SECTION 11: Care of The Newborn at Birth And Emergencies in the First Month of Life (IMEESC 3.2 and Integrated Management of Pregnancy and Childbirth. Managing Newborn Problems: a guide for doctors, nurses and midwives. WHO 2003 ISBN 92 4 154622 0 "WHO Newborn")

See "Saving Newborn Lives" Initiative at www.savethechildren.org/mothers/learn/newborn.htm

See "Safe Motherhood" Initiative at www.safemotherhood.org

See also "Managing Newborn Problems" at www.who.int/reproductive-health/docs/mnp.pdf/

Aims

- Understand the need for preparation, prior to delivery of the baby
- Identify the baby at risk of developing problems at birth
- Recognise the need for resuscitation of the neonate
- Understand the principles of neonatal resuscitation
- Develop the skills needed for effective neonatal resuscitation
- Recognise and manage common problems presenting in the first month of life

Introduction

Infant mortality in under resourced countries runs at an unacceptably high level – the World Health Organisation (WHO) estimates that, worldwide, there are 12000 neonatal deaths per day. Of these, one third are as a result of neonatal infections.

If deaths and long-term or permanent disability are to be avoided, the management of neonatal emergencies must be both coordinated and effective. The care delivered in the first few minutes and hours of life is a major determinant of outcome. The majority of births do not occur in hospitals, so it is important that birth attendants and community nursing teams have the skills to recognise the vulnerable baby prior to delivery, and have the skills to deliver effective care.

Babies are particularly vulnerable during the first month of life, and this section will focus on resuscitation of the newborn and the management of potentially life threatening conditions during the first month of life.

[1] Recognising the baby at risk of developing problems at birth

a. Preterm births

Defined as: less than 37 weeks gestation (or less than 259 days from the first day of the mother's last menstrual period). Maturity matters more than birth weight.

Preventative Strategies may include:

Minimising the risk of surfactant deficiency

- Can be halved if the mother is given a short course of high dose steroid treatment before delivery.
- Give two 12 mg doses IM or oral betamethasone or dexamethasone 24 hours apart, although it may be just as effective to give 6 mg twice a day for 48 hours.

Stopping premature uterine contractions

- Crush a 10 mg nifedipine capsule between the teeth to achieve sublingual absorption. Up to three further doses can be given at 15 minute intervals if uterine contractions persist.
- If this stops labour give between 20 mg and 50mg of a slow release tablet three times a day for the next three days.

Other problems associated with preterm birth

- Even very small babies can survive preterm birth successfully once the early problems associated with surfactant deficiency have been overcome and as long as they are nursed in a **clean environment** and **not allowed to get cold.**
- The main challenge is to give these babies enough milk for them to start growing again as soon as possible without allowing them to choke and inhale milk into the lung. Here too maturity is more important than weight. Babies born before 36 weeks of gestation nearly always need some help with feeding.
- Breast milk is ideal, and everything possible should be done to help the mother sustain her lactation until the baby is ready to feed reliably from the breast. A limited ability to suck and swallow usually appears from 32 weeks of gestation but it remains unpredictable, unreliable and uncoordinated until 36 weeks gestation. In the event that feeding cannot be initiated immediately after birth mothers should be encouraged to start expressing breast milk.

- Partial breast feeding can also help the mother to sustain her lactation but in any event the mother should regularly express milk. Expressing breast milk may be difficult for some mothers.

b. Infection

- Symptomatic ascending infection needs urgent treatment. If this is overlooked, both the mother and the baby's life will be in danger.
- Asymptomatic ascending infection is however a much commoner problem. This occasionally progresses so rapidly once labour starts that, unless treatment is started at once, the baby will die even if the most appropriate antibiotic is given immediately after birth.

- Because a range of bacteria can be involved, treatment needs to protect against group B streptococcal, coliform and Listeria infection, making a **combination of ampicillin and gentamicin** the best strategy.
- Because such infection is, by definition, silent, treatment needs to be considered in any **mother** going into active spontaneous labour before 35 weeks gestation. It should also be considered at *any* gestation if the mother's membranes rupture more than six hours before other signs of overt labour develop (because membrane rupture can be both a sign of, and a risk factor for, ascending bacterial infection). If premature rupture of membranes occurs before the onset of premature labour contractions then infection is more likely.
- What most people mean by premature rupture of membranes (PROM) is really preterm prelabour rupture of membranes (PPROM) where the membranes rupture before there is any overt sign of uterine activity or any detectable uterine contractions. When *this* happens in the preterm baby if is often a sign of the start of some sort of ascending infectious process – a process that has already weakened the amniotic membranes and will, as like as not, eventually stimulate the onset of preterm labour.

[1] In mothers with PPROM who show signs of being clinically infected you give antibiotics.
[2] In PPROM where there is no evidence of infection and no evidence of labour you can delay delivery by a week or more (on average) by giving the mother amoxicillin or, better still, erythromycin.
[3] In mothers who are in active labour five or more weeks before term and who give a clear history that the membranes had ruptured before they were able to detect any uterine contractions the risk of the baby becoming infected during delivery can be reduced substantially by giving antibiotics (ideally probably both penicillin and gentamicin) during labour. The question "how many hours before" does not arise here – you treat every mother coming under your care in active labour five or more weeks before term if it is clear that the membranes had ruptured before there was any other symptomatic evidence that labour had started.

- A maternal temperature in excess of 38ºC during labour is an important but uncommon sign of early ascending infection.
- Many of the babies who become infected during delivery develop respiratory symptoms very soon after birth, but in a few the features are those of neonatal sepsis.

c. Hypothermia

Seriously increases the risk of surfactant deficiency and hypoglycaemia and must be avoided.

2. PREPARATION FOR BIRTH

For the majority of deliveries, a minimum amount of equipment is needed. If all the equipment in the box is available, the vast majority of neonates can be successfully resuscitated.

EQUIPMENT NEEDS FOR CARE OF THE NEWLY BORN AND OLDER NEONATES

A clean dry towel
A firm working surface
A good soft well-fitting face mask (size 0/1 and 00)
T piece and manometer/pressure gauge or self inflating bag and reservoir
A source of air or oxygen (it does not need to be oxygen)
A pressure limiting device at 30 cm H_20
A stethoscope
Laryngoscope and set of suitable sized ET tubes (2.5, 3.0 and 3.5mm)
Suction devices: ideally mechanical plus wide bore suction tubes and those suitable for ET tubes
Umbilical venous catheter plus 0.9% saline
Clock
Roll of zinc oxide tape for name-band
Pulse oximeter (ideal)
Heat source

Most babies need very little help to achieve initial lung aeration at birth. A clean dry **towel**, a firm **working surface**, a good soft well-fitting **face mask** (see below), and a source of **air**

or oxygen (it does not need to be oxygen) is all that most full-term babies need. A **pressure limiting devise** is extremely helpful, and can help to ensure that mask pressure can be raised to and held at 30 cm H_20, without inadvertently rising higher than that.

About one term baby in a thousand does not respond to lung aeration with an immediate and easily detectable rise in heart rate. Here a **stethoscope** makes it very much easier to assess whether chest compression is called for.
An estimated one baby in every five thousand will have started to gasp due to hypoxia before birth and inhaled so much particulate matter into the trachea that it has impacted there. Resuscitation here is only possible if the accumulated debris can be removed. The easiest way to do that is to pass an **endotracheal tube** and then remove the debris by direct suction. Blind intubation is possible using a finger but a **laryngoscope** makes it easier to get the tube passed without trauma through the larynx. Nothing tenacious enough to block the trachea will ever be sucked out through such a tube, but suction on the end of the tube will nearly always serve to draw the debris into the tube. The tube can then be removed and the debris blown clear.

A range of simple suction devices can be used if mechanical **suction** is not readily available. Mouth suction can be very effective if no other option exists. A double mucus trap is used for this to prevent infected material being accidentally drawn into the mouth. Suction also occasionally makes it easier to achieve a good view of the larynx during intubation.

An **umbilical vein catheter** and the means to catheterise the umbilicus, together with **saline** or a plasma expander, may make the difference between life and death in one baby in six thousand on the verge of death from acute hypovolaemia. The same catheter can also be used to administer drugs but babies as ill as this seldom make an intact recovery.

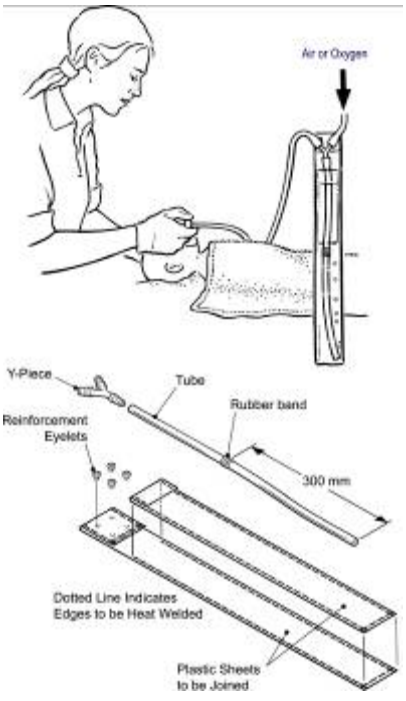
A **clock** will help you document how long resuscitation took.

A roll of **zinc oxide** tape half an inch wide can be used to make a simple name band for babies not delivered in their own homes. Take 6 inches of this tape, write the date and the mother's name at one end, turn the last 2 inches of the other end back on itself (so the tape does not stick to the skin), and then turn this into a simple bracelet round the child's wrist.

Nothing else is really critical, but a **pulse oximeter** can be of great help in picking out the occasional child with sub-clinical cyanosis in need of further evaluation.

Masks

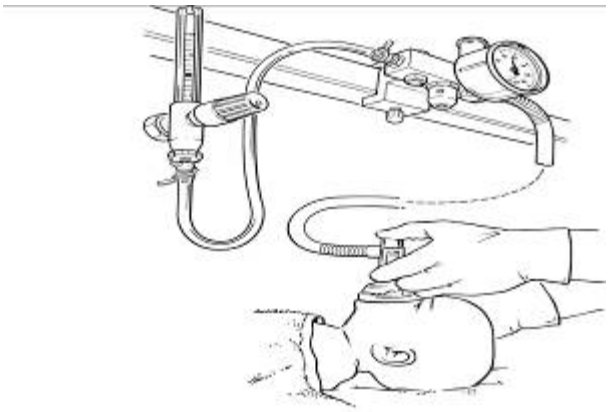
A soft close fitting face mask is *essential.* The Laerdal mask in by far the best studied device (*Lancet* 1985;**i**:207-10), but some other masks brought onto the market since then are probably equally effective. Access to a Laerdal size 0/1 and size 00 mask makes it possible to manage babies weighing as little as 500g or as much as 5000g at birth. The arrival of this mask on the market in 1984 probably did more to simplify neonatal resuscitation than any other single invention in the last twenty years. It provided a near air tight seal between mask and face in a way that had, until then, only been possible by using an endotracheal tube to achieve a seal between tube and larynx. With such a device it finally became as easy to use a mask as an endotracheal tube to administer a *sustained* inspiratory pressure of 25-30 cm H_2O to the fluid-filled lung of a baby in terminal apnoea.



Pressure limiting devices

Pressure to inflate the lung can be provided by squeezing a bag, or by making use of a cylinder (or a piped supply) of air or oxygen. Bag-and-mask devices have been widely used for forty years, and many now come with a pressure over-ride valve. They work very well when used to stimulate the breathing of a baby in primary apnoea, or to ventilate an already aerated lung. They cannot be used with as much confidence to aerate the fluid-filled lung of a baby in terminal apnoea because, unless they are fitted with a pressure manometer, it is difficult to assess just how much inspiratory pressure is being applied.

'Bagless' resuscitation has become increasingly popular in the last 15 years. All that is required is a supply of gas under pressure, a pressure limiting device, and a face mask with T-connector. Such a system leaves both hands free to keep the head optimally positioned, and to hold the mask in place.



Various pressure limitation devices have been used. The simplest is no more than a water column. This simple, easily constructed, device provides both a visual display of the pressure being applied and, at the same time, a safety 'blow off' valve. A weight controlled or magnetised valve works very well, but the use of an adjustable spring-loaded vent and the incorporation of a pressure manometer makes it possible to adjust inspiratory pressure flexibly as required. At least two commercial devices working on this principal are now widely available. The addition of an adjustable flow restrictor into the mask T-piece also makes it possible to control end expiratory pressure – a refinement of particular value when managing the initial stabilisation of a preterm baby.

3. MANAGEMENT AT DELIVERY

Summary of management of the healthy baby at birth

1. Clamp cord when pulsation stopped
2. Prevent hypothermia
3. Early feeding
4. Minimise risk of infection
5. Injection Vitamin K

- Most babies do not need any resuscitation at birth. Mouth suction, face mask oxygen, and vigorous stimulation in order to provoke a first gasp or cry are all pointless rituals that lack any clinical justification.
- Even in a baby born covered in meconium there is no evidence that carefully cleaning of the nose and mouth reduces the risk of meconium being drawn down into the lung. In the few babies where this does happen it almost always occurs before birth as a result of the fetus starting to gasp in response to a period of stress before or during delivery.

Preventing heat loss after birth

- As long as the baby becomes pink, and starts to breathe without distress, most babies must be with their mothers and have a first feed at the breast within minutes of birth.
- Colostrum is extremely nutritious and all mothers should be informed that it is ideal for their baby to feed on this as soon after birth as possible.
- Babies very easily get cold immediately after birth, and using water or oil to clean the skin within four hours of birth before body temperature has stabilised can make the baby dangerously hypothermic (a problem that may well be missed if a low reading thermometer is not used). Nothing is a more effective source of warmth than the mother's own body as long as the baby is first gently dried to minimize evaporative heat loss and mother and baby are then both protected from draught.
  - Heat and water loss through the skin can be a particular problem in babies born before 32 weeks of gestation. This can be limited by wrapping all but the face in a plastic drape for a few hours after birth.
  - Covering the head with a shawl or blanket also reduces heat loss from the head (babies have relatively big heads). Remember, however, that plastic over the face can cause death from suffocation.
- A larger sheet or blanket can be used to protect both mother and child from the convective heat loss caused by draughts.
- Heat supplementation can be provided by locally built and maintained incubators, overhead heating systems and by Kangaroo care.

Managing the placenta, cord and umbilical stump

- Babies often become relatively anaemic 4-6 months after birth because red cell production does not keep pace with body growth. This problem can be minimised by ensuring that blood intended for the baby is not left in the placenta at birth. If the baby is held higher than the placenta while the cord is still pulsating, blood will drain out of the baby and into the placenta. If the cord is clamped before it stops pulsating this will also reduce the normal 'placental transfusion' at birth, especially if the uterus has not yet contracted.
- If, however, blood is artificially 'milked' from the placenta into the baby at birth, it is possible to leave the baby with so many red cells that the blood becomes thick and

polycythaemic. This can put the circulation under strain, make the capillary circulation very sluggish, and increase the risk of jaundice.

