

## PERINATAL EDUCATION PROGRAMME

### NEONATAL ASPHYXIA AND RESUSCITATION

#### UNIT 16

##### OBJECTIVES

When you have completed this unit you should be able to:

1. Define neonatal asphyxia.
2. Appreciate the importance of neonatal asphyxia.
3. List which infants are likely to need resuscitation at birth.
4. Prepare for resuscitation.
5. Resuscitate an infant.
6. Prevent meconium aspiration.
7. List the dangers of hypoxia.

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### 16-1 WHAT IS NEONATAL ASPHYXIA?

Newborn infants normally start to breathe without assistance and often cry well. By 1 minute after delivery most infants are breathing well or crying. If an infant fails to establish adequate, sustained respiration after birth, the infant is said to have NEONATAL ASPHYXIA. These infants do not breathe well after birth. Neonatal asphyxia will result in hypoxia after delivery if the infant is not rapidly resuscitated.

**NEONATAL ASPHYXIA IS DEFINED AS THE FAILURE OF AN INFANT TO CRY OR BREATHE WELL AFTER DELIVERY**

Neonatal asphyxia is an important cause of neonatal death if not managed correctly.

*\*\*\* The word "asphyxia" causes an enormous amount of confusion as it is also used to indicate fetal hypoxia (i.e. "intrapartum asphyxia"). Neonatal asphyxia is being called "neonatal birth depression" in an attempt to get away from using asphyxia. Terms like "birth asphyxia" and "perinatal asphyxia" are of very little help as they are difficult to define and understand.*

### 16-2 WHAT IS HYPOXIA?

Hypoxia is defined as TOO LITTLE OXYGEN IN THE CELLS OF THE BODY. Hypoxia may occur in the fetus or the newborn infant. If the placenta fails to provide the fetus with enough oxygen, hypoxia will result and cause fetal distress. Similarly, with failure to breathe well after delivery (i.e. neonatal asphyxia) the infant will develop hypoxia. As a result of hypoxia the heart rate falls, central cyanosis develops and the infant becomes hypotonic (floppy) and unresponsive. Most fetal hypoxia occurs during labour (intrapartum hypoxia).

**HYPOXIA IS DEFINED AS TOO LITTLE OXYGEN IN THE CELLS OF THE BODY**

Note that the definitions of neonatal asphyxia and hypoxia are not the same. However, fetal hypoxia may result in neonatal asphyxia while neonatal asphyxia will result in hypoxia if the infant is not rapidly resuscitated. Many infants with fetal hypoxia during labour still manage to cry well at birth and, therefore, do not have birth asphyxia.

*\*\*\* Hypoxaemia means too little oxygen in the blood. It is sometimes used instead of hypoxia.*

**FETAL HYPOXIA DOES NOT ALWAYS RESULT IN NEONATAL ASPHYXIA**

### 16-3 WHAT IS THE APGAR SCORE?

The Apgar score is a method of assessing an infant's clinical condition after delivery. The Apgar score is based on 5 vital signs:

1. Heart rate.
2. Respiratory effort.
3. Presence or absence of central and peripheral cyanosis.
4. Muscle tone.
5. Response to stimulation.

Each vital sign is given a score of 0 or 1 or 2. A vital sign score of 2 is normal, a score of 1 is mildly abnormal and a score of 0 is severely abnormal. The individual vital sign scores are then totalled to give the Apgar score out of 10. The best possible Apgar score is 10 and the worst 0. An infant with a score of 0 shows no sign of life.

Normally the Apgar score is of 7 to 10. Infants with a score between 4 and 6 have moderate depression of their vital signs while infants with a score of 0 to 3 have severely depressed vital signs and are at great risk of dying unless actively resuscitated.

Due to the presence of peripheral cyanosis in most infants at delivery, it is unusual for a normal infant to score 10 at 1 minute. By 5 minutes most infants will have a score of 10. If the Apgar score is guessed, and not correctly assessed, too high a score is usually given. This is a common error in Apgar scoring.

### A NORMAL APGAR SCORE IS 7 OR HIGHER

*\*\*\* The Apgar score is named after the late Dr. Virginia Apgar, an anaesthetist, who described the scoring method in 1953.*

The method of assessing the Apgar score is described in skills workshop 16 of this PEP manual.

#### **16-4 WHEN SHOULD YOU DETERMINE THE APGAR SCORE?**

The Apgar score should be performed on all infants at 1 minute after complete delivery to record the infant's clinical condition at birth and to assess whether the infant requires resuscitation. If the 1 minute Apgar score is below 7, then the Apgar score should be repeated at 5 minutes to document the success or failure of the resuscitation efforts. If the 5 minute Apgar score is still low, it should be repeated every 5 minutes until a normal Apgar score of 7 or more is achieved. In many hospitals, the Apgar score is often routinely repeated at 5 minutes even if the 1 minute score was normal. This is not necessary and the infant should rather be handed to the mother. Apgar scoring is an important way to document the infant's clinical condition and the process of resuscitation in the hospital or clinical records.

