial pressure, the one-way “flap-valve” foramen ovale is pushed closed against the atrial septum. Even though the ductus venosus closes because of the clamping of the umbilical cord, the anatomical closure occurs at approximately one to two weeks. In summary, functional postnatal circulation generally is established within 60 seconds; however, completion of the transformation can take up to six weeks.⁵⁷

Dry, Warm, Position, Suction, Stimulate

The risk of hypothermia is greatest in the newborn delivered in the pre-hospital setting. In general, newborns have a poor mechanism for dealing with a cold environment. A newborn does not have the ability to shiver and generate heat and it cannot draw from fat stores. The metabolic rate of the newborn drastically increases when it enters the cold environment from the warmth of intrauterine life. Thermoregulation should be closely monitored in infants born out of hospital or in the environment outside the womb. Hypothermia increases metabolic needs and it interferes with simple functions such as breathing and feeding. So maintaining normal body temperature is very important.

If prepared, the EMS Personnel will do what is necessary to keep the neonatal infant dry and warm in order to prevent heat loss in an orderly fashion but also quickly, not needing to stop and figure out the next move. There are always exceptions however, when the infant presents

a more complicated set of issues. Even so the basics for life preservation can be accomplished first.

To dry the infant, use a gentle rubbing motion and continue to dry until the infant is obviously dry and warm. Prevent any type of draft on the infant. If there is a way to warm the immediate environment around the infant, do so to further prevent the infant from being chilled. The towels used to dry the infant should be discarded and the infant should be wrapped in a clean, dry towel or a blanket.

Then the infant should be placed in a position so that the airway is open and accessible. This can be accomplished by positioning the head slightly lower than the body with a thin pad placed under the shoulders to elevate them. Turn the infant's head to the side and suction the mouth first with a bulb syringe inserted 1 to 1.5 inches, 2 or 3 times. After the mouth has been suctioned, suction the nose with a bulb syringe inserted 0.5 inch into the nostril. The mouth must be suctioned first so that the infant does not attempt to breathe in and thus suck in some fluids from the mouth.⁵⁷

Supplemental Oxygen

It will be important now to assess the quality of breathing of the infant. After gentle stimulation, the infant's breathing may be independently stable. When the baby has blue skin tones to the chest, abdomen and lips, it will be necessary to provide supplemental oxygen. This is done by using an oxygen tubing with a flow at 6 lpm. The tube should be placed 0.5 inch from the infant's nose. The EMS Personnel will be able to monitor the breathing and check the pulse.

Removing Lung Fluid

After birth, the lung fluid is removed by several mechanisms, including evaporation, active ion transport, passive movement from Starling forces, and lymphatic drainage. Active sodium transport by energy-requiring sodium transporters, located at the basilar layer of the pulmonary epithelial cells, drive liquid from the lung lumen into the pulmonary interstitium where it is absorbed by the pulmonary circulation. Exposure to the air along with high concentrations of glucocorticoids and cyclic nucleotides reverses the direction of ion and water movement in the alveoli in order to also change the fetal lung epithelial cells from a pattern of chloride secretion to one of sodium re-absorption. This action accelerates re-absorption of the fetal lung fluid.⁵⁷

The first breath must overcome the viscosity of the lung fluid and the intra-alveolar surface tension. This first breath must also generate high transpulmonary pressure, which helps drive the alveoli fluid across the alveolar epithelium. With subsequent lung aeration, the

intraparenchymal structures stretch and gasses enter the alveoli, resulting in increased paO_2 and pH.

Respiratory Distress Syndrome

Respiratory distress syndrome (RDS) is caused by pulmonary surfactant deficiency in the lungs of neonates, most commonly in those born at < 37 wk gestation. Risk increases with degree of prematurity. Symptoms and signs include grunting respirations, use of accessory muscles, and nasal flaring appearing soon after birth. Diagnosis is clinical; prenatal risk can be assessed with tests of fetal lung maturity. Treatment is surfactant therapy and supportive care.⁵⁶

Lung expansion and aeration is a stimulus for surfactant release with the resultant establishment of an air-fluid interface and development of Functional Residual Capacity (FRC). Normally, 80 % to 90% of FRC is established within the first hour of birth in the term neonate with spontaneous respirations.⁵⁷

With adequate ventilatory support, surfactant production eventually begins, and once production begins, RDS resolves within 4 or 5 days. However, in the meantime, severe hypoxemia can result in multiple organ failure and death. Specific treatment is intra-tracheal surfactant therapy however, this requires endotracheal intubation. This will be necessary, no doubt, to achieve adequate ventilation and oxygenation.⁵⁶

Within minutes of delivery, the newborn's pulmonary vascular resistance may decrease by 8 fold to 10 fold. This causes an increase in neonatal pulmonary blood flow. At birth, if the lungs do not make the rapid transition to become the site for gas exchange, cyanosis and hypoxia rapidly develop.⁵⁷

An understanding of the structure and function of the fetal pulmonary vascularity and the subsequent transition to neonatal physiology is important to assist with adaptation effectively during resuscitation. In utero, the lungs develop steadily from an early time in gestation.⁵⁷

The first breath must overcome the viscosity of the lung fluid and the intra-alveolar surface tension. This first breath must also generate high trans-pulmonary pressure, which helps drive the alveoli fluid across the alveolar epithelium. With subsequent lung aeration, the intraparenchymal structures stretch and gasses enter the alveoli, resulting in increased paO_2 and pH. This increased paO_2 and pH result in pulmonary vasodilation.⁵⁷

Establish Effective Ventilation

The goal of the EMS Personnel in transport is to stabilize the airway and assure effective oxygenation and ventilation. Breaths delivered by bag-mask ventilation may be difficult to control and may result in overdistension and consequent pneumothorax so unless it is

absolutely necessary, forced ventilation is not recommended. The unheated non-humidified oxygen can quickly cool the infant via the large surface area of the lungs, resulting in hypothermia. With the neonatal infant any ventilation means of maintaining an open airway that is necessary, must be done remembering the smallness of the infant and all his or her organs.⁵⁷

Although the ideal mode of assisted ventilation is controversial, providing adequate positive end-expiratory pressure to prevent atelectasis, while at the same time preventing over-inflation. It is essential to use the lowest support possible to allow for adequate oxygenation and ventilation. Oxygen saturations should be monitored continually and arterial blood gas analyses performed as needed during the initial stabilization period. Saturations should be maintained in the 90% to 96% range for the term infant and 88% to 92% in the preterm infant after the initial stabilization.⁵⁷