- **Wait a minute before cutting the cord if it is still pulsating unless there is an overriding need to start stabilising the baby.**
- Prevention, rather than treatment, is the key. The cord must be cut cleanly in a way that avoids even the slightest risk of tetanus developing, and the cut stump secured in such a way that minimises the risk of late haemorrhage.
- A supply of fresh, disposable, razor blades is one widely adopted strategy in some communities where home birth is the norm. The umbilical stump will shrink as it dries out.
  - Some have tried to minimise the risk of bleeding by leaving a relatively long length of cord attached to the baby and securing this with two tape ligatures.
  - Plastic clamps that shut down further as the cord starts to shrink are very effective. They are relatively inexpensive, and they do make it possible to cut the stump short (about a centimeter from the skin). An elastic band, if carefully applied, is a cheap, and well tried, alternative (*Arch Dis Child* 1964;**39**:630.).
  - A stump that is left long provides a reservoir where bacteria can breed and multiply with great speed.
  - A short stump does not need to be covered except to keep it from snagging on clothes and blankets. It will also wither and fall off quicker if kept dry, left exposed and not routinely treated with any antiseptic lotion or powder.
- A little 'stickiness' is of no concern but a local antiseptic should be applied if a red skin flare suggests early spreading staphylococcal cellulitis. Some of these babies also merit an oral anti-staphylococcal antibiotic. Oral cloxacillin or oral flucloxacillin (25 mg/kg three times a day (<7 days BD, 7-21 days TDS)) is usually the most logical choice. Babies who become systemically unwell need urgent broad-spectrum antibiotic treatment, IV or IM, for incipient polymicrobial septicaemia. Choose a strategy from among the products listed in the short Formulary at the end of the sepsis section.
- Any residual risk of neonatal tetanus can be eliminated by ensuring that all mothers are themselves immunised against tetanus before delivery.

The risk of cross-infection during or after birth

- Puerperal infection ('child-bed fever') is an illness that killed thousands of recently delivered women for more than two centuries. That this could be eliminated if birth attendants washed their hands thoroughly ***every*** time they moved from one woman to

the next was shown many years before it was ever realised that this lethal illness was caused by group B streptococcal infection. The coming of antibiotic treatment has reduced the risk of death, but it has not lessened the need for meticulous hand washing. Failure to observe this simple but important precaution also puts the baby at risk of cross-infection, especially if the baby is being cared for in a hospital setting.

- Rotavirus diarrhea in the neonatal period is seldom lethal, but it can be very debilitating.
- The World Health Organisation estimates that infection is responsible for a third of all neonatal death (over 4000 deaths a day).

Hazardous birth rituals

- One misguided tradition that lasted for much of the twentieth century was a policy of separating mothers from their babies, and of herding all the babies into a single small side room for several hours each day and for most of the night as well. The Baby Friendly Initiative of UNICEF and WHO encourages the keeping of babies with their mothers at all times.
- Another is the discarding of colostrum with the view that is harmful for the baby. A failure to permit the baby to drink colostrum can lead to hypoglycaemia.

Effect of normal, vaginal delivery on a normal, term baby

- At the onset of labour, the lungs are full of fluid
- Labour encourages reabsorption of lung fluid. About 35 mls of fluid are expelled from the lungs during labour
- The first spontaneous breaths generate relatively high pressures to inflate lungs
- These first breaths establish the baby's functional residual capacity
- Surfactant is produced in the alveoli to prevent them collapsing during expiration. Production starts at 20 weeks gestation, and increases rapidly from 30-34 weeks.
- Caesarean section delays clearance of pulmonary fluid and reduces the initial functional residual capacity

- Surfactant production is reduced by hypothermia, hypoxia and acidosis

4. STABILISING THE TERM BABY AFTER BIRTH

Very few term babies need active 'resuscitation' at birth. Most will rapidly cry and expand their lungs without any help at birth, and attempts to clear the airway, to stimulate breathing, or to give facial oxygen do not really serve any useful purpose. Babies also make all the

circulatory adjustments required at birth without external intervention. All that the birth attendant has to do is to optimise the conditions needed for these changes to occur smoothly. To call such support and assistance 'resuscitation' risks leaving parents with the mistaken belief that their baby was in serious difficulty at birth.

The same is not true of the occasional shocked, limp, hypotonic baby. Here the tongue and jaw may well fall back, close off the back of the mouth, and obstruct breathing. The airway then needs to be managed in much the same way as it is in any unconscious or anaesthetised patient.

More seriously, one term baby in every three thousand has become so stressed during delivery that the heart and circulation will not pick up, even after air has been going into the lungs, without further help.

BABIES ARE NOT SMALL ADULTS

- Babies and adults have different needs during resuscitation. They also respond differently. In babies it is the 'pump' responsible for getting air in and out of the lung that usually fails first, while the pump responsible for sending blood round the body is still active.
- The lung is also initially full of fluid.
- In adults it is the heart that almost always fails first. As a result resuscitation has to concentrate on restarting the circulation, although breathing may also need attention as well if anoxia has affected the medullary centre in the brain responsible for respiration. The adult brain is very sensitive to lack of oxygen, and is generally held to suffer damage within 4 minutes if completely deprived of oxygen. The heart is also more vulnerable to lack of oxygen because it lacks the stores of glycogen always present at birth.
- Sudden collapse in adult life is usually due to some heart problem – commonly myocardial infarction, or pulseless arrhythmia, or both. Breathing then stops because oxygen is no longer being delivered to the brain. As a result any resuscitator has to try and mimic the action of both the heart and the lungs, preserving blood flow to the brain and to the heart. Once these immediate needs have been met it is then necessary to diagnose and treat the underlying heart problem. Defibrillator treatment can be critical, and drug treatment may also be important. None of this true in the newborn baby, where significant arrhythmia is never a problem, and the heart is never the first 'pump' to fail.

- Effective chest compression is also much easier to achieve in a baby than in an adult. The relative size of the heart, and the more pliable nature of the cartilaginous rib cage, both help to make compression more effective. Less also needs to be achieved. During adult cardio-respiratory resuscitation there is a need to continue delivering oxygen to the brain as well as the heart. In the baby it is only necessary to ensure that oxygenated blood gets to the coronary arteries and to the muscle of the heart.

SECTION 11 Quiz 1

1) With regard to newborn babies which of the following statements are true?

a) birthweight matters more than maturity as a risk factor for developing problems at birth
b) premature babies are more vulnerable to hypoglycaemia
c) antibiotics should not be given to newborn babies unless there is proven infection in them
d) most newborns need drying and keeping warm – only a few will need resuscitation
e) waiting to clamp the cord until it stops pulsating may reduce the risk of anaemia in the baby when 4 – 6 months old

ANSWERS: 1) b,d,e

Resuscitation Council (UK) RESUSCITATION GUIDELINES 2005

Main changes that have been made to the Neonatal Life Support (NLS) guidelines

- The use of food-grade plastic wrapping is recommended to maintain body temperature in significantly preterm babies.
- Attempts to aspirate meconium from the nose and mouth of the unborn baby, while the head is still on the perineum, is no longer recommended.
- Ventilatory resuscitation may be started with air. However, where possible, additional oxygen should be available if there is not a rapid improvement in the infant's condition.
- Adrenaline should be given by the intravenous or intraosseous route, as standard doses are likely to be ineffective if given via a tracheal tube.
- If there are no signs of life after ten minutes of continuous and adequate resuscitation efforts, then discontinuation of resuscitation may be justified.

Sequence of actions during resuscitation of the newly born

FIRST Keep the baby warm and assess

Babies are born small and wet. They get cold very easily, especially if they remain wet and in a draught.

- Whatever the problem, first make sure the cord is securely clamped and then dry the baby, remove the wet towels, and cover the baby with dry towels.
- For significantly preterm babies (30 weeks and below), there is now good evidence that placing the baby under a radiant heater and, without drying the baby beforehand, immediately covering the head and body, apart from the face, with food-grade plastic wrapping, is the most effective way of keeping these very small babies warm during resuscitation or stabilisation at birth.
- Drying the baby will provide significant stimulation and will allow time to assess colour, tone, breathing, and heart rate.

Reassess these observations regularly (particularly the heart rate) every 30 sec or so throughout the resuscitation process. The first sign of any improvement in the baby will be an increase in heart rate.

Consider the need for help; if needed, ask for help immediately.

- A healthy baby will be born blue but will have good tone, will cry within a few seconds of delivery, will have a good heart rate (the heart rate of a healthy newborn baby is about 120-150 beats min1), and will rapidly become pink during the first 90 sec or so. A less healthy baby will be blue at birth, will have less good tone, may have a slow heart rate (less than 100 beats min-1), and may not establish adequate breathing by 90-120 sec. An ill baby will be born pale and floppy, not breathing and with a slow or very slow heart rate.
- The heart rate of a baby is best judged by listening with a stethoscope. It can also be felt by gently palpating the umbilical cord but a slow rate at the cord is not always indicative of a truly slow heart rate - feeling for peripheral pulses is not helpful.

Second Airway management A Keep the airway open

- Before the baby can breathe effectively the airway must be open.
- The best way to achieve this is to place the baby on his/her back with the head in the **neutral position**, i.e. with the neck neither flexed nor extended. Most newborn babies will have a relatively prominent occiput, which will tend to flex the neck if the baby is placed on his/her back on a flat surface. This can be avoided by placing some support under the shoulders of the baby, but be careful not to overextend the neck.

- If the baby is very floppy it may also be necessary to apply chin lift or jaw thrust.

Notes:

The best way to stabilise a baby's condition at birth is to ensure that the upper airway remains unobstructed. The child will then have little difficulty in drawing air into its lung for itself when it takes its first spontaneous gasp or cry. Unfortunately books often talk of the need to keep the airway 'clear', giving the false impression that the baby is going to find it difficult to breathe unless all the fluid and mucus is first sucked out of the way. There is almost no evidence that this is ever necessary. **Moreover, blind deep suction of the nose or mouth can stimulate the vagus nerve leading to bradycardia and laryngospasm.**

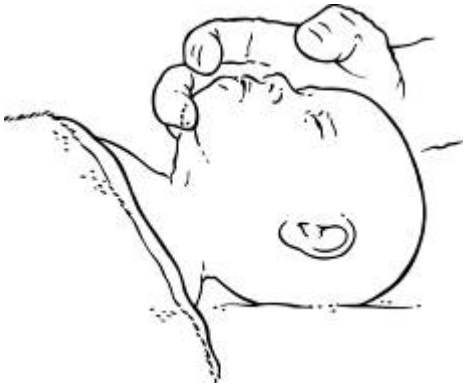
However, the upper airway of any baby who is born limp and hypotonic certainly needs to be maintained and secured in just the same way as the airway of any other unconscious patient. In an unconscious patient pharyngeal tone decreases even more than it does during sleep causing the upper airway to narrow or close. When such patients are laid on their back the tongue also falls back, further obstructing the airway. The three key ways to counter this are to:

- hold the head in the neutral position and
- support the chin or
- push the jaw forward.

NEUTRAL POSITION

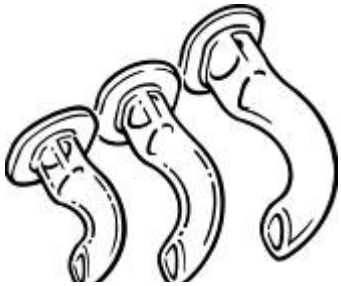
Because of molding, most babies have quite a prominent occiput at birth. Lying supine (on their back) on a flat surface, the neck becomes flexed, and the airway becomes obstructed. Exactly the same thing can happen if the neck is over-extended. The aim is to ensure that the head is in a 'neutral' position – a posture most easily achieved by placing a small (2cm) pad under the baby's shoulders.

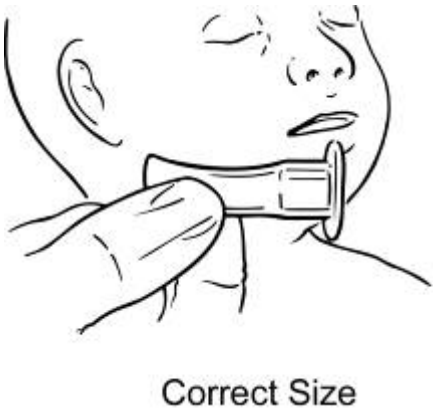
If tone is poor it may also be necessary to support the chin. It is important to support the bony part of the chin. Pressure anywhere else may merely push the base of the tongue backwards, making matters worse.



If tone is very poor it may be necessary to use one or two fingers under each side of the lower jaw, at its angle, in order to push the jaw forwards and outwards ('jaw thrust').

JAW THRUST





A Guedal oro-pharyngeal airway (Mayo tube) may be of help, especially if the jaw is small or there is some other oro-facial abnormality. Choose an airway that reaches the angle of the jaw when the flange is under the nose, and make sure it passes over the tongue and does not merely push the tongue further back. Put the airway into the mouth in the way you want it to lie after insertion – do not turn it round during insertion as is generally done when using such an airway in an adult.

Although it is rare for debris to totally block the trachea such a problem should be suspected if a baby tries to breathe but remains cyanosed and bradycardic, with laboured breathing and marked inter-costal and/or sub-costal recession. This is one of the few situations where tracheal intubation can be life saving at birth.

Meconium A large multicentred, randomised, controlled study1 has shown that attempts to aspirate meconium from the nose and mouth of the unborn baby while the head is still on the perineum (so-called intrapartum suctioning) does not prevent meconium aspiration syndrome and this practice is no longer recommended.

Another large multicentred randomised, controlled study2 has shown that attempts to remove meconium from the airways of vigorous babies after birth also fail to prevent this complication.

However, if babies are born through thick meconium and are unresponsive (or 'not vigorous') at birth, the oropharynx should be inspected and cleared of meconium. If intubation skills are

available, the larynx and trachea should also be cleared. It is acknowledged that no proof of the efficacy of this practice exists.

What to do if the trachea seems blocked

- If a baby passes meconium before birth and stress then also causes the baby to gasp, there is a risk of meconium being drawn down into the lung. This can certainly cause an inflammatory reaction, making the baby oxygen dependent for some days after delivery, but meconium itself seldom blocks the trachea, and elective intubation and direct tracheal 'toilet' at delivery does not seem to reduce the risk of a subsequent chemical pneumonitis.
- Thick particulate debris can, however, rarely cause tracheal obstruction. Greasy vernix, a lump of gelatinous postnasal mucus, a congealed blood clot, and thick particulate meconium, have all been found to cause laryngeal obstruction on occasion. Such debris is never going to be drawn up any standard suction catheter threaded into an endotracheal tube. The best that can be done is to insert an endotracheal tube as far into the trachea as possible, apply mechanical suction to the end of this tube, draw some of the material into the tube, and then remove the tube and blow it clear. Such a manoeuvre may need to be repeated 2-3 times. Luckily, experience suggests that such a problem will only be encountered once in every 5000 births at most.

Third Breathing B

- If the baby is not breathing adequately by about 90 seconds **give 5 inflation breaths.** Until now the baby's lungs will have been filled with fluid. Aeration of the lungs in these circumstances is likely to require sustained application of pressures of about 30 cm of water for 2-3 sec – these are 'inflation breaths'.
- If the heart rate was below 100 beats min-1 initially then it should rapidly increase as oxygenated blood reaches the heart. If the heart rate does increase then you can assume that you have successfully aerated the lungs. If the heart rate increases but the baby does not start breathing, then continue to provide regular breaths at a rate of about 30-40 min-1 until the baby starts to breathe.
- If the heart rate does not increase following inflation breaths, then either you have not aerated the lungs or the baby needs more than lung aeration alone. By far the most likely is that you have failed to aerate the lungs effectively. If the heart rate does not increase,

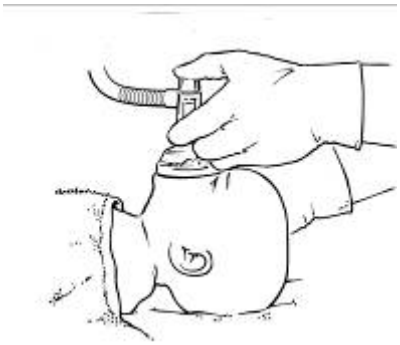
and the chest does not passively move with each inflation breath, then you have not aerated the lungs.

