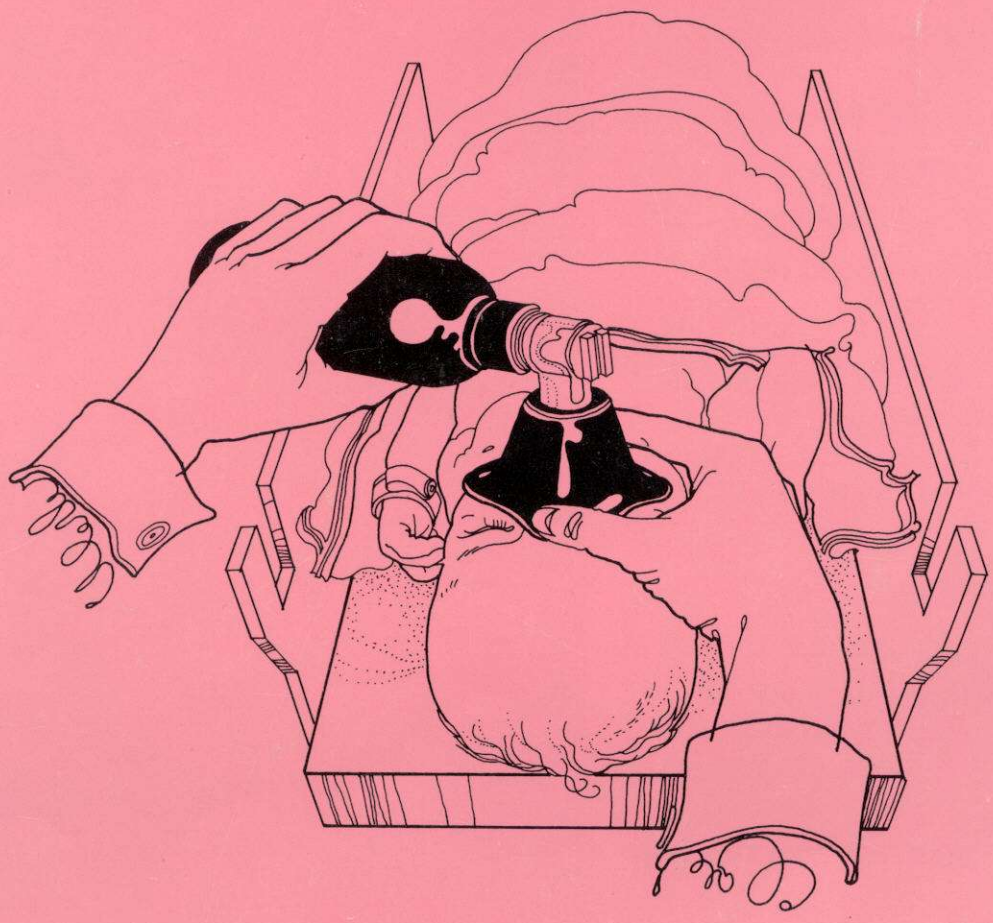
A Guide to Resuscitation of the Newborn Infant

by R W I Cooke MD MRCP



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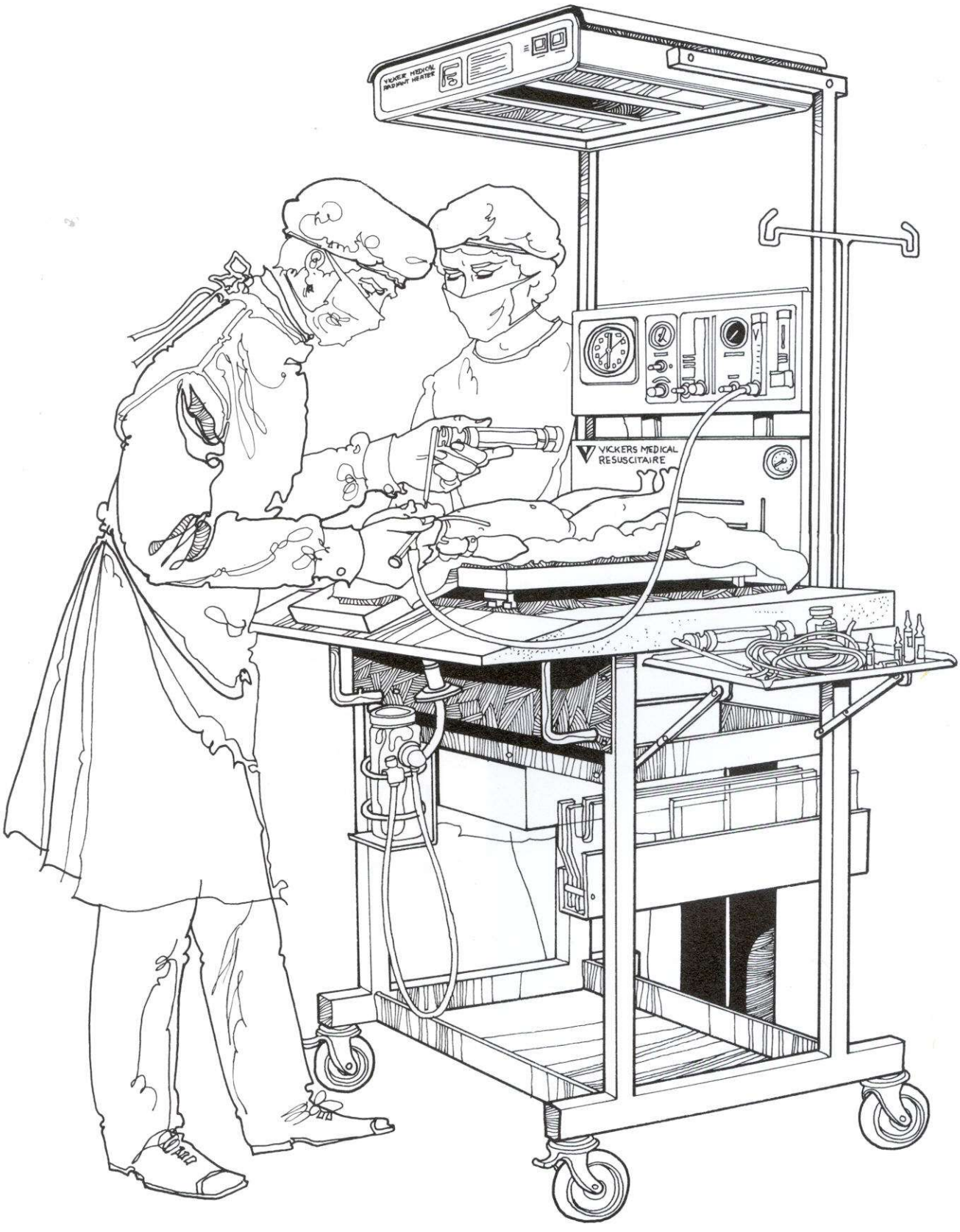
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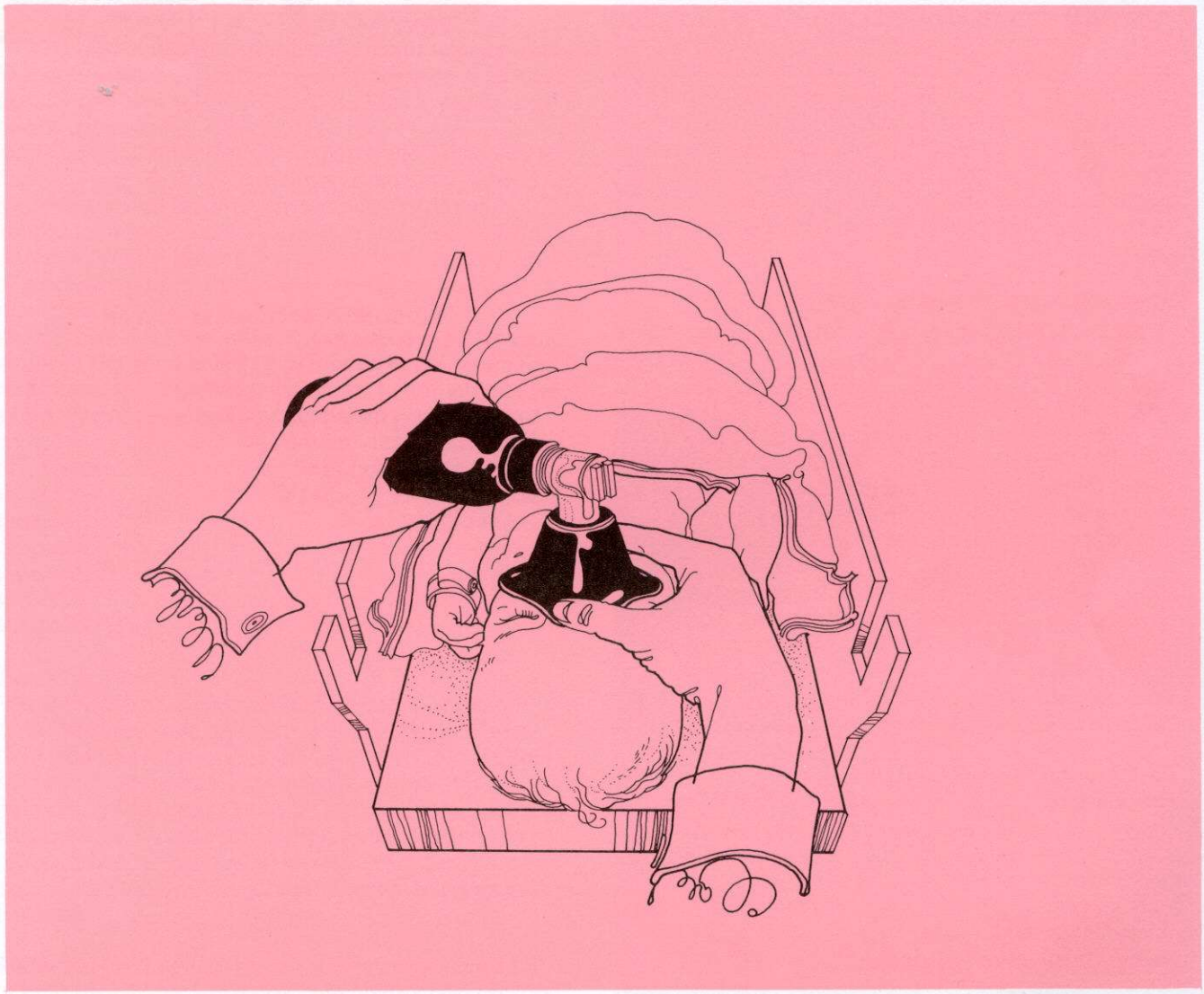


