Neonatal resuscitation skills are essential for all health care providers who are involved in the delivery of newborns. The transition from fetus to newborn requires intervention by a skilled individual or team in approximately 10% of all deliveries. Birth asphyxia is a serious clinical problem worldwide. The World Health Organization has defined birth asphyxia as “failure to initiate and sustain breathing at birth” and with an Apgar score of <7 at one minute of life. Anticipation, adequate preparation, accurate evaluation and prompt initiation of support are critical for a successful neonatal resuscitation. The ABCs (airway, breathing, circulation) that apply to older children and adults also apply to the neonate. If adequate respirations are not established despite drying, suctioning, and stimulation, additional resuscitative measures should be performed immediately. In fact, if there is any evidence of perinatal depression, vigorous resuscitation should be initiated earlier to counteract any hypoxemia or acidemia that may be present. Four percent of the newly born population requires bag mask ventilation with supplemental oxygen. The establishment of adequate ventilation must be emphasized because only a very small percentage will need chest compressions and medications.\(^{[25]}\) Indications for positive pressure ventilation administered either via bag and mask or via endotracheal tube include (1) an insufficient respiratory pattern manifested by gasping and/or apnea, (2) a heart rate that remains below 100 beats/min (bpm) for 30 seconds and (3) persistent central cyanosis despite administration of 100% oxygen.\(^{[26]}\)

**KEYWORDS:** Neonatal; Resuscitation.

**INTRODUCTION**

The successful transition from intrauterine to extrauterine life is dependent upon significant physiologic changes that occur at birth. In almost all infants (90 percent), these changes are
successfully completed at delivery without requiring any special assistance. However, about 10 percent of infants will need some intervention, and 1 percent will require extensive resuscitative measures at birth.\[1\]

Although the need for neonatal resuscitation can often be anticipated, on many occasions it is unexpected.

- Most newborns are vigorous at birth\[2\]
- Approximately 10% will require some assistance at birth to begin breathing
- Less than 1% will require extensive resuscitation

**Birth asphyxia** is a serious clinical problem worldwide. The World Health Organization has defined birth asphyxia as “failure to initiate and sustain breathing at birth” and with an Apgar score of <7 at one minute of life.

**FACTS**

- 6-10 out of 130 mill newborns need intervention at birth
- 4 mill birth asphyxia
- 1 mill die and a similar number develop sequels due to birth asphyxia (CP, Epilepsia)
- Most newborn infants are born outside hospitals without health personnel attending

**Pathophysiology**

Ninety percent of asphyxial insults occur in the antepartum or intrapartum periods as a result of placental insufficiency resulting in an inability to provide oxygen and remove carbon dioxide and hydrogen ion from the fetus. The remaining 10% are post-partum usually secondary to pulmonary, cardiovascular or neurologic insufficiency.

**Classification of Asphyxiated Newborn**

- Vigorous crying
- Pale, Apneic and bradycardia.
- Stillborn or macerated;
- Gasping and bradycardia.
- Asystole but potentially revivable
Clinical standards recommended for facilities providing planned birthing services