### ALL INFANTS SHOULD RECEIVE AN APGAR SCORE AT ONE MINUTE

#### **16-5 WHAT CAUSES A LOW APGAR SCORE?**

There are many causes of a low Apgar score. These include:

1. Fetal distress due to hypoxia before delivery (especially during labour).
2. Maternal general anaesthesia or recent analgesia.
3. Preterm infant.
4. Difficult or traumatic delivery.
5. Excessive suctioning of the pharynx after delivery.
6. Severe respiratory distress.

Note that fetal distress due to hypoxia during labour is only one of the many causes of neonatal asphyxia

It is important to always try and find the cause of a low 1 minute Apgar score. If the Apgar score remains low at 5 minutes, despite good resuscitation efforts, the infant probably had fetal hypoxia before birth.

### INTRAPARTUM HYPOXIA IS THE MOST IMPORTANT CAUSE OF NEONATAL ASPHYXIA

*\*\*\* A base deficit of 10 or more in a sample of umbilical artery blood strongly suggests that the infant has had significant hypoxia before delivery. This is very useful information in any delivery following a diagnosis of fetal distress. It is also very useful in infants who need resuscitation after delivery.*

#### **16-6 WHAT IS INFANT RESUSCITATION?**

Resuscitation is a series of actions taken to establish normal breathing, heart rate, colour, tone and activity in an infant with depressed vital signs (i.e. a low Apgar score).

#### **16-7 WHICH INFANTS NEED RESUSCITATION?**

All infants who do not breathe well after delivery (i.e. infants with neonatal asphyxia) or have a 1 minute Apgar score below 7 need immediate resuscitation. The lower the Apgar score the more

urgent is the need for resuscitation. Any infant who stops breathing or has depressed vital signs at any time after delivery or in the nursery also requires resuscitation. Therefore, it is important to formally assess the clinical condition of all infants after delivery.

**ALL INFANTS WITH A 1 MINUTE APGAR SCORE BELOW 7 REQUIRE RESUSCITATION**

*\*\*\* In practice, it may be obvious before 1 minute is reached that an infant will need resuscitation. Therefore, some protocols suggest that the need for resuscitation should be assessed at 30 seconds after delivery. However, it usually takes a minute to dry the infant well, clamp the cord and make a quick general examination.*

**16-8 CAN YOU ANTICIPATE WHO WILL NEED RESUSCITATION AT BIRTH?**

Yes. The following clinical situations often lead to the delivery of an infant with neonatal asphyxiated and a low Apgar score at 1 minute:

1. Signs of fetal distress during labour.
2. Delivery before 37 weeks of gestation.
3. Abnormal presentation of the fetus.
4. Difficult or traumatic delivery.
5. General anaesthesia or recent analgesia (pethidine or morphine within the last 4 hours).

Remember that any infant can be born with neonatal asphyxia without prior warning. It is essential, therefore, to be prepared to resuscitate any newborn infant. Anyone who delivers an infant must be able to perform resuscitation.

**ANY INFANT CAN HAVE NEONATAL ASPHYXIA WITHOUT WARNING SIGNS DURING LABOUR**

**16-9 WHAT EQUIPMENT DO YOU NEED FOR BASIC INFANT RESUSCITATION?**

It is essential that you have all the basic equipment needed for basic infant resuscitation. The equipment must be in working order and immediately available. The equipment must be checked daily.

A warm, well lit corner of the delivery room should be available for resuscitation. A heat source, such as an overhead radiant warmer, is needed to keep the infant warm. Avoid draughts. A good light, such as an angle poise lamp, is required so that the infant can be closely observed during resuscitation.

The following essential equipment must be available in the delivery room:

1. **SUCTION APPARATUS:** An electric or wall vacuum suction apparatus is ideal but the vacuum pressure should not exceed 200 cm water (i.e. 20 kPa or 200 mbar). Soft 10 end hole suction catheters are needed.
2. **OXYGEN:** Whenever possible a cylinder or wall source of 100% oxygen should be available. However, infants can be resuscitated without oxygen. A flow meter is needed and an air-oxygen blender is very useful. A pulse oximeter (saturation monitor) is very helpful to identify infants who are hypoxic.
3. **RESUSCITATOR:** A neonatal self-inflating ventilation bag (e.g. Laerdal, Ambu, Penlon or Cardiff) or simple Samson resuscitator must be available to provide ventilation. A reservoir is needed if high concentrations of oxygen are required. Correct size face masks are important.
4. **ENDOTRACHEAL TUBES:** 2,5 mm, 3,0 mm and 3.5 mm straight or shouldered tubes must be available. Introducers are also needed. Cuffed endotracheal tubes must not be used in newborn infants.

5. LARYNGOSCOPE: A laryngoscope with a small, straight blade (Miller 0 and 1 blades). Spare batteries and bulbs must be kept with the laryngoscope. This is the only expensive piece of equipment that is essential for all hospitals and clinics where deliveries are done.
6. NALOXONE: Ampoules of naloxone (Narcan). Syringes and needles will be needed to administer the drug.
7. WALL CLOCK or wrist watch: Needed to time the Apgar scoring.
8. DISPOSABLE GLOVES.