1. Introduction

Most newborn babies breathe and cry within a minute or two of delivery. To help those that do not manage the transition smoothly, many methods of resuscitation have been employed over the centuries, some useful, some bizarre and many useless. Better understanding of the physiology of the fetus and newborn infant has enabled simple, but effective resuscitation techniques to be developed and their value proved. All nurses, doctors and midwives should be able to carry out basic resuscitation of the newborn as birth is not always a predictable affair, and the presence of a neonatal paediatrician can never be guaranteed. This booklet outlines the principles and practical aspects, of newborn resuscitation, together with some of the problems that may be encountered.

2.A. Physiology and development of the respiratory system

The Lung

The lung begins to develop very early in fetal life, at 3–4 weeks. Extensive branching of the original lung buds results in the mature number of divisions to terminal bronchioles by 16 weeks of fetal life. Between 16 and 40 weeks further branching results in a complex series of respiratory bronchioles, and air sacs. True alveoli do not appear until after 40 weeks, and continue to develop until about 7–8 years of age.

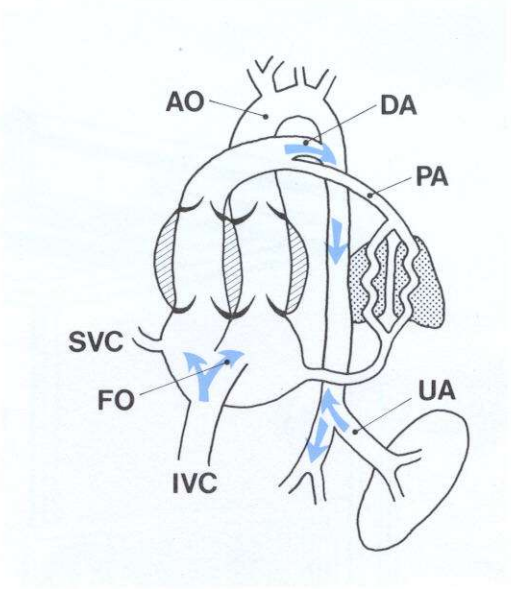
The respiratory surface of the lungs is very large; about 70 square metres in the adult. It is composed of two main cell types; epithelial or Type I cells (95%) and Type II cells, which contain lamellar inclusions of surfactant. Although Type II cells begin to contain surfactant as early as 22 weeks of fetal life, it is not usually released into the lung spaces until 32–34 weeks. The presence of surfactant, a mixture of surface active phospholipids, greatly reduces the surface tension of lung fluid, allowing the lungs to be expanded much more readily during air breathing. A deficiency of surfactant in lung fluid due to immaturity is largely responsible for hyaline membrane disease in preterm infants. Premature release of surfactant can be encouraged by giving cortico-steroids to the mother shortly before delivery.

Lung Fluid

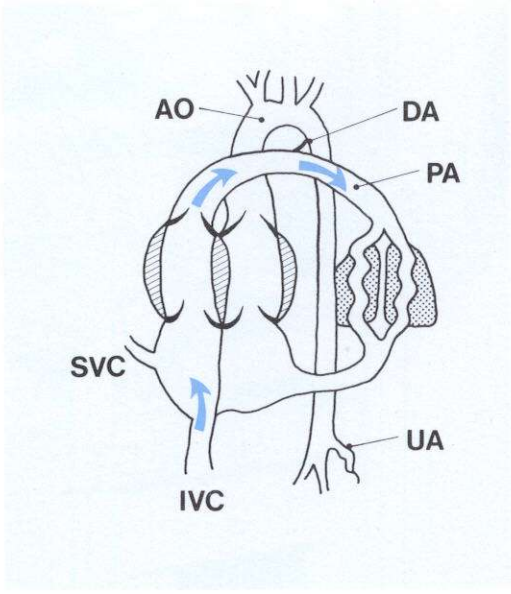
Large amounts of lung fluid are secreted by the fetal lung, and the daily production in mid-gestation is similar in volume to the fetal urine production. The secretion of lung fluid has an important role in stimulating lung growth, but its production rate is greatly reduced at the onset of air breathing at birth. Lung fluid at delivery can be seen streaming from the nose and mouth of the infant as the thorax is compressed after delivery of the head. The rest is coughed up and swallowed, or absorbed by lung lymphatics. Delayed clearance of the lung fluid may result in transient respiratory problems in the newborn.

The Pulmonary Circulation

The pulmonary circulation is separate from that of the foregut at 5 weeks of embryonic life and is derived from the branchial arches. The pulmonary artery and ductus arteriosus are equivalent to the left 6th branchial arch. The adult pattern of the main pulmonary artery branches is established before 19 weeks. The pulmonary arterioles in fetal life are however much more muscular than in early post-natal life, a rapid decrease in wall thickness being seen over the first two weeks after birth. The pulmonary vasculature in fetal life has a high resistance to flow, and only about 7% of total cardiac output passes through the lungs. Blood bypasses the lung via the foramen ovale at atrial level, and via the ductus arteriosus from the main pulmonary artery. The blood pressures in the right heart are equal to or exceed those in the left. Patency of the ductus arteriosus seems to depend on low arterial oxygen tension in the fetus, and possibly high levels of circulating prostaglandins.



Cardiovascular system in the fetus



Cardiovascular system in the newborn infant

AO = *Aorta*
DA = *Ductus arteriosus*
PA = *Pulmonary artery*
SVC = *Superior vena cava*
IVC = *Inferior vena cava*
FO = *Foramen ovale*
UA = *Umbilical arteries*

Fetal Breathing
From about 12 weeks of fetal life the fetus makes breathing movements of the diaphragm and chest wall. The movements are initially irregular, but become more frequent and regular with increasing gestational age. The movements are readily detectable by ultrasound examination, and can be used as an index of fetal well being. As the fetus exists in an environment of low oxygen tension and high carbon dioxide tension, both respiratory stimulants, it is remarkable that even in the mature fetus, the fetal breathing movements are inhibited for much of the time.