Chest Compressions

Most infants who present at delivery with a heart rate less than 100 BPM respond to effective ventilatory assistance with a rapid increase of heart rate to normal rates. In contrast, if an effective airway and effective ventilation is not established, further support will not be effective. Chest compressions should be initiated following only 30 seconds of effective PPVs if the heart rate remains less than 60 BPM.⁵⁸

An assessment of the heart rate can be obtained by palpating the umbilical stump at the level of insertion of the infant's abdomen. Chest compressions should be discontinued as soon as the heart rate is higher than 60 BPM. Chest compressions may be performed either by circling the chest with both hands and using a thumb to compress or by supporting the infant's back with one hand and using the tips of the middle and index finger to compress the sternum. The thumb technique is preferred because of improved depth control during compressions. Again, at all times the EMS must be cognitive of the smallness of the infant and how that affects all manipulation for breathing purposes.⁵⁸

Pressure should be applied to the lower portion of the sternum, depressing it to a depth approximately one third of the anterior-posterior diameter at a rate of 90 inches per minute. One ventilation should be interposed after every 3 chest compressions, allowing for 30 breaths per minute. The chest should fully re-expand during relaxation, but the thumb pressure should not remain in place. The recommended chest compressions/ ventilations ratio is 3:1. This would equal to 120 events to a minute. The EMS Personnel must evaluate the heart rate and color of the infant every 30 seconds. Infants who fail to respond may not be receiving effective ventilatory support; thus, constantly evaluating ventilation is imperative. Chest compressions should be discontinued when the heart rate is 60 BPM or higher.⁵⁸

Advanced Life Support Intervention

In many neonatal transport programs, a respiratory therapist (RT) is the second crew member rather than another RN, because of airway management expertise. Each kind of specialist, however, has advantages and disadvantages.

Preparation of the infant for transfer for subsequent care requires several considerations. First, completing all the routine care that is required of newborn infants is essential. These basics of care may be neglected in the rush to prepare the infant for transport, with potentially disastrous results. Following resuscitation, care must be taken to secure all lines, tubes, catheters, and leads for transport. Monitoring in the transport environment is only possible with functioning leads in place, which is frequently difficult. Rapid and complete documentation of the resuscitation and subsequent therapies also is required for future caretakers.

Medical transport of this high-risk and critically ill population requires skilled personnel and specialized equipment. Ideally, a neonatal transport team forms a system of perinatal care composed of neonatal ICU (NICU), the perinatal care unit, medical and surgical pediatric subspecialists, and the neonatal outreach program. This article reviews the issues related to transport of the critically ill newborn population, including personnel, medical control, equipment, policy development, and transport administration.

Because the outcome of an outborn neonate with major medical or surgical problems remains worse than for an inborn infant, primary emphasis should always remain on prenatal diagnosis and subsequent in-utero transfer whenever possible. Despite advanced training and technology, mothers usually make the best transport incubators.

Skills Required For Neonatal Transport

The EMS Personnel must be medically knowledgeable regarding airway management when involved in the transport of the neonatal infant. Most critically ill neonates who require transfer have existing or impending respiratory failure, either as a primary diagnosis or secondary to their primary disease prognosis. For this reason, transport teams commonly include respiratory therapists since competence in airway management is of utmost importance. Competence in airway management must be dependable and consistent so this issue dictates the extent of resident participation in neonatal transport.

Team competence in neonatal airway management is imperative. The team should be capable of:

- recognizing impending respiratory failure,
- performing effective bag-valve-mask ventilation,
- performing atraumatic intubation with appropriate endotracheal tubes,
- instillation of artificial surfactant, and

- management of ventilator settings.

Intravenous access – Nearly all ill neonates require peripheral or central intravascular access during transport so the necessary equipment along with competent skills for routinely and reliably securing intravenous (IV) access in these tiny and challenging patients has to be of top priority.

Advanced procedures – The transport team must also have competency and training in procedures such as percutaneous needle aspiration of the chest, chest tube insertion, umbilical catheter insertion, and intraosseous vascular access.

The transport team must also be independent in thought and action and think outside the box if need be. Each one of the team must have extensive experience in the rapid performance of advanced clinical skills under less-than-ideal conditions

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Objective #3

Observing Neonatal Distress

Any time that a EMS Personnel has to observe, evaluate or assess the neonatal infant, attempt to do it while the parent is coddling them to eliminate separation anxiety in a scary area.¹

Observing Responsiveness

The scene should be assessed from a distance first to understand all elements of the emergency situation and the individuals and elements in play. The infant should move or cry when tapped or gently shaken. The observation should involve determining if the infant is responsive to voices or to pain stimulus.¹

Common causes of shock in the neonatal infant include losing large amounts of fluid from diarrhea and vomiting, blood loss, and abdominal injuries, etc. The neonate's body can compensate for shock for a period of time but those compensating mechanisms can suddenly fail.¹ So it is vitally important to continually check the infant for responsiveness. Signs and symptoms of shock include:

- Rapid heart and respiratory rate
- Weak or absent pulse
- Delayed capillary refill;
- Decreased urine output;
- Altered mental status;
- Pale, cool, clammy skin.¹

Observing the Airways

The first thing of importance is to insure sufficient airway capacity. This may include simple CPR or it may require ventilation. To assure adequate airways use a slight head tilt chin-lift. If there is any evidence of airway obstruction, clear the airway. Be aware not to over- or under-extend the neck.

The airway and respiratory systems of the neonate infant has not developed fully. The tongue is large relative to the size of the mouth, and the airway is narrower than the adult airway and consequently is more easily obstructed. The muscles in the neck are not fully developed, so it may be difficult for the neonate infant to hold his or her head in an open-airway position when sick or injured.¹

Some unique points to remember about the neonate infant breathing is that they are nasal breathers. If the nose is obstructed, the infant will not immediately open his or her mouth to breathe as an adult would do. So it is important to make sure the nostrils are clear of secretions to facility breathing.¹

If providing ventilation for a neonate, use an appropriate pediatric-sized mask.¹ The resuscitation bags for newborn neonate should be capable of delivering 90% – 100% oxygen but not to exceed 750 mL. They must also be capable of avoiding excessive pressure.

If the infant is responsive but cyanotic, struggling to breathe or has inadequate breathing, arrange for immediate transport.