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Consideration</th>
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<tbody>
<tr>
<td>Resources</td>
<td>• Required at all times:&lt;br&gt; o A suitable place to resuscitate a newborn&lt;br&gt; o Suitable neonatal resuscitation equipment&lt;br&gt; o Clinicians trained in neonatal resuscitation&lt;br&gt; • Organised programs to develop and maintain the standards, skills and teamwork required for newborn resuscitation:&lt;br&gt; o Training requires regular reinforcement in clinical practice and/or refresher courses which should be undertaken at least annually&lt;br&gt; • Debriefing services for clinicians:&lt;br&gt; o Regardless of seniority, resuscitations can be stressful&lt;br&gt; o Reflection on practice provides a valuable learning opportunity</td>
</tr>
<tr>
<td>Clinical skill requirements</td>
<td>• Clinicians trained in:&lt;br&gt; o Basic neonatal resuscitation:&lt;br&gt; Airway support, ventilation via face mask and chest compressions&lt;br&gt; o Advanced neonatal resuscitation:&lt;br&gt; All the skills of basic neonatal resuscitation&lt;br&gt; Endotracheal intubation&lt;br&gt; Vascular cannulation&lt;br&gt; The use of drugs and fluids&lt;br&gt; • Clinicians responsible for neonatal resuscitation should be familiar with available neonatal resuscitation equipment</td>
</tr>
<tr>
<td>Clinician attendance at births</td>
<td>• Low risk births:&lt;br&gt; o A clinician trained in basic neonatal resuscitation should be in attendance and responsible only for the care of the newborn&lt;br&gt; o The Australian Resuscitation Council recommends a clinician trained in advanced neonatal resuscitation should also be available&lt;br&gt; • High risk births:&lt;br&gt; o A clinician trained in advanced neonatal resuscitation should be in attendance and responsible only for the care of the newborn&lt;br&gt; o More than one experienced person should be present to care for the newborn&lt;br&gt; • The Queensland Clinical Services Capability Framework describes the first principle as applying to all services and the second principle as applying to Level 3 services and above.2 Advanced neonatal resuscitation may not be possible in all Level 1 and 2 services</td>
</tr>
<tr>
<td>Documentation</td>
<td>Comprehensive and contemporaneous&lt;br&gt; When possible, one person should be appointed to document, the time, interventions and newborn’s response during resuscitation</td>
</tr>
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Risk factors for neonatal resuscitation

Maternal^{2}\[
• Prolonged rupture of membranes (greater than 18 hours)
• Bleeding in second or third trimester
• Pregnancy induced hypertension
• Chronic hypertension
\]
• Substance abuse
• Drug therapy (e.g. lithium, magnesium, adrenergic blocking agents, narcotics)
• Diabetes mellitus
• Chronic illness (e.g. anaemia, cyanotic congenital heart disease)
• Maternal pyrexia
• Maternal infection
• Chorioamnionitis
• Heavy sedation
• Previous fetal or neonatal death
• No prenatal care

Fetal\textsuperscript{2}
• Multiple gestation (e.g. twins, triplets)
• Preterm gestation (especially less than 35 weeks)
• Post term gestation (greater than 41 weeks)
• Large for dates
• Fetal growth restriction
• Alloimmune haemolytic disease (e.g. anti-D, anti-Kell, especially if fetal anaemia or hydrops fetalis present)
• Polyhydramnios and oligohydramnios
• Reduced fetal movement before onset of labour
• Congenital abnormalities which may effect breathing, cardiovascular function or other aspects of perinatal transition
• Intrauterine infection
• Hydrops fetalis

Intrapartum\textsuperscript{2}
• Non reassuring fetal heart rate patterns on cardiotocograph (CTG)
• Abnormal presentation
• Prolapsed cord
• Prolonged labour (or prolonged second stage of labour)
• Precipitate labour
• Antepartum haemorrhage (e.g. abruption, placenta praevia, vasa praevia)
• Meconium in the amniotic fluid
• Narcotic administration to mother within 4 hours of birth
• Forceps birth
• Vacuum-assisted (ventouse) birth
• Maternal general anaesthesia

SPECIFIC RECOMMENDATIONS[3]
Though neonatal resuscitation shares the foundation concepts of airway, breathing, and circulation with adult and pediatric resuscitation, the neonatal algorithm incorporates other concepts central to the care of the newly born infant (e.g. thermal control), emphasizes the importance of establishing adequate lung expansion and ventilation and dictates key variations in practice resulting from anatomic and developmental differences between neonatal and older pediatric patients. The algorithm for neonatal resuscitation begins with rapid assessment and the initial steps of resuscitation, then continues through positive-pressure ventilation (including intubation), chest compressions, medications, and special considerations.

Figure 2. The algorithm for neonatal resuscitation begins with a rapid assessment of the infant and continues through the initial steps of resuscitation, positive-pressure ventilation, chest compressions and medications. Endotracheal intubation may be considered at several steps during resuscitation.
INITIAL STEPS

The initial steps of resuscitation are to provide warmth by placing the baby under a radiant heat source, positioning the head in a “sniffing” position to open the airway, clearing the airway if necessary with a bulb syringe or suction catheter, drying the baby and stimulating breathing.