During labour fetal breathing movements usually stop. During the last moments of the second stage of labour, circulation in the umbilical cord is reduced or stopped due to compression. This leads to the onset of moderate fetal asphyxia. The physiological response to this is a short period of gasping movements followed by a cessation of breathing movements (primary apnoea). The blood pressure and heart rate rise slightly or remain stable. After a few minutes a second period of gasping commences and blood pressure and heart rate begin to fall rapidly. When these gasping movements cease the infant enters a second or terminal apnoea. The great majority of infants born commence respiration spontaneously within the first minute of life, and have not sustained any significant period of cord compression. Those infants not breathing during the first minute or so may either be in primary or secondary apnoea. Infants in primary apnoea (much the majority) will follow the physiological course detailed above, and commence respiration spontaneously at the end of primary apnoea. Those in secondary or terminal apnoea will usually die if adequate resuscitation is not carried out.

The 'First Breath'
When the infant takes its first few breaths marked cardiovascular changes begin. The clearance of lung fluid from the lungs allows the cross-sectional area of the airways to increase, the oxygen tension in the pulmonary tissues rises, and the carbon dioxide tension falls because of diffusion. The pulmonary arterioles dilate, either by mechanical alterations in the expanding lung or through the effect of changing gas tensions.

Pulmonary blood flow greatly increases causing a fall in pulmonary artery pressure, and a reduction in blood flow through the ductus arteriosus. The increase in pulmonary blood flow causes a rise in left atrial pressure, which tends to close the foramen ovale and reduce the flow of blood from right to left atrium. These changes occur with the onset of ventilation and occur before the cord is clamped.

Clamping of the umbilical cord removes the placenta from the infant's circulation, raising the systemic resistance, the systemic blood pressure and pulse rate. Over the following few hours the ductus arteriosus finally closes, although it may remain patent longer if the baby is hypoxic or preterm.

2.B. Anticipating problems

Some pregnancies are significantly more likely to end with death or damage to the fetus, and are termed "high-risk" pregnancies. Only about 70% of such pregnancies can be predicted before labour begins. In addition to maternal factors which contribute to the increased risk in some pregnancies, many fetal factors in pregnancy or labour can be also identified. Knowledge of such factors can allow the paediatrician, obstetrician or midwife to be prepared to resuscitate the infant at birth. Ideally a trained neonatal paediatrician should be present at any delivery where the pregnancy is of "high-risk" or the fetus has been thought to be compromised.

Maternal and Obstetric factors which indicate a 'high-risk' pregnancy

Maternal age	—	**Less than 16 years or late 30's especially if primiparous.**
Maternal illness	—	**Diabetes mellitus, renal failure, cyanotic or rheumatic heart disease.**
Maternal infection	—	**Fever in labour, amnionitis (prolonged rupture of membranes with discharge, or raised WBC).**
Maternal drugs	—	**Anaesthesia (general), drugs for hypertension and pre-eclampsia, excessive opiate analgesia, alcohol barbiturate or narcotic abuse.**
Obstetric disorders in pregnancy	—	**Moderate to severe rhesus isoimmunisation, hypertension with or without proteinuria, antepartum haemorrhage (placenta praevia or abruption of the placenta), polyhydramnios, or oligohydramnios.**
Obstetric disorders in labour	—	**Abnormal presentation (breech or transverse lie, any non-vertex presentation), prolapse of umbilical cord, operative delivery (Caesarean Section and most forceps deliveries).**

Fetal factors which indicate a 'high-risk' pregnancy

Preterm delivery	—	**Fetus less than 37 weeks gestation.**
Multiple delivery	—	**A minimum of one doctor or midwife per infant should be present.**
Ultrasound evidence of fetal abnormality	—	**Spinal, cardiac, renal tract or gastrointestinal abnormalities.**
Evidence of growth retardation	—	**Ultrasound evidence of slow increase in biparietal diameter or cranial/abdominal circumference ratio, other biochemical indices.**
Fetal distress	—	**Cardiotochogram abnormalities, fetal scalp sampling for pH measurement, fetal bradycardia on auscultation, meconium staining of liquor amnii.**

3.A. Preparing for resuscitation

One member of staff, a labour ward sister, a paediatrician or an anaesthetic technician should be made responsible for the day to day maintenance of the resuscitation equipment available. Ideally all equipment is assembled on a resuscitation trolley with adequate storage space, and a suitable gas supply. Nevertheless, the doctor or midwife responsible for resuscitation should try to be present long enough prior to resuscitation to be able to check that all the equipment is in working order.

Check that:–

1. **The overhead heater and lighting is on.**
2. **Oxygen supply via cylinders or hospital piped supply is adequate.**
3. **The laryngoscope is assembled and working.**
4. **The ventilation circuit (bag and mask or Y-piece for endotracheal tube) is present and assembled.**
5. **Suction (mechanical or by mouth and mucus trap device) is working.**
6. **The supply of endotracheal tubes and face masks is adequate.**
7. **The clock is working.**
8. **That a stethoscope is available.**
9. **That the drugs available, and the syringes and needles to give them, have been replaced after the last resuscitation.**

If you arrive in time for the delivery, **do** introduce yourself to the mother of the infant briefly. If the resuscitation is needed because of fetal distress in late labour, the sight of equipment and staff suddenly arriving in the delivery room can be very frightening. A few words at the right moment can make a big difference. Remember also to speak to the mother during the resuscitation and afterwards when it is very easy to forget the infant's mother in the excitement of the moment.

EQUIPMENT NEEDED FOR RESUSCITATION

1. **Resuscitation trolley with overhead heating and lighting, or table at suitable height with infra-red bulb and lighting overhead. Stop-clock if not on trolley.**
2. **Laryngoscope with preterm and term straight blade, with spare bulbs and batteries.**
3. **Selection of preterm and term face masks with either a proprietary resuscitation bag (Laerdal, Ambu or Penlon) or Jackson-Rees anaesthetic circuit with a rebreathing bag.**
4. **Connecting tube for oxygen supply with side hole, for ventilation via endotracheal tube. (No side hole needed if side arm Cole's tube used).**
5. **Endotracheal tubes. 2 mm to 4 mm if straight, or F8-F14 if Cole type.**
6. **Source of suction, or oral mucus extractors.**
7. **Fine suction catheters size F4-F8.**
8. **Umbilical catheterisation set with F3.5 and F5 catheters.**
9. **Cord ligatures and clamps.**
10. **Sterile syringes and needles 2, 5, 10 ml and 21G and 23G.**
11. **Universal sterile containers, and specimen bottles for haemoglobin blood sugar and electrolytes.**
12. **Emergency drugs tray.**

    Adrenaline 1 in 10,000

    Dextrose 10%

    Sodium bicarbonate solution 4.2 or 8.4%

    Calcium gluconate 10%

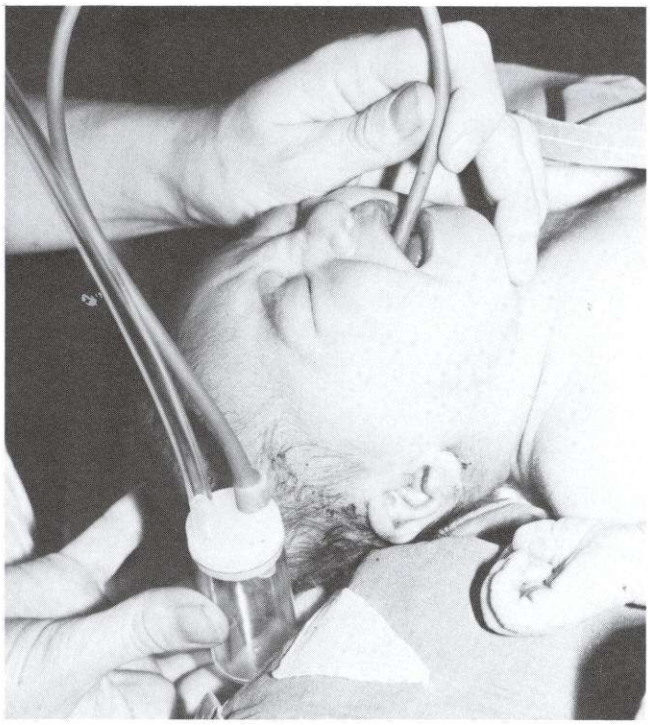
    Isoprenaline 0.2 mgm/ml

    Naloxone

    'Dextrostix' test strips and lancets.