\*\*\* Ampoules of 4% sodium bicarbonate and ampoules of 1:1000 adrenaline.

#### **16-10 HOW SHOULD YOU STIMULATE RESPIRATION IMMEDIATELY AFTER BIRTH?**

Immediately after birth all infants must be quickly **dried** in a warm towel and then placed in a second warm, dry towel before they are clinically assessed. This prevents rapid heat loss due to evaporation. Handling and rubbing the newborn infant with a dry towel is usually all that is needed to stimulate the onset of breathing. Gently flicking under the infant's feet may be helpful in stimulating breathing. **Stimulation alone** will start breathing in most infants. The infant's mouth can be wiped with a clean towel if there are excessive secretions. There is no need to smack newborn infants to get them to breathe. Infants who are active, pink and breathe well can stay with their mother. It is best to place these well infants in the kangaroo mother care position and allow them to take the mother's breast. Always wear gloves when delivering or resuscitating an infant.

<b>DRY AND STIMULATE ALL INFANTS IMMEDIATELY AFTER DELIVERY</b>
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Infants who breathe well at delivery should NOT be routinely suctioned as suctioning sometimes causes apnoea. Infants born by caesarean section also need not be routinely suctioned.

<b>IT IS NOT NECESSARY TO ROUTINELY SUCTION THE MOUTH AND NOSE OF INFANTS AFTER DELIVERY</b>
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#### **16-11 HOW DO YOU RESUSCITATE AN INFANT?**

If the infant fails to respond to drying and stimulation, then the infant must be actively resuscitated. The most experienced person, irrespective of rank, should resuscitate the infant. However, all staff who conduct deliveries must be able to resuscitate infants. It is very helpful to have an assistant during resuscitation.

There are 4 main steps in the basic resuscitation of a newborn infant. They can be easily remembered by thinking of the first 4 letters of the alphabet, i.e. "ABCD" - AIRWAY - BREATHING - CIRCULATION - DRUGS.

##### **STEP 1. OPEN AND CLEAR THE AIRWAY.**

1. OPEN THE AIRWAY by placing the infant's head in the neutral position with the neck slight extended. Do not flex or over extend the neck. It is best to place the infant on a firm surface, facing face up.
2. GENTLY CLEAR THE THROAT. The infant may be unable to breathe because the airway is blocked by mucus or blood. Therefore, if the infant fails to breathe after stimulation, gently suction the back of the mouth and throat with a soft F 10 catheter. Excessive suctioning, especially if too deep in the region of the vocal cords, may result in apnoea and bradycardia by stimulating the vagal nerve. This can be prevented by holding the catheter 5 cm from the tip when suctioning the infant's throat. Do not suction the nose before suctioning the mouth or throat as this often causes the infant to gasp and inhale mucus and blood. Never hold an infant upside down to clear secretions. With a clear, open airway, stimulate the infant again

by gently flicking the feet if breathing has not already started. Remember to keep the infant warm.

Once the airway has been opened and the infant stimulated, the infant's breathing, colour and heart rate must be assessed. If stimulation, positioning and suctioning fail to start breathing after 30 seconds, the infant needs mask ventilation. Do not waste time by giving oxygen, without also applying mask ventilation, if the infant does not breathe. Any infant who is not breathing or breathing poorly, gasping, or has a heart rate below 100 breaths per minute needs ventilation.

**VENTILATION IS THE MOST IMPORTANT STEP IN NEWBORN RESUSCITATION AND IS INDICATED IF THE INFANT DOES NOT BREATHE WELL OR HAS A HEART RATE BELOW 100**

*\*\*\* Free flow oxygen alone, without ventilation, is only indicated in the few infants who breathe well with a good heart rate but remain centrally cyanosed.*

**STEP 2. START THE INFANT BREATHING BY PROVIDING ADEQUATE VENTILATION.**

1. **MASK VENTILATION:** If the infant fails to breathe adequately despite stimulation and opening the airway, some form of artificial ventilation (breathing) is required. Most infants can be adequately ventilated with a bag and mask. The mask must be held tightly over the infant's nose and mouth. Make sure the head is in the correct position and the airway is clear. Even if breathing is not started, most infants can be kept alive with face mask ventilation until help arrives. Intubation and ventilation are only needed if adequate chest movement cannot be achieved with mask ventilation. Good bag and mask ventilation is the most important step in resuscitation an infant. Ventilate the infant at about 40 breaths per minute.
2. **INTUBATION AND VENTILATION:** The most effective method of ventilation is via an endotracheal tube. All staff who frequently deliver infants should learn this simple technique. Infants who fail to respond to mask ventilation must be intubated. Ventilate the infant at a rate of about 40 breaths a minute. Make sure that the infant's chest moves well with each breath and that good, bilateral air entry is heard. Adequate ventilation is by far the most important step in resuscitating an infant with severe neonatal asphyxia. Respiratory stimulants such as Vandid must not be used as they are dangerous and do not help.