Observing Bleeding

If the neonate is bleeding, it is important to remember that a very small amount of blood loss can cause the infant to slip into a state of shock.⁵⁷ Neonatal bleeding results from disorders of platelets, coagulation proteins, and disorders of vascular integrity. While healthy newborns have low levels of some coagulation proteins, this is normally balanced by the paralleled decrease in fibrinolytic activity.⁶⁰

The signs and symptoms of bleeding disorders vary with the cause of bleeding, magnitude of blood loss and the underlying disease. Signs of abnormal bleeding tendency include excessive bruising, prolonged bleeding from puncture sites, umbilical oozing, gastrointestinal bleeding, pulmonary hemorrhage or andintracranial hemorrhage. When blood loss is large, the infant may present with signs of hypovolemia.⁶⁰

For secondary bleeding disorders, it is advisable to treat the underlying disease. Replacement of clotting factors is often necessary. If the neonatal is presenting with severe, life threatening bleeding, it is important to maintain adequate circulating of the blood volume and at some point blood will need to be sent for clotting studies. If the clotting defect is not known, consider giving:

- -Vitamin K 1 mg IV **slowly over 1 min** (Rapid infusion of Vitamin K can cause cardiac dysrhythmias).
- -Fresh Frozen Plasma 10 m
- -Platelets 1 unit
- -Cryoprecipitate 1 unit⁶⁰

Observing Signs of Pain

Pain is a subjective experience and to measure it in an objective way is difficult. Infants have been reported to be capable of experiencing pain irrespective of gestational age,⁷ but the response to pain may differ with gestational age. The eye squeeze is the facial action most often seen in the preterm infants in response to perpetrated pain.¹¹

Inadequate assessment of pain in the neonate infant is a persistent problem for the Emergency Medical.

Observing Fever

The average normal temperature in a newborn is 99.5 degrees F. A rectal temperature of 100.4 degrees F is considered fever. Neonates do not develop fever as readily as older children do. Any fever requires extensive evaluation because it may be the symptom of a deeper cause such as pneumonia, sepsis, or meningitis. It must be remembered that a neonate has very little control over controlling their body temperature. Since fever can be a serious problem, it is advisable to take it seriously because it could be the cause of:

- Mental status changes;
- Decreased feeding;
- Skin warm to touch;
- Rashes or hemorrhagic spots on the skin.

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Objective #4

Assess Risk Factors for the Neonate

Congenital Risk Factors – Congenital Anomalities

A congenital anomaly may be viewed as a physical, metabolic, or anatomic deviation from the normal pattern of development that is apparent at birth or detected during the first year of life.¹³ A “birth defect” or congenital anomaly is a health problem or physical change, present in a baby at the time he or she is born. Most birth defects occur due to environmental and genetic factors. Birth defects may be very mild where the baby looks and acts like any other baby, or birth defects may be very severe. Some of the severe birth defects can be life threatening, in which case a baby may only live a few months or may die at a young age.

- **Musculoskeletal anomalies** – cleft lip/palate, polydactyly, clubfoot;
- **Cardiovascular and respiratory malformations** – malformed genitalia, renal agenesis;
- **Central nervous system anomalies** – anencephaly, spina bifida, hydrocephalus, microcephalus;
- **Gastrointestinal malformations** – rectal atresia/stenosis, tracheo-esophageal fistula, omphalocele;
- **Chromosomal anomalies** – Wolf-Hirschhorn syndrome, Jacobsen syndrome, Charcot-Marie-Tooth disease type 1A

Additional Risk Factors

Premature Birth Challenges

A premature baby may not be able to process bilirubin as quickly as full-term babies do. Also, he or she may feed less and have fewer bowel movements. These conditions result in less bilirubin eliminated in the baby’s stool.

Bruising During Birth

Sometimes babies are bruised during the delivery process. If a newborn has bruises, he or she may have a higher level of bilirubin from the breakdown of more red blood cells.

Blood Type

If the mother’s blood type is different from her baby’s, the baby may have received antibodies from the mother through the placenta that causes his or her blood cells to break down more quickly.¹⁴

Choanal Atresia

Choanal Atresia is a bony or membranous occlusion that blocks the passageway between the nose and the pharynx. It can result in serious ventilation problems in the neonate.¹ Choanal atresia may affect one or both sides of the nasal airway. Choanal atresia blocking both sides of the nose causes acute breathing problems with cyanosis and breathing failure. Infants with bilateral choanal atresia may need resuscitation at delivery.¹⁵

In order to resuscitate the baby, it may be necessary to place an airway so that the infant can breathe. In some cases, intubation or tracheostomy may be needed. Surgery to remove the obstruction cures the problem. However, an infant can learn to mouth breathe, which can delay the need for immediate surgery.

Cleft Lip/Palate

Cleft lip and cleft palate are birth defects that affect the upper lip and roof of the mouth. A cleft lip is when one or more fissures originate in the embryo. It is usually a vertical, off-center split in the upper lip that may extend up to the nose.¹ They happen when the tissue that forms the roof of the mouth and upper lip don't join before birth. The problem can range from a small notch in the lip to a groove that runs into the roof of the mouth and nose. This can affect the way the child's face looks. It can also lead to problems with eating, talking and ear infections.¹⁶ Treatment usually is several stages of surgery to close the lip and palate.

Sudden Infant Death Syndrome

Sudden infant death syndrome (SIDS) is the sudden unexplained death during deep of an apparently healthy baby in the first year of life.¹

When EMS Responders arrive, they may see distraught parents with their infant in respiratory and cardiac arrest during the scene size-up. Emergency care must be started immediately while transport is being arranged.¹ Responding to these calls is difficult even for the most experienced and well-trained EMT. While working to hopefully revive the infant, the EMT may also be faced with consoling the parent or other caregiver, as well as assessing and recording information about the death scene. The EMT has three primary roles in responding to a sudden, unexpected infant death:

- Providing immediate emergency medical care to the baby;
- Observing, assessing, and documenting the scene;
- Offering support and consolation to parents/caregivers.¹⁷

Objective #5

Evaluating the Neonatal Disorders

Evaluating the Cardio-Respiratory System

The heart and lungs are one of the first things to be evaluated on the infant. A normal heart rate is 100 to 160 beats minutes but the rhythm must be regular also. An irregular rhythm from premature atrial or ventricular contractions is not uncommon. The chest wall should be examined for symmetry, and lung sounds should be equal throughout. Grunting, nasal flaring, and retractions are signs of respiratory distress.⁵

