

## **Newborn resuscitation and support of transition of infants at birth Guidelines**

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### **Key points**

- In management of the umbilical cord, clamping after at least 60 seconds is recommended, but if this is not possible cord milking is an option in babies > 28 weeks gestation.
- In non-vigorous infants born through meconium, immediate laryngoscopy with or without suction after delivery is not recommended.
- Laryngeal mask may be considered in infants of  $\geq 34$  weeks gestation ( $> \sim 2000\text{g}$ ) if face mask ventilation or tracheal intubation is unsuccessful.
- If there is no response to initial inflations despite an open airway, consider increasing the inflation pressure.
- A starting pressure of 25 cm H<sub>2</sub>O is suggested for preterm infants < 32 weeks gestation.
- Initial delivered oxygen concentration depends upon gestation:
  - $\geq 32$  weeks gestation - 21% oxygen

- 28-32 weeks - 21-30% oxygen
- < 28 weeks - 30% oxygen.
- In babies < 32 weeks, delivered oxygen concentration should be titrated to achieve saturations of > 80% at 5 minutes.
- Intraosseous access is an alternative method of emergency vascular access if umbilical access is not possible.
- Both initial and subsequent IV/IO adrenaline doses are 20 micrograms kg<sup>-1</sup> (0.2 mL kg<sup>-1</sup> of 1:10,000 adrenaline (1000 micrograms in 10 mL)), in the absence of a response to CPR give repeat doses every 3-5 minutes.
- Stopping resuscitation should be considered and discussed if there has been no response after 20 minutes and exclusion of reversible problems.

## **Introduction**

Resuscitation Council UK (RCUK) has produced these Newborn Life Support Guidelines, based on the International Liaison Committee on Resuscitation (ILCOR) 2020 Consensus on Science and Treatment Recommendations (CoSTR) for Neonatal Life Support. [NLS CoSTR's 2019 and 2020], and the European Resuscitation Council Guidelines for Newborn resuscitation and support of transition of infants at birth. The guidelines cover the management of the term and preterm infant.

RCUK and the ERC have produced guidance on newborn life support in the context of COVID-19. This is based on an ILCOR CoSTR and systematic review. Our understanding of the risks to infants potentially exposed to COVID-19 and the risk of virus transmission and infection to those providing care is evolving. Please [check the RCUK website](#) for the latest guidance for treatment and resuscitator precautions.

The process used to produce the Resuscitation Council UK Guidelines 2021 is accredited by the National Institute for Health and Care Excellence (NICE). The guidelines process includes:

- Systematic reviews with grading of the certainty of evidence and strength of recommendations. This led to the International Liaison Committee on Resuscitation (ILCOR) Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science with Treatment Recommendations.
- The involvement of stakeholders from around the world including members of the public and cardiac arrest survivors.

- Details of the guidelines development process can be found in the Resuscitation Council UK [Guidelines Development Process Manual](#).

## **Factors before delivery**

### **Transition and the need for assistance after birth**

- Most infants adapt well to extra-uterine life but some require help with stabilisation, or resuscitation. Up to 85% breathe spontaneously without intervention; a further 10% respond after drying, stimulation and airway opening manoeuvres; approximately 5% receive positive pressure ventilation. Intubation rates vary between 0.4 and 2%. Fewer than 0.3% of infants receive chest compressions and only 0.05% receive adrenaline.

### **Risk factors**

- A number of risk factors have been identified as increasing the likelihood of requiring help with stabilisation, or resuscitation (Figure 1).

