ANZCOR Guideline 13.4 – Airway Management and Mask Ventilation of the Newborn Infant

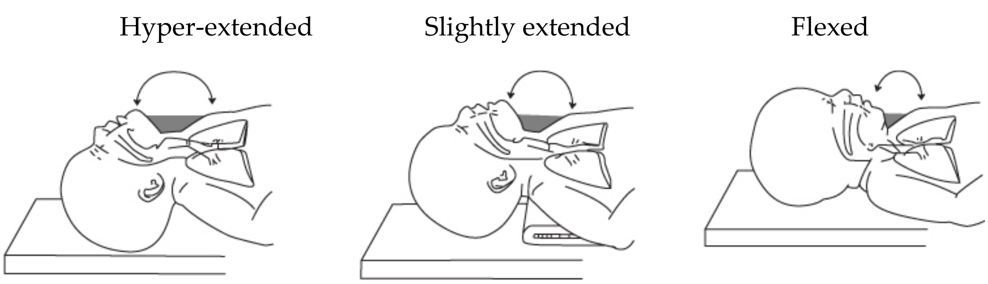
Guideline

EFFECTIVE VENTILATION IS THE KEY TO SUCCESSFUL NEONATAL RESUSCITATION

All personnel involved in the birth and care of newborn infants must be familiar with the ventilation equipment and be proficient in its use.

1. Positioning and the Airway

The newborn infant who needs resuscitation should be placed on his or her back with the head in a neutral or slightly extended position (the sniffing position) [Class A, expert consensus opinion]. Particularly if moulding during birth has caused a very prominent occiput, a 2cm thickness of blanket or towel placed under the shoulders may be helpful in maintaining good positioning [Class B, expert consensus opinion].



The slightly extended, or sniffing position of the baby illustrated in the middle panel results in optimal airway patency for resuscitation.

If respiratory efforts are present but not producing effective ventilation (the heart rate does not rise above 100/min) the airway may be obstructed and consideration should be given to other methods to improve airway patency, including support of the lower jaw, opening the mouth, or in some cases upper airway suction [Class A, expert consensus opinion].

1.1. Mouth and Pharyngeal Suction

Normal newborn infants do not require suctioning of the nose, mouth or pharynx after birth [Class A, expert consensus opinion]. They clear their airways very effectively, and suctioning can delay the normal rise in oxygenation.[1]

The airway is sometimes obstructed by particulate meconium, blood clots, tenacious mucous or vernix and may need to be cleared.

However, pharyngeal suction can cause laryngeal spasm, trauma to the soft tissues and bradycardia. It can also prolong cyanosis and delay the onset of spontaneous breathing [LOE II[1,2]]. Therefore, any pharyngeal suction should be done briefly and with care.

In general, suction should not be used ***except*** when babies show obvious signs of obstruction either to spontaneous breathing or to positive pressure ventilation [Class A, expert consensus opinion]. Pharyngeal suction may be required to visualise the vocal cords during intubation.

1.2. Management of the Airway in the Presence of Meconium Stained Liquor

Aspiration of meconium before or during birth, or during resuscitation can cause meconium aspiration syndrome (MAS) and all infants born through meconium stained fluid must be regarded as at risk.

1.2.1. Intrapartum pharyngeal suction

Suctioning the infant's mouth and pharynx before the delivery of the shoulders makes no difference to the outcome of babies with meconium stained liquor and is not recommended [LOE II[3,4]].

1.2.2. Endotracheal suction

For babies who are vigorous after exposure to meconium stained liquor, (breathing or crying, good muscle tone), routine endotracheal suctioning is discouraged because it does not alter their outcome and may cause harm [Class A, LOE II[5,6]].

For babies who are not vigorous (not breathing or crying, low muscle tone) the available evidence does not support or refute the value of routine endotracheal suctioning in preventing MAS (CoSTR 2015). [7] Observational studies suggest that these meconium-exposed depressed infants are at increased risk to develop MAS [LOE IV[8,9]].

