INVITED ARTICLE

# RESUSCITATION AT BIRTH

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## ABSTRACT

**Birth asphyxia is frequent and often severe, occurring in about 10% and 1% respectively of all births; in a third it is unexpected. Delivery rooms must be organised and equipped and trained staff readily available so as to provide appropriate and timely resuscitation of the newborn. Simple procedures designed to prevent hypothermia, maintain a patent airway, improve oxygenation and ventilation are sufficient for the majority of babies. Circulatory support and biochemical resuscitation will be needed in a few. In the absence of other abnormalities, the long term prognosis for newborns who respond promptly to resuscitation is good. Every baby, no matter how severely asphyxiated must therefore be promptly and vigorously resuscitated. Only those with a Apgar score of < 4 at 10 minutes, prolonged hypotonia or seizures have a poor prognosis.**

**With the needs in cardio-pulmonary resuscitation understood and met, research is now being directed at neuroresuscitation.**


**Keywords:** Infant, Newborn, Resuscitation

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## INTRODUCTION

The transition from the foetal to the neonatal state is a hazardous point in the life of the human being. Though the majority of foetuses accomplish this without any assistance, a significant number need assistance, which, if not provided promptly and appropriately, will result in an increased morbidity and mortality in the neonatal period and more importantly, life-long neurological deficits.

Observations indicate that in general about 10% of babies need assistance at birth (1). In the majority of them the assistance needed is only minimal, but in about 1% major assistance involving ventilatory and circulatory support is needed (2). The incidence of those needing assistance at birth will vary with the nature of the obstetric population and may be much higher in situations where there is poor antenatal and intrapartum care. The neonate who is in need of assistance at birth is usually labelled as being asphyxiated or having asphyxia neonatorum.

Asphyxia literally means without pulse. However, asphyxia neonatorum has come generically to mean hypoxemia with or without hypercapnia in the foetus or newborn infant occurring as a consequence of failed gas exchange across the placenta or lungs for a variety of reasons. Not every baby who needs assistance with transition is however biochemically asphyxiated. The procedures undertaken to accomplish successful transition constitute resuscitation. Advances in obstetric care have enabled the identification of the asphyxiated foetus well before its birth in the majority of pregnancies. A significant number estimated to be about 30% however are still not identifiable until after birth, even in centres with the highest form of antenatal and intrapartum foetal monitoring (3). The unexpected delivery of a limp, pale and apnoeic infant is sufficient to throw even a modern delivery suite into momentary chaos. The occurrence of inadequate resuscitation as a result of lack of preparedness, incompetent personnel or equipment failure, all of which are usually avoidable is unacceptable. The prevention of such occurrences calls for a high degree of discipline, commitment, cooperation, organisation and readiness among the obstetric, anaesthetic and paediatric staff.

## ANTICIPATION

A cornerstone for successful resuscitation is anticipation of the compromised foetus. Anoxia, drug effect, prematurity, anomalies, trauma and infection are the primary conditions leading to a difficult transition and consequent asphyxia. Some of the clinical conditions associated with asphyxia are outlined in Table I.

## PERSONNEL

The presence of any of these conditions categorises the foetus as being at high risk and necessitates the presence at delivery of a person trained in resuscitation. Since a

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**Table I**
**Clinical conditions associated with Asphyxia**

**MOTHER**

addiction, hypertension, diabetes, infection.

**PREGNANCY**

multiple, amniotic fluid volume or colour changes, placenta previa, abruption, prolapsed cord.

**LABOUR**

abnormal presentation, premature or post term, precipitate or prolonged labour, uterine rupture, heavy sedation or anaesthesia, difficult delivery, shoulder dystocia.

**FOETUS**

abnormality in size, multiple anomalies, foetal distress

paediatrician cannot always be available, it is mandatory that the obstetric attendant must be capable of initiating and maintaining the resuscitative procedures. A second person is also necessary to provide assistance. These two persons should have no responsibility other than caring for the baby.