Figure 1: Common factors associated with an increased risk of a need for stabilisation, or resuscitation at birth

Ante-partum factors	Intrapartum factors
<p><b>Fetal</b></p> <ul style="list-style-type: none"> <li>• Intrauterine growth restriction</li> <li>• &lt; 37 weeks gestation</li> <li>• Multiple pregnancy</li> <li>• Serious congenital abnormality</li> <li>• Oligo or polyhydramnios</li> </ul> <p><b>Maternal</b></p> <ul style="list-style-type: none"> <li>• Infection</li> <li>• Gestational diabetes</li> <li>• Pregnancy-induced hypertension</li> <li>• Pre-eclampsia</li> <li>• High BMI</li> <li>• Short stature</li> <li>• Preterm lack of antenatal steroids</li> </ul>	<ul style="list-style-type: none"> <li>• Evidence of fetal compromise (non-reassuring CTG, etc.)</li> <li>• Meconium stained amniotic fluid</li> <li>• Delivering vaginally by breech</li> <li>• Forceps or vacuum delivery</li> <li>• Significant bleeding</li> <li>• Caesarean-section before 39 weeks</li> <li>• Emergency Caesarean-section</li> <li>• General anaesthesia</li> </ul>

## Staff attending delivery

- Any infant may develop problems during birth. Local guidelines indicating who should attend deliveries should be developed, based on current understanding of best practice and clinical audit, and taking into account identified risk factors (Figure 1). As a guide:
  - Personnel competent in newborn life support should be available for every delivery.
  - If intervention is required, there should be personnel available whose sole responsibility is to care for the infant.
  - A process should be in place for rapidly mobilising a team with sufficient resuscitation skills for any birth.

## Equipment and environment

- All equipment must be regularly checked and ready for use.
- Where possible, the environment and equipment should be prepared in advance of the delivery of the infant. Checklists facilitate these tasks.
- Resuscitation should take place in a warm, well-illuminated, draught-free area with a flat resuscitation surface and a radiant heater (if available).
- Equipment to monitor the condition of the infant and to support ventilation should be immediately available.
- Additional equipment that might be required in case of more prolonged resuscitation should be easily accessible.

## **Planned home deliveries**

- Ideally, two trained professionals should be present at all home deliveries.
- At least one must have received quality assured training in providing mask ventilation and chest compressions to the newborn infant.
- Recommendations as to who should attend a planned home delivery vary but the decision to undergo such a delivery should not compromise the standard of initial assessment, stabilisation or resuscitation at birth.
- Whilst rarely required, there are limitations to the provision of advanced resuscitation at home and this should be made clear to the mother.
- A minimum set of equipment of an appropriate size for the newborn infant should be available, [a suggested equipment list](#) is available.
- Caregivers undertaking home deliveries should have pre-defined plans for difficult situations.
- Unexpected deliveries outside hospital are likely to involve emergency services that should be prepared and trained for such events and carry appropriate equipment.

## **Briefing**

- If there is sufficient time, brief the team (roles, tasks, responsibilities, equipment, plan).
- Checklists are helpful.
- Prepare the family if it is anticipated that resuscitation might be required.

## **Training/education**

## **Recommendations**

- Newborn resuscitation providers must have relevant current knowledge, technical and non-technical skills.
- Structured educational programmes, teaching the knowledge and skills required for newborn resuscitation are required.
- The content and organisation of such training programmes may vary according to the needs of the providers and the organisation of the institutions.
- Programmes should include:
  - newborn life support training carried out by appropriately qualified faculty
  - regular practice and drills
  - simulation including team and leadership training
  - feedback
  - objective, performance focused debriefings and reflection.
- Ideally, training should be repeated at least once per year.

## **Thermal control**

### **Recommendations**

#### **Standards**

- The infant's temperature should be regularly monitored after birth and the admission temperature should be recorded as a prognostic and quality indicator.
- The temperature of newborn infants should be maintained between 36.5 °C and 37.5 °C.
- Hypothermia ( $\leq 36.0$  °C) and hyperthermia ( $> 38.0$  °C) should be avoided. In appropriate circumstances, therapeutic hypothermia may be considered after resuscitation ([see post-resuscitation care](#)).

#### **Environment**

- Protect the infant from draughts. Ensure windows are closed and air-conditioning appropriately programmed.
- Keep the environment in which the infant is looked after (e.g. delivery room or theatre) warm at 23-25 °C.
- For infants  $\leq 28$  weeks gestation the delivery room or theatre temperature should be  $> 25$  °C.