Consider:

- Is the baby's head and neck in the neutral position?
- Do you need jaw thrust?
- Do you need a longer inflation time – correct time is 2-3 sec inspiration?
- Do you need a second person's help with the airway?
- Is there an obstruction in the oropharynx (laryngoscope and suction under direct vision)?
- What about an oropharyngeal (Guedel) airway?

Mask inflation of the lung

Having positioned the baby correctly it is then usually quite easy to use mask pressure to encourage lung aeration, and then control breathing – should that be necessary.



If the baby is unusually limp the help of a second person may make management easier. Aerating the fluid-filled lung at birth is usually achieved by the *negative* pull of the child's rib cage. It takes a *positive* pressure of about 30 cm H_2O sustained for 2-3 seconds to achieve much the same thing, and it may take 4-5 such breaths to achieve reasonably even aeration. In that brief time much of the 100 ml of fluid that the average 3 kg baby has in its lung at birth is transferred into the lung's lymph channels and the interstitial tissue spaces.

Bag-and-mask pressure can achieve the same thing as mask pressure delivered using a constant flow of gas and a variable pressure valve. However it is not possible to control the pressure applied with anything like the same precision with a bag-and mask-device unless the bag is fitted with a pressure manometer. *Remember that you cannot breathe through the bag valve mask system and so do not leave the mask sealed to the face and expect the baby to breathe from the bag. The valve between the bag and mask prevents this.*

Most babies will respond to any inflationary maneuver of this type by gasping and then coming round on their own without further support. If this does not happen it is still easy to confirm that lung aeration has been achieved, because the heart rate will rise reliably and consistently above 100 beats per minute as soon as it has. If lung aeration has been achieved and the baby does not quickly start to breathe proceed to circulation C

There is incontrovertible evidence that even babies in terminal apnoea can be resuscitated using mask resuscitation and chest compression without any need for tracheal intubation. Staff should not worry, therefore, that they are not going to be able to manage a terminally ill baby on their own without further support, just because they have never been taught, or had a chance to undertake, tracheal intubation. The only real advantage of intubation in a situation as serious as this is that, once the trachea has been intubated, it is easier to ask a second person to continue to support respiration while the most experienced person present starts to deal with the C and the D of resuscitation.

Should one use air or 100% oxygen for resuscitation of the newborn?

Concern about possible injurious effects of excess oxygen, particularly in preterm infants, and the apparent effectiveness of air in some limited, randomised, controlled, human studies of resuscitation at birth, has resulted in a minor change in the guidelines.

There is no evidence to suggest that any one concentration of oxygen is better than another when starting resuscitation. Some clinicians may wish to start with air. However, where possible, it is recommended that additional oxygen should be available for use if there is not a rapid improvement in the infant's condition. Equally, hyperoxia should be avoided, especially in the preterm infant.

Mouth to mouth resuscitation

Most current guidelines on neonatal care steer clear of discussing the role of mouth-to-mouth resuscitation, and the risk of AIDS or hepatitis has further fueled that reluctance. However there is no doubt that this can be a very effective way of reviving an apparently lifeless baby. More importantly, unlike all the other strategies being discussed here, it requires no equipment. Just remember to –

- Keep the upper airway open by optimising the position of the head and jaw as described above.
- Cover the baby's nose and mouth with your mouth (or close the mouth of a big baby and just pinch the nose).
- Use the pressure you can generate with your cheeks, and try to aerate the lung by sustaining that pressure for 2-3 seconds.
- Only use as much air for each breath as you can keep in your cheeks (i.e. do not 'blow' air into the baby).
- Watch for chest movement, and allow time for lung recoil.
- Once the chest starts to move sustain what has been achieved with 20-25 artificial breaths a minute.

One possible way of using this approach and avoid the risk of infecting the healthcare worker is to train mothers prior to delivery in how to achieve this on a manikin.

Check progress before moving on

- If the heart rate has **not** risen to about 100 beats per minute within 20 seconds of initial lung aeration something is wrong. ***Never*** move on to deal with the issues covered under letter C of the resuscitation alphabet until you are quite sure you have achieved objective A and B. To do so is quite futile - chest compression will never restore the circulation until the blood being massaged from the lung to the heart contains oxygen.
- Look and see if the chest moves each time you apply mask pressure. Movement should not be difficult to see once the first few breaths have aerated the lung. It is usually easier to judge success with your eyes than with a stethoscope.
- Go back and check that the child's head is well positioned. Check chin support and jaw thrust. Ask a second person to help you position the baby optimally.

- Few babies need support with their breathing once their lungs have been aerated. Most will gasp, cry, or breathe just as soon as an attempt is made to get air into the lung and then continue breathing adequately.
- A few may, however, benefit from further support if they do not start to breathe regularly, or only gasp occasionally. Some may be limp and hypotonic, and a few may be drowsy because of drugs given to the mother during labour. Check that the heart rate remains normal (above 100 beats per minute) and that there is no central cyanosis (best judged by looking at the colour of the tongue).
- If breathing is laboured, or irregular, or the child's colour remains grey or blue, try and assess whether there is hypoxaemia with a pulse oximeter. The aspiration of liquor or meconium into the lung before birth can also render a baby oxygen dependent. Other possibilities include intrapartum pneumonia, diaphragmatic hernia, choanal stenosis, pneumothorax, and, more rarely, pulmonary hypoplasia (possibly associated with a skeletal or renal abnormality). Cyanotic congenital heart disease is another possibility, although this usually takes a little time to appear. Hypoxaemia can also be the first sign of persistent fetal circulation. You should be able to achieve a saturation of at least 95% when the child is breathing 100% oxygen if there is no right-to-left shunt. Many babies continue to be given oxygen for a few minutes after birth when this is really not necessary. In contrast, many of the small number who really do need continuing supplemental oxygen are often only recognised to be in need of this when they have already become quite ill.
- If breathing does require continued support, try and reduce mask inflation pressures to little more than half of what was needed to aerate the lung in the first place. It is not difficult to over-ventilate a baby with healthy lungs and to wash out so much of the carbon dioxide that normally provides the main stimulus to breathing that all such activity stops for a while. There is also increasing evidence that sustained over-ventilation can seriously reduce cerebral blood flow.

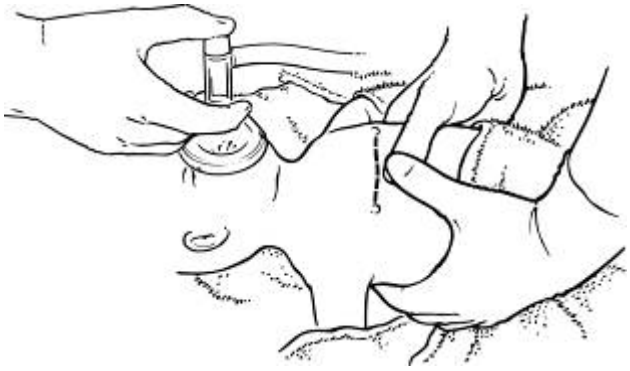
Preterm babies

- Babies with surfactant deficiency may have difficulty in expanding their lungs, and in developing a normal 'cushion' of trapped lung gas (functional residual capacity, or FRC), at birth.

- The preterm lung is, however, quite a delicate structure with relatively little elastic support, and any use of undue pressure during resuscitation can initiate what later becomes a cascade of barotrauma.
- While an inspiratory pressure of 30 cm H_2O may well be necessary to aerate the lung at birth, such pressure is best not applied too abruptly, and should be reduced as rapidly as possible after that. The key aim must be to conserve such surfactant as already exists by sustaining the lung's functional residual capacity – an objective best achieved by providing at least 5 cm H_2O of positive end expiratory pressure (PEEP) consistently. Aim to achieve this, not only during initial stabilisation at delivery, but also during transfer to, and care in, the nursery. Where this can be achieved using nasal prongs or a nasal mask (nasal PEEP) it may be possible to avoid tracheal intubation altogether.

Fourth Circulation C Chest compressions

- If the heart rate remains slow (less than 60 min-1) or absent following 5 inflation breaths, despite good passive chest movement in response to your inflation efforts, start chest compression. Almost all babies needing help at birth will respond to successful lung inflation with an increase in heart rate followed quickly by normal breathing.
- Chest compression should be started only when you are sure that the lungs have been aerated successfully.
- In babies, the most efficient method of delivering chest compression is to grip the chest in both hands in such a way that the two thumbs can press on the lower third of the sternum, just below an imaginary line joining the nipples, with the fingers over the spine at the back.
- Compress the chest quickly and firmly, reducing the antero-posterior diameter of the chest by about one third.
- Because oxygenation is such an important part of neonatal resuscitation **the ratio of compressions to inflations in newborn resuscitation is 3:1.**
- Chest compressions move oxygenated blood from the lungs back to the heart, into the heart, and out into the ascending aorta. From there the two coronary arteries will then quickly deliver oxygen to the failing anoxic heart muscle. Allow enough time during the relaxation phase of each compression cycle for the heart to refill with blood. Ensure that the chest is inflating with each breath.



- It is not possible to compress the chest effectively more than about 60 times a minute because sluggish venous return delays atrial filling.

Fifth Drugs D

In a very few babies inflation of the lungs and effective chest compression will not be sufficient to produce an effective circulation. In these circumstances drugs may be helpful.

Drugs are needed only if there is no significant cardiac output despite effective lung inflation and chest compression.

The drugs used are adrenaline (1:10,000), sodium bicarbonate (ideally 4.2%), and dextrose (10%). They are best delivered close to the heart, usually via an umbilical venous catheter or, failing that, by direct cardiac puncture (only by those trained in this). Unfortunately, most of the babies in whom cardiac output only returns after treatment with bicarbonate do not survive to discharge, and most of those who do survive later develop profound disabling spastic quadriplegia. Many would question the wisdom of persisting with resuscitation when the outlook is as bleak as this in many health care settings. It follows, therefore, that drug treatment has a very limited role during neonatal resuscitation.

Where the cause of the child's terminal apnoea is a sudden, and much more abrupt, asphyxial event – such as shoulder dystocia or an occasional case of late cord prolapse –

these reservations may be less valid. Here there is at least anecdotal evidence that the outlook, if the circulation can be restarted, is much less bleak.

Acidosis not serious enough to precipitate circulatory standstill will nearly always correct itself spontaneously within 90 minutes once the circulation has been restored and the baby starts to breathe for itself. It does not, therefore, usually call for artificial correction. Indeed doing this only increases the amount of sodium that the potentially compromised kidney will need to excrete over the next few days.

- **Adrenaline:** The recommended dose for adrenaline is 10 microgram kg-1 (0.1 ml /Kg of 1:10,000 solution). If this is not effective a dose of up to 30 microgram/ Kg (0.3 ml/Kg of 1:10,000 solution) may be tried. *A solution of 1 in 10,000 adrenaline should be made up and available in all delivery areas.* Do not use a higher dose by these routes as it is harmful.
- **Sodium bicarbonate:** The dose for sodium bicarbonate is between 1 and 2 mmol /Kg (2 to 4 ml of 4.2% bicarbonate solution). **This *has* to be given intravenously; giving it into the trachea would cause a lethal chemical burn.** Indeed it really has to be delivered into the heart itself (either by direct puncture or through an umbilical catheter) to be effective when there is complete circulatory standstill.
- **Glucose**: The dose of glucose recommended is 200 mg/Kg (2 ml/Kg of 10% dextrose). Higher doses can lead to hyperglycaemia which is associated with cerebral oedema and cerebral haemorrhage. It is known that severe hypoglycaemia is rare immediately after birth, but tends to present after 1-2 days. However, hypoglycaemia **(less than 2.5 mmol/litre (45mg/dl)** is a potential problem for stressed or asphyxiated neonates, so its use should be considered in cardiac arrest, as the heart will not recover in the presence of hypoglycaemia. This should be followed by an infusion of 5ml/kg/hour of 10% glucose, until feeding is well established.
  The **route** of administration is IV, but glucose may also be given in the same dose via NG tube (10% solution) if the baby is not feeding well.
- **Naloxone** can be used to reverse profound opiate induced respiratory depression, but has no real role in neonatal resuscitation. If it does prove necessary, give it intramuscularly, and give a full 200 microgram 'depot' dose irrespective of body weight. If naloxone is given intravenously it is likely to be eliminated from the body six times as fast as the opioid drug causing the respiratory depression.

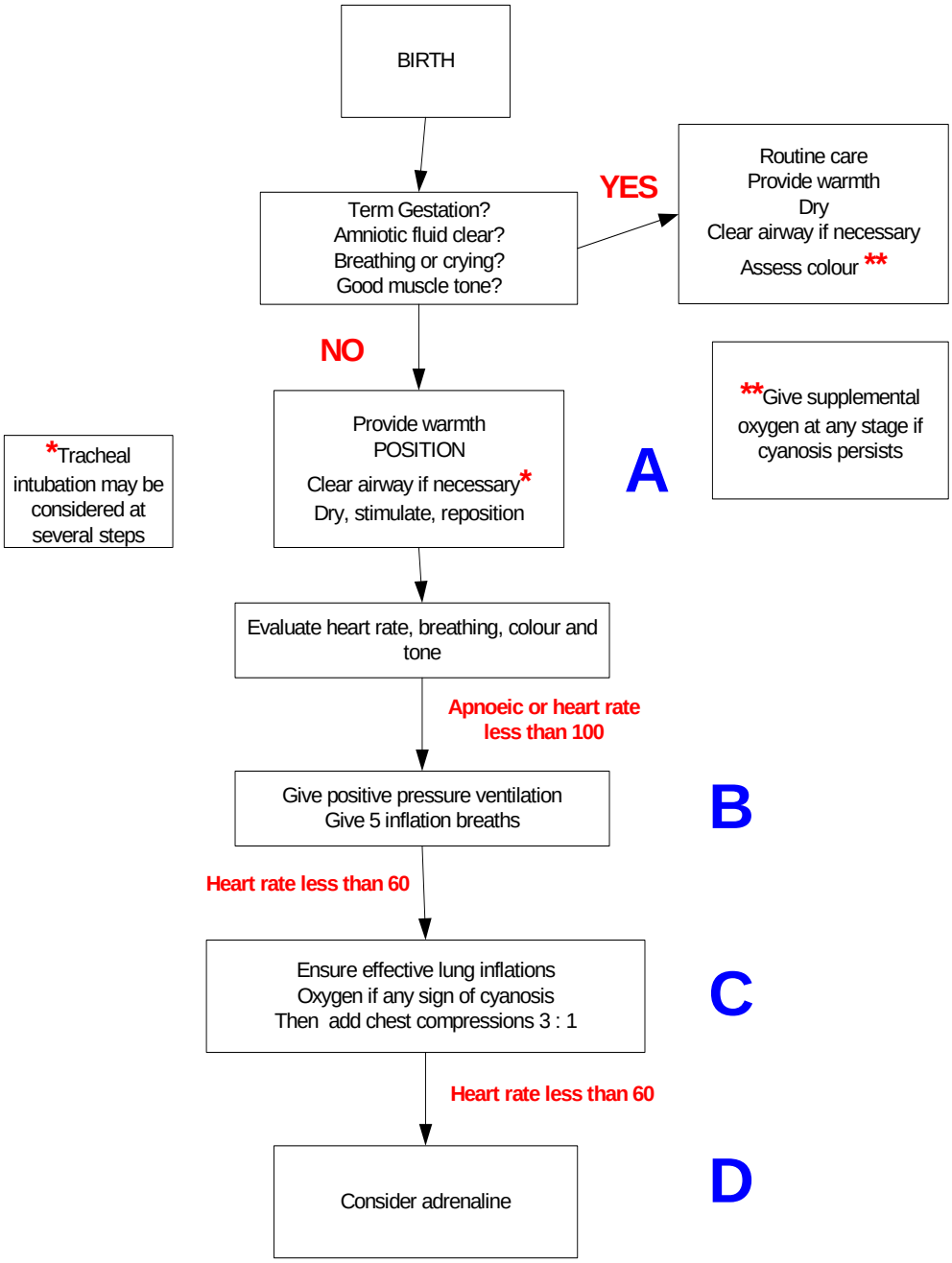
No other drug has ever shown itself to be of any use during neonatal resuscitation.