Neonatal Heart Murmur

Heart murmur is the noise made by blood as it travels through the heart. However, blood flow in normal circumstances flows silently. When the blood starts to flow turbulently, noise is produced. The noise can be heard by auscultation and termed "heart murmur".²¹ A murmur heard in the first 24 hour is most commonly caused by a patent ductus arteriosus. However, the disappearance of this murmur normally occurs within 3 days.⁵

Blood flow through the aortic valve and pulmonary valve. Blood flow across these two valves is audible in some children not because there is anything wrong with these valves, but because children have a faster heart rate. This results in the blood traveling with a higher speed causing the heart murmur. Also, children have thinner chest walls, which allows sounds to be more readily audible.²¹

Femoral Pulses

Femoral pulses are normally checked against the brachial pulses. If the femoral pulse is weak or delayed it may suggests aortic coarctation or left ventricular outflow tract obstruction.⁵ However, recent data suggests that the femoral pulse may not be reliable for determining heart rate. Umbilical pulsations must not be relied upon if low or absent so heart rate in newborn resuscitation should rely solely on the stethoscope. In the absence of a stethoscope only the umbilical pulse should be used with an awareness of its limitations.²²

Central Cyanosis

Central cyanosis suggests congenital heart disease, pulmonary disease, or sepsis. The respiratory system is evaluated by counting respirations over a full minute because breathing in neonates is irregular; normal rate is 40 to 60 breaths/min.⁵ Central cyanosis indicates a need for treatment. It is generally due to the accumulation of desaturated or oxygen-depleted, hemoglobin.

Cyanosis due to airway obstruction is treated, of course, by opening the airway. But cyanosis due to inadequate ventilations is treated by ventilating the baby. In mild cases, cyanosis may be resolved by providing 100% oxygen to the baby.²³

Neonatal Apnea

Neonatal Apnea is the unexplained cessation of breathing for 20 seconds or more—or a shorter pause associated with cyanosis, pallor, bradycardia, hypoxia, or hypotonia— after 37 weeks' gestational age.¹⁹ Apnea is the most common problem of ventilatory control in the premature infant frequently prolonging the need for cardiopulmonary monitoring.²⁵ Apnea has been traditionally classified into three categories:

- **Central** – No evidence of upper airway obstruction and inspiratory muscle activity fails following an exhalation;
- **Obstructive** – Obstructed upper airway, typically with respiratory effort but no airflow;
- **Mixed** – Obstructed respiratory efforts, usually heralded by central pauses; both central and obstructive apnea occurs during the same episode.^{19, 25}

The Neonatal Apnea physical exam should include the monitoring of vital signs for fever, respiratory effort, arrhythmia, and oxygen saturation. A complete neurological exam should be completed with an emphasis on abnormalities in tone or development.⁵

Evaluating the Head and Neck

In a delivery, the head is commonly molded with the overriding of the cranial bones at the sutures and some swelling and ecchymosis of the scalp. In a breech delivery, the head has less molding.⁵

Hypothyroidism

Since the head circumference and fontanelle size can indicate a congenital disorder or head trauma, it must be evaluated closely. A large anterior fontanelle may be a sign of hypothyroidism.⁵ Congenital hypothyroidism has a frequency of 1 case per 3500 live births. Approximately 75% of infants with congenital hypothyroidism have defects in thyroid gland development, 10% have hereditary defects in thyroid hormone synthesis or uptake, 5% have secondary or tertiary hypothyroidism, and 10% have transient hypothyroidism. Untreated congenital hypothyroidism in early infancy results in profound growth failure and disrupted development of the CNS, leading to developmental cognitive delay.²⁰

Craniosynostosis

Craniosynostosis results in growth restriction perpendicular to the affected suture and compensatory overgrowth in unrestricted regions.⁵ Craniosynostosis consists of the premature fusion of one or more cranial sutures, often resulting in an abnormal head shape. It may result

from a primary defect of ossification or, more commonly, from a failure of brain growth. Simple craniosynostosis refers to when only one suture fuses prematurely. On the other hand, complex or compound craniosynostosis is when there is premature fusion of multiple sutures. When children with complex craniosynostosis also display other body deformities, it is referred to as syndromic craniosynostosis.²⁴

The craniosynostosis anomaly may suggest a genetic disorder such as Apert's syndrome or Crouzon's disease. If the synostosis is accompanied by restricted brain growth or hydrocephalus, neurosurgical intervention is necessary.⁵

Evaluating Abdomen and Pelvis

When the abdomen is not round and symmetric, a scaphoid abdomen may indicate a diaphragmatic hernia, allowing the intestine to migrate through it to the chest cavity in utero; pulmonary hypoplasia and postnatal respiratory distress may result.⁵

Asymmetric Abdomen

An asymmetric abdomen suggests an abdominal mass.⁵ Asymmetric Larger-for-Gestational Age (LGA) infants had greater odds of hypoglycemia, hyperbilirubinemia, and composite morbidity, respectively, compared with symmetric non-LGA infants. Asymmetric LGA infants are at higher risk for morbidity than symmetric LGA and non-LGA infants.²⁶

Splenomegaly

Splenomegaly suggests congenital infection or hemolytic anemia. The kidneys may be palpable with deep palpation; the left is more easily palpated than the right. Large kidneys may indicate obstruction, tumor, or cystic disease.⁵

Umbilical Hernia

An umbilical hernia, due to a weakness of the umbilical ring musculature, is common but rarely significant. The presence of a normally placed, patent anus should be confirmed.⁵

Musculoskeletal System

The extremities are examined for deformities, amputations, incomplete or missing limbs, contractures, and mal-development. Brachial nerve palsy due to birth trauma may manifest as limited or no spontaneous arm movement on the affected side, sometimes with adduction and internal rotation of the shoulder and pronation of the forearm. The spine is inspected for signs of spina bifida, particularly exposure of the meninges, spinal cord, or both.⁵

Orthopedic Examination

Orthopedic examination includes palpation of long bones for birth trauma but focuses on detection of hip dysplasia. Risk factors for dysplasia include female sex, breech position in utero, twin gestation, and family history. The Barlow and Ortolani maneuvers are used to check for dysplasia. These maneuvers must be done when neonates are quiet. The position is the same for both: Neonates are placed on their back with their hips and knees flexed to 90° (the feet will be off the bed), feet facing the clinician, who places an index finger on the greater trochanter and a thumb on the lesser trochanter