**MOST INFANTS CAN BE ADEQUATELY VENTILATED WITH A BAG AND MASK**

Ventilation is usually given with supplementary oxygen until good breathing efforts are established. Set the flow meter at 5 litres per minute. However, it has recently been suggested that room air may be better than oxygen for resuscitation. Added oxygen should probably be stopped once the infant is centrally pink. It is very useful to have a blender so that added oxygen can be added or stopped. Mouth-to-mouth ventilation should be avoided, especially if the infant is exposed to HIV.

The method of mask ventilation and tracheal intubation is described in skills workshop 16 of this PEP manual.

If the infant breathes well and has a good heart rate, but remains centrally blue, give free flowing oxygen until the colour improves. The oxygen tubing can simple be held over the infant's face. Remember that a bag and mask will not deliver oxygen unless the bag is squeezed. A reservoir is needed to ventilate an infants with 100% oxygen.

Once adequate ventilation has been given for 30 seconds, the infant's breathing, colour and heart rate must again be assessed. If the heart rate remains below 60 beats per minute in spite of effective ventilation, chest compressions are needed.

*\*\*\* The question of using room air or oxygen in neonatal resuscitation is being hotly debated as additional oxygen may increase the risk of neonatal encephalopathy. Many experts suggest that room air should be used unless ventilation for 30 seconds does not correct central cyanosis.*

**STEP 3. OBTAIN A GOOD CIRCULATION WITH CHEST COMPRESSIONS.**

Apply chest compressions (external cardiac massage) at a rate of about 120 times a minute. Three chest compressions should be followed by a breath. One or both hands can be used to give chest compressions.

**CHEST COMPRESSIONS ARE INDICATED IF THE HEART RATE IS LESS THAN 60 BEATS PER MINUTE AFTER 30 SECONDS OF ADEQUATE VENTILATION**

The method of giving cardiac massage is described in skills workshop 16 of this PEP manual.

Once both effective ventilation and chest compressions have been given for 30 seconds, again assesses the infant's breathing, colour and heart rate. If the heart rate has not increased above 60 beats per minute, give adrenaline (epinephrine).

**STEP 4. GIVE ADRENALINE.**

Adrenaline 1:10 000 should be given intravenously or placed down the endotracheal tube. The intravenous route is preferable. Adrenaline stimulates the myocardium and increases the heart rate. One ml of adrenaline 1:1000 must first be diluted with 9 ml normal saline to give a 1:10 000 solution. One ml of the diluted solution can then be given to term infants and 0,5 ml to preterm infants (recommended dose is 0,25 ml/kg of diluted adrenaline). Adrenaline is very important if no heart beat can be detected. The dose can be repeated every three to five minutes if the heart arte remains slow.

**ADRENALINE IS INDICATED IF THE HEART RATE IS LESS THAN 60 BEATS PER MINUTE AFTER 30 SECONDS OF CHEST COMPRESSIONS**

If the infant has a good heart rate and is centrally pink, but still does not breathe, consider giving Narcan.

*\*\*\* 1:1000 adrenaline gives 1 mg/ml. Therefore 1 ml of 1:10 000 adrenaline gives 0,1mg while 0,5 ml gives 0,05mg. A dose of 0,25 ml/kg of 1: 10 000 adrenaline gives 0,025 mg/kg.*

**STEP 5. DRUGS TO REVERSE PETHIDINE AND MORPHINE.**

If the mother has received either pethidine or morphine during the 4 hour period before delivery, the infant's poor breathing may be due to narcotic depression. If so, the depressing effect of the maternal analgesia on the infant's respiration can be rapidly reversed with Narcan (1 ml ampoule contains 0,4 mg naloxone). Narcan 0,1 mg/kg (i.e. 0,25 ml/kg) can be given by intramuscular injection into the anterolateral aspect of the thigh. Do not use Neonatal Narcan as this preparation requires too big a volume. Narcan will not help resuscitate an infant if the mother has not received a narcotic analgesic during labour, or has only received a general anaesthetic, barbiturates or other sedatives. Narcan is not a general respiratory stimulant. Never give Narcan before providing adequate ventilation.

**NARCAN MUST ONLY BE USED AFTER ADEQUATE VENTILATION HAS BEEN PROVIDED**

*\*\*\* Narcan acts more rapidly if injected directly into the umbilical vein or if given down the endotracheal tube. Intramuscular Narcan may take a few minutes to reverse the effects of opiates. Flumazenil (Anexate) will reverse the depressant effect of benzodiazepines such as diazepam (Valium).*

*\*\*\* With experience and further training, additional medication can be given if the above steps fail to resuscitate the infant:*

1. *The injection of 2 ml/kg of 4% sodium bicarbonate into the umbilical vein to correct acidosis and stimulate the cardiorespiratory system. Sodium bicarbonate should only be given once adequate ventilation has been achieved. An 8% solution must never be used as it is*

- extremely hypertonic. Never give sodium bicarbonate down the endotracheal tube. Ideally, sodium bicarbonate should only be given after confirming a severe metabolic acidosis*
2. *If the infant remains shocked with poor peripheral perfusion despite all other attempts at resuscitation, a plasma volume expander such as stabilized human serum, Haemaccel, Plasmolyte B or Normal Saline can be given intravenously. The required volume is usually 10 ml/kg over 10 minutes.*
  3. *Only give extra glucose intravenously if the blood glucose concentration is low when measured with a reagent strip. Do not routinely give glucose during resuscitation. Usually a 10% glucose solution is adequate to correct any hypoglycaemia.*

A summary of the method of resuscitating a newborn infant is shown in flow diagram 16-1.