Temperature Control

Very low-birth-weight (<1500 g) preterm babies are likely to become hypothermic despite the use of traditional techniques for decreasing heat loss. For this reason additional warming techniques are recommended (eg, prewarming the delivery room to 26°C, covering the baby in plastic wrapping (food or medical grade, heat-resistant plastic), placing the baby on an exothermic mattress and placing the baby under radiant heat). The infant’s temperature must be monitored closely because of the slight, but described risk of hyperthermia when these techniques are used in combination.

Other techniques for maintaining temperature during stabilization of the baby in the delivery room have been used (eg, prewarming the linen, drying and swaddling, placing the baby skin-to-skin with the mother and covering both with a blanket) and are recommended, but they have not been studied specifically (Class IIb, LOE C). All resuscitation procedures, including endotracheal intubation, chest compression, and insertion of intravenous lines, can be performed with these temperature-controlling interventions in place.

Infants born to febrile mothers have been reported to have a higher incidence of perinatal respiratory depression, neonatal seizures, and cerebral palsy and an increased risk of mortality. Animal studies indicate that hyperthermia during or after ischemia is associated with progression of cerebral injury. Lowering the temperature reduces neuronal damage. Hyperthermia should be avoided. The goal is to achieve normothermia and avoid iatrogenic hyperthermia.

Clearing the Airway

When Amniotic Fluid Is Clear

Suctioning in the presence of secretions can decrease respiratory resistance. Therefore it is recommended that suctioning immediately following birth (including suctioning with a bulb syringe) should be reserved for babies who have obvious obstruction to spontaneous breathing or who require positive-pressure ventilation (PPV).
When Meconium is Present
Elective and routine endotracheal intubation and direct suctioning of the trachea were initially recommended for all meconium.\[14\]

Assessment of Oxygen Need and Administration of Oxygen
There is a large body of evidence that blood oxygen levels in uncompromised babies generally do not reach extrauterine values until approximately 10 minutes following birth. Oxyhemoglobin saturation may normally remain in the 70% to 80% range for several minutes following birth, thus resulting in the appearance of cyanosis during that time. Other studies have shown that clinical assessment of skin color is a very poor indicator of oxyhemoglobin saturation during the immediate neonatal period and that lack of cyanosis appears to be a very poor indicator of the state of oxygenation of an uncompromised baby following birth.

Optimal management of oxygen during neonatal resuscitation becomes particularly important because of the evidence that either insufficient or excessive oxygenation can be harmful to the newborn infant. Hypoxia and ischemia are known to result in injury to multiple organs. Conversely there is growing experimental evidence, as well as evidence from studies of babies receiving resuscitation, that adverse outcomes may result from even brief exposure to excessive oxygen during and following resuscitation.

ABC’s of Resuscitation
A B C (A: Airway, B: Breathing, C: Circulation
A - establish open airway Position, suction
B - initiate breathing, Tactile stimulation, Oxygen
C - maintain circulation, Chest compressions, Medications

The Apgar score was proposed as a “simple, common, clear classification or grading of newborn infants” to be used “as a basis for discussion and comparison of the results of obstetric practices, types of maternal pain relief and the effects of resuscitation” (our emphasis). It was not designed to be assembled and ascribed in order to then identify babies in need of resuscitation. However, individual components of the score, namely respiratory rate, heart rate and tone, if assessed rapidly, can identify babies needing resuscitation. Furthermore, repeated assessment particularly of heart rate and to a lesser extent breathing, can indicate whether the baby is responding or whether further efforts are needed.
**Apgar Score:** Taking an Apgar score is not a prerequisite for resuscitation. The need for resuscitation must be recognized before the end of the first minute of life which is when the first Apgar score is taken.

<table>
<thead>
<tr>
<th>Sign</th>
<th>0</th>
<th>1</th>
<th>2</th>
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<tbody>
<tr>
<td>Heart Rate</td>
<td>Absent</td>
<td>&lt;100beats/min</td>
<td>&gt;100beats/min</td>
</tr>
<tr>
<td>Respiration</td>
<td>Absent</td>
<td>Weak cry</td>
<td>Strong cry</td>
</tr>
<tr>
<td>Muscle Tone</td>
<td>Limp</td>
<td>Some flexion</td>
<td>Active motion</td>
</tr>
<tr>
<td>Reflex</td>
<td>No response</td>
<td>Grimace</td>
<td>Active withdrawal</td>
</tr>
<tr>
<td>Color</td>
<td>Blue, pale</td>
<td>Body pink,</td>
<td>Complete pink</td>
</tr>
</tbody>
</table>

**Classification according to initial assessment**

On the basis of the initial assessment, the baby can be placed into one of three groups.