3.B. The First Moves

As soon as the infant is born, an assessment of his condition is needed. While this is being done heat loss must be avoided, and the upper airways cleared.



Brief suction with Macrae catheter to clear pharynx of blood and mucus.

At birth the infant has a body temperature a little higher than his mother. Because he is wet, however, and labour rooms are often cool, a fall in temperature of a degree every minute or two after delivery is possible. This loss of temperature due to evaporation of water must be prevented. The infant is received in a warm dry towel, wiped quickly dry and placed in a second wrap. The nasopharynx is briefly sucked out using a wide bore suction catheter attached to a mucus trap and operated by oral suction or a mechanical sucker on the resuscitation trolley. Neither of these procedures should take more than 10-15 seconds, and the infant is carefully observed during them.

3.C. Assessment of the Situation

Although several methods are available to assess the degree of asphyxia in the newborn infant, the score devised by Dr. Virginia Apgar over 30 years ago remains almost universally in use. Five variables are briefly observed and scored at one minute after birth and indicate the need for help. A repeated scoring at five minutes indicates the response to resuscitation and gives a rough prognostic index. Conventionally, if the score is not optimal by five minutes, the time taken to reach this point is also recorded.

With a little practice, very rapid yet accurate scoring is possible. As the infant is received and dried, the trunk skin colour and the overall muscular tone and limb movements are noted. As the nasopharynx is sucked out, the infant's response, and the presence of respiratory effort is seen. Using an infant stethoscope, the heart rate over 15 seconds is counted, and the score worked out. A score of 4 or less indicates the need for immediate resuscitation; 6 or more and the infant will usually improve spontaneously, although if he is not obviously breathing regularly or crying well, careful observation for a few more minutes is needed.

If the baby is actively resuscitated, observation of his responses should be made as these will give further information about the condition of the infant at birth and his prognosis. Onset of gasping in response to artificial ventilation, before the baby looks pink indicates that he was in primary apnoea and had not undergone a prolonged period of asphyxia. If however, the infant becomes quite pink before showing signs of spontaneous respiration, it is likely that a considerable period of asphyxia has elapsed.

The Apgar Score

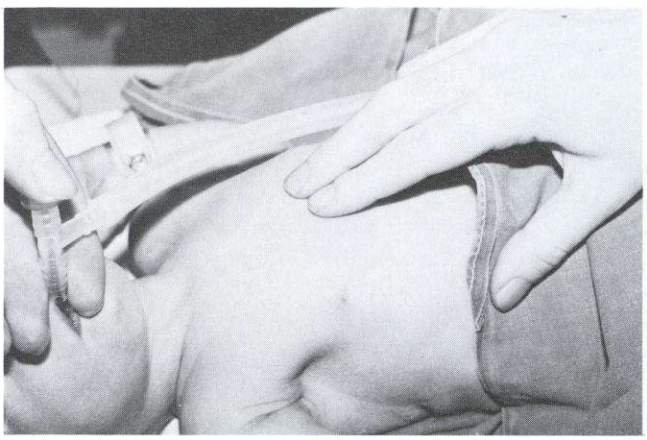
Sign	Score 0	Score 1	Score 2
Heart rate	Absent	Below 100/min	Above 100/min
Respiratory effort	Absent	Weak	Good, crying
Muscle tone	Flaccid	Some flexion of extremities	Well flexed
Reflex irritability	No response	Grimace	Cough or sneeze
Colour	Pale or blue	Body pink, extremities blue	Completely pink

4. Resuscitation

4.A. Cardiac Support

If at the initial quick assessment no apex beat can be heard or felt, external cardiac massage should be started. Place the baby on his back on a firm surface. With the index and middle finger on the lower half of the sternum compress the chest 100-120 times a minute. Aim to depress the sternum by about 2 cm. Do not be too violent especially in preterm infants, as bone fractures, and laceration of the liver may result which will greatly hamper recovery, or result in death of the infant. External cardiac massage is probably effective through compression of the lungs and great vessels as well as the heart, and so the exact position of the fingers is probably not critical.

Ventilation in the absence of an adequate circulation of blood will achieve little, and so external cardiac massage is advisable in all infants when a heart rate slower than 60 per minute is present. When cardiac massage and ventilation are given together two operators are needed. Give 5-6 compressions between each inflation of the lungs.
Good synchronisation is important to avoid injury to the baby.



External cardiac massage showing sternal compression with second and third fingers.

4.B. Ventilation of the Lungs

If the infant has a very low assessment score or is not breathing within 2 minutes of birth, ventilation should be started after the upper airways are cleared. Slapping the buttocks or the soles of the feet achieve nothing in an asphyxiated infant. Blowing oxygen over his face with a funnel is equally useless if he is not breathing.

Mouth to nose ventilation is quite effective but not usually used because of hygenic considerations except in emergency resuscitation. Bag and mask, nasal catheter and endotracheal tube are the methods usually used.

A bag and mask technique is simple to apply but some skill is required, and more than two hands are often needed. A tight fitting face mask is used to cover the infant's nose, and the mouth held closed. An anaesthetic circuit (Jackson Rees or similar) with a rubber bag connected to a gas supply and manometer is used to inflate the lungs. Alternatively a proprietary resuscitation bag (Laerdal, Penlon, Ambu) can be used. The latter is easier to use and is to be recommended for the occasional user. Inflate the lungs 30-40 times a minute. Do not be tempted to puff too quickly, and try to keep the inspiratory time at about 1 second. Immediately check that air entry can be heard over the chest and that the chest is visibly seen to expand. The stomach may blow up rapidly and this can lead to splinting of the diaphragm and poor air entry to the lungs. If this occurs insert an 8F gauge catheter into the stomach and aspirate with a syringe. Keep a hand on the abdomen whilst ventilating if you have one to spare.

The heart rate will begin to increase after about 30-60 seconds of ventilation in most cases. If this does not occur, make sure that an anaesthetist or paediatrician trained in neonatal resuscitation is called, and continue your efforts. Check again that the face mask is fitting well, and that chest movement is visible.

Nasal catheter ventilation is very simple, and has the advantage of needing only one pair of hands. A nasal catheter is passed to 5 cm through one nostril and attached to a gas supply and manometer. The baby's mouth is held closed and the nose pinched 30-40 times a minute. Inflation of the stomach can be a problem as with bag and mask ventilation. The flow rate of gas via the catheter must be carefully controlled.

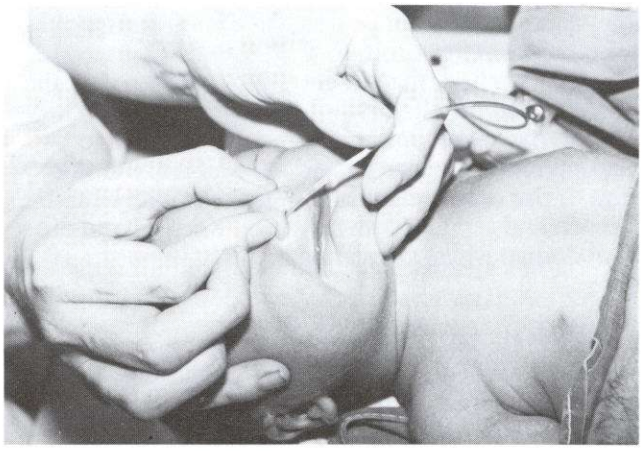
Endotracheal intubation, although requiring some skill, is easily learned. It remains the method of choice as effective ventilation is more certain and can be carried out single handedly. Inflation of the stomach does not usually occur.

The pressure needed to inflate the lungs of a newborn infant varies greatly, but will often decrease after the first few breaths. A starting pressure of 25 cm of water and sometimes higher, is often required, but ventilation can usually be continued at 20 cm thereafter. With a bag and mask the maximum inflation pressure is determined by the opening pressure of the exit valve. If the recommended flow to the device is exceeded, or fast ventilation is used, this pressure will be exceeded, and the risk of pneumothorax is increased.