## EQUIPMENT

The following must be available on site: resuscitation table with attached source of light and warmth and stop clock; suction bulbs, pump (50-100cm H20) and catheters (size Fg 4, 6 and 8); oxygen and air supply with reducing valves, flow meter and blender; face masks of different sizes; resuscitation bag with pressure blow off at 30cm H20 and pressure measuring device and connectors for face mask and endotracheal tube; laryngoscopes with Miller blades size 0 and 1; endotracheal tubes, size 2.5-3.5; sterile towel, scissors and cord clamps; antiseptic cleaning solution and alcohol swabs; adhesive tapes precut to appropriate lengths; stethoscope with infant endpiece, intravenous giving sets, umbilical catheterisation set, syringes (2, 5 and 10 ml) and blood specimen containers.

## DRUGS

These are listed in Table II. Non-essential drugs and drugs meant for the mother should not be stored with the drugs used in resuscitation. Sodium bicarbonate and adrenaline are usually supplied in strengths that are higher than that which is required and must therefore be appropriately diluted before use. Likewise there is a neonatal and an adult preparation of Naloxone.

**Table II**
**Drugs used in Resuscitation**

1. 10% glucose for infusion
2. 0.9% sodium chloride
3. 8.4% sodium bicarbonate
4. 10% calcium gluconate
5. Water for injection
6. Naloxone (Narcan) 20 ug/ml
7. Epinephrine 1 in 10,000

## ASSESSMENT

Nowhere in medicine does treatment precede assessment and the delivery room is no exception. Errors in resuscitation often arise from inaccurate or inadequate assessment of the baby's condition. This is best accomplished by the APGAR scoring system (4) (Table III). Immediate and repeated scoring provides a rapid but dependable measurement of physiological status and

**Table III**
**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 |

a guide to selecting resuscitation measures. Most term infants will have scores of 8 or more at and beyond 1 minute. Extremely premature infants though not asphyxiated may have low scores which nevertheless indicate their need for assistance (5). Besides scoring the baby, assessment should also include a rapid estimation of the gestational age (Table IV) and weight, and the recognition of major congenital anomalies and extensive soft tissue injuries of the head. The history of the mother's major medical and obstetric problems should ideally have been ascertained before the baby's birth. All these put together enables the resuscitator to have a proper perspective of the pathophysiological changes that are operating and the manner in which the baby is going to respond to resuscitative measures.

## TREATMENT

The physiology of resuscitation is the pathophysiology of asphyxia. Treatment becomes logical when the physiological events occurring at birth and the pathophysiological changes following the onset of asphyxia are understood.

## NORMAL ADAPTATION

Mild hypoxia, hypercarbia and acidosis, rising blood pressure and cooling of the body are the stimuli that result in the first breath. Subsequent breaths occur resulting in lung expansion and this together with the effect of oxygen on the pulmonary vasculature results in a fall in pulmonary vascular resistance. Blood flow into the lungs increases, oxygenation of blood occurs in the lungs and pulmonary venous return to the left atrium increases. The foramen ovale closes, followed by the ductus arteriosus and the adult circulation becomes established.

## CHANGES IN ASPHYXIA

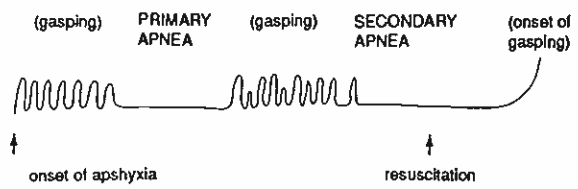
When infants become asphyxiated, they experience a well defined sequence of events which consists of

**Table IV**
**Criteria for rapid Gestational Assessment at delivery**

| | 36 Weeks and Earlier | 37-38 Weeks | 39 Weeks and Beyond |
|---|---|---|---|
| Creases in soles of feet | One or 2 transverse creases; posterior three-fourths of sole smooth | Multipe creases; anterior two-thirds of heel smooth | Entire sole covered with creases, including heel |
| Breast nodule | 2mm | 4mm | 7mm |
| Scalp hair | Fine and woolly; fuzzy | Fine and wooly; fuzzy | Coarse and silky; each hair single-stranded |
| Earlobe | No cartilage | Moderate amount of cartilage | Stiff earlobe with thick cartilage |
| Testes and scrotum | Testes partially descended: scrotum small, with few rugae | ? | Testes fully descended: scrotum normal size with prominent rugae |

predictable changes in the heart rate and breathing patterns (Fig. 1). At the onset of the asphyxial episode, irregular gasping respiration replace regular breaths and the heart rate begins to fall. As the asphyxial process continues, breathing stops and a period called "primary apnoea" begins. With continuation of the asphyxia,