For the Barlow maneuver, the Emergency Medical Personnel can adduct the hip while pushing the thigh posteriorly. A clunk indicates that the head of the femur has moved out of the acetabulum; the Ortolani maneuver then relocates it and confirms the diagnosis.⁵

For the Ortolani maneuver, the hip is returned to the starting position; then the hip being tested is abducted and gently pulled anteriorly. A palpable clunk of the femoral head with abduction signifies movement of an already dislocated femoral head into the acetabulum and constitutes a positive test for hip dysplasia.⁵

The maneuver may be falsely negative in the neonatal infant because of tighter hip muscles and ligaments. If the infant is high risk such as a girl who was in the breech position, hip ultrasonography should be done at four to six weeks.⁵

Neurologic System

The neonate's tone, level of alertness, movement of extremities, and reflexes are evaluated. Typically, neonatal reflexes, including the Moro, suck, and rooting reflexes.

Moro Reflex

Moro reflex is a type of involuntary response that is present at birth but disappears after 3 or 4 months.²⁹ The neonate's response to startle is elicited by pulling the arms slightly off the bed and releasing suddenly. In response, the neonate extends the arms with fingers extended, flexes the hips, and cries.⁵

This is a normal reflex present in newborn infants but the presence of a Moro reflex in an older infant, child, or adult is abnormal. Two-sided absence of the Moro reflex suggests damage to the brain or spinal cord.²⁹

Rooting Reflex

The rooting reflex is stimulated by the stroking of the neonate's cheek or lateral lip. This prompts the neonate to turn the head toward the touch and open the mouth to commence sucking.⁵ It may disappear at three or four months of age.³⁰

Suck Reflex

A pacifier or gloved finger is used to stimulate this reflex. These reflexes are present for several months after birth and are markers of a normal peripheral nervous system.⁵ So if the neonate does not have the suck reflex, there may be a problem that needs to be evaluated.

Skin

A neonate's skin is usually ruddy but cyanosis of fingers and toes is common in the first few hours. Dryness and peeling often develop within days, especially at wrist and ankle creases. Petechiae may occur in areas traumatized during delivery. If the head is the presenting part, the face may have petechiae. However, neonates with diffuse petechiae should be evaluated for thrombocytopenia.⁵

Thrombocytopenia

Thrombocytopenia is the low blood platelet count. Platelets (thrombocytes) are colorless blood cells that play an important role in blood clotting. Platelets stop blood loss by clumping and forming plugs in blood vessel holes. Thrombocytopenia often occurs as:

- a result of a separate disorder,
- leukemia or an immune system malfunction,
- a medication side effect.²⁷

In rare cases, the number of platelets may be so low that dangerous internal bleeding can occur. Neonatal Thrombocytopenia is isoimmune and often drug-related. It can have an abrupt onset or insidious onset but generally it is abrupt for neonatal infants.⁵

Erythema Toxicum

Many neonates have erythema toxicum, a benign rash with an erythematous base and a white or yellow papule. Erythema toxicum is a common, noncancerous skin condition seen in newborns.²⁸ This rash, which usually appears 24 hours after birth, is scattered over the body and can last up to two weeks.⁵ Erythema toxicum can appear in 50% or more of all normal newborn infants.²⁸

Objective #6

Stabilizing the Neonatal Infant

A common feature of disease in the neonatal period progresses rapidly. Appropriate stabilization, initiated on recognition of a problem, is necessary throughout the transfer process.³⁴ At birth the neonate has three major physiological adaptations necessary for survival:

- Stabilization of the Neonate Lungs;
- Changing The Circulation Pattern in the Neonate Newborn;
- Maintain Body Temps for the Neonate.

The decision to transport an infant depends upon a variety of factors including: availability of 24-hour skilled nursing, respiratory therapy, equipment, x-ray and laboratory support, as well as physician knowledge and time. If the infant has unstable vital signs, the transport team will remain at the referring hospital until the baby is sufficiently stabilized to ensure a safe transport. It is unsafe to transport an unstable infant.³⁴

If the infant's heart rate does not respond to effective ventilation or cannot be detected, chest compressions should be initiated: Place thumbs over lower 1/3 of sternum. Wrap fingers around infant's chest, supporting spine with fingers. The EMS personnel can compress 1/3 AP diameter of chest at a rate of 90/minute which will coordinate with the ventilation.³⁴

Stabilization of the Neonate Lungs

The neonate Infant with small airways disease such as wheezing disorders, cystic fibrosis and chronic lung disease have hyper-inflated lungs and ventilation inhomogeneities. In infants it is difficult to target small airways function.³²

There are various reasons for respiratory problems. Some of the more common are:

- Transitory Tachypnea of the Newborn (TTN);
- Pneumonia/Aspiration Syndrome from Meconium or Amniotic Fluid ;
- Obstruction from a mass, hernia, pneumothorax.

Endotracheal intubation of the newborn infant is associated with significant adverse physiologic responses that include bradycardia secondary to vagal stimulation, an increase in blood pressure, a progressive decrease in oxygen saturation that varies with the duration of the procedure, and increases in intracranial pressure.³⁰

Protecting The Neonate's Lungs

In attempting to provide ventilator support, the neonate infant's lungs and airways are subjected to forces that lead to acute and chronic tissue injury. This results in alterations in the way the lungs develop and the way they respond to subsequent noxious stimuli. The injury can then lead to alterations in lung development, which result in alterations in the lung function as the infant's body attempts to heal and continue to develop.

When the neonate infant has respiratory failure, the EMS Personnel has to understand the respiratory physiology as well as the respiratory system development, growth, and healing processes. Along with this, the energy production required for a newborn infant to sustain his or her metabolic functions is dependent upon the availability of oxygen and its subsequent metabolism.

Changing the Circulation Pattern

The transition from fetal to neonatal circulation may be without incident. But to make this switch, the respiratory system must instantaneously initiate and maintain oxygenation. Infants are very sensitive to hypoxia and permanent brain damage can occur with any incident of hypoxemia.³¹

The lungs of the neonatal newborn transfers oxygen to the blood by diffusion. This is driven by the oxygen pressure. For gas exchange to occur efficiently, the infant's lungs must remain expanded, the lungs must be both ventilated and perfused, and the ambient partial pressure of oxygen in the air must be greater than the partial pressure of oxygen of the blood. The efficiency of the newborn infant's respiratory system is determined by both structural and functional constraints.