1. **Vigorous breathing or crying**
   **Good tone**
   **Heart rate higher than 100 min$^{-1}$**
   This baby requires no intervention other than drying, wrapping in a warm towel and, where appropriate, handing to the mother. The baby will remain warm through skin-to-skin contact with mother under a cover, and may be put to the breast at this stage.

2. **Breathing inadequately or apnoeic**
   **Normal or reduced tone**
   **Heart rate less than 100 min$^{-1}$**
   Dry and wrap. This baby may improve with mask inflation but if this does not increase the heart rate adequately, may also require chest compressions.

3. **Breathing inadequately or apnoeic**
   **Floppy**
   **Low or undetectable heart rate**
   **Often pale suggesting poor perfusion**
   Dry and wrap. This baby will then require immediate airway control, lung inflation and ventilation. Once this has been successfully accomplished the baby may also need chest compressions and perhaps drugs.
There remains a very rare group of babies who, though breathing adequately and with a good heart rate, remain hypoxaemic. This group includes a range of possible diagnoses such as diaphragmatic hernia, surfactant deficiency, congenital pneumonia, pneumothorax, or cyanotic congenital heart disease.\cite{15}

**Positive-Pressure Ventilation (PPV)\cite{16}**

The most important aspect of newborn resuscitation for ensuring adequate ventilation of the lungs, oxygenation of vital organs, and initiation of spontaneous breathing.

- Ventilation can almost always be initiated using a bag and mask and room air.
- When no equipment is available then mouth to mouth-and-nose breathing should be done

**HOW TO VENTILATE**

Select the appropriate mask

- Reposition the newborn
- Make sure that the neck is slightly extended.
- Place the mask on the newborn's face, so that it covers the chin, mouth and nose.
- Form a seal between the mask and the infant's face. Squeeze the bag with two fingers only or with the whole hand, depending on the size of the bag

After effectively ventilating for about 1 minute, stop briefly but do not remove the mask and bag and look for spontaneous breathing.

- If there is none or it is weak, continue ventilating until spontaneous cry/breathing begins.
- If the newborn starts crying: stop ventilating but do not leave the newborn.
- If breathing is slow (frequency of breathing is <30), or if there is severe chest indrawing: continue ventilating and ask for arrangement for referral if possible. (A newborn will benefit from transfer only if it is properly ventilated and kept warm during transport).

**If there is no gasping or breathing at all after 20 minutes of ventilation then stop ventilation.**

A small proportion of infants fail to respond to ventilation with the bag and mask. This happens infrequently but, when it does, additional actions must be taken.
ENDOTRACHEAL INTUBATION\textsuperscript{[16]}

This has been shown to provide more effective ventilation in severely depressed/ill newborns. It is more convenient for prolonged resuscitation but is also a more complicated procedure that requires good training.

- Baby’s chin , sternum and genitalia are lined up in the single plane.
- Laryoscope and blades are placed in that angle.
- Then intubator can see the anatomical like posterior tongue, epiglottis, larynx and oesophagus.
- Then intubator can make adjustment in position of the blade and can locate the vocal cord.

CHEST COMPRESSION\textsuperscript{[16]}

- Compressions should be administered if the heart rate is absent or remains <60 bpm despite adequate assisted ventilation for 30 seconds.
- In newborns with persistent bradycardia (heart rate <80/min and falling) despite adequate ventilation,
- chest compressions may be life-saving by ensuring adequate circulation.

A higher mean arterial pressure was observed using the method in which the hands encircle the chest compared to the two-finger method of compressing the sternum.

Two people are needed for effective chest compression and ventilation. Before the decision is taken that chest compressions are necessary, the heart rate must be assessed correctly.