## **Term and near-term infants > 32 weeks gestation**

- Dry the infant immediately after delivery.
- Cover the head and body of the infant with a warm towel.
- If no resuscitation is required place the infant skin-to-skin with mother and cover both with a towel. Monitor to ensure continued normothermia.
- If the infant needs support with transition or when resuscitation is required, place the infant on a warm surface using a preheated radiant warmer.

## **Preterm infants ≤ 32 weeks gestation**

- Completely cover with polyethylene wrapping (apart from face) without drying and use a radiant warmer.
- If umbilical cord clamping is delayed and a radiant warmer is not accessible other measures will be needed to ensure thermal stability while still attached to the placenta.
- Further interventions which may be required include increased room temperature, warm blankets, head cap and thermal mattress.
- Skin-to-skin care is feasible in less mature infants however caution is required in the more preterm or growth restricted infant in order to avoid hypothermia.
- For infants receiving respiratory support, use of warmed humidified respiratory gases should be considered.
- A quality improvement program including the use of checklists and continuous feedback to the team has been shown to significantly reduce hypothermia at admission in very preterm infants.

## **Out of hospital management**

- Infants born unexpectedly outside a normal delivery environment are at higher risk of hypothermia and subsequent poorer outcomes.
- They may benefit from placement in a food grade plastic bag after drying, followed by swaddling.
- Well newborns > 30 weeks gestation may be dried and nursed skin-to-skin to maintain their temperature during transfer as long as mothers are normothermic.
- Infants should be protected from draughts and watched carefully to ensure airway and breathing are not compromised.

## **Management of the umbilical cord after birth**

- The options for managing cord clamping and the rationale should be discussed with parents before birth.
- Where immediate resuscitation or stabilisation is not required, aim to delay clamping the cord for at least 60 seconds. A longer period may be more beneficial.
- Clamping should ideally take place after the lungs are aerated.
- Where adequate thermal care and initial resuscitation interventions can be safely undertaken with the cord intact it may be possible to delay clamping whilst performing these interventions.
- Where delayed cord clamping is not possible consider cord milking in infants > 28 weeks gestation.

## **Initial assessment**

- A rapid initial assessment should usually occur before the umbilical cord is clamped and cut:
  - Observe **tone** (and **colour**).
  - Assess adequacy of **breathing**.
  - Count the **heart rate**.
  - Take appropriate action to keep the baby warm during these initial steps.
  - This rapid assessment serves to establish a baseline, identify the need for support and/or resuscitation and the appropriateness and duration of delaying umbilical cord clamping.
  - Frequent re-assessment of heart rate and breathing will guide whether further interventions are needed.

### **Tactile stimulation**

- Initial handling is an opportunity to stimulate the infant during assessment by:
  - drying the infant
  - gently stimulating the infant as you dry them (e.g. rub the soles of the feet or back). Avoid more aggressive methods of stimulation.

### **Tone and colour**

- A very floppy infant is likely to need respiratory support.



- Colour is a poor means of judging oxygenation as cyanosis can be difficult to recognise.
- Pallor might indicate shock or rarely hypovolaemia – consider blood loss.

## **Breathing**

- Is the infant breathing? - Note the rate, depth and symmetry, work/effort of breathing as:
  - adequate
  - inadequate/abnormal pattern - such as gasping or grunting
  - absent.

## **Heart rate**

- Determine the heart rate with a stethoscope and a saturation monitor +/- ECG (electrocardiogram) for later continuous assessment.
  - Fast ( $\geq 100 \text{ min}^{-1}$ ) – satisfactory
  - Slow ( $60\text{-}100 \text{ min}^{-1}$ ) – intermediate, possible hypoxia
  - Very slow/absent ( $< 60 \text{ min}^{-1}$ ) – critical, hypoxia likely
- If the infant fails to establish spontaneous and effective breathing following assessment and stimulation, and/or the heart rate does not increase, or decreases if initially fast, respiratory support should be started.