As soon as the baby is born, the foramen ovale, ductus arteriosus, ductus venosus and umbilical vessels are no longer needed so the sphincter constricts causing the blood entering the liver to pass through the hepatic sinusoids. The occlusion of the placental circulation causes an immediate fall of blood pressure in the IVC and right atrium.³¹

Increasing uptake of oxygen by lungs induces a constriction in the veins and arteries. Aeration of the lungs at birth is associated with a dramatic fall in pulmonary vascular resistance. This happens because the lungs expand. There is also a marked increase in pulmonary blood flow. Then because the lungs increase in size there is a stretching that causes a normal progressive thinning of the walls of the pulmonary arteries.³¹

On the first breath the pulmonary alveoli opens up. The pressure in the pulmonary tissues decreases as the blood from the right heart rushes to fill the alveolar capillaries. Then pressure

in the right side of the heart decreases but pressure in the left side of the heart increases as more blood is returned from the vascularized pulmonary tissue.³¹

Resulting circulatory changes include blood pressure that is high in the aorta and the systemic circulation is well established. The control of circulation is a reflex function regulated by several factors. Respiratory and circulatory reflexes are usually strong in the healthy full-term newborn, but the efficiency that the newborn neonate has in controlling cardiovascular function is susceptible to a variety of environmental factors.³¹

Maintaining Body Temps

Low birth weight babies have a higher chance of survival if they are kept warm so the reason for the use of incubators. Open cots with an overhead radiant warmer have also been used for babies needing intensive care. At the present time, it is not clear which method of maintaining body temperature is best for newborn babies - radiant warmers or incubators but it is advisable to use one of them to create continuity in body temperature.³⁵

The provision of a thermoneutral environment is an essential component of the immediate and longer term care of the neonate infant. A variety of methods are currently employed including incubators and open-care systems, with or without modifications such as heat shields and plastic wrap. Whichever system is utilized it must allow ready access to the neonate infant but also minimize alterations in the immediate environment.³⁵

Objective #7

Appraise the Jaundice Factor in the Neonate

Jaundice, a common condition in neonate infants, is the yellow color of the skin and whites of the eyes caused by excess bilirubin in the blood. Bilirubin is produced by the normal breakdown of red blood cells. Normally, bilirubin passes through the liver and is excreted as bile through the intestines. Jaundice occurs when bilirubin builds up faster than a newborn's liver can break it down and pass it from the body. Reasons for this include:

- Newborns make more bilirubin than adults do since they have more turnover of red blood cells.
- A newborn baby's still-developing liver may not yet be able to remove adequate bilirubin from the blood.
- Too large an amount of bilirubin is reabsorbed from the intestines before the baby gets rid of it in the stool.

Levels of bilirubin above 25 mg can cause severe health issues such as deafness, cerebral palsy, or other forms of brain damage in some babies. In less common cases, jaundice may indicate the presence of another condition, such as an infection or a thyroid problem. The American Academy of Pediatrics (AAP) recommends that all infants should be examined for jaundice within a few days of birth.

Types of Jaundice

Jaundice is the most common condition that requires medical attention in newborns.³⁶ The most common types of jaundice are:

Physiological (normal) Jaundice

Physiological jaundice occurs in most newborns due to the immaturity of the baby's liver, which leads to a slow processing of bilirubin. It generally appears at 2 to 4 days of age and disappears by 1 to 2 weeks of age.³⁷ Physiological jaundice occurs in more than 50% of babies and is considered basically harmless.³⁸

Jaundice of Prematurity

This type of jaundice occurs more frequently in premature babies as they may not be developed enough to properly excrete bilirubin from their bodies, causing a buildup of it in their system.³⁹ Jaundice in premature babies needs to be treated at a lower bilirubin level than in full term babies in order to avoid complications.³⁷

Breastfeeding Jaundice

Breastfeeding jaundice can occur when a breastfeeding baby is not getting enough breast milk because of difficulty with breastfeeding or because the mother's milk is not in yet. Breast milk jaundice peaks at 10 to 21 days, but may last for 2 to 3 months. Breast milk jaundice is normal. However, breastfeeding does not need to be discontinued even for a short time.⁴² This is not caused by a problem with the breast milk itself, but by the baby not getting enough to drink.³⁷

Neither should breastfeeding be discontinued "in order to make a diagnosis" if the baby is doing well on breast only. If the baby is nursing well, more frequent feedings may be enough to bring the bilirubin down more quickly.⁴²

Treatment

The biliblanket may be used as an alternative or additional treatment for the infant's jaundice. This system uses fiber optics and represents advanced technology in phototherapy treatment given in the hospital or at home. The biliblanket provides the highest level of therapeutic light available to treat a neonatal baby. The strength of light from the biliblanket is about the same,

as the shade on a sunny day, yet is safer because the biliblanket filters out potentially harmful ultraviolet and infrared energy.³⁸

Jaundice Complications

Normally, newborn jaundice disappears without treatment or complications. However, if since being diagnosed with newborn jaundice, a neonatal infant's jaundice has not disappeared after two weeks or his or her palms or soles become yellow, his skin appears bright yellow, or some other symptoms have developed, some further complications may have occurred. The symptoms may be that the infant is generally not feeding well; develops a fever, or becomes listless. Although rare, jaundice can cause kernicterus with complications including brain damage, deafness and cerebral palsy.⁴⁰

Kernicterus

Kernicterus usually develops in the first week of life, but may be seen up until the third week.⁴¹ Kernicterus is a form of brain damage caused by excessive jaundice. The bilirubin levels are so high that it can move out of the blood into the brain tissue. When babies begin to be affected by excessive jaundice and brain damage begins, they become excessively lethargic and it is difficult to arouse them from sleep. Immediate treatment should be done to prevent further damage, so as little as possible permanent damage occurs. Measures to increase feeding and hydration such as lactation and increased breast-feeding and/or temporary supplementation should be considered.⁴⁰

Newborns with Rh hemolytic disease are at high risk for severe jaundice. However, kernicterus has been seen in apparently healthy babies.⁴¹

Objective #8

Examining the Neonate Infant in a Major Catastrophe

Major catastrophes are a challenge in the environment of adult victims and patients but when there are infants involved the stakes of care are suddenly complicated. More than likely the EMS Personnel will have two patients to care for because the neonatal infant will no doubt be injured along with his or her mother. Similar injuries will be the case but different treatments for the pair. Compromised ventilation, impact trauma and loss of blood are the considerations for the EMS Personnel when approaching a disaster area. These three injuries will be complicated by an environment of chaos and even limited medical resources.