One small RCT in non-vigorous infants compared tracheal intubation and suctioning with no suctioning. No benefit was found in reducing MAS and or mortality.[10] The other evidence in relation to tracheal intubation and suctioning is conflicting and is of very low quality.[7] Taken together, ANZCOR suggests that there is insufficient published human evidence to suggest routine tracheal intubation for suctioning of meconium (CoSTR 2015).[7] Potential benefits of removing meconium from the trachea need to be weighed against what is likely to be an urgent need for other resuscitation manoeuvres. Emphasis should be made on initiating ventilation rapidly in non-breathing or ineffectively breathing infants.

ANZCOR recommends that if tracheal suction is performed, it should be accomplished before spontaneous or assisted respirations have commenced, and very promptly so as to minimise delay in establishing breathing [Class A, expert consensus opinion]. Stimulation to breathe should not be provided beforehand. There is no evidence to support repeated intubation for endotracheal suction, and it is likely to cause further delays in resuscitation, so ANZCOR suggests against repeated intubation for suctioning.

2. Tactile Stimulation

Drying and stimulation are both assessment and resuscitative interventions. However, if in response, the term or preterm infant fails to establish effective respirations and heart rate does not increase to more than 100/min, CPAP or positive pressure ventilation should be commenced. If the infant is breathing, CPAP may be sufficient to augment endogenous effort. In the non-breathing infant intermittent positive pressure ventilation (IPPV) is necessary.

3. Positive Pressure Ventilation

After stimulation, positive pressure ventilation should be started if the heart rate is less than 100/min and either the infant remains apnoeic or the breathing is inadequate. (See also guideline 13.3).

The primary measure of effectiveness of ventilation is a prompt improvement in heart rate, which is then sustained. Chest wall movement and other cues to adequacy of lung inflation should be assessed if the heart rate does not improve.

If there is little or no visible chest wall movement the technique of ventilation should be improved. This includes assuring the facemask fits well on the face with minimal leak, and that the head and jaw position are correct. Two people may be able to provide mask ventilation more effectively than one, with one person supporting the jaw and holding the mask in place with two hands, and the other providing positive pressure inflations.[11] If these manoeuvres are ineffective in moving the chest wall and increasing the heart rate, the inflating pressure must be increased until chest wall movement is seen and the heart rate increases [Class A, expert consensus opinion]. Suctioning of the airway is sometimes required. Occasionally an oro-pharyngeal airway is helpful, such as when the baby has an abnormally small jaw or large tongue.

3.1. Manual Ventilation Devices

A T-piece device, a self-inflating bag (approximately 240 mL), and a flow-inflating bag are all acceptable devices to ventilate newborn infants either via a facemask, laryngeal mask or endotracheal tube. [Class A, extrapolated evidence[12-18]].

	Self-inflating bag	**Flow-inflating bag (with manometer)**	**T-piece resuscitation device (with manometer)**
Needs pressurised gas source	No	Yes	Yes
Assists user to detect mask leak	No	Yes	Yes
Peak inflation pressures	Inconsistent, may be very high	Consistency depends on user skills	Consistent, adjustable
Delivers PEEP or CPAP	No	Depends on user skills	Yes
Can deliver sustained inflation	No	Depends on user skills	Yes

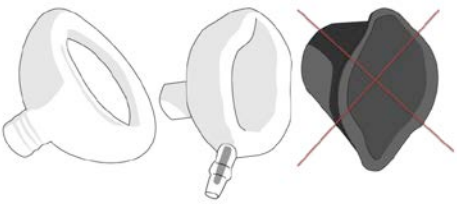
3.2. Effectiveness of T Piece Devices Versus Self-Inflating Bags

ANZCOR suggests the use of a T piece device for delivery of IPPV or CPAP during newborn resuscitation. [Class B, expert consensus opinion]. In making this suggestion, we have diverged from the CoSTR Treatment Recommendation, which found insufficient evidence to recommend T piece resuscitators over self-inflating bags.[7] In doing so, we take into account the level of resources for health care in Australia and New Zealand and we place higher value on the demonstrated benefits of PEEP in recruiting lung volume, the routine use of manometry to adjust inflating pressures and the reliable titration of oxygen concentration than on the lack of evidence from any large RCT showing improvement in outcome.