Acute blood loss as a cause of circulatory arrest (circulatory volume support)

- Sudden acute blood loss is rare, but often unrecognised, cause of acute circulatory collapse. Bleeding from an aberrant placental blood vessel (*vasa praevia*) can rapidly lead to hypovolaemic death. The response to a rapid, generous, infusion of any intravenous fluid can be equally dramatic. Speed is of the essence. Circulatory collapse probably does not occur until the baby has lost between 30 and 40 ml/kg of blood, but 20 ml/kg of 0.9% sodium chloride ('normal saline') will usually reverse the immediate critical hypovolaemia rapidly. The initial intravenous fluid bolus should be **10 ml/kg** of **0.9% saline**, and **this can be repeated ONCE** if there is no immediate response, or only minimal response. So can plasma albumin, or some artificial plasma expanding agent (such as gelatin). A packed red cell transfusion using group O Rh-negative blood can be given later to correct the associated anaemia.
- Other, less well recognised, causes of hypovolaemic collapse include acute feto-maternal blood loss, sudden twin-to-twin transfusion, and accidental incision of the placenta during caesarean delivery. There are reports suggesting that placental abruption can also occasionally cause fetal blood loss. Partial cord occlusion can occasionally obstruct the umbilical vein while blood flow from the baby to the placenta remains uninterrupted causing acute unrecognised hypovolaemia. The resultant circulatory arrest and bradycardia does not respond to any of the maneuvers commonly used during resuscitation, but does respond promptly to volume replacement.

Aside from these specific indications 'volume' should not be used during neonatal resuscitation. There is no evidence to suggest benefit from this, and routine use only compounds the problem of fluid balance that can develop over the next 2-3 days if severe intrapartum stress causes secondary renal failure.

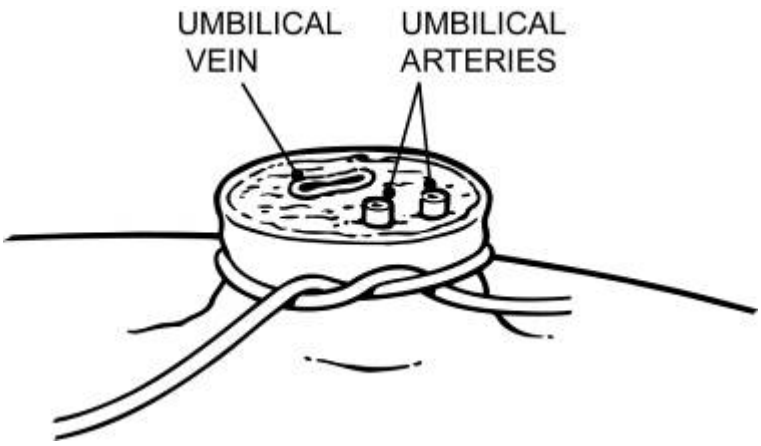
Newborn Resuscitation Algorithm (Resuscitation Council 2005)



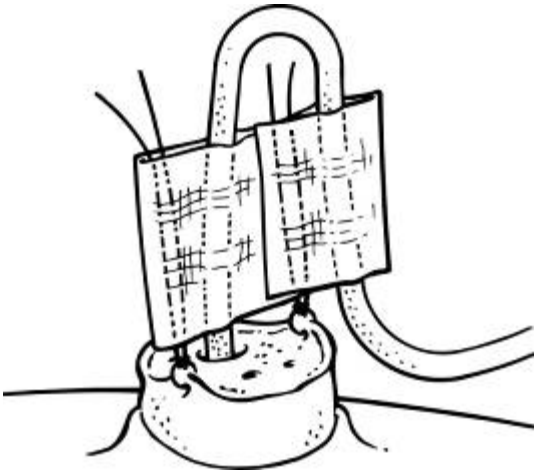
Umbilical catheterisation

The only quick way of correcting hypovolaemia in a shocked baby at birth is to catheterise the umbilical vein. When circulation is at a standstill such a catheter also provides a route for delivering drugs to the heart (although such a catheter does not always pass up through the *ductus venosus* to enter the right side of the heart). The essential steps are as follows –

- Place a loose cord ligature round the base of the cord (tightening and securing this later as necessary).
- Cut the cord about one centimetre from the skin in a single clean stroke using a sharp scalpel or a razor blade (a saw like action can leave the edge of the vein jagged and hard to cannulate).



- Identify the three cord vessels. The thin-walled vein is usually in the upper right quadrant (towards the head end of the baby). The two stiff, white, contracted, bloodless arteries (which pass down the abdominal wall to join the iliac arteries) are usually in the two lower quadrants.
- Take an end-hole umbilical catheter and attach it, via a 3-way tap, to an empty 2 ml syringe.
- Take hold the edge of the vein with fine artery forceps and thread the catheter in far enough for blood to flow back easily. If you are able to advance the catheter 10 cm in a 3 kg baby the tip has probably just entered the tight atrium (7cm is a more appropriate distance for a 1 kg baby). Never force the catheter if resistance is encountered in the first 2-3 cms. Ideally check position with Xray or ultrasound.
- Take a blood sample for haematocrit if facilities allow, and then give any emergency drug or fluid as required.



- Ensure that no air bubbles are present in the catheter by with drawing some blood. Then flush the catheter with saline to maintain patency, and secure the catheter in place with two sutures and tape as shown.

- The whole procedure should be done as cleanly as possible although, in a real emergency, there is no time to adopt a full aseptic technique.

Sixth ENVIRONMENT E

- This is always an issue at risk of being overlooked. It is really the ***first*** issue that ought to receive attention, both in those babies who are healthy, and in those in need of stabilisation, at birth.
- A CLEAN environment is the first objective.
- A WARM environment is the second. It only takes a few seconds to dry the baby and provide a clean dry blanket for warmth. If the room in which delivery occurs is clean, warm, and free of draughts this is also a great help.
- Small babies in particular rapidly become cold, especially if left wet, and cold stress can be lethal. Enclosing the trunk and the limbs in a clear plastic drape or bag can greatly reduce evaporative heat loss. Indeed, babies born more than 10 weeks early have skin that is so thin that it is not really 'waterproof' and this will cause excessive evaporative heat loss to persist for several days after birth.

Seventh FAMILY F

- If you are on your own, the mother's needs come first – most babies are quite good at looking after themselves.
- If you are not on your own things are much easier, and this 'ABC' summary really only comments on the care that should be given to the baby. Remember that parents need to be told what is happening. They will fear the worst, even if the baby was only taken away from them for a few minutes at birth.

- Some babies need to be stabilised at birth but few need to be resuscitated. If you tell parents that their baby needed 'resuscitation' at delivery, then they may well start to think that their child was in the process of dying. That may well make you feel that you have done something useful, and it may make the parents very grateful. However, it will also make them feel that something must have gone 'wrong' during delivery, and it may well lead them to worry that their child could be 'brain damaged' as a result. The words we use matter. Parents can easily read meanings into them that we never intended.
- Write down what you saw and did, distinguish fact from opinion, and make no assumption as to causation. Use adjectives with great care, and do not make judgmental comments on the actions of others.

Poor response to resuscitation

If the baby either fails to respond, or makes a poor response to resuscitation, the most likely problem is inadequate oxygenation. The following steps should be taken:

- Check the airway and ventilation
  - Check for technical faults if using equipment
    - Is the oxygen attached?
    - Is the airway blocked?
    - has the correct size of oropharyngeal airway been selected?
    - Is the endotracheal tube in the correct place?
  - Re-examine the chest to see if a pneumothorax has developed – this is not uncommon, but seldom causes a problem. Drain a tension pneumothorax with a small cannula over needle (21 gauge) in the second intercostal space in the mid-clavicular line
  - Consider the possibility of a congenital heart lesion if the baby remains cyanosed, despite breathing and a good heart rate
  - Consider the possibility of maternal opiates or anti-hypertensive sedation such as diazepam or phenobarbitone if the baby is pink, well perfused, but requires assisted ventilation
  - Severe anaemia, caused by blood loss, should respond to a rapid bolus of **10 to 20ml/kg of O-ve blood.**
  - **Consider hypoglycaemia**

Stopping resuscitation

Even with the most effective resuscitation, not all babies will survive. The prognosis is poor if the baby has been without a cardiac output after 10 minutes of resuscitation. If the baby does not respond in spite of effective ventilations and chest compressions, the outcome is unlikely to be altered by use of drugs, although these should be considered. The decision to stop resuscitation should be taken by the most senior health worker present, and the reason for the decision should be clearly documented.

Documentation

It is important to keep accurate records of the steps taken during resuscitation, so that the reason for any decision is clearly documented, including the decision to start as well as end resuscitation. This is important, irrespective of the immediate outcome of the resuscitation effort. As with any documentation, keep to the facts and make a complete record of all the steps taken, their timings and the impact they had on the baby's progress.

Remember to sign and date the record.

Vitamin K

Following resuscitation/stabilisation of the newborn ALL should receive 1mg Vitamin K intramuscularly (NOT INTRAVENOUSLY AS IM INJECTION PROVIDES A DEPOT OVER MANY WEEKS) to prevent possible haemorrhagic disease of the newborn.

SECTION 11 Quiz 2

1) **Regarding resuscitation of the newborn which of the following statements are true?**
   a) the primary problem is usually of cardiac origin
   b) most newborn babies need supplemental oxygen for the first few minutes of life
   c) the principles of resuscitation differ depending on the cause of the problem
   d) drugs are rarely needed
   e) an airway containing mucus often causes a problem in the newborn unless cleared by suction

2) **Put the following in the order 1 – 5 which you would resuscitate a newborn**
   a) give drugs
   b) breathing
   c) airway
   d) dry and assess
   e) circulation

3) **If the newborn is not breathing on initial assessment which of the following statements are true?**
   a) the head should be placed in the neutral position
   b) if airway opening manoeuvres have been ineffective, an oropharyngeal airway may help open the baby's airway
   c) initial breathing support should include 5 inflation breaths each sustained for 2 – 3 seconds duration
   d) inflation breaths can be assumed to be effective if the heart rate increases
   e) chest compressions should be started at a rate of 5 chest compressions to 1 breath if the heart rate is less than 60 bpm

ANSWERS: 1) d 2) 1 =d, 2= c, 3 = b, 4 = e, 5 = a 3) a,b,c,d (e should be 3compressions to 1 breath)

5. COMMON EMERGENCY PROBLEMS IN THE FIRST MONTH OF LIFE

MANY EMERGENCIES CAN BE PREVENTED BY ATTENTION TO INFECTION PREVENTION, ADEQUATE WARMTH AND GOOD FEEDING PRACTICES.

The aim of this section is to

- Recognise and understand the principles of managing breathing difficulties in the newborn and be aware of the treatment of common causes of respiratory problems
- Recognise and understand the causes, effects and management of conditions causing circulatory problems in the new born
- Recognise and understand the causes and management of conditions affecting the conscious level of a newborn baby

Essential equipment list

Oxygen and low flow-meters
Incubators or other forms of warming babies (kangaroo care blankets, over-head heaters)
Head boxes
Suction systems
Self inflating bag and set of masks
Phototherapy system
(Pulse oximeter)
(Nasal CPAP)
Simple icterometer
Blood glucose sticks
WHO Hb sticks
Sterile instruments for UVC catheter

DRUG USE IN THE NEWBORN BABY

Relatively few drugs are needed to deal with most common neonatal emergencies. All the products listed as capable of being given by intramuscular injection (IM) in this section can also be given intravenously (IV) unless otherwise stated. The IV route should always be considered if the child is already being given IV glucose or glucose with saline, because this can reduce the amount of pain to which the child is subjected. There are dangers associated with rapid administration however, and breaking into an existing IV line can increase the risk of sepsis. Erecting an IV line merely to administer drugs also risks exposing the child to a dangerous fluid overload unless a syringe pump can be used to control the rate at which fluid is infused.

BREATHING PROBLEMS

Breathing problems are particularly common in the period immediately after birth.

Features of respiratory distress in the newborn include

- Tachypnoea (rate > 60 /min),
- Recession of the chest wall and sternum
- Expiratory grunting
- Nasal flaring
- Prolonged apnoea
- Gasping
- Tachycardia
- SaO_2 < 94% in air
- Cyanosis is a relatively late presentation of a respiratory cause, but may reflect a cardiac cause

These signs are relatively non-specific and as well as conditions affecting the respiratory system can result from cardiac, neurological and metabolic abnormalities.

Causes of respiratory distress in the newborn

Common

- Lack of surfactant causing respiratory distress syndrome in the pre-term baby
- Infection acquired before or during delivery
- Transient tachypnoea of the newborn (wet lung)

Less common

- Meconium aspiration
- Persistent pulmonary hypertension of the newborn
- Pneumothorax

Rare

- Pulmonary hypoplasia
- Congenital abnormalities e.g. diaphragmatic hernia, choanal atresia, tracheo-oesophageal fistula
- Respiratory distress syndrome in the term baby
- Pulmonary haemorrhage

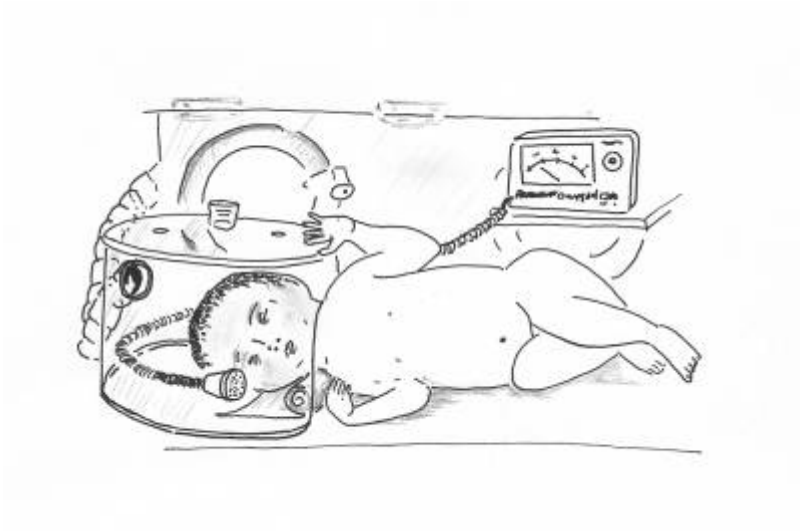
Non-respiratory

- Cardiac lesions
- Intra-cranial pathology
- Severe anaemia

General approach

Certain general principles underpin all management -

- Assess **Airway** and **Breathing**
- Babies should be offered enough supplemental oxygen to avert any suggestion of central cyanosis. Pulse oximetry offers an ideal way of assessing need and of rationalising use. It can be employed to assess initial disease severity, to monitor subsequent progress, and to ensure that such supplies of oxygen as are available are optimally used. Tents and incubators are not an efficient way of giving oxygen. Giving oxygen into a clear plastic hood (head box) placed over the head stops the oxygen supply from dropping every time a tent or incubator door is opened. A nasal catheter, or prongs, optimises the efficient use of the available supply. These devices also make it very much easier to move and handle the baby without disrupting that supply. However they make it rather more difficult to assess how much oxygen is needed to control cyanosis. For that purpose it can be useful to revert to head box use intermittently to determine what inspired oxygen concentration provides a comparable saturation reading.



