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Queensland Clinical Guidelines

Translating evidence into best clinical practice

Maternity and Neonatal **Clinical Guideline**

Neonatal resuscitation

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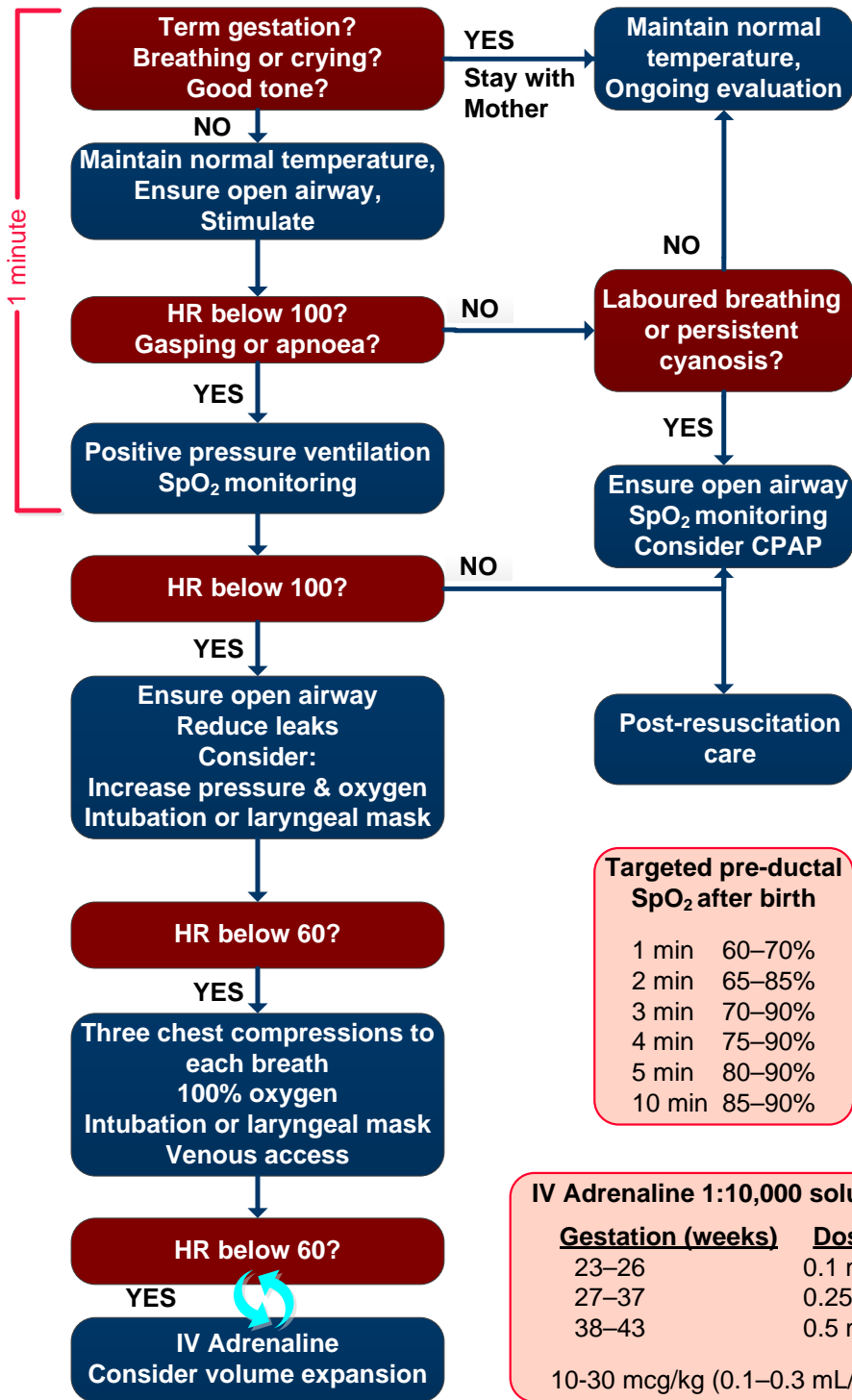
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Flow Chart: Neonatal resuscitation

Newborn Life Support

At all stages ask: do you need help?