## **Classification according to initial assessment**

- On the basis of the initial assessment, the infant can usually be placed into one of three groups as the following examples illustrate.

Transition	Assessment	Actions
<p>Satisfactory transition:</p> <ul style="list-style-type: none"> <li>• Good tone</li> <li>• Vigorous breathing or crying</li> <li>• Heart rate - fast (<math>\geq 100 \text{ min}^{-1}</math>)</li> </ul>	<ul style="list-style-type: none"> <li>• Breathing does not require support</li> <li>• Heart rate is acceptable</li> </ul>	<ul style="list-style-type: none"> <li>• Delay cord clamping for at least 60 seconds</li> <li>• Dry, wrap in warm towel.</li> <li>• Keep with mother or carer and ensure maintenance of temperature.</li> <li>• Consider early skin-to-skin care if stable.</li> </ul>
<p>Incomplete transition:</p> <ul style="list-style-type: none"> <li>• Reduced tone</li> <li>• Breathing inadequately (or apnoeic)</li> <li>• Heart rate - slow (<math>&lt; 100 \text{ min}^{-1}</math>)</li> </ul>	<ul style="list-style-type: none"> <li>• Breathing requires support</li> <li>• Slow heart rate may indicate hypoxia</li> </ul>	<ul style="list-style-type: none"> <li>• Delay cord clamping only if you are able to appropriately support the infant; consider cord milking if <math>&gt; 28</math> weeks.</li> <li>• Dry, stimulate, wrap in a warm towel.</li> <li>• Maintain the airway, - lung inflation and ventilation.</li> <li>• Assess changes in heart rate and breathing.</li> <li>• Apply a saturation probe +/- ECG.</li> <li>• If no improvement in heart rate, continue with ventilation.</li> <li>• Help may be required.</li> </ul>

Transition	Assessment	Actions
<p>Poor / failed transition:</p> <ul style="list-style-type: none"> <li>• Floppy +/- Pale</li> <li>• Breathing inadequately or apnoeic</li> <li>• Heart rate - very slow (<math>&lt;60 \text{ min}^{-1}</math>) or undetectable</li> </ul>	<ul style="list-style-type: none"> <li>• Breathing requires support</li> <li>• Heart rate suggestive of significant hypoxia</li> </ul>	<ul style="list-style-type: none"> <li>• Clamp cord immediately and transfer to the resuscitation platform. Delay cord clamping only if you are able to appropriately support/resuscitate the infant.</li> <li>• Dry, stimulate, wrap in warm towel.</li> <li>• Maintain the airway - lung inflation and ventilation.</li> <li>• Assess changes in heart rate and breathing.</li> <li>• Apply a saturation probe +/- ECG.</li> <li>• Continue newborn life support according to response.</li> <li>• Help is likely to be required.</li> </ul>

### Preterm infants

- Preterm babies should be managed in the same way as term babies with these considerations:
  - Consider alternative/additional methods for thermal care e.g. polyethylene wrap.
  - Apply a saturation probe +/- ECG.
  - Gently support, initially with CPAP, if breathing.

## Newborn life support

- Following initial assessment and intervention continue respiratory support if:

- The infant has not established adequate, regular breathing, or
- The heart rate is  $< 100 \text{ min}^{-1}$ .
- Ensuring an open airway, aerating and ventilating the lungs is usually all that is necessary. Without these, other interventions will be unsuccessful.

## **Airway**

- Commence life support if initial assessment shows that the infant has not established adequate regular normal breathing, or has a heart rate  $< 100 \text{ min}^{-1}$ .
- Establishing and maintaining an open airway is essential.