- Babies should always have their actual oxygen needs monitored at regular intervals. Measuring the inspired concentration needed is one of the best ways of measuring of the child's changing condition. This can be done quite easily using one of a range of inexpensive fuel-cell probes.
- The level of SaO2 that is optimal in the neonate continues to be the subject of debate. ESS-EMCH advises that SaO2 be kept between 94% and 96% in babies cared for at sea level.
- Keep the baby warm, and keep handling to a minimum. Where it can be afforded, the semi-continuous use of a pulse oximeter makes it possible to leave the child clothed, to minimise handling, and to dispense with any other monitoring of pulse and respiration.
- Try to humidify the air the baby is breathing if the oxygen content needs to rise much above 40% (since piped and cylinder supplies of oxygen are very dry). A simple bubble humidifier will usually suffice. If the baby is receiving head box oxygen in an incubator, consider placing the bubble humidifier within the incubator to improve humidification by raising the temperature of the water in a simple and controlled, manner.
- Babies with serious respiratory distress should not be offered milk (or anything else by mouth) until their condition has stabilised and a probable cause for the distress has been established. Support expression of milk in the mother so that she is ready when her baby has recovered to provide breast milk.
- Babies less than 2-3 days old, and older babies who look fluid depleted, should always be started on an hourly IV infusion of 5 ml/kg/hour of 10% dextrose (or, for babies more than 3 days old, of 10% dextrose with 0.18 % sodium chloride). 5ml/Kg per hour of 10% glucose is the minimum amount of glucose (equivalent to 8mg/Kg/minute of glucose) needed to avoid hypoglycaemia in a baby who is not receiving any enteral glucose. Higher concentrations than 10% are sclerosing to veins and there is good evidence that the newborn can easily excrete 120ml/Kg/day. NOTE: 5ml/Kg per hour corresponds to 5

"standard infusion giving set" drops/minute in a 3Kg baby and 3.5 drops per minute in a 2Kg infant. Ideally in neonates should use an infusion set with a micro-dropper (where 1ml = 60 micro-drops). A standard infusion set gives 20 drops/ml and can lead to dangerous fluid overload if not carefully controlled. Older babies who seem relatively stable and only moderately ill can be offered small quantities of milk through a fine naso-gastric feeding tube.

- Give antibiotics, at least for the first 48 hours, if bacterial infection is a plausible reason for the child's respiratory distress either IM, or IV if there is an IV line in place. Take blood for culture first wherever possible. Remember, however, that excess antibiotic usage generates a lot of nursing work, as well as being costly. Excess use can cause overt *Candida* infection (thrush), and also risks the eventual emergence of multi-resistant organisms, especially in a hospital setting. The widespread use of ampicillin has caused many coliform organisms to become increasingly resistant to this antibiotic, while units using a lot of cefotaxime are starting to encounter serious *Enterobacter* sepsis.
- Take a chest x-ray where facilities allow, as long as this can be done without destabilising the baby, in order to get further insight into the probable cause of the problem.
- Take stringent steps to prevent nosocomial cross infection within the unit. This can be a particular problem, not only with some bacterial infections (such as *Listeria*) arising at birth, but also with some troublesome viral infections (such as Respiratory Syncitial Virus RSV bronchiolitis) more commonly seen later in the first month of life.

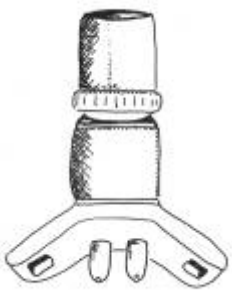
Specific management issues

Some problems call for an individualised approach -

Primary surfactant deficiency ('RDS')

The principles of treating RDS are
- Minimal handling of the baby
- Supplementary oxygen
- IV fluids
- No oral feeding
- Increased end expiratory pressure
- Avoid hypothermia

- Surfactant deficiency is by far the commonest cause of respiratory distress in the preterm baby in the first three days of life. Luckily it is a self-limiting condition, because birth always triggers an immediate increase in surfactant production. The challenge is, therefore, to support the baby for the first two days of life without doing further damage to the lung until such time as the deficiency resolves itself.
- The key features of RDS (cyanosis, an expiratory 'grunt', tachypnoea, and intercostal and/or subcostal recession) all become clinically obvious within four hours of birth. Supplemental oxygen, minimal handling, IV fluid and 'nil by mouth' have been the standard ingredients of care for the last fifty years. Elective surfactant administration (which is expensive) and ventilation (which is complex) have become the standard approach to management in the last twenty years. However, it is now becoming clear that the very small baby can pay a high price for chronic tracheal intubation which, by interrupting cilial flow, can interfere with the way necrotic material is normally cleared from the lung.
- In fact, most babies will manage well for themselves as long as they are offered help to keep the lung from closing down and becoming airless for the 2-3 days it takes for surfactant production to 'switch on'. The expiratory grunt which is a characteristic feature of this condition is the baby's own method of sustaining positive end expiratory pressure (PEEP), and holding the alveoli open. Making the baby breathe against a constant positive airway pressure (CPAP) gradient achieves the same thing and, by applying this pressure at the nose (nasal CPAP), the complications associated with tracheal intubation can be avoided.
- To be maximally effective we now know that CPAP should be applied from birth, just as soon as the lung has first been aerated. Paired short prongs or specially made nasal mask are probably best because they minimise airway resistance.



Even the 3mm nasal cannulae normally used to provide supplemental oxygen have some effect. However pressures of 5 to 8 cm H_2O really require the use of a purpose made device. There are several to choose from. All that is then required is a controlled flow of blended, humidified, air and oxygen, and a simple device for producing controlled adjustable back pressure. Many commercial devices have been developed for doing this, but there is no evidence that they work any better than a simple water trap with a known height of water in it. Regular nursing attention is necessary to make sure that the device remains correctly positioned and does not cause necrotic pressure damage to the nose, but this is a skill that does not take long to acquire.

Transient tachypnoea of the newborn This is almost indistinguishable from RDS at birth. Unlike RDS however, the symptoms do not become more marked with time in the hours after birth. Most of these babies are born at, or near, term. All are tachypnoeic, and a few are overtly cyanosed for 6-12 hours after birth. The condition seems to be caused by some poorly defined difficulty with lung aeration and pulmonary adaptation at birth. All these babies will recover on their own as long as handling is kept to a minimum and as long as they are not fed until their symptoms have subsided. Some need supplemental oxygen, but few need it for more than 24 hours.

Aspiration pneumonia Aspiration of particulate matter can occasionally almost block the trachea. It can also, more commonly, cause a chemical pneumonitis. Meconium can be particularly irritant in this regard, making the term baby very oxygen dependent for the best part of a week. It may also trigger a persistent fetal circulation (see below). Nevertheless with minimal handling, IV fluid and generous supplemental oxygen, most of these babies can be expected to make a complete recovery as long as there has been no associated anoxic cerebral damage. Providing unnecessary respiratory support may actually make matters worse by increasing the risk of pneumothorax. Antibiotics should probably be given until it is clear there is no associated bacterial infection.

- Aspiration after birth can also cause a similar picture. Milk can block the trachea but it seldom causes much of an inflammatory reaction. Gastric acid can be much more

damaging. Recurrent minor unrecognised reflux and aspiration is probably commoner than a single massive episode of aspiration and it can certainly, over time, render the baby quite oxygen dependent. Babies who are hypotonic, or have a poor cough reflex, are probably at particular risk in this regard.

Bacterial pneumonia This should be managed as outlined in the section on suspected infection, remembering that there may be septicaemia as well as pneumonia.

Persistent fetal circulation

- This is an uncommon, but potentially life threatening, condition caused by poor lung perfusion after birth. It may complicate birth asphyxia, meconium aspiration, early bacterial pneumonia, diaphragmatic hernia, RDS or – very occasionally – be a primary disorder.
- After birth the pressures in the pulmonary vessels remains high, so that the normal fall in pressure in the right atrium, right ventricle and pulmonary arteries, does not occur. As a result of this, the blood flows through the fetal circulation (the foramen ovale and ductus arteriosus), from the right side of the heart, to the left. This blood has not been oxygenated, so the baby soon becomes cyanosed. It is difficult to differentiate this from a congenital cardiac malformation. Serious cyanosis in a baby with a well aerated lung on chest x-ray and progressive acidosis can cause rapid self-perpetuating cyclical deterioration.
- The treatment in the first instance is oxygenation, minimal handling, IV fluids and avoidance of oral feeds. Metabolic acidosis should be vigorously and rapidly corrected, or even over-corrected.
- Survival is only likely however, once a well established problem has developed, in a unit capable of providing sustained respiratory support.

Pneumothorax This is present more frequently than expected, and may occur spontaneously in up to 2% of babies. It is often asymptomatic, and may be associated with meconium aspiration and respiratory distress syndrome. It does not automatically need to be treated, unless it causes progressive respiratory distress. Emergency treatment is by thoracocentesis followed by the insertion of a chest drain into the 4^{th} or 5^{th} intercostal space in the mid to anterior axillary line.

- **Lung hypoplasia due to oligohydramnios** Chronic loss of liquor for many days before birth can occasionally impede lung growth enough to jeopardise survival, but what looks like a serious problem at delivery can occasionally resolve quite quickly after 1-2 days. Where the oligohydramnios is due to bilateral renal agenesis or dysplasia, however, there is no hope for survival. The stiffness of the lung in these cases causes marked

intercostal and subcostal recession, and there is unrelievable cyanosis. Chest x-ray will often reveal an untreatable pre-terminal pneumothorax.

- **Congenital malformation** The commonest congenital defect causing respiratory distress soon after birth is diaphragmatic hernia. This occurs in 1:4000 births and more commonly affects the left side. Clinical examination reveals reduced air entry on the affected side, and a displaced apex beat. The chest x-ray is diagnostic. It used to be thought that early surgery improved the chance of survival, but this now known to be untrue. The issue of transfer does not have to be considered, therefore, until it is clear that the child's initial respiratory problems have stabilised. An IV line should be erected in the interim, the gut kept as empty of gas as possible, and food withheld. Restricted lung growth means that only about half these babies have any chance of survival.

Management of diaphragmatic hernia

- oxygen supplements,
- minimal handling,
- IV fluids and withholding of oral feeds
- NGT to keep the stomach empty
- Stabilisation of respiration
- Transfer to surgical care if responds to treatment

A number of rare, generalised, skeletal abnormalities affecting rib growth also cause severe untreatable lung hypoplasia.

Congenital heart disease occasionally causes overt cyanosis from birth, but there are seldom any associated signs of respiratory distress.

Recurrent apnoea

- Irregular, and periodic, breathing is common in the preterm baby and often becomes more of a problem after the first few days of life before then becoming less common again. It usually stops being an issue at least 3-4 weeks before the baby was due to be born. Pre-term babies may suffer episodes of hypoxaemia with or without absent ventilation (apnoea). Sometimes recurrent apnoea is associated with gastric reflux, particularly in neurologically compromised babies with poor airway protective reflexes.
- It is important to check that the baby is not septic, or having subtle seizures both of which require specific treatment.

- Monitoring is needed if the baby becomes bradycardic and cyanosed - the best monitoring device is a pulse oximeter.
- Gentle stimulation is usually all that is required to start the baby breathing again.
- Mask resuscitation can occasionally be called for, and there should always be equipment to hand so that this is not delayed should it be necessary.
- Oral caffeine, if available, will nearly always reduce the number of episodes in the preterm baby, and caffeine seldom causes the tachycardia and the other side effects sometimes seen with theophylline **Caffeine citrate** Give a 20 mg/kg loading dose by mouth, followed by 5 mg/kg once every 24 hours. No commercial formulation is generally available, but an oral solution is not difficult to prepare.
- Stubborn recurrent apnoea occasionally requires management with a period of nasal CPAP.
- Sometimes a sudden cluster of apnoeic episodes can be an indication of early sepsis in a previous well baby. Skilled nursing staff will nearly always be able to recognise that the condition of such a baby has also changed in other ways.

SECTION 11 Quiz 3

1) When considering management of breathing problems of babies in the first month of life which of the following statements are true?

a) it is recommended to feed babies by mouth if they have serious respiratory distress
b) an IV infusion of 10% dextrose is recommended in babies during the first 48 hours of life
c) enough supplemental oxygen to ensure oxygen saturations of 94% or more should be given
d) frequent handling is helpful

2) Which of the following are features of primary surfactant deficiency (RDS)?

a) a self limiting condition causing respiratory distress in the pre-term baby during the first 3 days of life
b) cyanosis
c) tachypnoea
d) grunting

3) Which of the following statements are true about recurrent apnoea in the first month of life?

a) is common in the pre-term baby
b) may be related to recurrent seizures
c) should be monitored with pulse oximetry if causing cyanosis and bradycardia
d) may be an indication of early sepsis in a previously well baby

ANSWERS: 1) b,c (frequent handling is dangerous) 2) a,b,c,d 3) a ,b,c,d

SUSPECTED INFECTION

Babies are very prone to infection and can become ill very rapidly once infection takes hold. Antibiotic treatment is only likely to work if started early, but the recognition of early infection is not easy. A recent WHO study showed that more than a third of all death in the first month of life in most resource-poor countries was caused by infection. It also found (*Pediatr Infect Dis J* 2003;**22**:711) that more than 80% of these babies had one or more of the following eight signs or symptoms when first seen –

Signs associated with infection in the neonate

- Child feeding less than well than before
- Child lying quiet and making few spontaneous movements
- Deep body temperature more than 38°C
- Capillary refill time > 2 seconds
- Respiratory rate 60 or more breaths a minute
- Indrawing of the lower chest wall when breathing, *or* grunting
- Cyanosis
- History of a convulsion

All such babies deserve immediate admission and careful review. Suspect bacterial septicaemia with or without early meningitis and treat as such by –

- Secure the **airway** and ensure the baby is **breathing adequately**
- Give high flow **oxygen until stable**
- Insert an IV cannula, using full sterile precautions. Umbilical vein catherisation may be the easiest way to gain vascular access quickly in a shocked baby less than a week old. Otherwise it might be necessary to site an **intra-osseous** line or cannulate a **scalp vein**.