A flow-inflating bag with manometer is also suitable. The T Piece device or flow-inflating bag should be used with a blender and both compressed air and oxygen, to allow accurate titration of inspired oxygen concentration to meet the baby's needs.

A self-inflating bag must always be available for back-up in case of failure of pressurised gas delivery [Class A, expert consensus opinion]. A self-inflating bag cannot deliver CPAP and may not be able to achieve PEEP even with a PEEP valve in place.

3.3. Facemasks



The appropriate size of facemask must seal around the mouth and nose but not cover the eyes or overlap the chin. Therefore, a range of sizes must be available for different sized babies. Masks with a cushioned rim are preferable to masks without one [Class A, LOE III-2[19]]. With bag-mask ventilation it can be difficult to establish and maintain a good seal between the mask and the infant's face[20] and so it cannot be assumed that just because the mask is on the face, there is a good seal.

Suitable facemasks, with cushioned rims, are shown on the left. The one in the centre has an inflatable rim, which should be filled with air using a syringe until the rim is firm. The Rendell Baker style mask on the right should not be used.

The face mask should be applied using a rolling motion from chin to nose bridge and held in place using a suitable grip that minimises leaks. [21,22]

3.4. Initiating Ventilation

The aim of ventilation is initially to clear lung liquid, establish lung aeration and enable gas exchange.[23-26] The optimal strategy for this in newborns needing resuscitation has not been established, but some studies suggest that sustained initial breaths[24] and positive end expiratory pressure[27] are helpful, particularly in premature lungs. There is good support for these concepts from animal studies, but care must be taken to avoid high tidal volumes during resuscitation, which can cause sustained damage to immature lungs.[28]

The suggested initial pressures are 30 cm H_2O for term infants and 20-25 cm H_2O for premature infants. On devices that can deliver PEEP, 5 cm H_2O is the recommended initial setting. Pressures should be adjusted up or down according to response. For preterm infants, it is particularly important to avoid creation of excessive lung expansion during ventilation immediately after birth. Although measured PIP does not correlate well with volume delivered in the context of changing respiratory mechanics, monitoring of inflation pressure may help provide consistent inflations and avoid unnecessarily high pressures and excessive volumes.[29]

Higher inflation pressures may be required to aerate the lungs during the first few inflations than for subsequent inflations, particularly in infants who have not made any respiratory effort. If pressure is not being monitored, the minimal inflation required to achieve visible chest wall movement and an increase in heart rate should be used. When it becomes evident that the infant is responding to ventilation, in many cases inflation pressures and rate can (and should) be decreased.

Subsequent ventilation should be provided at 40-60 inflations/minute with an inspiratory time of 0.3-0.5 seconds.

For most infants, ventilation can be accomplished with progressively lower pressures and rates as resuscitation proceeds [Class A, expert consensus opinion].

3.5. PEEP During Resuscitation

PEEP has been shown to be very effective for improving lung volume, reducing oxygen requirements and reducing the incidence of apnoea in premature babies with respiratory distress syndrome.[30] Studies in intubated premature animals demonstrate that it helps establish aerated lung volume.

There is low quality evidence indicating that PEEP produces only modest reduction in maximum oxygen concentration during preterm infant resuscitation[7]. We place higher value on the evidence for routine use of PEEP during ventilation in infants receiving subsequent neonatal intensive care, the demonstrated benefits of PEEP in establishing lung aeration in newborn preterm animal models and the much stronger evidence that CPAP can be used to support spontaneous breathing in term and preterm infants with a variety of lung disorders. We place lower value on the absence of evidence of other benefits from human infant trials. [7,31] ANZCOR recommends the use of PEEP (5-8 cm H_2O pressure) during resuscitation of newborn infants wherever appropriate equipment is available [Class A, expert consensus opinion].

High levels of PEEP (>8 cm H_2O) have the potential to reduce pulmonary blood flow and cause pneumothorax, and should be used with great caution.[32]

3.6. Assessing the Effectiveness of Ventilation

The effectiveness of ventilation is confirmed by observing three things:
1. Increase in the heart rate above 100/min.
2. A slight rise of the chest and upper abdomen with each inflation.
3. Oxygenation improves.

If the chest and abdomen do not rise with each inflation, or the heart rate does not increase above 100 beats per minute, the technique of ventilation needs to be improved.