**Fig 1.**
**Effect of birth asphyxia on the respiratory pattern**




respirations which are more erratic and weak resume. Continuation of asphyxia results in the beginning of "secondary apnoea". The infant in secondary apnoea will have a profoundly falling heart rate, leading ultimately to death. During the asphyxial process the infant progressively becomes hypoxic, hypercarbic and acidotic. This results in pulmonary vasoconstriction and diversion of blood flow away from the lungs through the foramen ovale and ductus arteriosus to the systemic circuit where it is most needed, to the head and heart. The foetal circulation therefore persists. At the same time blood flow to the rest of the viscera and skin is reduced. With resuscitation the process described earlier now reverses, beginning at the point to which asphyxia had proceeded (6).

## OBJECTIVE OF RESUSCITATION

This is to prevent neonatal morbidity and mortality by establishing and maintaining ventilation, oxygenation and the circulation and by minimising heat loss.

## RESUSCITATIVE PROCEDURES AS GUIDED BY THE APGAR SCORES

APGAR 8-10. Healthy infant, pink, active, responsive, vigorously crying with a rapid heart rate.

Brief low pressure suction of the mouth and nose.
Wipe dry with a sterile towel.
Place under a radiant warmer.
Reassess at 5 minutes.

APGAR 6-7. Mild asphyxia: slightly cyanotic, moving with decreased tone, breathing shallowly or periodically, with a heart rate >100/min.

Suction, wipe dry and keep warm.
Stimulate by gentle slapping of sole and rubbing of back.
Administer oxygen through a mask held just above the face.
If the baby improves, then continue the oxygen until the baby becomes pink vigorous and then remove the oxygen; reassess to confirm that Apgar scores are maintained. If the baby does not improve then treat as in moderate asphyxia.

APGAR 3-5. Moderate asphyxia: cyanotic, poor tone, weak respiratory efforts and slowing heart rate <100/min.

Suction, wipe dry, keep warm.
Ventilate with 100% oxygen through a mask and using pressure adequate to move the chest; auscultate and ensure that air entry is equal.
If the baby improves, continue ventilation until respirations become regular and heart rate is stable and >100/min. If the baby does not improve, the chest does not move or the air entry is unequal or poor then treat as in severe asphyxia.

APGAR 0-2. Severe asphyxia: deeply cyanotic or pale, limp, apnoeic or gasping and heart rate slow or absent.

Suction, wipe dry and keep warm.
Perform laryngoscopy, aspirate trachea, intubate and ventilate with 100% oxygen at 40-60 breaths/min. using pressures sufficient to move the upper chest wall.
Perform cardiac massage if heart rate is <60/min.
Majority of babies will improve within 1-2 minutes, showing initially a rise in heart rate followed by disappearance of pallor or cyanosis and restoration of tone, respiration and responses.
If the baby does not improve then rule out oesophageal intubation, blocked endotracheal tube, intubation of the right main bronchus, pneumothorax and diaphragmatic hernia.

Obtain vascular acess by catheterising the umbilical vein and correct acidosis by administering sodium bicarbonate in a dose of about 2mmol/kg as a 4.2% solution over 2 minutes. In the absence of improvement, adrenaline 0.1ml/kg of 1:10000 solution and 2ml/kg of 10% calcium gluconate should be given, the latter slowly over 2 minutes. If at least intermittent respiratory efforts are not present within 30 minutes then resuscitative procedures should not be continued.

Intravenous naloxone 10ug/kg should be given to all babies who become pink and are well perfused but fail to breathe if there is a history of recent maternal opiate sedation.

## SPECIAL SITUATIONS

### 1. MECONIUM STAINED LIQUOR

As the risk of aspirating meconium into the trachea and bronchi is high, the nose and mouth must be cleared before the chest is delivered. Laryngoscopy must immediately follow and the trachea aspirated before the baby begins to breathe.

### 2. HAEMORRHAGIC SHOCK

These babies will present with low scores initially and with resuscitation will show pallor, tachycardia poor pulses and slow capillary filling. Transfusion with 20ml/kg of O Rhesus negative blood, plasma or a crystalloid may be immediately needed.