Take a sample of blood for culture if available and for blood glucose and other biochemical tests if available. Failure to sterilise the skin rigorously can render blood culture results uninterpretable. 0.5% aqueous chlorhexidine is the most effective antiseptic. Employ two different swabs, applying each for ten seconds, and then leave the skin to dry for 30 seconds. A key-hole drape and no-touch technique will reduce the risk of recontamination.

- Give 2 ml/kg of 10% glucose IV over 2–3 minutes, followed by a first dose of ampicillin and gentamicin (or chloramphenicol) using the dose regime outlined at the end of this section of the handbook. If the child almost immediately becomes more alert and active then you know that hypoglycaemia was probably one of the child's problems, even before the laboratory report comes back saying the blood glucose was well below 2.5 mmol/l (36mg/dl). Further monitoring of the blood glucose level should not be necessary as long as this infusion is continued until it is clear that the child is well enough to be fed orally.
- If IV access is not immediately possible give initial antibiotic dose IM. Never wait for the results of cultures or microscopy before starting antibiotics. Any delay can reduce the baby's chances of survival as well as leading to permanent damage if meningitis is present.
- Start a sustained hourly IV infusion of 5 ml/kg of 10% dextrose (or 10% dextrose in 0.18% sodium chloride after 3 days) wherever possible in any child who is shocked, dazed or drowsy, and in any child less than a week old.
- If the baby is shocked, give an IV bolus of 10ml/kg of 0.9% saline
- If the child has any respiratory symptoms take a chest x-ray if facilities allow. Look regularly to see if cyanosis is developing and give supplemental oxygen using a nasal catheter or prongs or a head box as outlined on. Most of the babies who become infected during delivery develop respiratory symptoms and progressive signs of septic shock within a few hours of birth. Do not give anything by mouth to a child who is breathless, especially if there is additional evidence of oxygen dependency, until symptoms have stabilised.
- If there are any features suggestive of meningitis get a lumbar puncture done within 2 hours of starting antibiotic treatment because the blood culture is sterile in 15% of babies with early meningitis. **Do not delay antibiotic therapy pending the undertaking of a lumbar puncture.** See below for a discussion of the best antibiotic to choose if meningitis is a possibility.

- Microscopic examination of the CSF (meningitis = 20 or more cells/mm^3) can provide early confirmation of meningitis, but a differential white blood cell count does not help with the decision to initiate or continue antibiotic treatment.
- Surface swabs and gastric aspirate cultures are not of any diagnostic help, but urinary tract infection is occasionally the primary focus of what then becomes a Gram negative septicaemic illness. Check a clean catch or supra-pubic urine sample for infection (primarily by microscopy). Identification of a urine infection may suggest imaging of the renal tract and prophylactic antibiotics.
- **Watch for, prevent and correct any sign of, hypothermia.**
- Antibiotics can be stopped after 48 hours if the blood cultures are negative **and** the baby has improved. If blood cultures are not available, continue the antibiotics for the full course appropriate for the site of infection (meningitis 10-14 days).

Drugs used for severe infection in the neonate

- **Ampicillin (or amoxicillin)** Give 100 mg/kg per dose IM where meningitis is a possibility. Give 50 mg/kg per dose in other situations. Give one dose every 12 hours in the first week of life, every 8 hours in a baby 1–3 weeks old, and every 6 hours in a baby older than that. Oral dosing can sometimes be used to complete a course of treatment.
- **Benzylpenicillin** Give 60 mg/kg if meningitis, **or** tetanus is a possibility. The same high dose should be given if congenital syphilis is compounded by CNS involvement. Give 30 mg/kg per dose in all other situations. Time the interval between each dose as for ampicillin. Oral dosing (with phenoxymethylpenicillin) can sometimes be used to complete a course of treatment.
- **Cefotaxime** Give 50 mg/kg per dose IV or IM. Time the interval between each dose as for ampicillin except in meningitis where doses are given 6 hourly.
- **Ceftriaxone** Give 25-50 mg/kg once a day IV or IM. A single dose will suffice when treating gonococcal conjunctivitis.
- **Chloramphenicol** This remains a useful antibiotic, although there is a serious risk of death from liver failure if the dose suggested here is exceeded. Give a 25 mg/kg loading dose IM followed by 12.5 mg/kg once every 12 hours to babies less than 1 week old. Give this dose every 8 hours in babies 1–4 weeks old unless there is evidence of liver damage or renal failure. Babies older than this can be given (12.5mg/kg) once every (6) hours

from the outset. Oral dosing can be used to complete any course of treatment. (can double dose in those over 1 month with severe infection)

- **Cloxacillin (or flucloxacillin)** Give 100 mg/kg per dose IM or IV if meningitis or osteitis is a possibility. Give 50 mg/kg per dose in other situations. Time the interval between each dose as for ampicillin. Oral treatment can often be given to complete a course of treatment. (25mg/kg standard, 50mg/kg severe, 100mg/kg in osteomyelitis and meningitis)
- **Erythromycin** Give 12.5 mg/kg per dose by mouth once every 6 hours. There is no satisfactory IM Preparation.
- **Eye drops (and ointments)** Prophylactic 1% silver nitrate drops have been used to minimise the risk of gonococcal infection (IM ceftriaxone being used for overt infection). The use of 2.5% polyvidone-iodine solution may be equally effective. 1% tetracycline ointment should be used (with oral erythromycin) to treat chlamydia conjunctivitis - a condition that is not prevented by silver nitrate use. *Pseudomonas* infection requires treatment with systemic and topical gentamicin (0.3% eye drops).
- **Gentamicin** Give 5 mg/kg IM or IV once every 24 hours. If baby weighs less than 2Kg give 4mg/Kg per dose. Leave 36 or 48 hours between each dose if there is renal failure.
- **(<32 weeks-4-5 mg/kg 36 hourly, >32 weeks 4-5mg/kg 24hrly. Blood levels if available.**
- **Hepatitis B vaccine** Give 0.5 ml IM into the thigh within 12 hours of birth. Remind the mother that booster injections will be required at ages 6 weeks and 14 weeks after birth. Babies born to mothers developing hepatitis during pregnancy, or with hepatitis surface (s) antigen (HbsAg), should also, if possible, be given 200 units of hepatitis B immunoglobulin IM into the other thigh within 24 hours of birth. Breast feeding can safely continue.
- **Isoniazid** Give 5 mg/kg by mouth once a day. Review progress at 6 weeks, noting weight gain and taking an x-ray. If there are features suggestive of active infection start active triple therapy for TB. If there are not continue giving isoniazid for another 4 months, and then give BCG two weeks after this treatment is stopped.
- **Metronidazole** Give a 15 mg/kg loading dose and 7.5 mg/kg per dose once every 12 hours in babies less than 4 weeks old and every 8 hours in children older than that. Treatment can be given IV or my mouth, but solubility makes IM use unsatisfactory. If use IV start maintenance 24 hours after loading, if oral then give first dose 12 hours after loading.

- **Miconazole** This controls infection with Candida ('thrush') better than topical nystatin. Use the oral gel at least four times a day and the skin cream twice a day for at least 7 days. Topical treatment with 0.5% aqueous gentian violet for not more than 4 days may be equally effective. Oral nystatin drops (1 ml four times a day) can be used to reduce heavy intestinal tract carriage.
- **Nevirapine** Give the mother a 200 mg oral dose in labour. Then give the baby one 2 mg/kg dose by mouth 2 days later to minimise feto-maternal transmission of HIV infection. It is not easy to get clear evidence to show that this is worth doing where the mother had already started taking zidovudine at least 4 weeks before delivery. Advice on breast feeding has to be individualised when the mother has HIV.
- **Procaine penicillin** Give asymptomatic babies born to mothers with evidence of untreated syphilis a single 100 mg/kg IM injection. ***Never*** give this drug IV. Babies thought to be infected at birth are often given 100 mg/kg once a day for 10 days, but repeated IM injections can cause a sterile abscess with subsequent muscle fibrosis and atrophy, and treatment with IM or IV benzylpenicillin for 10 days (as specified above) is just as effective. Babies born to mothers fully treated for syphilis (1.8 grams (2.4 megaunits) of benzathine benzylpenicillin at least 4 weeks before birth need no further treatment after birth.
- **Zidovudine** Babies born to mothers taking zidovudine during pregnancy should be given 2 mg/kg once every six hours for 6 weeks after delivery. In babies born more than 6 weeks early this dose should only be given once every 12 hours for the first 2–4 weeks. Advice on breast feeding has to be individualised when the mother has HIV.

SECTION 11 Quiz 4

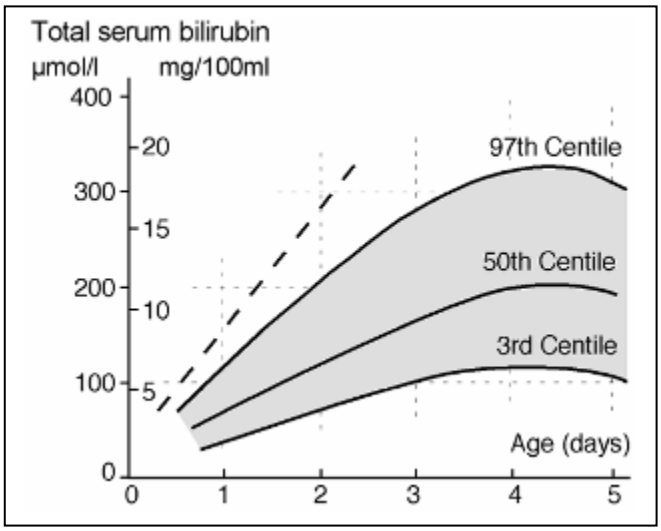
1) **Which of the following are features of sepsis in the first month of life?**
   a) poor feeding
   b) skin capillary refill time less than 2 seconds
   c) indrawing of lower chest wall when breathing
   d) respiratory rate 60/minute or more
   e) hypoglycaemia

2) **Management of suspected sepsis in the first month of life includes which of the following procedures?**
   a) lumbar puncture
   b) urine culture
   c) antibiotics only if definite bacteriological evidence of infection

ANSWERS: 1) a,c,d,e 2) a, b

SEVERE JAUNDICE

All babies become progressively more jaundiced for a few days after birth. This is because in utero many of the products liberated when red cells reach the end of their natural life span cross the placenta to reach the maternal liver before birth. These have to be handled by the baby after birth, and it takes the neonatal liver a little time to adjust to this new task. The serum bilirubin level usually peaks at between 100 and 300 µmol/l 3–5 days after birth (Figure), but this peak may be higher than usual if red cells were breaking down faster than usual at the time of birth.



There is in this situation an increasing risk that bilirubin will breach the blood/brain barrier causing critical damage to many cells in the brain's basal nuclei if, in the presence of haemolysis, the unconjugated serum bilirubin level is allowed to rise much above 350 µmol/l. Indeed, in a small preterm baby who is also ill, the safe limit may be nearer to 250 µmol/l).

There is nothing that can usefully be done once that happens. Many of these babies will die after becoming ill and stiff with their heads arched backwards in kernicterus. The survivors will almost all become severely deaf, and the majority will also develop athetoid cerebral palsy.

Regular early and frequent enteral feeding, by increasing bilirubin elimination through the gut, can make such a problem less likely.

Haemolysis

Term babies should seldom need treatment with phototherapy unless there is an unusually high rate of red cell breakdown. However, phototherapy should be started just as soon as jaundice becomes apparent if there is evidence of haemolytic disease. The trend in the bilirubin level should then be checked twice a day (the level can not be judged from skin

colour once phototherapy has been started). The following facts or findings suggest that there could be haemolytic disease –

Most importantly: clinically noticeable jaundice within 24 hours of birth (or any level above the dashed line in figure), especially if the mother is blood group O and the baby is group A or group B, or the mother is rhesus negative and the baby is rhesus positive.

These factors below suggest a risk for haemolysis.

- Red cell antibodies in the mother's blood.
- A positive Coombs or direct anti-globulin test in blood from the umbilical cord.
- A family history of G6PD deficiency or congenital spherocytosis.
- A history that previous children were seriously jaundiced in the first week of life.
- Otherwise unexplained neonatal anaemia at birth (a haemoglobin level <130 g/l or a haematocrit < 40%).

Causes of abnormally raised bilirubin
- Haemolytic disease
- Neonatal sepsis
- Breast milk jaundice
- Hypothyroidism
- Congenital infection
  - Toxoplasmosis
  - Cytomegalovirus
  - Rubella
  - Hepatitis

Causes of Physiological Jaundice in the Neonatal Period
- Increased breakdown of red blood cells in the first few days of life
- Reduced life span of red cells (70 days compared with 120 in the adult)
- Less efficient metabolism of bilirubin by the immature liver

Assessing the degree of jaundice

Some means of estimating the level of jaundice makes it much easier to determine which babies really do and do not need such treatment. Kernicterus, in the absence of overt haemolysis, is excessively uncommon in the **term** baby until the serum bilirubin level exceeds 425 µmol/l.

Jaundice in the newborn baby can be overlooked in babies with dark skin but is easily judged once the skin is blanched free of blood by finger pressure. The face is the first to show signs of jaundice. The trunk only becomes yellow as jaundice deepens. If the skin over the lower

leg looks yellow then the serum bilirubin level is probably approaching 250 µmol/l. If the hands and feet look yellow it is certainly above 200 µmol/l.

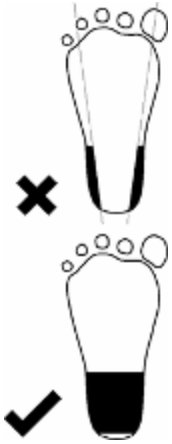
Several electronic devices have been developed for judging skin colour, but none have yet been shown to work significantly better than the simple 'icterometer' devised by Gosset in 1960 (*Lancet*, 1960;**i**:87). Jaundice is judged by pressing the clear plastic of this simple device against the tip of the nose (or against the gums in a dark skinned baby) and then matching the colour of the skin against the icterometer's colour scale. Levels in excess of 350 µmol/l are unlikely to be missed if a blood sample is taken once the icterometer reads 3.5 or more. This inadequately known device, which only costs $20, is still made by Thomas Ingram, PO Box 305, Birmingham, B19 1BB in the UK, and by Cascade Health Care Products of Salem, Oregon in the USA.

Nevertheless high levels can only be monitored by taking a blood sample. Many biochemical techniques for doing this are quite complex and time consuming, and some require quite a large sample of blood. Ward based devices for judging the bilirubin content of a spun microhaematocrit tube optically are accurate until the level exceeds 350 µmol/l, and adequate for most clinical purposes. The machine is only reliable, however, if calibrated daily and regularly serviced. The accurate measurement of values in excess of 350 µmol/l is only possible in a biochemistry laboratory.

Direct or conjugated bilirubin presents no threat to the brain, but conjugated bilirubin only accounts for a small fraction of the total serum bilirubin level in the first week of life (and a fraction that is not easily measured with any precision using most biochemical techniques). Decisions about treatment should be based, therefore, on the total serum bilirubin level, remembering that even laboratory estimates have limited precision – duplicate measurements, even from the same laboratory, can vary by up to 10% (95% confidence limits).

Collecting blood

Only a small amount of blood is needed to check the bilirubin. Although described as a heel prick, sticking a needle into the heel runs a high risk of entering the underlying bone, and can lead to osteomyelitis, so should be avoided.
It is safe to take blood from any part of the back third of the foot.