### **Techniques to help open the airway**

- Place the infant on their back with the head supported in a neutral position.
- In floppy infants, pulling the jaw forwards (jaw lift) can help open and/or maintain the airway and reduce mask leak. When using a face mask, two-person methods of airway support are superior.
- A laryngeal mask is an alternative means of establishing and securing an airway in infants of  $\geq 34$  weeks gestation ( $\sim 2000\text{g}$ ).
- An oropharyngeal airway is an alternative means of establishing and securing an airway, although it can increase airway obstruction in infants  $< 34$  weeks.
- A nasopharyngeal airway may be considered where there is difficulty maintaining an airway and mask support fails to achieve adequate aeration.

### **Airway obstruction**

- Airway obstruction can be due to inappropriate positioning, decreased airway tone and/or laryngeal adduction, especially in preterm infants at birth.
- Suction is only required if airway obstruction, due to mucus, vernix, meconium, blood clots, etc, is confirmed through inspection of the pharynx after failure to achieve aeration.
- Any suctioning should be undertaken under direct vision, ideally using a laryngoscope and a wide bore catheter.

### **Meconium**

- Non-vigorous newborn infants delivered through meconium-stained amniotic fluid are at significant risk for requiring advanced resuscitation and a

neonatal team competent in advanced resuscitation may be required.

- Use the standard NLS algorithm, if chest rise is not seen after 5 inflation breaths, repositioning and delivering a further 5 inflation breaths, inspect the airway under direct vision.
- Routine suctioning of the airway of non-vigorous infants is likely to delay initiating ventilation and is not recommended.
- Rarely, an infant may require tracheal intubation and tracheal suctioning to relieve airway obstruction.

## **Initial inflations and assisted ventilation**

### **Lung Inflation**

- If apnoeic, gasping or not breathing effectively, aim to start positive pressure ventilation as soon as possible – ideally within 60 seconds.
- Apply an appropriately fitting face mask connected to a means of providing positive pressure ventilation, ensure a good mask seal by using an align, roll, check approach.
- Give five inflation breaths maintaining the inflation pressure for up to 2-3 seconds.
- Inflation pressures:
  - Term: 30 cm H<sub>2</sub>O
  - Preterm: 25 cm H<sub>2</sub>O
- % oxygen:
  - > 32 weeks: 21%
  - 28-32 weeks: 21-30%
  - < 28 weeks: 30%

### **Assessment**

- Check the heart rate:
  - A heart rate that increases within 30 seconds or a stable heart rate, if initially > 100, confirms adequate ventilation/oxygenation.
  - A slow or very slow heart rate usually suggests continued hypoxia and almost always indicates inadequate ventilation.
- Check for chest movement:
  - Visible chest movement with inflations indicates a patent airway and delivered volume.

- Failure of the chest to move may indicate obstruction of the airway or insufficient inflation pressure to aerate the lungs.

## Ventilation

- If there is a heart rate response:
  - Continue uninterrupted ventilation until the infant begins to breathe adequately and the heart rate is above  $100 \text{ min}^{-1}$ .
  - Aim for about  $30 \text{ breaths min}^{-1}$  with an inflation time of  $\sim$ one second.
  - Reduce the inflation pressure if the chest is moving well.
  - Reassess heart rate and breathing at least every 30 seconds.
  - Consider a more secure airway (laryngeal mask/tracheal tube) if apnoea continues or if mask ventilation is not effective.

## Failure to respond

- If there is no heart rate response **and** the chest is not moving with inflations:
  - Check if the equipment is working properly.
  - Recheck the head-position and jaw lift/thrust.
  - Recheck mask size, position and seal and repeat 5 inflation breaths.
  - Consider other airway manoeuvres:
    - 2-person mask support if single handed initially.
    - Inspection of the pharynx and suction under direct vision to remove obstructing foreign matter if present.
    - Securing the airway via tracheal intubation or insertion of a laryngeal mask.
    - Insertion of an oropharyngeal/nasopharyngeal airway if unable to secure the airway with other means.
  - Consider a gradual increase in inflation pressure.
  - If being used, check on a respiratory function monitor that expired tidal volume is not too low or too high (target about  $5 \text{ to } 8 \text{ mL kg}^{-1}$ ), then
  - Repeat inflations.
  - Assess heart rate and chest movement, ideally continuously with a saturation monitor +/- ECG.
- If insertion of a laryngeal mask or tracheal intubation is considered, it must be undertaken by personnel competent in the procedure with appropriate equipment. Otherwise continue with mask ventilation and call for help.
- **Without adequate lung aeration, chest compressions will be ineffective; therefore, where the heart rate remains very slow, confirm effective ventilation through observed chest movement**