The 5 steps in resuscitation are followed step by step until the 3 most important vital signs of the Apgar score have returned to normal:

1. A PULSE RATE ABOVE 100 BEATS PER MINUTE. Easily assessed by palpating the base of the umbilical cord or listening to the chest with a stethoscope. A good heart rate is the best indicator of adequate ventilation during resuscitation.
2. A GOOD CRY OR GOOD BREATHING EFFORTS (not just gasping). This assures adequate breathing.
3. A PINK TONGUE. This indicates a good oxygen supply to the brain. Do not rely on the colour of the lips or buccal mucosa.

**A GOOD HEART RATE IS THE BEST INDICATOR OF ADEQUATE VENTILATION**

**16-12 DOES THE MECONIUM STAINED INFANT NEED SPECIAL CARE?**

Yes. All infants that have meconium stained amniotic fluid (liquor) at birth need special care to reduce the risk of severe meconium aspiration after delivery. Whenever possible all these at risk infants should be identified before delivery, especially infants with thick meconium in the amniotic fluid.

**16-13 WHY DOES THE MECONIUM STAINED INFANT NEED SPECIAL CARE?**

As a result of hypoxia before delivery, the fetus may make gasping movements and also pass meconium before birth. Therefore, the fetus can suck meconium into the upper airways together with amniotic fluid. Fortunately most of the meconium is unable to reach the fluid filled alveoli of the fetus. Only after delivery, when the infant inhales air, does meconium enter the small airways and alveoli.

Meconium contains enzymes from the fetal pancreas that can cause severe lung damage and even death if inhaled into the alveoli after delivery. Meconium also obstructs the airways. This results in respiratory distress due to meconium inhalation.

*\*\*\* Meconium often burns the infant's skin and digests away the infant's eye lashes! Therefore, imagine the damage meconium can cause to the delicate lining of the bronchi and alveoli.*

**16-14 HOW CAN YOU PREVENT MECONIUM ASPIRATION AT VAGINAL DELIVERY?**

Many cases of meconium aspiration syndrome can be prevented with the correct care of the infant during delivery. A suction apparatus and a F 10 end hole catheter must be ready at the bedside. If possible, the person conducting the delivery should have an assistant to suction the infant's mouth when the head delivers.

After delivery of the head, the shoulders should be held back and the mother asked to pant to prevent delivery of the trunk. The infant's face is then turned toward the assistant so that the mouth and pharynx can be well suctioned. Only when no more meconium can be cleared, should the infant be completely delivered. If the infant cries well after delivery, no further resuscitation or suctioning is needed. However, some infants develop apnoea and bradycardia as a result of the suctioning and, therefore, need ventilation after delivery.

If an infant needs ventilation, the pharynx should again be suctioned, preferably under direct vision using a laryngoscope, before ventilation is started. If the infant is intubated, direct suction can be applied to the endotracheal tube. Withdraw the endotracheal tube while applying suction. Repeat until no more meconium is obtained. This aggressive method of suctioning is very successful in preventing severe meconium aspiration but should not be used when resuscitating infants that are not meconium stained.

**MECONIUM STAINED INFANTS MUST BE SUCTIONED BEFORE DELIVERY OF THE SHOULDERS**

**16-15 HOW CAN YOU PREVENT MECONIUM ASPIRATION AT CAESAREAN SECTION?**

When a meconium stained infant is delivered by caesarean section, the mouth and pharynx must be suctioned with a F10 end hole catheter, BEFORE the shoulders are delivered. After complete delivery, move the infant immediately to the resuscitation table. If the infant does not breathe spontaneously, further suctioning under direct vision is needed before stimulating respiration or applying ventilation. Infants who breathe well after delivery do not need to be suctioned again.

**16-16 WHEN IS FURTHER RESUSCITATION HOPELESS?**

Every effort should be made to resuscitate all infants that show any sign of life at delivery unless the infant's gestational age, weight or severe birth defects indicate a very poor chance of survival.. The severity of neonatal asphyxia at 1 and 5 minutes is not a good indicator of the likelihood of hypoxic brain damage or the possibility of an unsuccessful resuscitation. If the Apgar score remains low after 5 minutes, efforts at resuscitation must be continued. It is important to keep repeating the Apgar score every 5 minutes until the score is normal or resuscitation is abandoned. If the infant has not started to breathe, or only gives occasional gasps by 20 minutes, the chance of death or brain damage is extremely high. The exception is when the infant is sedated by maternal drugs. It is preferable if an experienced person decides when to abandon further attempts at resuscitation. Resuscitation can also be stopped if there are no signs of life after 10 minutes.