The (2-thumb, encircling-hands method) of chest compression is preferred than two –finger method, with a depth of compression one third the anterior-posterior diameter of the chest and sufficient to generate a palpable pulse.
MEDICATIONS

Neonatal resuscitation utilizes a relatively limited assortment of medications in the acute setting. Again, the focus of neonatal resuscitation is ventilation, not reversal of arrhythmias, and effective lung expansion and ventilation obviate the need for medications in most resuscitations. Epinephrine remains the principal medication used in neonatal resuscitation. In contrast to pediatric resuscitation, high-dose intravenous epinephrine has never been recommended for newly born infants. The unique risk of intracranial hemorrhage in preterm infants and evidence for direct myocardial damage from high-dose epinephrine make its use in neonates potentially harmful.\[17,18\] Bicarbonate may also pose special hazards in neonatal resuscitation, as the likelihood of incomplete lung expansion or primary pulmonary pathology preventing adequate ventilation is highest in this age group. Bicarbonate used in the setting of inadequate removal of CO2 can paradoxically worsen acidosis. Volume expansion in the newly born infant may be crucially important to replace acute blood volume loss; in this case rapid replacement and repeated doses may be necessary. However, determining the need for volume expansion in settings of asphyxia, hydrops, or sepsis can be more complicated and volume administration may be limited by myocardial insufficiency. Neonatal resuscitation guidelines continue to recommend an initial dose of 10 mL/kg of volume expander, followed by reassessment of the need for a repeat dose.

The newly revised neonatal resuscitation guidelines suggest isotonic crystalloid as the preferred volume expander. This recommendation rests on evidence that crystalloid is as effective as albumin-containing solutions in the acute treatment of hypotension.\[19\] However, it is also based on the results of a meta-analysis of colloid vs. crystalloid which demonstrated higher mortality associated with the use of albumin-containing solutions across age groups (neonatal, pediatric, and adults) and across indications (hypotension, hypoalbuminemia, burns). Further limitations in terms of cost, availability, and infectious disease risk make albumin solutions less practical, as well.

The umbilical vein is the preferred route for administration of volume expanders and medications during resuscitation of the newly born infant; however, the intratracheal route continues to be an acceptable first line of administration for epinephrine. The newly revised guidelines omit any recommendation of high-dose epinephrine by this route. Instead, the dosage at the higher range of the intravenous dose (0.1 - 0.3 mL/kg of 1:10,000 solution) should be given by the endotracheal route. When umbilical venous access is not available as
the definitive route for epinephrine, bicarbonate, or volume expansion, the intraosseous route may offer an acceptable alternative to venous access."[20]

SPECIAL CONSIDERATIONS

The 2000 Guidelines include a discussion of non-initiation and discontinuation of neonatal resuscitation. The circumstances of these decisions differ dramatically from those encountered in other age groups. Non-initiation of resuscitation may be considered in the setting of confirmed lethal anomalies, such as anencephaly, trisomy 13 or trisomy 18. Resuscitation may be withheld also in the setting of extreme prematurity, with birth weight < 400 grams and gestational age < 23 weeks."[21-22] While these guidelines are not absolute, their purpose is to stimulate dialogue and offer a basis for discussion at the regional, hospital, and individual family level.

Discontinuation of resuscitation may be considered after full resuscitative efforts have not resulted in return of spontaneous circulation within 15 minutes after birth. While resuscitation of "recently" stillborn infants may result in return of spontaneous circulation, there is no agreement regarding the optimal management of infants who continue with prolonged and refractory bradycardia."[23-24] In general, the preferred approach to discontinuation of resuscitation in such cases, or in cases of possibly lethal anomalies, is to defer decisions until ++9/****complete information can be collected regarding the infant's status and prognosis. Decisions to stop support can then be made with adequate information and understanding of the family.

Special considerations also encompass the variety of congenital anomalies which may require an individualized approach to neonatal resuscitation - e.g. immediate intubation of an infant with congenital diaphragmatic hernia and respiratory distress or placement of a nasopharyngeal airway and prone positioning of an infant with Pierre Robin sequence.

Causes of poor response to resuscitation overlap considerably with those encountered in pediatric resuscitation, but others - such as anatomical airway obstruction, complex congenital heart lesions or congenital heart block - may have their initial presentation in the setting of neonatal resuscitation.
Post resuscitation care

Infants (especially preterm) who required resuscitation are at increased risk for all of the general post-resuscitation complications, especially.

- Heat loss
- Develop RDS due to immature lungs
- Intracranial hemorrhage
- Hypoglycemia
- Necrotizing enterocolitis
- Oxygen injury

REFERENCES