**before progressing to chest compressions.**

## **Airway adjuncts, assisted ventilation devices, PEEP and CPAP**

### **Continuous positive airway pressure (CPAP) & Positive end expiratory pressure (PEEP)**

- In spontaneously breathing preterm infants, consider CPAP as the initial method of breathing support after delivery - using either mask or nasal prongs.
- When giving positive pressure ventilation aim to use a PEEP of 5-6 cm H<sub>2</sub>O.

### **Assisted ventilation devices**

- Use an appropriate size face mask to provide a good seal between mask and face.
- Where possible use a T-piece resuscitator (TPR) to deliver CPAP or positive pressure ventilation (PPV) with PEEP.
- Nasal prongs of appropriate size may be a viable CPAP alternative to facemasks.
- If a self-inflating bag (SIB) is used, it should be of sufficient volume to deliver an adequate inflation. Care should be taken not to deliver excessive volume.
- SIB cannot deliver CPAP effectively.

### **Laryngeal mask**

- Consider using a laryngeal mask in infants of  $\geq 34$  weeks gestation (~2000g):
  - if there are problems with establishing effective ventilation with a facemask
  - where intubation is not possible or deemed unsafe because of congenital abnormality, a lack of equipment, or a lack of skill
  - as an alternative to tracheal intubation as a secondary airway
  - Some devices have been used successfully in infants down to 1500g.

### **Tracheal tube**

- Tracheal intubation may be considered at several points during neonatal resuscitation:

- when ventilation is ineffective despite optimising facemask technique and/or increasing inspiratory pressure
- where ventilation is prolonged, in order to establish a more secure airway
- when suctioning the lower airways to remove a presumed tracheal blockage
- when chest compressions are performed
- in special circumstances (e.g. congenital diaphragmatic hernia or to give surfactant).
- Exhaled CO<sub>2</sub> detection should be used when undertaking intubation to confirm correct tube placement.
- A range of different sized tubes should be available.
- The use of a video laryngoscope may aid tube placement.
- The tracheal tube should be confirmed secured and its position confirmed by radiography.
- Respiratory function monitoring may also help confirm tracheal tube position and adequate ventilation through demonstrating adequate expired tidal volume (about 5 to 8 mL kg<sup>-1</sup>) and minimal leak.

## **Air/Oxygen**

- Pulse-oximetry and oxygen blenders should be used during resuscitation in the delivery room.
- Aim to achieve target oxygen saturation above the 25<sup>th</sup> percentile for healthy term infants in the first 5 minutes after birth.
- If there is no increase in heart rate or saturations remain low, despite effective ventilation, increase the oxygen concentration to achieve adequate preductal oxygen saturations.
- Check the delivered inspired oxygen concentration and saturations frequently (e.g. every 30 seconds) and titrate to avoid both hypoxia and hyperoxia.
- Wean the inspired oxygen if saturations exceed 95%.

### **Term and preterm infants ≥ 32 weeks**

- In infants receiving respiratory support at birth, begin with air (21%).

### **Preterm infants < 32 weeks.**



- Resuscitation should be initiated in air or a low inspired oxygen concentration based on gestational age:
  - 28 - 31 weeks: 21-30%
  - < 28 weeks: 30%
- In infants < 32 weeks gestation the target should be to avoid an oxygen saturation below 80% and/or bradycardia at 5 minutes of age. Both are associated with poor outcome.