Try and use a 2.4 mm blood lance, but never use the same lance on more than one baby because of the risk of transmitting hepatitis or HIV infection. It is not necessary or appropriate to try and sterilise the skin first as long as it is clean, and the use of anesthetic cream does nothing to reduce the response of the baby to the pain inflicted. A spring-loaded lance does seem to render the procedure less painful. The baby will also show fewer signs of distress if held, or given something to suck, during the procedure. Grip the heel firmly enough to make it go red, but not white, stab the heel just once, and then squeeze gently and intermittently to stimulate blood flow. The use of a standard lance should optimise blood collection because it helps to ensure that the skin is punctured to a standard depth. A shallower prick is unlikely to reduce the pain inflicted because it will almost certainly prolong the procedure. A double puncture may help if a lot of blood is needed. Slight finger pressure on the site for about a minute is usually enough to stop any further bleeding after the procedure is over.

Phototherapy

In babies who are very yellow, the best preventive measure is to start phototherapy. Use light from a bank of at least six 24-inch 20 watt fluorescent strip lights suspended not more than 30 cm above the unclothed baby. (Lights placed 60 cm from the baby are only about half as effective.) Placing a white sheet under and round the baby will increase the effectiveness of any treatment. Many consider the placing of a thin sheet of perspex or polythene between the lights and the baby a wise safety precaution. Such steps should immediately halt any further rise in the level of jaundice and reduce the level substantially

within 36 hours unless there is very serious haemolysis. If it does not, there is something wrong with the way treatment is being given.

It is important to monitor body temperature and to protect the baby from draught. It is also standard practice to mask the eyes to prevent the retinal damage that might occur were the child to lie looking directly at the light with their eyes open for any length of time.

Feeding, especially breast feeding, should continue without interruption and more frequent breast feeding is helpful by helping to elinimate meconium from the bowel. Extra fluid (eg breast milk substitute, water, sugar water etc) should not be given – it actually makes jaundice worse. Letting the baby come out for feeding will not reduce the effectiveness of treatment once the bilirubin level has started to fall.

Exchange transfusion

Exchange transfusion is generally only undertaken if the rate of red cell breakdown is likely to exceed the ability of phototherapy to control levels of bilirubin. However this is very likely to occur in babies with a positive Coombs test who are already anaemic (because of fetal haemolysis) at birth, and a cord blood haemoglobin of less than 130 g/l serves to identify most of these babies. Here a 500 mg/kg infusion of human immunoglobulin, given IV over two hours, marginally reduces the number requiring an exchange, although it also increases the number needing a 'top up' transfusion for late neonatal anaemia.

Function of exchange transfusion

- Removal of maternal antibodies
- Removal of antibody coated red blood cells before they haemolyse
- Corrects anaemia
- Lowers total bilirubin, if sufficient time for equilibration between intravascular and extravascular levels

Exchange Transfusion

1. Calculate the baby's circulating volume = 85 ml/kg. Twice this amount of blood will be required. Do not exceed this (usually <1 bag of blood = 450ml) Do not use blood > 4 days old
2. Check that the blood is compatible with the mother's serum and the same ABO group as the baby. If the exchange is for severe anaemia, use packed red cells if possible
3. Ensure the baby is closely monitored throughout the procedure
4. This is a sterile procedure, so gloves and gowns must be used and universal precautions applied
5. Secure umbilical vein access
6. Ideally, use a blood warmer (especially for low birth weight infants) otherwise warm by placing under mother's dress next to skin
7. Set up a closed circuit with either a 4-way tap, or two 3-way taps. The four links are
    a. The baby
    b. The syringe for removing and replacing blood
    c. The blood to be transfused
    d. The route for discarding the baby's blood
8. Make sure that the total blood in and out is recorded. Plan to spend 1.5 to 2 hours on the procedure
9. Withdraw 6 mls of blood from the baby and discard it
10. Withdraw 6 mls of blood from the blood bag or bottle and transfuse into the baby

Steps 9 and 10 should in total take about 3 minutes to avoid abrupt changes in BP

11. Repeat steps 9 and 10 until the correct volume of blood has been exchanged.
12. Symptomatic hypocalcaemia may occur as the citrate in donor blood binds calcium. This responds best to halting the procedure for 15 minutes. Giving calcium gluconate is of little benefit and may be hazardous, so is best avoided.

Exchange transfusion should only be undertaken once all the attendant risks have been considered. Even in experienced hands 1% of babies may suffer a sudden circulatory arrest during or shortly after the procedure. This should respond to prompt intervention using the approach adopted when dealing with circulatory standstill at birth, but the baby needs to be monitored closely, and staff need to be ready for such a possibility if this is not to prove fatal. Air embolism can kill within minutes, and faulty technique can cause sudden hypo- or hypervolaemia, or introduce later sepsis. The use of donor blood more than five days old can cause serious hyperkalaemia and an arrhythmia. Blood straight from the fridge at 4ºC can impose a major cold stress.

Cytomegalovirus (CMV) infection may occur if the blood does not come from a CMV-negative donor. It is also critical to avoid causing hepatitis B or HIV infection. There is, in addition, a definite, but poorly understood, risk that the procedure will trigger serious necrotising enterocolitis. Avoid, if possible, the use of heparinised blood.

Late jaundice

Ten per cent of breast fed babies are still slightly jaundiced a month after birth, but the institution of further tests and investigations seldom reveals anything worthy of treatment if the baby is otherwise well. However it is important to identify biliary atresia promptly because operative intervention is much more likely to be successful if undertaken within eight weeks of birth. Even mild jaundice merits review if the stool becomes grey or putty coloured rather than yellow or green.

All babies with continuing jaundice should be given a prophylactic 1 mg IM injection of vitamin K if it is not clear that they received such an injection at birth to minimise the risk of potentially fatal late vitamin K deficiency bleeding. **Vitamin K** Vitamin K deficiency bleeding ('haemorrhagic disease of the newborn') is rare except in babies getting relatively little breast or artificial milk after birth. Give babies not well enough to be fed, or showing any sign of a bleeding tendency, a single 1 mg 'depot' injection IM. While IV administration is safe it only provides very short term protection from vitamin K deficiency.

Late anaemia

Causes of anaemia at birth
- Haemorrhage
- Twin-to-twin transfusion
- Feto-maternal transfusion
- Placental abruption
- Haemolysis due to
  - Rhesus incompatibility
  - ABO incompatibility

Haemolysis, even if it is not severe enough to require intervention in the first week of life, may continue for some weeks after birth. An attempt should therefore be made to check all babies with a positive Coombs test for late anaemia when they are about six weeks old. Babies with a capillary haemoglobin of less than 80 g/l or a haematocrit of less than 25% should then be given a 20 mg/kg 'top up' transfusion of cross matched, or group O Rh-negative, blood over two hours. Red cell concentrate or Packed cells is preferable.

SECTION 11 Quiz 5

1) Concerning jaundice in the first few days of life in the full term infant which of the following statements are true?

a) it may be normal
b) it can cause severe brain injury if the unconjugated bilirubin rises above 350 mmol/L
c) during phototherapy the eyes should be masked
d) gastric feeding should be continued throughout phototherapy even when the bilirubin level is falling
e) pre-term infants are more likely to need treatment than term infants

ANSWERS: **1) a, b, c, d, e**

FITS, SPASMS AND COMA

Causes of neonatal fits

- Hypoxia
- Hypoglycaemia
- Meningitis
- Drug related seizures
- Sepsis
- Tetanus
- Hypocalcaemia
- Hyper or hypo natraemia
- Metabolic abnormalities
- Developmental disorders
- Benign neonatal seizures

Focus on the limited number of conditions where immediate treatment can have a major impact on long term outcome. There are many situations where seizures are simply the outward sign of damage that can not now be undone even though it may be possible to stop continuing seizure activity from making matters worse.

If the baby is alert and well between episodes of seizure activity, seems normal on examination, and is feeding normally, it may be perfectly appropriate to do nothing.

In **benign neonatal sleep myoclonus,** jerky movements that spare the face only occur when the child is going to (or waking from) sleep. No treatment is required and the problem disappears before the child is a year old.

Benign neonatal seizures, which are sometimes familial, can also be managed without drug treatment, and resolve within a few days or weeks.

Focal seizures can also be the sign of what was otherwise a silent haemorrhagic infarction of part of the brain. While investigation would explain what was going on, it would not alter management.

Well but jittery baby	Baby with clonic seizures
No abnormal eye movements	Abnormal eye movements
No apnoea	Apnoea
No colour changes	Pallor or cyanosis
No heart rate changes	Tachycardia
Easily triggered by handling and stopped by gentle passive flexion of the affected limb	Independent of handling
Rhythmical movements	Jerky with fast and slow components that are not equal

Management of the fitting neonate

- Airway and Breathing
- Circulatory access
- Give glucose IV or NG (2ml/Kg of 10% glucose)
- Give antibiotics IV or IM
- Stop fit with anticonvulsant:
  - Phenobarbitone 20mg/Kg over 5 minutes IV or IM
  - Paraldehyde 0.2ml/Kg IM or 0.4ml/Kg rectally

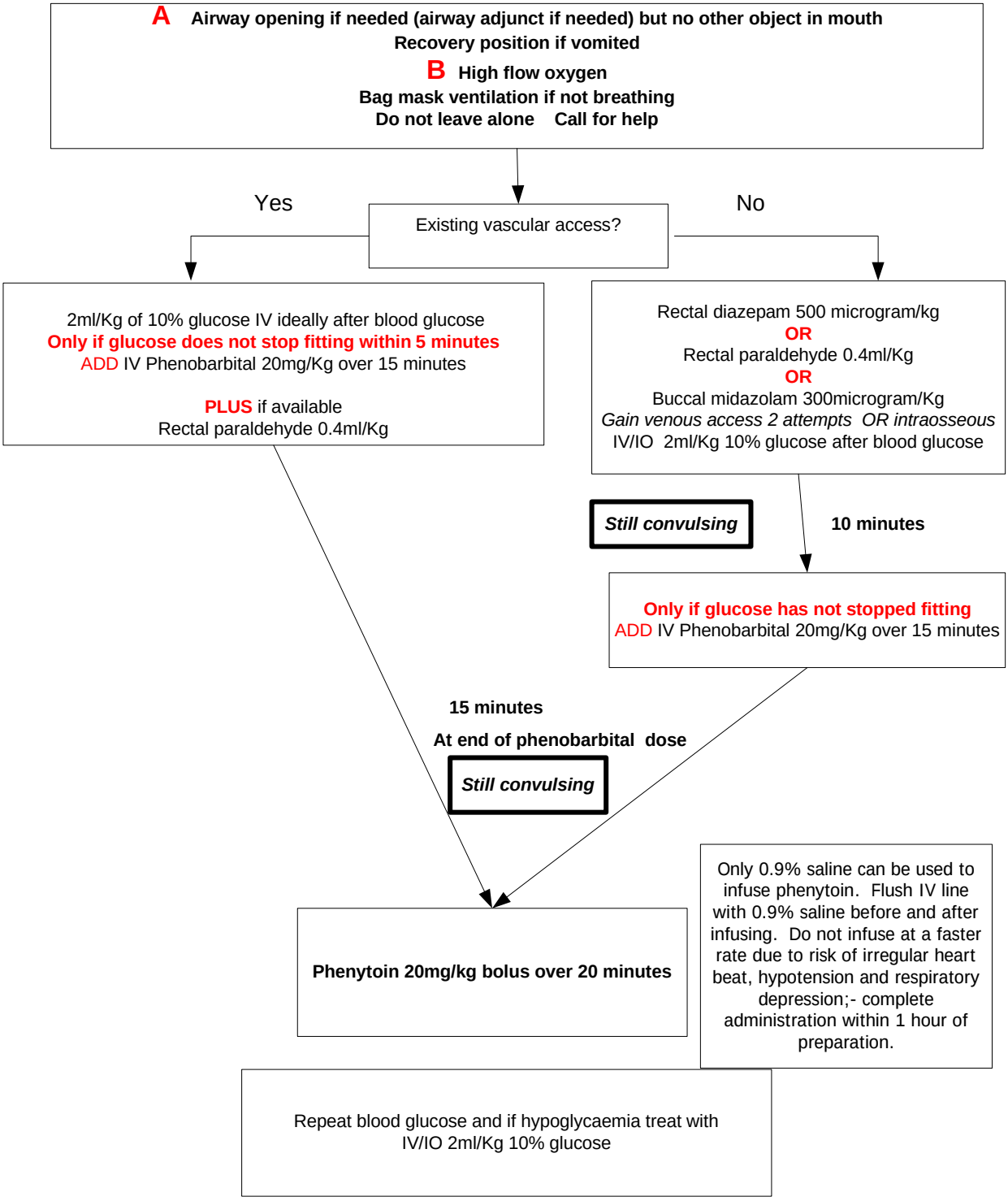
Airway and Breathing

Give high flow **oxygen**

Circulation

Achieve **vascular access** if possible

Pathway of Care Prolonged Fitting [A] in neonates



NOTES

A. Indications: Still fitting when seen (ETAT) OR If already in hospital where onset of fit is seen and generalised convulsion lasting > 10-15 minutes or repeated convulsions without return of consciousness between fits.

B. Hypoglycaemia is blood glucose <2.5 mmol/l (45mg/dl) if well nourished and < 3.0mmol/l (55mg/dl) if severe malnutrition

C. **If blood glucose cannot be measured treat as hypoglycaemia.**

D. If hypoglycaemia has been present give feed (milk or sugar water) orally or NG when conscious. To make an oral or NG sugar solution dissolve 4 level teaspoons of sugar (20 gram) in 200ml of clean water.

E. If IV/IO glucose does stop fitting, repeat blood glucose 30 minutes later.

If there is any concern that the child is not otherwise entirely well it is essential to rule out th**e three main treatable causes of fitting (hypoglycaemia, meningitis and tetanus)** since any delay in diagnosis could be serious.

1. **Hypoglycaemia (less than 2.5 mmol/litre (45mg/dl) Always think of this** Erect an IV line, using sterile precautions and take a sample of blood for blood culture and for biochemical tests (if available). Then give 2 ml/kg of 10% dextrose over 2–3 minutes. If the child almost immediately becomes more alert and active 'on the end of your needle' you have made the diagnosis, even before the laboratory report comes back saying the blood glucose was well below 2.5 mmol/l (45mg/dl). You have also initiated the only treatment necessary.

- If this is what happens it is then important to keep the blood sugar level stable by starting a sustained infusion of 5 ml/kg of 10% dextrose per hour for the next 2-4 days while gradually building up oral feeds.
- Fits due to hypoglycaemia typically start in a previously well child on the second day of life. Although laboratory estimates of blood glucose are ideal for diagnosing and managing this condition reagent strips can be helpful.

2. Meningitis *Always try to recognize this.* Meningitis may occur at any time in the neonatal period and is frequently fatal. Survival depends on rapid treatment and early diagnosis. Since, however, confirmatory diagnosis may take several hours it is appropriate to start treatment just as soon as the diagnosis is suspected. Ampicillin and gentamicin (see the neonatal formulary) is the most frequently used combination where the organism remains uncertain. Benzylpenicillin may be preferable for known group B streptococcal infection. Cefotaxime is the drug of choice for most Gram negative organisms (with ceftazidime for *Pseudomonas* infection). Neither cefotaxime nor ceftazidime should be used on its own if *Listeria* infection is a possibility. It is important to attempt lumbar puncture once the baby has been stabilised, and ideally within 2 hours of initiating antibiotic treatment, because this serves to confirm the diagnosis. Failure to recognise that a baby has meningitis as well as septicaemia can result in inappropriate low dose treatment for too short a time**.** Lumbar puncture is also more likely than blood culture to identify the organism responsible, and to identify it quickly.