### 3. EXTREMELY PREMATURE INFANT

Though the Apgar scores may not be very low, they are nevertheless unable to maintain adequate respiratory efforts and would therefore need to be intubated even in the absence of bradycardia or apnoea.

### 4. FAILURE OF RESUSCITATIVE EFFORTS

Three groups of conditions may present. The first group comprising oesophageal intubation, bronchial intubation, blocked endotracheal tube, insufficient airway pressure, inappropriate gas, pneumothorax and hypovolemia are all readily diagnosable with a systematic approach and when corrected will result in rapid improvement. The second group with diaphragmatic hernia, bilateral pleural effusion, congenital pneumonia, massive aspiration and pulmonary haemorrhage are sometimes difficult to diagnose and always difficult to resuscitate, but with perseverance could be salvaged. The third group with pulmonary hypoplasia or severe prolonged hypoxia are usually not salvageable.

## TRANSPORT TO THE NURSERY

Transport should commence only after abnormalities in colour, heart rate, ventilation, perfusion and body temperature have been corrected. The resuscitating team must accompany the baby and continue providing assistance during transport. Resuscitation is only the first step in the management of an asphyxiated or otherwise compromised infant. Very often the benefits obtained during resuscitation are lost because of failure to recognise that the infant needs continued assistance in the nursery.

## PRACTICAL POINTS

Prolonged oropharyngeal suction can cause reflex bradycardia, vocal cord spasm and apnoea.

- The neck must not be kept in a hyperextended position during ventilation or intubation.
- For effective ventilation ensure a complete seal between the mask and the face.
- A size 2.5 endotracheal tube need to be used only when the baby is below 1kg.
- Air entry and breath sounds may be deceptively normal during oesophageal intubation.
- Viscid meconium in the trachea may not be completely removed by a catheter passed through the endotracheal tube.
- Bronchial intubation occurs very easily.
- Avoid injecting drugs directly into the umbilical vein as it may not reach the systemic circulation.
- Avoid intracardiac injections.
- Adrenaline may be administered intra tracheally (7).

## OUTCOME

The prognosis in infants requiring resuscitation at birth is determined by the intensity and duration of the asphyxial process and by the presence of other conditions. The Apgar scores at 1 minute have little predictive values. The majority of resuscitated infants have a relatively uneventful neonatal course and can look to a normal neurological development. Those in whom the Apgar score at 5 minutes was < 2 or < 4 after 10 minutes or had seizures or prolonged hypotonia have a high incidence of late sequelae or mortality (Table V).

**Table V**
**Neurological Sequelae in Infants surviving Asphyxia**

| Reference | Definition of asphyxia | Sequelae (%) in survivors | Mortality % |
|---|---|---|---|
| Drage 1966[8] | 0-3 at 1'<br>0-3 at 5' | 3.6<br>7.4 | 23.0<br>50 |
| Scott 1976[9] | apnoeic at 20' | 13 | 52 |
| Thomson 1977[10] | 0-3 at 5' | 7 | 46.7 |
| Nelson 1977[11] | 0-3 at 5' | 4.7 | 15.5 |
| Nelson 1977[12] | 0-3 at 10' | 16.7 | 34 |
| Nelson 1981[13] | 0-3 at 15'<br>0-3 at 20' | 36<br>57.1 | 52.5<br>59 |
| Ergander 1983[14] | 0-3 at 5' | 22 | 21 |

## CONCLUSION

The first few minutes of life are vital to the immediate outcome of a child. The needs then are very basic and can easily be met with simple means. If delivery room staff work towards anticipating problems, develop and practise a coordinated approach towards resuscitation, and implement their efforts in a disciplined and timely manner, a great deal of morbidity and, in some circumstances, mortality may be avoided. There is now intense research in neuroresuscitation and the focus is

on reduction of cerebral metabolism, elimination of potentially hazardous metabolic waste products, maintenance of cerebral blood flow following ischaemia and the prevention of cerebral oedema formation (15-17). Resuscitation at birth is still more an art than a science and blind and rigid adherence to protocols can sometimes be not advantageous to the baby. The dividends of effective and timely efforts are the reduction for further intervention and the assurance of the best long term outlook for the infant.

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