## **Chest compressions**

### **Assessment of the need for chest compressions**

- If the heart rate remains very slow ( $< 60 \text{ min}^{-1}$ ) or absent after 30 seconds of good quality ventilation, start chest compressions.
- When starting compressions:
  - Increase the delivered inspired oxygen to 100%.
  - Call for experienced help if not already summoned.

### **Delivery of chest compressions**

- Use a synchronous technique, providing three compressions to one ventilation at about 15 cycles every 30 seconds.
- Use a two-handed technique for compressions if possible.
- Re-evaluate the response every 30 seconds.
- If the heart rate remains very slow ( $< 60 \text{ min}^{-1}$ ) or absent, continue chest compressions, but ensure that the airway is secured.
- Titrate the delivered inspired oxygen against a reliable pre-ductal oxygen saturation.
- Consider vascular access and drugs.

## **Vascular access**

- During the resuscitation of a compromised infant at birth peripheral venous access is likely to be difficult and suboptimal for vasopressor administration.

### **Umbilical Venous Access**

- The umbilical vein offers rapid vascular access in newborn infants and is the primary method of access during resuscitation.

- Ensure a closed system to prevent air embolism during insertion should the infant gasp and generate sufficient negative pressure.
- Confirm position in a blood vessel through aspiration of blood prior to administering drugs/fluids.
- Clean, rather than sterile, access technique is sufficient in an emergency.
- The umbilical route may still be achievable some days after birth and should be considered in cases of postnatal collapse.

### **Intraosseous Access**

- Intraosseous (IO) access can be an alternative method of emergency access for drugs/fluids.

### **Support of transition / post-resuscitation care**

- If venous access is required following resuscitation, peripheral access may be adequate, sometimes central access is needed.
- IO access may be sufficient in the short term if no other site is available.

## **Drugs**

### **During active resuscitation**

If the HR remains below  $60 \text{ min}^{-1}$  despite adequate control of the airway, effective ventilation and chest compressions for 30 seconds, then consider:

- Adrenaline:
  - Intravenous is the preferred route, intra-osseus is an alternative:
    - 20 micrograms  $\text{kg}^{-1}$  ( $0.2 \text{ mL kg}^{-1}$  of 1:10,000 adrenaline [1000 micrograms in 10 mL]).
  - intra-tracheal route if intubated and no other access available.
    - 100 micrograms  $\text{kg}^{-1}$  ( $1.0 \text{ mL kg}^{-1}$  of 1:10,000 adrenaline [1000 micrograms in 10 mL])
  - If tracheal adrenaline is given IV or IO access should still be sought.
  - Subsequent doses every 3-5 minutes if heart rate remains  $< 60 \text{ min}^{-1}$ .
- Glucose:
  - In a prolonged resuscitation to reduce likelihood of hypoglycaemia.
  - Intravenous or intraosseous:
    - 250 mg  $\text{kg}^{-1}$  bolus ( $2.5 \text{ mL kg}^{-1}$  of 10% glucose solution).
- Volume replacement

- With suspected blood loss or shock unresponsive to other resuscitative measures.
- Intravenous or intraosseous:
  - 10 mL kg<sup>-1</sup> of group O Rh-negative blood or isotonic crystalloid.
- Sodium bicarbonate:
  - May be considered in a prolonged unresponsive resuscitation to reverse intracardiac acidosis.
  - Intravenous or intraosseous:
    - 1-2 mmol kg<sup>-1</sup> sodium bicarbonate (2-4 mL kg<sup>-1</sup> of 4.2% solution) by slow intravenous injection.

## **In the absence of an adequate response**

- Consider other reversible factors (e.g. tension pneumothorax, hypovolaemia, equipment failure) or congenital abnormalities.

## **Post-resuscitation care**

- Infants who have required resuscitation may later deteriorate. Post resuscitation care should be in an environment in which close monitoring can be provided.
- Care provided during the resuscitation should be accurately documented.

### **Glucose**

- Monitor glucose levels carefully after resuscitation.
- Have protocols/guidance on the management of unstable glucose levels.
- Avoid hyper- and hypoglycaemia.
- Avoid large swings in glucose concentration.
- Consider the use of a glucose infusion to avoid hypoglycaemia.