*\*\*\* Some people claim that resuscitating infants with severe neonatal asphyxia is contra-indicated as they survive with brain damage. Research has indicated that this claim is not correct as many infants with severe neonatal asphyxiated, that are aggressively resuscitated and survive, recover completely.*

**16-17 WHAT POST RESUSCITATION CARE IS NEEDED?**

All infants that require resuscitation must be carefully observed for at least 4 hours after delivery. Their temperature, pulse and respiratory rate, colour and activity should be recorded and their blood glucose concentration checked. Keep these infants warm and provide fluid and energy either intravenously or orally. Usually these infants are observed in a closed incubator. Do not bath the infant until the infant has fully recovered.

If the infant has signs of respiratory difficulty, or is centrally cyanosed in room air after resuscitation, it is essential to provide oxygen while the infant is being moved to the nursery. Some infants may even require ventilation during transport.

Careful notes must be made describing the infant's condition at birth, the resuscitation needed and the probable cause of the neonatal asphyxia.

**16-18 WHAT CARE SHOULD YOU GIVE TO MECONIUM STAINED INFANTS IN THE NURSERY?**

All heavily meconium stained infants should be observed in the nursery for a few hours after delivery as they may show signs of hypoxic damage or meconium aspiration syndrome. Most meconium stained infants have swallowed meconium before delivery. Meconium is a very irritant substance and causes meconium gastritis. This results in repeated vomits of meconium stained mucus. Infants with lightly meconium stained amniotic fluid who appear well after delivery can be kept with their mothers.

Meconium gastritis may be prevented by washing out the stomach with 2% sodium bicarbonate (mix 4% sodium bicarbonate with an equal volume of sterile water). Five ml of 2% sodium bicarbonate is repeated injected into the stomach via a nasogastric tube and then aspirated until the gastric aspirate is clear. All heavily meconium stained infants should have a stomach washout on arrival in the nursery. This should be followed by a feed of colostrum. Routine stomach washouts in preterm infants or infants born by caesarean section are not needed. A stomach washout is also not needed if there is only lightly meconium stained amniotic fluid.

*\*\*\* Colostrum contains phagocytic cells that ingest any meconium that remains in the stomach. This reduces the chance of further vomiting.*

**A STOMACH WASHOUT IS ONLY NEEDED IF THE INFANT IS COVERED WITH THICK MECONIUM**

**16-19 WHAT IS THE DANGER OF HYPOXIA BEFORE OR AFTER DELIVERY?**

If the cells of the fetus or newborn infant do not receive enough, many organs may be damaged. This may result in either:

1. Transient damage which will recover completely after delivery.
2. Permanent damage that will not recover fully after birth.
3. Death of the fetus or newborn infant.

**16-20 WHAT ORGANS ARE COMMONLY DAMAGED BY HYPOXIA?**

1. The BRAIN needs a lot of oxygen and, therefore, is very sensitive to hypoxia either before or after delivery.
2. The KIDNEYS may be damaged, resulting in haematuria, proteinuria and decreased urine output for the first few days after delivery. Occasionally renal failure may result.
3. The HEART may be damaged causing heart failure. This presents with hepatomegaly, respiratory distress and poor peripheral perfusion.
4. The GUT may be damaged causing necrotising enterocolitis.
5. The LUNGS may be damaged resulting in respiratory distress with pulmonary artery spasm (persistent pulmonary hypertension).

*\*\*\* At the onset of hypoxia, blood is shunted away from the kidneys, gut and lungs to the brain and heart. This mechanism to protect the brain and heart may cause ischaemic damage to the kidneys, gut and lungs. The increased blood flow to the brain may cause intraventricular haemorrhage in preterm infants. With severe, prolonged hypoxia, cardiac output falls and as a result the brain and myocardium may also suffer ischaemic damage.*

**FETAL HYPOXIA MAY CAUSE BRAIN DAMAGE**

**16-21 WHAT DAMAGE IS DONE TO THE BRAIN BY HYPOXIA?**

Different types of brain damage can occur depending on the gestational age of the fetus and the severity of the hypoxia:

1. INTRAVENTRICULAR HAEMORRHAGE. Hypoxia may damage small blood vessels around the ventricles of the brain in preterm infants. These immature vessels may bleed into the ventricles which can damage the surrounding brain. An intraventricular haemorrhage usually presents within the first 2 days after delivery. A mild haemorrhage is usually asymptomatic but a severe haemorrhage causes apnoea, shock and death. The clinical diagnosis of intraventricular haemorrhage can be confirmed with ultrasonography of the brain.
2. Hypoxia may cause decreased blood flow (ISCHAEMIA) which results in INFARCTION (death) of part of the brain. In preterm infants this usually causes spastic diplegia (spastic weakness of both legs). In term infants hypoxia usually causes convulsions, mental retardation and cerebral palsy.