In a major catastrophe, the scene must be secure first and organized into a triage according injury severe. Another category that may need to be added to this triage routine is a specified location for the infants and young children and if possible specially trained EMS Personnel will be dispatched to the disaster location.

Compromised Respiratory

We addressed ventilation issues earlier in the course but with the emphasis of post birth ventilation problems. Compromised respiratory issues with the neonatal infant in a disaster area may not only be problems with breathing but there could be extreme dust, ash or other foreign elements that the EMS Personnel will need to clear from the infant's nose, throat and other respiratory passages.

Normal respiratory rate for an infant less than one year old is 30 to 60. Normal Pulse Rate is 100 to 160 and the lower limit of normal systolic BP is 60 or higher.

Respiratory / Cardiac Arrest Treatment for the Infant

Ventilation can be administered for 20 minutes. CPR method for the infant should be done with 2 fingers rather than the hand. As with an older baby or child the chest should be at a depth of 1/3 - 1/2. The compression Rate can be about 100 per minute. CPR should be started for a heart rate of less than 60. The EMS Only AEDs with pediatric capabilities should be used on the infant.⁴⁸

Neonatal Resuscitation

Neonatal resuscitation should be given with tactile stimulation after making sure the infant is dry and warm and in a positive position for the best manipulation. Advanced Life Support (ALS) should be called for back-up immediate.⁴⁸ If the infant is in a state of apnea or is gasping with a heart rate less than 100 or has central cyanosis, it is necessary to ventilate with BVM at 40 to 60 a minute.⁴⁸

Impact Trauma

Since the communication with an infant is non-verbal the physical examination must be all inclusive. As the EMS personnel is doing a physical examination, he or she must watch the infant to note the reflexes that can determine injury, pain or even discomfort. Any type of impact will have left bruising but perhaps not visible yet to the eye. If a parent or another adult was with the infant when the incident occurred, he or she may be able to explain in what location on the infant's body the impact or impacts occurred. Particularly precarious are impacts to the head. Even a small impact can cause substantial injury as the neonatal's skull has not been fully formed.

There more than likely will be no bleeding at the point of impact so the fingers have to do the examination in order to accurately determine the severity of the impact and if possible what impacted the neonatal infant. If it were a sharp object the internal injury will be different than if the object was large and flat.

With heavy impact or with loss of blood, the infant could regress into a state of shock and not respond to normal stimulus.

Primary injury

Primary injury is that which is caused by the trauma itself. The most subtle finding is that of subarachnoid blood. This is well described on computed tomography (CT), and has a typical location in the inter-hemispheric fissure posteriorly. Recognizable blood in the basal cisterns and around the brain stem is unusual in abuse, and is more suggestive of a ruptured aneurysm.

Loss of Blood

The loss of blood will, no doubt, be quite obvious in a full body examination. If the infant is bleeding, the first line of defense against a state of unconsciousness or getting infection in the wound is to bind the wound so the bleeding stops.

Blood loss has two effects on the body. First, there is a loss of volume within blood vessels to be pumped and secondly, a reduced oxygen carrying capacity occurs because of the loss of red blood cells. Hypovolemic shock occurs when there is significant bleeding that occurs relatively quickly. Trauma is the most common example of bleeding or hemorrhage. The infant can sustain a much lower volume of blood loss because there is a much smaller amount of blood.⁴⁶

So again it is of utmost importance to stop the bleeding and then to secure the wound so the risk of infection is lowered.

Control of Infection

In emergency situations, babies have a greater need for the disease-fighting factors and the comfort provided by breastfeeding. If the mother is with the infant and able to breastfeed, it will be an asset to all concerned. Refrigeration, bottles, or water for preparing formula are not necessary and will probably be inaccessible in a disaster area, at least in the beginning.⁴³

So if the mother is with the infant, the two can be treated as a unit because many things will be simpler and more effective if the mother can breastfeed and comfort the infant. EMS Personnel as well as the mother must all maintain greater level of cleanliness as the neonatal infant has more of a vulnerability to infection and disease. His or her immune system is still quite fragile.

Rescuing a Family

If the EMS Personnel has been called to extricate a family from their home that is soon to be flooded, etc, then they must spring into action to remind the mother of essentials she needs for the infant. These essentials could include formula, diapers, bottles, powdered milk, medications, baby wipes and diaper rash ointment.⁴⁷ Even if the weather is considerably warm the infant will need blankets to protect against exposure to the elements of wind and rain, etc. If the family has rain coats or something that is water proof, it would be a good idea to retrieve it for protection against the elements for the duration of the transport to safety.

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Objective #9

Recognizing Neonatal Injuries in Child Abuse

In the first year of life, accidental injury occurs more often than intentional injury but still the incidence of trauma in children younger than 12 months is approximately 24.4 cases per 1000 children per year.⁴⁴ Child abuse is often misdiagnosed and under-recognized by physicians and caregivers because it occurs in many forms. It is, however, best defined as a purposeful infliction of physical or emotional harm, sexual exploitation, and/or neglect of basic needs.⁴⁴

Anatomic features make infants especially prone to neurologic injury from excessive shaking or trauma. Infants have a large head compared with their body size, and the cervical para-spinal muscles are weak. This is the reason for head lag observed during the first month of life. The infant brain has a higher water content than that of the adult brain and the subarachnoid spaces are also larger in infants than in adults, given the small size of their brains.⁴⁴

The mechanism by which brain damage occurs is controversial. Traditionally, shearing forces were believed to cause axonal damage. Acceleration and deceleration forces may damage the neuraxis to cause apnea, with ischemia and cerebral edema occurring later.⁴⁴

Biomechanical studies of infant trauma injuries have shown that the magnitude of angular deceleration is 50 times greater when the infant's head strikes a surface than when he or she is only shaken. This force is distinct from those of other accidental traumas that occur in infants. This evidence suggests that the term shaking-impact syndrome is more accurate than shaken baby syndrome.⁴⁴

Risk Factors

Physical abuse tends to occur at moments of great stress in the lives of individuals who were abused as children. People who commit physical abuse may have poor impulse control not thinking about what happens as a result of their actions. Child abuse is found in every racial or ethnic background and social class. One of the most common form of child abuse is neglect.