### **Thermal Care**

- Aim to keep the temperature between 36.5 °C and 37.5 °C.
- Rewarm if the temperature falls below this level and there are no indications to consider therapeutic hypothermia (see below).

### **Therapeutic Hypothermia**

- Once resuscitated, consider inducing hypothermia to 33-34 °C in situations where there is clinical and/or biochemical evidence of significant risk of moderate or severe HIE (hypoxic-ischaemic encephalopathy).
- Clearly document the evidence to justify treatment including cord blood gases and neurological examination.
- Arrange safe transfer to a facility where monitoring and treatment can be continued.
- Therapeutic hypothermia, without HIE, is likely to be harmful (see temperature maintenance).

## **Documentation and Prognosis**

- Ensure clinical records allow:
  - accurate retrospective evaluation of the clinical state of the infant at birth
  - documentation of interventions and response during the resuscitation

## **Communication with the parents**

### **Where intervention is anticipated**

- Whenever possible, decisions to resuscitate an extremely preterm or clinically complex infant should include close consultation with the parents and senior clinicians.
- Discuss options, including the potential need and magnitude of resuscitation and the prognosis before delivery to develop an agreed plan.
- Carefully record all discussions and decisions in the mother's notes prior to delivery and in the infant's records after birth.

### **For every birth**

- It is reasonable for mothers/fathers/partners to be present during the resuscitation where circumstances, facilities and parental inclination allow.
- The views of both the team leading the resuscitation and the parents must be taken into account in decisions on parental attendance.
- Parents should be kept informed of the resuscitation or stabilisation care provided to their infant.
- Witnessing the resuscitation of their infant may be distressing for parents. If possible, identify a member of healthcare staff to support them and to keep them informed during resuscitation.

- Allow parents to hold or even better to have skin-to-skin contact with their infant as soon as possible after delivery or resuscitation, even if unsuccessful.
- Provide an explanation of any procedures and why they were required as soon as possible after the delivery.
- Ensure a record is kept of events and any subsequent conversations with parents.
- Allow for further discussions at a later time to allow parents to reflect and to aid parental understanding of events.
- Consider what additional support is required for parents following delivery and any resuscitation.

## **Withholding and discontinuing resuscitation**

- Recommendations must be interpreted in the light of current national/regional outcomes.
- When discontinuing, withdrawing or withholding resuscitation, care should be focused on the comfort and dignity of the infant and family.
- Such decisions should ideally involve senior paediatric/neonatal staff.
- Where life-sustaining treatment is withheld or withdrawn, infants should be provided with appropriate palliative (comfort-focused) care.

### **Discontinuing resuscitation**

- When the heart rate has been undetectable for >10 minutes after delivery, review:
  - clinical factors (e.g. gestation, dysmorphic features)
  - effectiveness of resuscitation
  - clinical team views about continuing resuscitation.
- Stopping resuscitation should be discussed and occur if there has been no response after 20 minutes and reversible problems have been excluded.
- Partial or incomplete heart rate improvement with resuscitative efforts makes treatment decisions more complex. It may be appropriate to take the infant to the intensive care unit and consider withdrawing life sustaining treatment if they do not improve.

### **Withholding resuscitation**

- Decisions about withholding life sustaining treatment should usually be made after discussion with parents in the light of regional or national

evidence on outcomes.

- Attempted resuscitation is usually not appropriate where there is extremely high (> 90%) predicted neonatal mortality and unacceptably high morbidity in surviving infants.
- Resuscitation is nearly always indicated if there is a high (> 50%) survival rate and what is deemed to be acceptable morbidity.
- Resuscitation should also usually be commenced in situations where there is uncertainty about outcome and there has been no chance to have prior discussions with parents.
- In conditions where there is low survival (< 50%), high morbidity and the anticipated burden of medical treatment for the child is high, parental wishes regarding resuscitation should be sought and usually supported.

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