Tracheal intubation (or use of a laryngeal mask airway) should be considered if ventilation via a facemask is still ineffective despite the above measures [Class A, expert consensus opinion].

4. Continuous Positive Airway Pressure (CPAP)

For spontaneously breathing term newborns with respiratory distress ANZCOR suggests a trial of CPAP, although there are no studies to support this recommendation. For preterm infants, see Guideline 13.8.

5. Mouth-to-Mouth/Nose and Mouth-to-Mask Ventilation

Where neonatal inflation devices are not available, ANZCOR suggests mouth-to-mouth-and-nose ventilation can be used. [Class B, extrapolated evidence[33]]. To decrease the risk of infection to the resuscitator, maternal blood and other body fluids should first be wiped from the face of the infant. The rescuer should then apply the mouth over the mouth and nose of the infant and give small puffs at a rate of 40-60 breaths per minute to produce a small rise and fall of the chest, until the baby improves.

6. Supplemental Oxygen During Resuscitation

There are now many studies showing that the blood oxygen levels of normal newborns can take up to 10 minutes to rise above 90%.[34-40] While insufficient oxygenation can impair organ function or cause permanent injury, there is increasing evidence that even brief exposure to excessive oxygenation can be harmful to the newborn during and after resuscitation.[41-45]

Furthermore, visual assessment of the presence or absence of cyanosis bears a poor relationship to oxyhaemoglobin saturation measured with an oximeter.[46]

6.1. Pulse oximetry

Oximetry is recommended when the need for resuscitation is anticipated, when CPAP or positive pressure ventilation is used, when persistent cyanosis is suspected, or when supplemental oxygen is used (see Guideline 13.3) [Class A, expert consensus opinion].

6.2. Administration of supplemental oxygen

Meta-analyses of randomized controlled trials comparing neonatal resuscitation initiated in 21% versus 100% oxygen showed increased survival in infants for whom resuscitation was initiated with air.[47,48] In the studies of term infants receiving resuscitation with intermittent positive pressure ventilation, 100% oxygen conferred no short term advantage and resulted in increased time to first breath and/or cry.[49,50] However, there are no studies in term infants that compare commencing in oxygen concentrations other than 21% or 100%.

It is suggested that regardless of gestation, the goal of oxygen administration should be to aim for oxygen saturations resembling those of healthy term babies. The interquartile range of pre-ductal saturations measured in normal term infants at sea level are suitable targets [Class A, expert consensus opinion[45]]. ANZCOR suggests use of the following target range. Although the 75th centile for normal infants rises above 90%[40], in the following table the upper saturation targets while administering oxygen have been capped at 90%, to avoid risk of exposing infants to excessive oxygen. Some infants achieve saturations over 90% without supplemental oxygen.