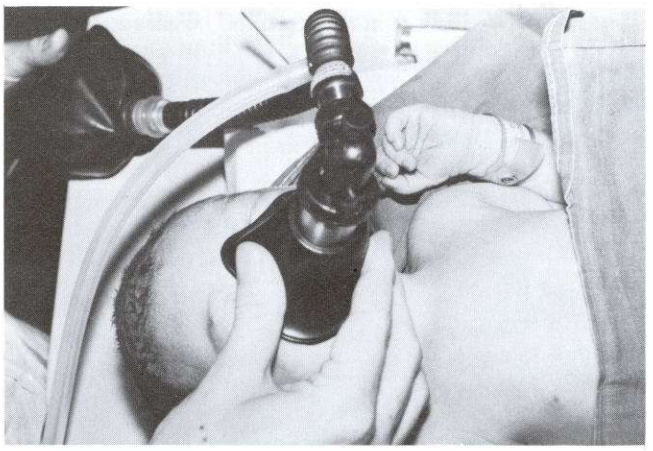
With a manometer system such as is found on a resuscitation trolley, the pressure being given is shown on a dial or water-column. The inertia of such systems means that the displayed pressure may be exceeded at higher rates of ventilation, particularly with a water manometer. Such a system also incorporates a deadweight valve which will 'blow-off' when a pressure of 30 or 40 cm is exceeded. This is a safety precaution to protect the infant from excessive pressures.

Whichever method is used for ventilation, spontaneous respiration by the infant should begin within a few minutes. If the infant is not very asphyxiated, gasping will begin while he is still cyanosed, otherwise he will become pink before beginning to breathe. Continue ventilation but reduce the rate until the baby takes over completely. Observe him for a minute or so to check that respiration is regular before removing the mask, catheter or endotracheal tube.

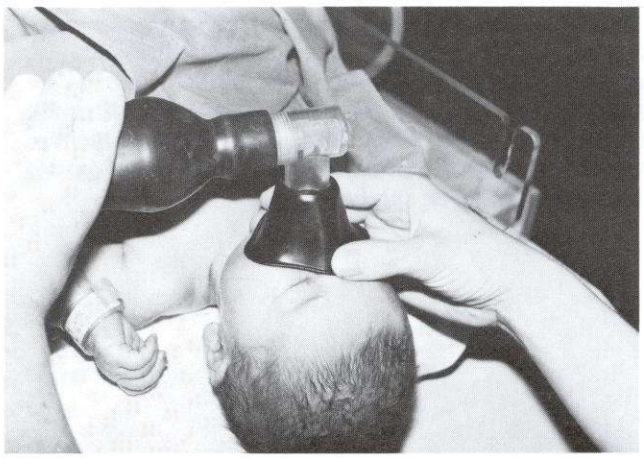
Ventilation of infant at birth using:



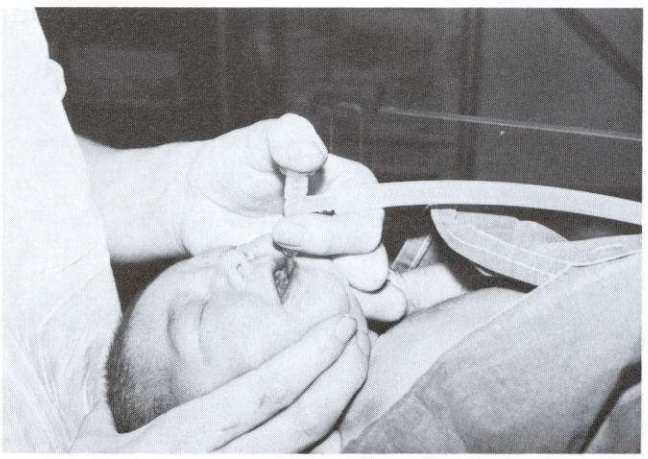
A. Nasal catheter



B. Mask and anaesthetic circuit



C. Bag and mask resuscitator



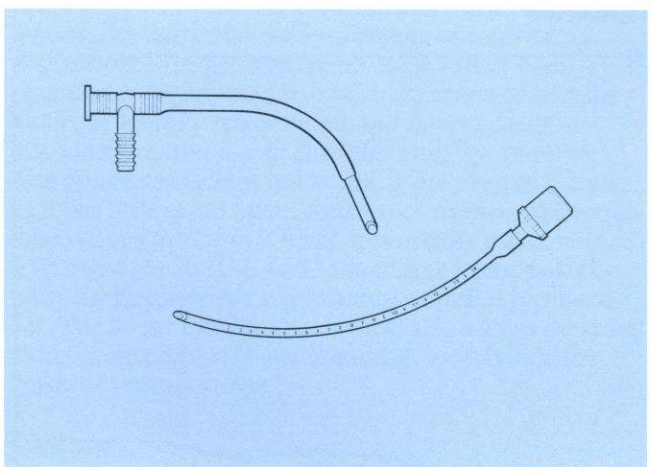
D. Endotracheal tube

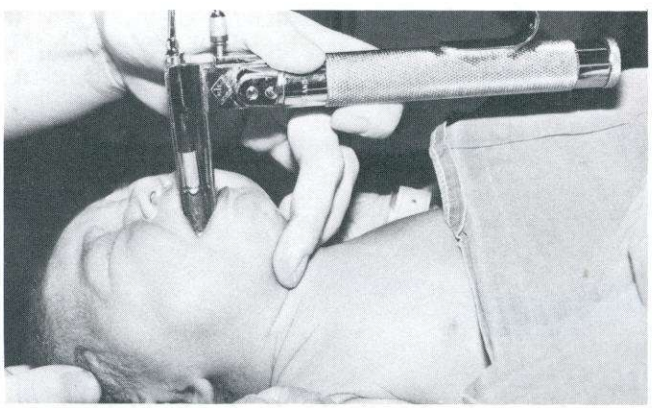
4.C. How to intubate the trachea

The size of tube needed depends upon the infant's weight but an approximate guide is given in the table.

	Cole Type	Straight
Over 2 Kg	12 - 14 FG	3.5 mm
1 - 2 Kg	10 - 12 FG	3 mm
Less than 1 Kg	10 FG	2 - 2.5 mm

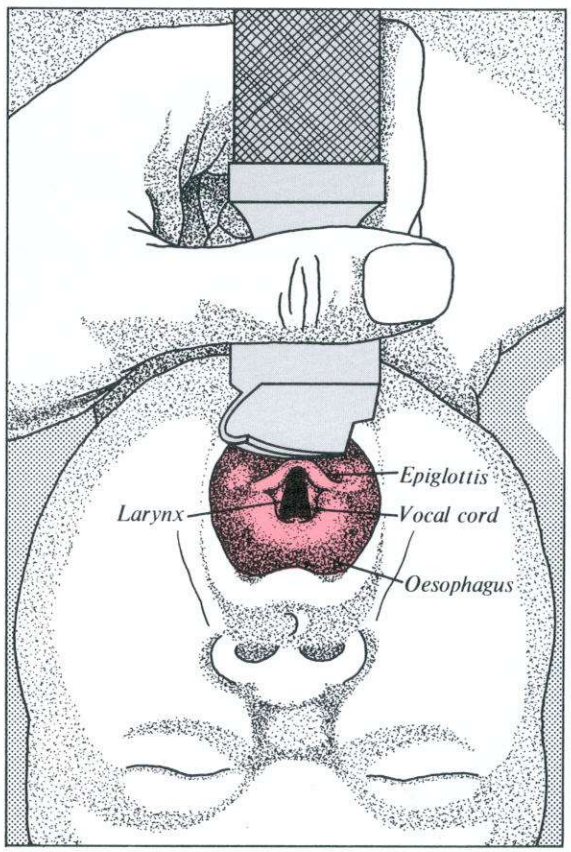
Two sorts of tube are available, the Cole type with a shoulder near the tip, and straight tubes. The Cole tube is easier to insert and can be provided with a side arm for connection to the gas supply so that ventilation can be carried out with the thumb over the end of the tube. Cole tubes are not very satisfactory for long term ventilation, and a straight soft, thin walled tube should be used if it is expected that the baby will need more than a short period of ventilation. With practice they are just as easy to insert. An introducer is rarely if ever required for intubation in the newborn.