Targeted pre-ductal SpO₂ 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)

January 2016

Abbreviation: CPAP: Continuous positive airway pressure; HR: Heart rate; SpO₂: Peripheral capillary oxygen saturation

Flowchart: F16.5-1-V3-R21

Abbreviations

ANZCOR	Australian and New Zealand Committee on Resuscitation
bpm	Beats per minute
CDH	Congenital diaphragmatic hernia
CPAP	Continuous positive airway pressure
ETT	Endotracheal tube
FiO ₂	Fraction of inspired oxygen
HIE	Hypoxic ischaemic encephalopathy
HR	Heart rate
IO	Intraosseous
IV	Intravenous
LMA	Laryngeal mask airway
NICU	Neonatal intensive care unit
PEEP	Positive end expiratory pressure
PIP	Peak inspiratory pressure
PPV	Positive pressure ventilation
PPROM	Preterm prelabour rupture of membranes
RhD	Rh Blood Type D (Rh positive)
SpO ₂	Peripheral capillary oxygen saturation
UVC	Umbilical venous catheter

Definitions

Acrocyanosis	Blue hands and feet due to inadequate circulation of blood and oxygen to the extremities normally found in the first few hours after birth.
Cold stress	Temperature between 36.0 °C and 36.4°C
Corrected age	Gestation plus postnatal age in weeks
Hyperthermia	Temperature greater than 37.5 °C
Mild hypothermia	Temperature between 35.5 °C and 35.9 °C
Moderate hypothermia	Temperature between 32.0 °C and 35.4°C

Table of Contents

1	Introduction	7
1.1	Clinical standards	7
1.2	Clinicians.....	8
2	Risk factors for neonatal resuscitation	9
3	Preparation: staff, equipment, medications and environment.....	10
3.1	Communication and information sharing	11
4	Assessment and management of baby	12
4.1	Initial assessment and management	12
4.2	Subsequent assessment and management	13
4.3	Oxygen saturation monitoring.....	14
4.3.1	Care of baby during resuscitation	15
5	Airway management.....	16
5.1	General principles	16
5.2	Airway and delivery devices	17
5.2.1	Delivery devices.....	18
5.3	Supplemental Oxygen	19
5.4	Oxygen/air mix.....	19
5.5	Positive pressure ventilation	20
5.6	Intubation	21
5.6.1	ETT size and length	21
5.6.2	Endotracheal intubation	22
6	Chest compressions.....	23
7	Medication and fluids.....	24
7.1	Adrenaline (epinephrine)	25
7.2	Volume expanding fluids.....	26
8	Special circumstances.....	27
8.1	Preterm baby	27
8.2	Other special circumstances.....	28
8.3	Congenital anomalies	29
9	Care after resuscitation	30
9.1	Cord blood sampling	30
9.1.1	Umbilical artery cord blood gases.....	30
9.2	Continuing clinical care.....	31
9.3	Monitoring and management.....	32
10	Ethical considerations	33
	References	34
	Appendix A Equipment and medications for neonatal resuscitation	35
	Appendix B Oxygen/air mix and target oxygen saturation	36
	Appendix C Endotracheal tube intubation	37
	Acknowledgements.....	38

List of Tables

Table 1 Clinical standards	7
Table 2 Clinicians	8
Table 3 Risk factors	9
Table 4 Preparation	10
Table 5 Communication and information sharing	11
Table 6 Assessment and initial management at birth.....	12
Table 7 Subsequent assessment and management	13
Table 8 Oxygen saturation monitoring.....	14
Table 9 Care of baby	15
Table 10 General principles.....	16
Table 11 Assist ventilation devices.....	17
Table 12 Delivery devices.....	18
Table 13 Supplemental oxygen	19
Table 14 Suggested oxygen/air flows at 10 litres per minute.....	19
Table 15 Suggested oxygen/air flows at 8 litres per minute	19
Table 16 Positive pressure ventilation.....	20
Table 17 ETT and suction catheters sizes	21
Table 18 Endotracheal intubation.....	22
Table 19 Chest compressions	23
Table 20 Medication and fluids.....	24
Table 21 Adrenaline (epinephrine) administration.....	25
Table 22 Administration of volume expanding fluids	26
Table 23 Preterm baby	27
Table 24 Other special circumstances	28
Table 25 Congenital anomalies	29
Table 26 Cord blood gas sampling.....	30
Table 27 Umbilical artery cord blood gases	30
Table 28 Continuing clinical care.....	31
Table 29 Monitoring and management.....	32
Table 30 Ethical considerations.....	33

Table of Figures

Figure 1 Rounded doses of IV adrenaline (epinephrine) 1:10,000	25
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1 Introduction

Spontaneous respirations are initiated in approximately 85% of babies born at term with an additional 10% responding to drying and stimulation. Approximately 3% will require positive pressure ventilation (PPV) to initiate breathing with 2% requiring intubation to support breathing. Only 0.1% will require chest compressions with or without adrenaline (epinephrine) to achieve transition to extra-uterine life.¹

1.1 Clinical standards

All birthing facilities require appropriate preparation for neonatal resuscitation.