3. In term infants, hypoxia and ischaemia of the brain presents in the first 72 hours as NEONATAL ENCEPHALOPATHY (hypoxic ischaemic encephalopathy). This is common especially where monitoring and care of the fetus during labour is poor.
4. Hypoxia may also cause blindness, deafness or learning and behaviour problems at school.

### 16-22 WHAT ARE THE CLINICAL SIGNS OF NEONATAL ENCEPHALOPATHY?

1. Altered level of consciousness. Either depressed level of consciousness with poor feeding, or staring with increased irritability.
2. Altered tone. Either increased tone or hypotonia.
3. Poor feeding or abnormal breathing with apnoea.
4. Fits (convulsions).
5. Abnormal reflexes e.g. no or poor Moro reflex.

Most infants with neonatal encephalopathy are clinically behaving abnormally in the first 12 hours after delivery. Most, but not all, cases of neonatal encephalopathy are due to intrapartum hypoxia (hypoxia during labour or just before delivery). Hypoglycaemia, meningitis and brain haemorrhage can also give neonatal encephalopathy.

\*\*\* A number of scoring methods are available to assess the severity of neonatal encephalopathy on a daily basis for the first two weeks of life. This can help to predict the outcome.

### 16-23 WHAT ARE THE RESULTS OF NEONATAL ENCEPHALOPATHY?

1. The encephalopathy may recover completely and the child develops normally. This is common with mild encephalopathy when the infant appears normal by 7 days of age.
2. The encephalopathy may get worse and the infant dies during the first few days.
3. The encephalopathy may recover slowly and the child survives but has permanent brain damage with cerebral palsy or mental disability. This is often seen when the signs of neonatal encephalopathy have not disappeared by 7 days of life.

## CASE PROBLEMS

### CASE 1

After a normal pregnancy, an infant is born by elective caesarian section under general anaesthesia. The indication for the caesarean section is two previous caesarean sections for cephalopelvic disproportion. Immediately after delivery the infant is dried and placed under an overhead radiant warmer. At 1 minute after birth the infant has a heart rate of 80 beats per minute, gives irregular gasps, has blue hands and feet but a pink tongue, has some muscle tone but does not respond when dried. At 5 minutes the infant has a heart rate of 120 beats per minute and is breathing well. The tongue is pink but the hands and feet are still blue. The infant moves actively and cries well.

#### 1. What is the infant's Apgar score at 1 minute?

The Apgar score at 1 minute is 4: heart rate=1, respiration=1, colour=1, tone=1, response=0.

#### 2. Does this infant have neonatal asphyxia? Give your reasons.

Yes, the infant has neonatal asphyxia because the infant failed to establish adequate, sustained respiration. The diagnosis of neonatal asphyxia is supported by the low Apgar score at 1 minute.

#### 3. What is the probable cause of the neonatal asphyxia?

The general anaesthetic. Both the intravenous drugs and the anaesthetic gases cross the placenta and may sedate the fetus. These sedated infants usually respond rapidly to resuscitation.

**4. What should be the first 2 steps in resuscitating this infant?**

If respiration cannot be stimulated by drying the infant and flicking the infant's feet then the following 2 steps must be taken:

- (i) Position the head correctly and clear the airway by gently suction of the throat.
- (ii) Ventilation must be started if the infant does not start breathing well. Most infants can be adequately ventilated with a bag and mask. If good chest movement cannot be obtained with mask ventilation, the infant must be intubated and ventilated.

**5. What is this infant's Apgar score at 5 minutes?**

The Apgar score at 5 minutes is 9: heart rate=2, breathing=2, colour=1, tone=2, response=2. This indicates that the infant has responded well to resuscitation.

**6. Why is this infant very unlikely to have suffered brain damage due to hypoxia?**

Because there is no history of fetal distress to indicate that this infant had been hypoxic before delivery. The rapid response to resuscitation also suggests that there was not fetal hypoxia. There is also no good reason why the fetus should be hypoxic as the mother has had an elective caesarean section and was not in labour. Most fetal hypoxia occurs during labour.

**7. What should be the management of this infant after resuscitation?**

The infant should be kept warm and be transferred to the nursery for observation for a few hours. Both the general anaesthetic and the low 1 minute Apgar score will increase the risk of hypothermia and apnoea.

**CASE 2**

After fetal distress has been diagnosed, an infant is delivered by a difficult vacuum extraction. At delivery the infant is covered with thick meconium. The infant starts to gasp before 1 minute. Only then are the mouth and pharynx suctioned for the first time. The Apgar score at 1 minute is 3. By 5 minutes the Apgar score is 6. By 15 minutes the infant is active and crying well. It is decided to bath the infants and give a stomach washout in labour ward before transferring both mother and infant to the postnatal ward.

**1. What are the probable causes of the low 1 minute Apgar score ?**

Hypoxia resulting in fetal distress, as indicated by the passage of meconium before delivery. The difficult delivery by vacuum extraction may also result in a low Apgar score, while inhaled meconium may have blocked the airway.