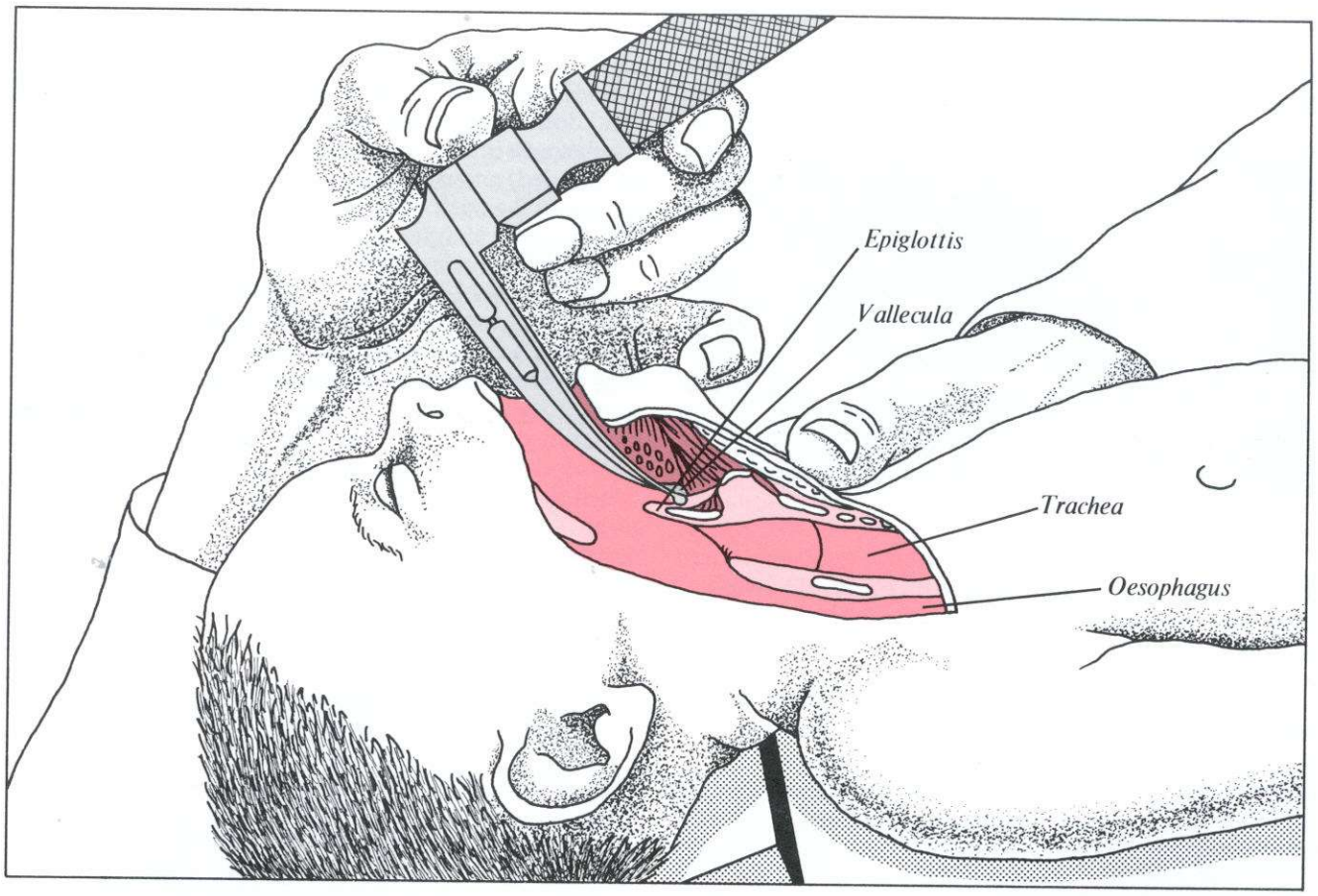
Positioning the baby for intubation, showing slight extension of neck and gentle finger pressure over larynx.

Place the baby on a firm surface with his head towards you. The surface should be level or very slightly tilted head down. Take a neonatal straight bladed laryngscope in the left hand (whether you are right or left handed) and advance the tip of the blade over the tongue to the back of the pharynx. Lift the whole laryngoscope and the opening of the larynx should be visible. Brief suction with a wide-bore catheter may be needed to clear secretions. Gentle pressure on the front of the baby's neck over the larynx may help to bring the opening of the larynx into view. Do not allow the neck to become over extended as it will be difficult to see the larynx. If you cannot see the larynx, the blade of the laryngoscope may be inserted too far, so withdraw it slowly and watch for the appearance of the epiglottis. When the epiglottis and vocal cords are seen, insert an endotracheal tube about 2 cm beyond the cords and remove the laryngoscope. Connect the tube to a gas supply and manometer or a resuscitation bag and ventilate the baby as described.

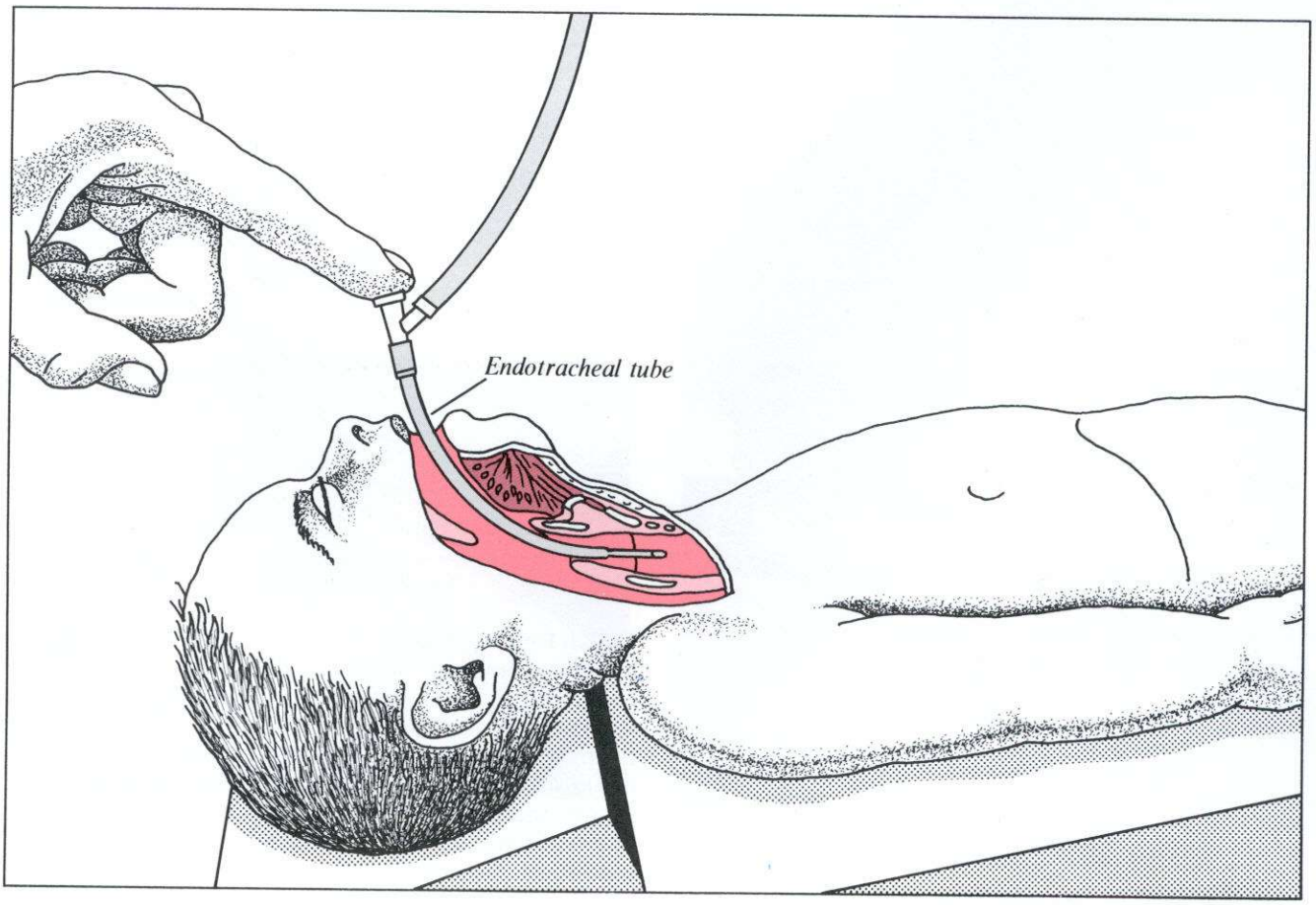


View of the vocal cords

Watch for chest movement and check for sounds of air entry over both sides of the chest. They should be equal. If sounds are not heard well on the left side withdraw the tube a little and listen again. It may be in the right main bronchus. If chest movement is poor or not visible listen over the stomach. Loud sounds suggest that the tube is lying in the oesophagus. If in doubt about the position of the tube, pull it out and reintubate. Do not allow the baby to deteriorate while making several attempts at intubation, but use a bag and mask instead, or between attempts.