Some risk factors for child abuse include:

- Alcoholism;
- Drug abuse;
- Being a single parent;
- Lack of education;
- Poverty.⁵¹

The EMS personnel arriving on the scene of an incident should look for the following signs to that could be child abuse:

Symptoms include:

- Black eyes;
- Broken bones that are unusual and unexplained;
- Bruise marks shaped like hands, fingers;
- Bulging fontanelle;
- Burn marks;
- Choke marks on the neck;
- Cigarette burns on exposed areas or on the genitals;
- Human bite marks;
- Unexplained unconsciousness in an infant.⁵¹

When the EMS Personnel has questions about the cause of injury which he or she finds on an infant, the right questions should be asked to protect the infant and even other children in the home. If there are suspicions of child abuse, the proper reporting must also be done to prevent additional incidents from happening.

Shaken Baby Syndrome

Shaken baby syndrome (SBS) is of particular interest to the neurologist, as it affects the nervous system. Shaken baby syndrome may cause long-term damage in the developing nervous system, and the effects may even be lethal.⁴⁴

Shaken baby or Shaken Impact Syndrome (SBS) is a form of inflicted head trauma. Head injury, as a form of child abuse, can be caused by direct blows to the head, dropping or throwing the child, or shaking the child. Head trauma is the leading cause of death in child abuse cases in the United States.⁴⁹ Whiplash-shaking often results in bilateral subdural hemorrhage. It is true that while it is unusual to slap or spank an infant, the significance of shaking or jerking has only been realized in recent times.⁴⁴

When the infant is shaken, movement of the immature brain in relation to the skull and the poor muscle tone in the neck cause the bridging vessels to tear. That results in a subdural hematoma. Retinal hemorrhages also are produced when venous congestion causes rupture of the retinal vasculature. Therefore, shaken baby syndrome is defined by subdural hemorrhage and retinal hemorrhage.⁴⁴

The Physiology of Shaking

Shaking produces repeated acceleration– deceleration forces, so-called whiplash, mainly in an antero-posterior direction, but the brain will also rotate within the calvarium, as a secondary motion. These movements can cause tearing of the delicate bridging veins, which course from the cerebral cortex, through the subarachnoid space and the potential subdural space, to drain into the venous sinuses. This results in hemorrhage into the subarachnoid or subdural spaces or both. The infant brain is more at risk from a shaking injury due to:

- its greater relative weight;
- the lack of tone in the supporting muscles of the neck;
- the poor myelination associated with a higher water content.

The relative degree of myelination contributes to the development of shearing injuries, most commonly at the gray–white interface, with a subcortical or callosal location.⁴⁵

There may be, presumably, a controversy as to the precise mechanism of injury, whether it be a pure shaking-whiplash injury, or whether there is an additional impact injury. It is only of slight importance, however, because it is well observed that the forces generated are of a magnitude greater than an impact against a soft surface. It is accepted that the forces generated during a vigorous shaking alone are sufficient to cause devastating cerebral damage.⁴⁵ After the shaking, swelling in the brain can cause enormous pressure within the skull, compressing blood vessels and increasing overall injury to its delicate structure.⁴⁹

Rib Fracture

Child abuse should always be suspected, especially if injuries are not consistent with the history of the chief complaint.⁵³ There are numerous reports of fractured ribs as a result of child abuse and it has been documented that fractured ribs are the third most frequent skeletal injury in battered infants. Almost all infants with bone injuries from child abuse have other associated injuries. A newborn infant was discovered to have five fractured ribs 9 hours after a vacuum-assisted delivery and moderate shoulder dystocia.⁵⁰

The diagnosis of child abuse was seriously considered, but little evidence was found to support this explanation of the injury despite the presence of several child-abuse risk factors. The mother's interactions with the child, as observed by nursing staff, medical staff, and social service personnel, were considered to be appropriate so child abuse was not a factor in this situation even though it was a consideration.⁵⁰

Mortality/Morbidity

Abuse and neglect account for 5% to 14% of all deaths of infants and children. In 2006 in the United States, 1,530 fatalities from child abuse were reported, and 45% involved infants younger than 12 months.⁴⁴ Children under the age of one were most vulnerable and accounted for 40.9% of all fatalities. The tragedy of child abuse- and neglect-related fatalities has been brought close to home with an increasing frequency by recent media reports.⁵² Shaken baby syndrome is reported to be the leading cause of death in children younger than 4 years.

- In children younger than 1 year, homicide is the leading cause of death. This is the only cause of death in children that is increasing in frequency.
- In a series of 80 patients younger than 2 years who had head trauma and died because of the injury, 43% had evidence of child abuse.⁴⁴

An estimated 1,401 child abuse and neglect-related fatalities were confirmed by CPS agencies which is nearly 4 every day. Since 1985, the rate of child abuse fatalities has increased by 39%. Based on these numbers, more than three children die each day as a result of child abuse or neglect.⁵³

The EMS Personnel on the Child Abuse Call

Because EMS providers are often called to homes with infants and children, they can have an important role in identifying and documenting vital information that could provide evidence of child abuse. Proper documentation of all information collected is of utmost importance. Often, cases of abuse involve life-threatening conditions that need prompt and efficient response to resuscitate, pack and transport the neonatal patient. Awareness of surroundings, observation of other children in the home and history provided by the caregiver must be documented accurately. The responsibility of the EMS Personnel is to document everything that is seen on site in objective language without flavoring it with emotions no matter how horrific the abuse may be.⁵⁴

The EMS Personnel must document any bruising, swelling or other external injuries to aid in quicker diagnoses when the patient is brought to the emergency department. This documentation will include the presence of blood excretions, vomit that may be around the patient at the time of the intervention. Special note should be taken of the mechanism of injury and it should be documented. If the parent or caregiver states that the infant sustained a fall or impact, it is important to document that. It is beneficial to note and estimate the heights of chairs, couches or beds from which the fall occurred and what type of floor there was.

If the EMS Personnel saw bystanders who may know the family or might have observed something it will be important to the documentation to record that. Also it will be important to note the demeanor of the parents and/or the caregiver in order to evaluate the entire scene. In

the case that there is a crime scene investigation at a later time, it is important to have as complete a documentation as possible.⁵⁴

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