3. Tetanus *Do not forget this*. Neonatal tetanus has to be a possibility if a previously well and still conscious baby starts to develop increasingly frequent muscle spasms 3–14 days after birth, especially if there is any doubt about the way the umbilical cord was managed at birth and there is no proof that the mother was ever immunised with tetanus toxoid. Involuntary muscle contractions are typically triggered by quite light touch or sound, and the hands and jaw are often held firmly clenched.

- **Airway** and **Breathing** are frequently compromised. Sometimes a tracheostomy will be required as intubation may trigger very dangerous spasms of the airway.
- Give high dose **benzylpenicillin** 60 mg/kg one dose every 12 hours in the first week of life, every 8 hours in a baby 1–3 weeks old, and every 6 hours in a baby older than that. Oral dosing (with phenoxymethylpenicillin) can sometimes be used to complete a course of treatment.
- Give a 150 unit/kg dose of IM **human tetanus immunoglobulin** (if available), and 0.5 ml of IM tetanus toxoid vaccine into a different limb.
- A 300 - 400mcg/kg dose, can repeat after 10 minutes if required)of **diazepam** IV or, failing that, down a feeding tube, may help to control the spasms. This dose can be doubled if necessary, and further 1 mg/kg doses given every 6 hours as necessary. Repeat treatment can be offered as often as once every six hours as long as the baby is monitored for signs of respiratory depression. Slow and incomplete absorption limits the usefulness of IM administration.
- **Paraldehyde** may occasionally be helpful. Give 0.2 ml/kg *deep* IM. This dose can be repeated once if seizures persist. Give within 10 minutes when using a plastic syringe (because paraldehyde interacts with many plastics). Some clinicians prefer to give a single 0.4 ml/kg dose mixed with an equal volume of mineral oil into the rectum.
- Treat any obvious umbilical infection with an additional broad-spectrum antibiotic.
- Minimise handling and give frequent small tube feeds.
- Oxygen may help if the spasms are causing cyanosis, but in severe cases survival may be dependent on the availability of respiratory support sometimes with tracheostomy to protect the airway.
- Immunising the mother (two 0.5 ml doses a month apart) will prevent a similar tragedy in any future pregnancy.

Treatment of neonatal tetanus

- **Airway and Breathing**
- Benzylpenicillin 60 mg/kg
- Human tetanus immunoglobulin 150units/kg IM
- Tetanus toxoid vaccine 0.5ml IM into **different** limb
- Consider 1mg/kg diazepam IV, NG or PR to control spasms
- Minimise handling
- Frequent small tube feeds
- Oxygen as needed

SECTION 11 Quiz 6

1) To prevent neonatal tetanus which of the following statements are correct?

a) the stump should be cut short
b) the stump should be kept covered for the first 5 days after birth
c) prophylactic antiseptic lotion to the cord is helpful
d) all mothers should be immunised against tetanus before delivery

ANSWERS: 1) a,d

Rule out any other biochemical cause

Remember the biochemical disturbance may not be the main underlying problem. In many babies with evidence of hypoglycaemia or hypocalcaemia, the biochemical disturbance is only one symptom of another more serious illness. Of these by far the most important treatable condition is meningitis. Unless the baby is otherwise entirely well it is important not to miss this possibility.

- Other important diagnostic possibilities include hypocalcaemia, hyponatraemia and hypernatraemia. Other clinical features will help in the recognition of hypo- and hypernatraemia, and a serum sodium level clinches the diagnosis. Any existing problem will be made worse if hypernatraemia is corrected too rapidly.
- Fits due to hypocalcaemia (a serum calcium of < 1.7 mmol/l), with or without hypomagnesaemia, are generally benign and occur unexpectedly in an otherwise well but hyper-reflexic child more than 2-3 days old. As with hypoglycaemia

symptoms may settle 'on the end of needle' if the baby is given 2 ml/kg of 10% calcium gluconate as a *slow* IV infusion, but such seizures usually respond perfectly adequately to oral supplementation. They are not a serious cause for concern, but it is appropriate to investigate the mother for an unrecognised endocrine abnormality if facilities allow. DO NOT ALLOW IV CALCIUM TO GO OUTSIDE THE VEIN AS IT WILL CAUSE SEVERE TISSUE DAMAGE.

Kernicterus Babies with brain damage due to jaundice are stiff and stuporose, but seldom have fits. Symptoms usually appear quite abruptly 3-6 days after birth, but by the time they appear it is too late to initiate treatment.

Inborn errors of metabolism Other more complex biochemical disturbances are usually associated with metabolic acidosis and progressively deepening coma in a child who was initially well for 1–2 days after birth. They are generally too complex to treat without substantial biochemical support, but it may be appropriate to take specimens for later diagnostic evaluation because many of these conditions are familial and genetically determined. Pyridoxine deficiency is one of the few rare treatable conditions.

Other problems arising during delivery Once bacterial meningitis has been excluded intrapartum asphyxia or birth trauma will turn out to be the underlying problem in most other babies presenting with fits in the first 2–3 days of life. Most of these babies already look stressed and unwell within a few hours of birth. The onset may be a little more sudden and abrupt in the preterm baby who suffers a sudden intraventricular haemorrhage. These babies usually become progressively more stuporose and unresponsive over time, and there is relatively little that can be done to improve the long term outlook. An attempt should be made to minimise hypoxia, and anticonvulsant treatment is sometimes initiated in the hope that it will reduce the number of apnoeic episodes. Many are too ill to accept even tube feeds and, where this is the case, it may be appropriate to minimise the risk of hypoglyceamia by giving IV glucose. Unfortunately an infusion of more than 3 ml/kg of 10% dextrose per hour may result in water retention if there is renal failure. Where there is any possible suggestion of a generalised bleeding tendency give 1 mg of IM vitamin K (unless this was given at birth) especially if the baby has had relatively little milk since birth. **Vitamin K** Vitamin K deficiency bleeding

('haemorrhagic disease of the newborn') is rare except in babies getting relatively little breast or artificial milk after birth. (see above)

The outlook is fairly bleak for babies who have not recovered and started to feed normally within a week of birth.

Drug related seizures Accidental infiltration of the fetal scalp during the injection of lidocaine into the maternal perineum can cause fits simulating intrapartum asphyxia but, with supportive treatment, there is every prospect of complete recovery. Some babies born to drug-dependent mothers show symptoms of drug withdrawal 1–2 days after delivery and a small minority have seizures. More gradual withdrawal from the drug to which they have been exposed is the only treatment usually necessary.

Developmental disorders It is said that up to 10% of otherwise unexplained neonatal seizures are associated with the existence of some underlying cerebral problem (often cortical dysgenesis). Some of these children will benefit from continuing anticonvulsant treatment.

Anticonvulsant treatment

Treatment with phenobarbital will often control neonatal seizures although it is doubtful whether it often has any major influence on the long term outcome. In one recent study it was effective in 45 % of patients studied.

Adding phenytoin increased the success rate to 60% (but treatment with phenytoin is not always straightforward). In cases where such anticonvulsant treatment is effective it can usually be stopped after 7–10 days.

Paraldehyde can be an extremely effective short term measure. While large IM injections can cause a painful sterile abscess, this is not a problem when the volume does not exceed 1 ml. Also consider the rectal route which can be equally effective.

Phenobarbital Give a 20 mg/kg loading dose followed by 4 mg/kg once every 24 hours. Treatment can be given IV, IM or by mouth. Seizure control may be achieved more

quickly if the first dose is given IV, but this loading dose must be given slowly, over at least 5 minutes, to minimise the risk of shock, hypotension or laryngospasm. Some texts recommend the use of a higher dose if the standard dose fails, but this can cause respiratory depression.

Phenytoin Initial seizure control with this drug requires the presence of a saline filled IV line (because the drug crystalises out in dextrose solutions). The same problem also renders the IM route unavailable. Give a 20 mg/kg loading dose IV slowly over 10-20 minutes (to avoid cardiac arrhythmia) and then 2 mg/kg IV or by mouth once every 8 hours. Babies more than 2-3 weeks old may need a considerably larger maintenance dose.

Paraldehyde Give 0.2 ml/kg by *deep* IM injection. This dose can be repeated once if seizures persist. Give within 10 minutes when using a plastic syringe (because paraldehyde interacts with many plastics). Some clinicians prefer to give a single 0.4 ml/kg dose mixed with an equal volume of mineral oil into the rectum.

SECTION 11 Quiz 7

1) Causes of fits in babies which need treatment include which of the following conditions?

(a) hypoglycaemia reversed by giving 2.5 to 5 ml/kg of 10% glucose
(b) hypocalcaemia which always needs treatment with intravenous calcium
(c) meningitis

ANSWERS: 1) a,b,c

VOMITING AND FEEDING PROBLEMS

- **Ingested liquor / blood -** Babies who have swallowed a lot of liquor, or blood, before birth may retch and appear distressed after birth, particularly if the liquor contained meconium. Such problems almost always settle within a few hours without any intervention
- **Oesophageal atresia** – should always be considered in the baby with excess frothy saliva. Surgery is much more likely to be successful if this can be performed before aspiration pneumonia develops. Pass a large bore catheter as far down the oesophagus as possible. If an x-ray shows that this has stopped at the level of the heart and has not entered the stomach the diagnosis is made. Such a baby needs referral for surgery and steps taken to suck the blind upper oesophageal pouch clear of all accumulating secretions at least once an hour before and during transfer. Site an IV line and ensure the baby does not become hypoglycaemic.
- **Uncoordinated feeding -** Babies born before 36 weeks gestation often have difficulty sucking and swallowing in a coordinated way. Most will initially need some tube feeds. They are not likely to start gaining weight until they are taking at least 120 ml/kg of milk a day, and they need to be fed regularly at least once every 4 hours day and night. Breast milk can be supplemented with formula milk at this time if donor milk is not available, but every effort needs to be made to sustain the mother's lactation. In this circumstance it may help to let the preterm baby to suckle regularly at the breast.
- **Regurgitation** - Hurried feeding may cause regurgitation and, if the cough reflex is poorly developed, this can cause the baby to inhale milk into the lung. This will cause a chemical pneumonitis – which could progress to bacterial pneumonia, and make the baby increasingly oxygen dependent. Newborn babies benefit, therefore, from frequent small feeds every 2-3 hours. Patience is required, and feeds should only be increased gradually over the first 3-5 days of life. Dehydration (and the risk of hypoglycaemia) need to be prevented during this period by giving supplemental 10% dextrose IV so that total fluid intake (taking the IV and the oral intake together) does not fall below 120 ml/kg per day.
- **Respiratory distress –** A small proportion of babies show signs of respiratory distress during the first 2-3 days of life because lung surfactant production is limited.

Such babies should not be offered anything by mouth until these problems settle. Peristaltic activity is also reduced or absent in babies who are shocked, ill or infected, so these too should not be offered anything by mouth. The passage of stool, a renewed interest in sucking, and return of bowel sounds suggests that the paralytic ileus has resolved, and oral feeding can be re-introduced.

- **Feeding tubes** - Orogastric feeding is the best option for babies who have not yet developed a coordinated suck and swallow reflex. Nasogastric tubes are popular and easier to secure in place, but can almost completely block one nostril, significantly increasing the work of breathing. The modern tendency to leave a fine bore NGT in place is not encouraged as it partially obstructs the nostril, makes estimate of the gastric residue difficult and may encourage reflux. Preterm babies nearly always accept the quick passage of a large orogastric feeding tube without showing any sign of distress. In this situation, therefore, it is often better to pass a wide-bore oral tube each time, test for any 'gastric residual', syringe the feed slowly in over about five minutes, and then withdraw the tube again in one steady movement. The tube can then be washed out, left in weak sodium hypochlorite, and reused for the same baby indefinitely. Small frail babies should be handled as little and gently as possible and can be left lying undisturbed in their cots during a tube feed as long as the head end of the cot is elevated 25 cm.
- **Hypoglycaemia (less than 2.5 mmol/litre (45mg/dl)**

If drowsy, unconscious or convulsing, check blood glucose

If glucose <1.1 mmol/l (<20 mg/100 ml), give glucose IV.
If glucose 1.1–2.2 mmol/l (20–40 mg/100 ml), feed immediately and increase feeding frequency.

If you cannot check blood glucose quickly, assume hypoglycaemia and give glucose IV. If you cannot insert an IV drip, give expressed breast milk or glucose through a nasogastric tube. Consider an IO or UVC line if unconscious and may have hypoglycaemia.

- **Change in feeding habit** - A **sudden reluctance** to feed is one of the commonest early signs of bacterial infection. Babies who are becoming drowsy or unconscious also show no interest in feeding.

- **Vomiting –** Persisting **minor reflux** is seldom a problem even if it makes the baby go temporarily apnoeic. Indeed it is much better that the baby should go briefly apnoeic, than that it should inhale what has just refluxed up the oesophagus. This is particularly true if what has come up contains gastric acid (easily tested using blue litmus paper 2-3 times a day). Such reflux in a small baby often responds to smaller more frequent feeds.
- **Serious vomiting**, often associated with abdominal distension, in the first few days of life suggests the existence of a problem requiring referral for surgical review. This is particularly true if the vomit is green or bile stained as this is suggestive of duodenal atresia and requires urgent surgical intervention. If serious vomiting develops in a baby who has passed changing stool, the diagnoses of **volvulus, pyloric stenosis or intussusception** must be a considered, so surgical evaluation is essential.

- **Necrotising enterocolitis** – Preterm or light for dates babies are at increased risk of developing this condition, as are those with underlying cardiac abnormalities. The immature gut is not sufficiently developed to receive enteral feeds or cope with bacterial colonisation.

  Suspect the condition in a baby who had started accepting oral feeds, and then develops an ileus or becomes lethargic and starts passing a bloody stool. The problem is caused by the sudden focal invasion of bacteria into an area of ischaemic gut, and an abdominal x-ray will often show gas accumulating within the gut wall. Treat as for suspected sepsis and, because the gut wall has often been invaded by anaerobic Gram negative organisms, give metronidazole as well. Feeds should be discontinued for at least 5 days. Measure haemoglobin daily and transfuse if it falls below 8g/dl (haematocrit below 24%).

  Immediate mortality is quite high, but many cases resolve without surgical intervention (although a stricture may occasionally develop later in the affected area of gut), and it is usually possible to reintroduce feeds after ~5 days. A baby who is sucking and showing interest in food is usually ready for feeding. Intestinal perforation is generally the main indication for surgical intervention, but the prognosis really depends on

whether there is generalised peritonitis, and on whether some part of the gut has become totally dead and gangrenous.

SECTION 11 Quiz 8

1) Concerning feeding in the newborn which of the following statements are correct?

a) preterm babies (< 36 weeks gestation) are likely to need some tube feeds
b) if tube feeds are needed, the orgogastric route will significantly increase the work of breathing
c) sudden reluctance to feed may be an early sign of sepsis

2) Which of the following statements are true concerning necrotising enterocolitis?

a) It should be suspected if there is sudden intestinal ileus
b) It can be confirmed by abdominal x-ray if gas is seen within the gut wall
c) It has a high mortality
d) It should always be treated surgically

ANSWERS: 1) a, c 2) a,b,c