Intubation of a neonate, showing the position of the laryngoscope blade



Correct positioning of endotracheal tube

4.D. Drugs

Drugs and Resuscitation
Drugs have only a small part to play in resuscitation of the newborn. The main objective is to achieve adequate circulation and ventilation. No drugs should be needed unless correct ventilation of the lungs and cardiac massage have not improved the baby's condition within 2 - 3 minutes.

Sodium Bicarbonate
When there is evidence of prolonged asphyxia prior to delivery and there is a poor response to resuscitation, 2 mls/Kg 8.4% sodium bicarbonate solution may be given slowly via the umbilical vein to correct acidosis. It is best diluted with water or dextrose 5%, to twice its volume. Blind injection into the umbilical vein should be avoided, as bicarbonate solution is very corrosive if it escapes into tissues around the umbilicus. Introduce a saline filled 5FG catheter aseptically 7 cm into the umbilical vein, and use this as the route for injection.

Calcium and adrenalin
If severe bradycardia or asystole persist despite previous measures, intravenous calcium gluconate 10% (1 ml/Kg) and adrenaline 1/10,000 (0.1 ml/Kg) may improve matters. The umbilical vein should again be used, as a peripheral vein is usually not visible if the infant is badly asphyxiated and the circulation very poor.

Naloxone
If the baby's mother has received pethidine during her labour, the baby may suffer a degree of respiratory depression. This problem tends to be rather over-diagnosed. An affected baby usually starts to breathe alone, or is easily resuscitated, but fails to sustain adequate breathing over the following few minutes. The opiate antagonist naloxone, is the drug of choice, as it has little or no agonist action of its own. Although intravenous injection is ideal, it is usually easier to give 0.05 mgm per Kg IM. and to continue to support the baby's respiration for a few minutes until it begins to act. The larger intramuscular dose also allows the drug to act longer which is an advantage, as it avoids the need for repeat dosage.

Dextrose
Asphyxiated babies often develop hypoglycaemia. Check the blood sugar during and after resuscitation with 'Dextrostix' on a heel prick blood sample. If hypoglycaemia is present give 2 mls/Kg of 10% dextrose solution and follow with a slow infusion of 10% dextrose to avoid rebound hypoglycaemia.

4.E. Special Problems with Resuscitation

1. Meconium Aspiration
Aspiration of meconium and other fluids such as blood and mucus occurs most often in growth retarded asphyxiated babies. Meconium is passed during labour in response to stress and is aspirated by the baby's gasping during delivery. In babies who have passed meconium, examine the mouth and pharynx as soon as the head is delivered. If meconium is present in the pharynx, suck it away with a mucus extractor, and quickly pass a catheter into the trachea under direct vision with a laryngoscope. Apply suction and withdraw the catheter, and repeat once or twice if meconium is obtained. Resuscitate with oxygen and bag and mask or endotracheal tube. It is advisable to aspirate the stomach contents with a wide-bore catheter as they are likely to be regurgitated and inhaled later.

2. The abnormal baby
Some babies are born with major congenital malformations of chromosomal abnormalities (e.g. Down's syndrome, Edward's syndrome) which are either incompatible with life, or are likely to cause a major degree of later handicap. Many of these infants will not require resuscitation to survive, but a proportion will. A decision has to be made on the spot, often by a junior member of staff, as to how to proceed. The initial responses of other staff members and the parents of the child often do not help. If a confident diagnosis of a major abnormality can be made in which the outlook cannot be substantially improved by medical or surgical treatment, there is no obligation to actively intervene. If there is doubt about this, initial management should be active, and further opinion sought. Treatment can be stopped if it is seen later that the initial assessment was too optimistic. If a severely abnormal infant is not treated keep him warm, and transfer him to a suitable cot or incubator. Explain your reasons to the parents at once, and record them in the casenotes.

3. Hydrops fetalis
Infants with hydrops fetalis from whatever cause are gravely ill at birth and almost invariably need active resuscitation. Problems may arise with intubation of the trachea because oedema makes the larynx invisible. Great care should be taken to avoid damaging the friable tissues of the infant's mouth when intubating. If the larynx cannot be seen directly it may be possible to intubate using the index finger as a guide. Locate the epiglottis with the tip of the left index finger and slide the endotracheal tube along the inside of the finger until it can be introduced.

Ventilation of the lungs can be hampered by pleural and peritoneal collections of fluid. If this is suspected aspiration from the chest and abdomen by needle and syringe should be attempted. Care should be taken if cardiac massage is needed as the liver and spleen are enlarged and easily damaged. The use of bicarbonate solution should be avoided if possible, and immediate exchange transfusion is indicated to correct anaemia.

4. The very preterm infant
When is a baby too small to resuscitate? Even with full intensive care support, infants of less than 26 weeks gestation rarely survive. Most infants weighing less than 700 grams at birth also do not survive.

If such a baby is born, and especially if birth injury or severe asphyxia are present, a decision not to attempt resuscitation is often made. The baby should be kept warm and the parents informed. Do not tell the parents that the baby is dead unless you are sure. Allow the mother to hold her baby as she wishes. If he still shows signs of life he should be transferred to the Special Care Baby Unit. Such a transfer does not mean that intensive management must occur, but can allow a careful assessment of the baby's condition to be made, and the weight and gestational age to be checked.

5. Poor response to resuscitation
A slow or inadequate response to resuscitation may be due to shock, acidosis or anatomical problems in the chest.

Shock may follow fetal haemorrhage because of vasa praevia, or loss of blood from fetus to placenta in association with placenta praevia or abruption of the placenta. The baby looks pale with poorly perfused skin, although may become pink readily on ventilation with oxygen. Transfusion with 20 mls/Kg O Negative blood, or plasma will help correct the low intravascular volume.

If metabolic acidosis is suspected as a cause of persisting bradycardia, treatment with sodium bicarbonate may be indicated (q.v.). If possible, get a measurement of venous or arterial pH and pCO_2 before giving the bicarbonate (a cord sample will do). This will help guide further management.

Anatomical abnormalities of the lungs, congenital or acquired, can impair resuscitation. Pneumothorax secondary to resuscitation is not uncommon. Unequal breath sounds, uneven expansion of the chest, or abnormal apex position may suggest the diagnosis. Transillumination of the chest or X-ray will confirm the diagnosis. If these are not available, aspirate the suspected side with a fine needle and syringe.

Diaphragmatic hernia may not be suspected initially, as some infants will respond to resuscitation despite this abnormality. A displaced apex beat, poor spontaneous respiration and uneven air entry to the chest together with a relative emptiness of the abdomen. A chest X-ray is required for confirmation. Ventilate only with an endotracheal tube and aspirate the stomach continuously to avoid bowel distension and increasing respiratory embarrassment. All cases of diaphragmatic hernia have a degree of lung hypoplasia, and a faster rate of ventilation is beneficial. Rapid transfer to a paediatric surgical centre is needed, but the mortality is very high due to the lung abnormality.

Lung hypoplasia, alone or in association with renal agenesis is not uncommon, but can be difficult to diagnose initially. Failure to pass urine in the first 24 hours, and characteristic facial and limb abnormalities indicate renal agenesis.

6. Failure of resuscitation
Even infants who show no signs of life at birth, have a good chance of survival if they respond promptly to resuscitation. If no apex beat is detectable by 15 minutes of resuscitation there is probably little point in proceeding as survival is very unlikely. If an apex beat is heard, but no respiratory effort is made by 20 minutes, transfer on a ventilator to a neonatal intensive care unit is advisable so that further assessment can be made. Intact survival is unlikely.