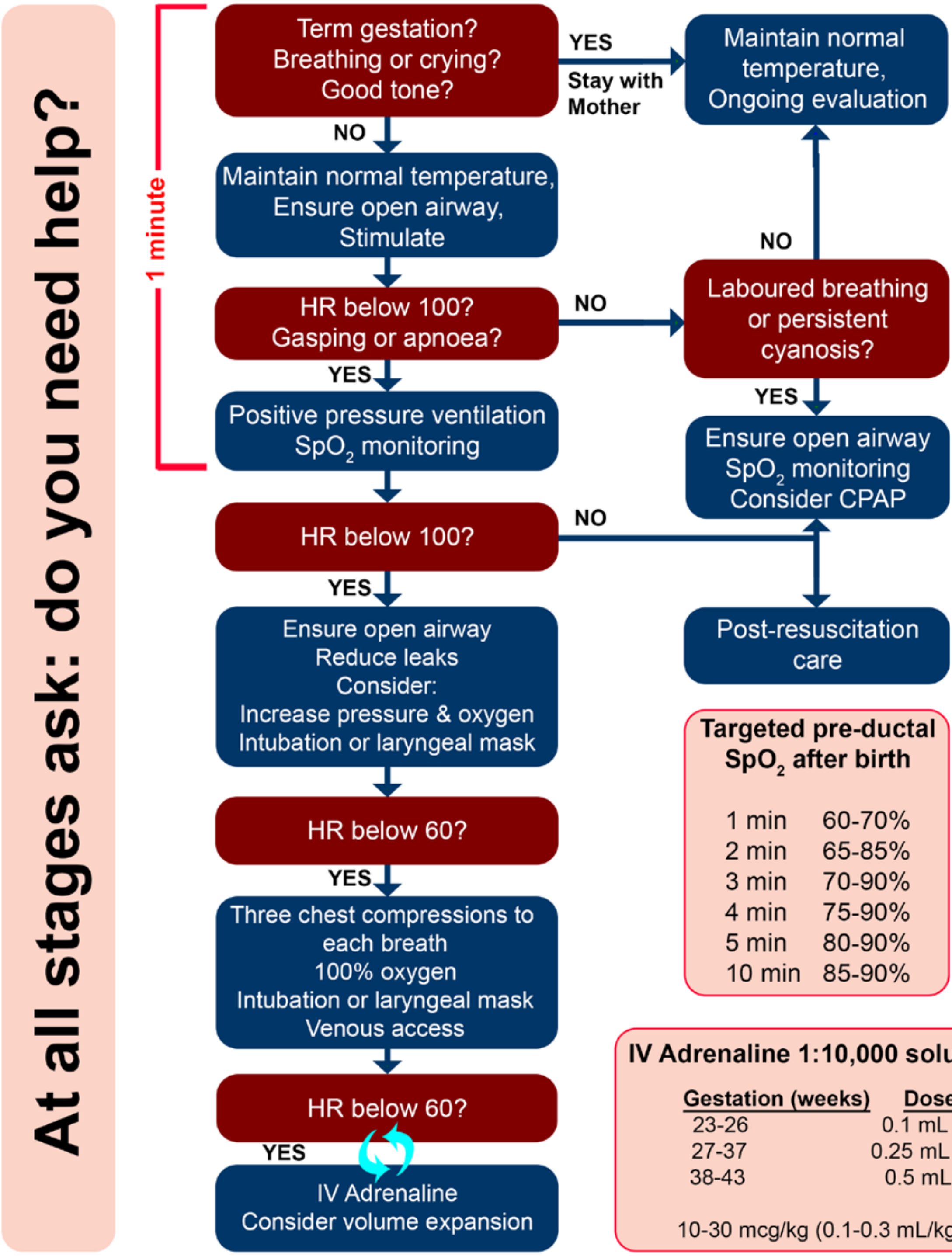
Time from birth	Target saturations for newborn infants during resuscitation
1 min	60-70
2 min	65-85
3 min	70-90
4 min	75-90
5 min	80-90
10 min	85-90

For term and near-term infants ANZCOR recommends that air should be used initially with supplemental oxygen reserved for those whose saturations do not meet the lower end of the targets despite respiratory support [Class A, expert consensus opinion]. If, despite effective ventilation there is no increase in oxygenation (assessed by oximetry wherever possible) or heart rate, a higher concentration of oxygen should be used.[51-53] If the saturations reach 90% while supplemental oxygen is being administered, the concentration of oxygen should be decreased [Class A, expert consensus opinion].

For considerations of very preterm infants see guideline 13.8

In all cases, the first priority is to ensure adequate inflation of the lungs, followed by increasing the concentration of inspired oxygen only if needed [Class A, expert consensus opinion].

Newborn Life Support



Targeted pre-ductal SpO_2 after birth

1 min	60-70%
2 min	65-85%
3 min	70-90%
4 min	75-90%
5 min	80-90%
10 min	85-90%

IV Adrenaline 1:10,000 solution

Gestation (weeks)	Dose
23-26	0.1 mL
27-37	0.25 mL
38-43	0.5 mL

10-30 mcg/kg (0.1-0.3 mL/kg)

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Whakahauora Aotearoa

7. Pace of Resuscitation

In all infants, resuscitators should aim to ensure that effective spontaneous or assisted ventilation of the lungs has been established by 1 minute. The response to each set of actions in the algorithm should be assessed. If heart rate, breathing, tone and oxygenation do not improve or the infant is deteriorating, progress to the next step [Class A, expert consensus opinion].

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