**2. What mistake was made with the management of this infant?**

The infant's mouth and pharynx should have been well suctioned BEFORE the shoulders were delivered. This will usually prevent severe meconium aspiration as the airway is cleared of meconium before the infant starts to breathe.

**3. What size catheter would you have used to suction this infant's mouth and pharynx?**

A large catheter (F 10) must be used as a small catheter will block with meconium. The catheter should have a hole at the end and not just at the side.

**4. Should this infant be given a bath and stomach washout in labour ward after it starts to breathe spontaneously?**

No. These should not be done until the infant has been stable for a number of hours in the nursery. As there was thick meconium, the infant should then be given a stomach washout with 2% sodium bicarbonate followed by a breastfeed.

**5. What 2 complications is this infant at high risk of?**

This infant may develop meconium aspiration syndrome as meconium was probably inhaled into the lungs after birth. The infant may also suffer brain damage or damage to other organs due to hypoxia causing fetal distress during labour.

**CASE 3**

A woman with an abruptio placentae delivers at 32 weeks. Before delivery the fetal heart rate was only 80 beats per minute. The infant appeared dead at birth but was intubated and ventilated. Cardiac massage was also given. The 1 minute Apgar score was 2. Despite further efforts at resuscitation, the Apgar score at 5, 10, 15 and 20 minutes remained 2.

**1. What is the probable cause of neonatal asphyxia in this infant?**

Fetal distress caused by fetal hypoxia. Abruptio placentae (placental separation before delivery) is a common cause of hypoxia and fetal distress.

**2. Why is it possible to successfully resuscitate some infants that appear dead at birth?**

If a fetal heart is heard just before delivery but the infant appears dead at birth, the duration of cardiac arrest has only been a few minutes. With ventilation and cardiac massage, it is possible to resuscitate some of these infants. Most of the survivors do not suffer brain damage.

**3. What is the significance of the low Apgar scores at 5, 10, 15 and 20 minutes?**

The failure to respond well to resuscitation suggests that the infant will die due to severe hypoxic damage to the brain and heart. If the Apgar score remains low at 20 minutes, attempts at resuscitation may be stopped.

**4. Which 5 organs are likely to be damaged by severe hypoxia?**

The brain, heart, kidneys, gut and lungs.

**5. What is neonatal encephalopathy?**

Abnormal behaviour of a newborn infant within hours of birth. The important features of neonatal encephalopathy are altered level of consciousness, abnormal muscle tone, poor feeding and breathing, depressed reflexes and convulsions. Neonatal encephalopathy is usually due to intrapartum hypoxia.

**CASE 4**

After a normal labour and delivery at term, the infant cries well at birth. No analgesia was needed and the amniotic fluid was not meconium stained. The infant is then well suctioned as this is the routine practice in the clinic. Immediately after suctioning the infant stops breathing and becomes cyanosed. The 1 minute Apgar score is not done. The medical officer tries unsuccessfully for 5 minutes to intubate the infant. When an intramuscular injection of Narcan fails to stimulate respiration, further attempts at resuscitation are abandoned. The infant starts to gasp at 5 minutes. Face mask oxygen was given and eventually the infant cried weakly. No one at the clinic had been trained in basic neonatal resuscitation.

**1. What was the first mistake that was made in managing this infant?**

The infant's mouth and throat should not have been suctioned as there was no clinical indication. The infant breathed well after delivery and was not meconium stained. Normal infants must not be routinely suctioned. The 1 minute Apgar score should have been done to document the infant's clinical condition at this time.

**2. Why did the infant stop breathing and become cyanosed?**

Excessive, deep suctioning often causes apnoea. This is why routine suctioning has been stopped.

**3. How should this infant have been resuscitated?**

The head and neck should have been correctly positioned to open the airway. Then mask ventilation should have been given. With this basic resuscitation, the infant would have almost certainly have started to breathe normally and cry within a minute. The infant became more and more hypoxic while attempts were made to intubate the trachea. The Apgar should also have been done at 5 minutes and every 5 minutes thereafter to record the condition of the infant during the resuscitation attempt.

**4. What is the value of giving Narcan to infants with neonatal asphyxia?**

It is useful in reversing respiratory depression in the newborn infant if the mother had received pethidine or morphine during the 4 hours before delivery. There was no indication for giving Narcan in this infant as the mother had not received any analgesia. Narcan is not a respiratory stimulant.

**5. Should attempts at resuscitation have been abandoned before 5 minutes?**

No. Attempts should be continued for at least 20 minutes. An urgent telephone call to the referral hospital could have provided the correct advice needed. Some infants with neonatal asphyxia will eventually start gasping spontaneously even if the correct resuscitation is not given. However, during the period of inadequate resuscitation the infant becomes progressively more hypoxic. This can result in brain damage.

**6. Who should be trained to give basic resuscitation to newborn infants?**

All the medical and nursing staff who deliver infants. Often it cannot be predicted during labour which infants will not breathe well and need resuscitation. Clinics and hospitals should not deliver infants if they are not able to provide good resuscitation.

**Flow diagram 16-1: The method of resuscitating a newborn infant.**