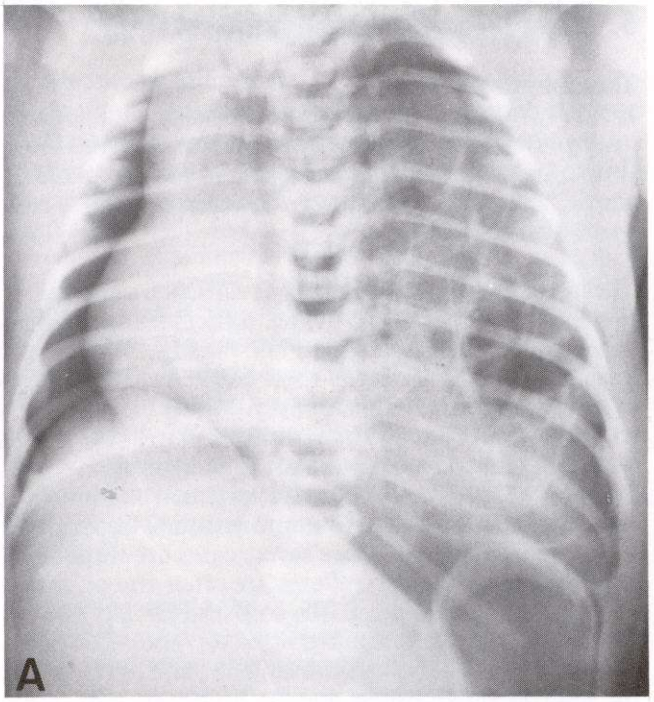
If the baby dies, speak to the parents at once. Keep explanations simple at first, but offer to speak to them again later in order to explain things further. The opportunity should be given to the parents to hold and examine their dead baby despite the reservations the staff may feel. This can be very helpful to the parents' reactions toward the death in the months to come. Inform the family doctor. Contact with the hospital chaplain or local priest can often be helpful, as friends and neighbours will often feel unable to give support in the situation.

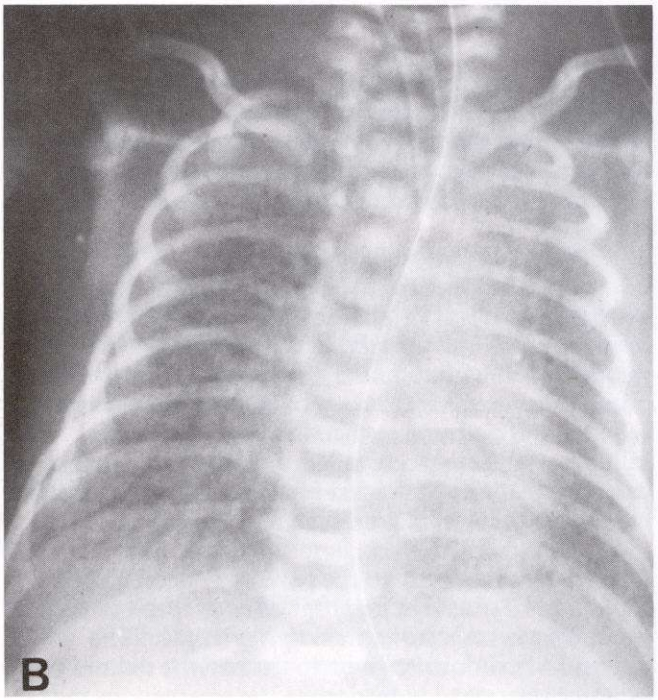
5. Aftercare of the asphyxiated infant

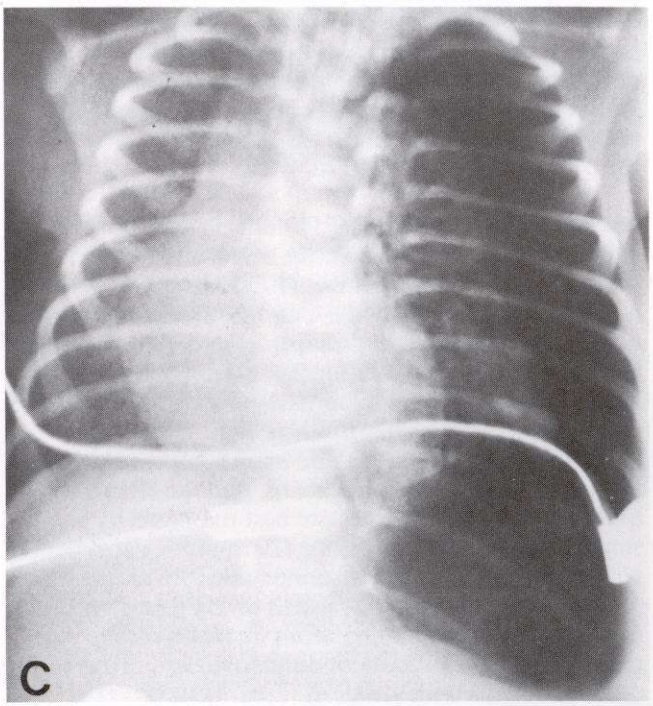
The asphyxiated infant
If a baby responds quickly to resuscitation and appears lusty within a few minutes, he should be observed for a further hour or so before being sent to the post-natal wards. This period need not be in a nursery, and is best spent with his mother.

The infant in whom prolonged or difficult resuscitation is needed is at risk of further difficulties and should be transferred for observation and management to the Special Care Unit. Some of these babies will show signs of post-asphyxial encephalopathy. Milder cases are lethargic at first but become restless and irritable during the first day. They are often tachypnoeic, tachycardic, and have a staring expression and brisk reflexes. Symptoms tend to improve after 24 hours, and the prognosis is good. More severe cases are stuporous and hypotonic. Tendon reflexes are often absent, and convulsions are common. The convulsions may not be very obvious to the untrained observer, and often take the form of abnormal eye movements, and apnoea. If the state of consciousness and the fits improve by 3-5 days, the prognosis is fairly good. Slower progress indicates a greater risk of death or poor outcome in survivors. The severest cases of post asphyxial encephalopathy are more or less comatose from birth with marked hypotonia and convulsions appearing early. Most will die without respiratory support, and the outcome in those who survive is poor.

Management of asphyxiated infants is mainly supportive. Residual metabolic acidosis should be corrected if severe, and careful monitoring for hypoglycaemia carried out. Care should be taken, however, to keep fluid administration to a minimum as these infants retain water markedly for the first 48 hours or more. Severe hyponatraemia can occur, the management of which is fluid restriction and not sodium supplementation. The main symptoms in post-asphyxial infants are convulsions, and the effects of brain swelling. The former are best managed by a single dose of phenobarbitone (20 mgm/Kg IM) which will achieve a rapid and sustained anticonvulsant level for at least 3 days. It is not worth trying to stop more minor convulsions which do not interfere with respiration as large doses of anticonvulsant drugs can cause problems with sedation. Treatment of brain swelling with steroids, phenobarbitone, osmotic agents such as mannitol and hyperventilation all have their advocates. These therapies have been mainly used in different situations in older patients, and no conclusive evidence as to their value in the newborn exists.







Reasons for poor response to resuscitation – chest X-ray appearances:

A. Diaphragmatic hernia

B. Widespread atelectasis (hyaline membrane disease)

C. Pneumothorax

Speaking to parents

Birth asphyxia and the need for resuscitation causes much anxiety for the baby's parents. After the initial fears for survival, they will want to know about the chances of brain damage having occurred, and what their baby will be like in ten years time. If the baby has not had convulsions, and appears normal on neurological examination when going home, it is reasonable to be optimistic. Follow-up until at least 18 months of age on an occasional basis is advisable. When a baby has had convulsions, or is not completely normal neurologically on discharge, the prognosis should be more guarded, but not unduly pessimistic, as most will still do well. Closer follow-up is imperative. Advise all parents of infants who have shown neurological symptoms after birth asphyxia not to have them immunised against Pertussis.

FURTHER READING

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A Vickers Healthcare Company

A Vickers Medical Publication
Pub. No. 735-45-007

Printed in England (7/83)