Table 1 Clinical standards

Aspect	Good practice point
Environment	<ul style="list-style-type: none"> • Provide a warm and draft free environment • Refer to Table 4 Preparation for further advice
Equipment¹	<ul style="list-style-type: none"> • Resuscitation equipment and medications are available for all births • Undertake regular checks to ensure equipment is complete and operational • Refer to Table 4 Preparation and Appendix A Equipment and medications for neonatal resuscitation
Communication and information sharing	<ul style="list-style-type: none"> • Include known risk factors affecting resuscitation and management in discussions between maternal and neonatal/paediatric caregivers including: <ul style="list-style-type: none"> ○ Maternal conditions ○ Antenatal diagnoses ○ Fetal well-being assessments¹ • Include parents in discussions and decision making <ul style="list-style-type: none"> ○ Prepare parent(s) for the possibility of resuscitation • Refer to Table 5 Communication and information sharing
Documentation¹	<ul style="list-style-type: none"> • Appoint one person to be responsible for documentation where this is feasible • Use a standard form to record resuscitation • Record observations, interventions and times during resuscitation • Ensure contemporaneous and comprehensive documentation • Assess and record the Apgar score at one and five minutes after birth and then every five minutes until heart rate (HR) is normal and respiration has been established or the Apgar score is 8 and full ventilator assistance is being given

1.2 Clinicians

Appropriate training and availability of clinical staff is required for neonatal resuscitation.

Table 2 Clinicians

Aspect	Good practice point
Clinical skills¹	<ul style="list-style-type: none"> • Basic neonatal resuscitation: <ul style="list-style-type: none"> ○ Airway support, ventilation via face mask/laryngeal mask and chest compressions • Advanced neonatal resuscitation (all of the following): <ul style="list-style-type: none"> ○ Basic neonatal resuscitation skills ○ Endotracheal intubation ○ Vascular cannulation (umbilical/peripheral) ○ Medication and fluid use • Clinicians responsible for neonatal resuscitation should be familiar with available neonatal resuscitation equipment • Training requirements: <ul style="list-style-type: none"> ○ At least annual training and competency assessment with formal refresher courses every two years and regular drills¹ • Regular reinforcement in clinical practice may involve brief, on-site activities to support technical skills, knowledge and teamwork
Clinician attendance at birth¹	<ul style="list-style-type: none"> • Low risk births: <ul style="list-style-type: none"> ○ A clinician trained in basic neonatal resuscitation should be in attendance and responsible only for the care of the newborn ○ A clinician trained in advanced neonatal resuscitation should also be available in case required • High risk births: <ul style="list-style-type: none"> ○ A clinician trained in advanced neonatal resuscitation should be in attendance and responsible only for the care of the newborn ○ More than one experienced person should be present to care for the newborn • An advanced trained clinician for unplanned high risk births may not be available at non-tertiary facilities
Clinician attendance at caesarean section²	<ul style="list-style-type: none"> • Where there are no antenatally identified risk factors and regional anaesthesia has been used, the clinician should be capable of performing basic neonatal resuscitation including assisted ventilation <ul style="list-style-type: none"> ○ Intubation skills are not necessary

2 Risk factors for neonatal resuscitation

There are a number of factors that places the baby at risk of requiring resuscitation at birth. The list is not exhaustive and the magnitude of the risk varies depending on the number and severity of the problem.¹

Table 3 Risk factors

Aspect	Consideration
Maternal¹	<ul style="list-style-type: none"> • Prolonged rupture of membranes (greater than 18 hours) • Bleeding in second or third trimester • Hypertension in pregnancy • Substance use • Prescribed medication (e.g. lithium, magnesium, adrenergic blocking agents, narcotics) • Diabetes mellitus • Chronic illness (e.g. anaemia, congenital cyanotic heart disease) • Maternal pyrexia • Maternal infection • Chorioamnionitis • Heavy sedation • Previous fetal or neonatal death • No/minimal antenatal care
Fetal¹	<ul style="list-style-type: none"> • Multiple gestation (e.g. twins, triplets) • Preterm gestation (especially less than 35 completed weeks) • Gestation greater than 41 completed weeks • Large for dates based on ultrasound estimation of fetal weight • Fetal growth restriction • Alloimmune haemolytic disease (e.g. anti-D, anti-Kell, especially if fetal or other antibody known to cause haemolytic disease in the fetus or baby especially if fetal anaemia or hydrops fetalis present) • Polyhydramnios and oligohydramnios • Reduced fetal movement before onset of labour • Congenital abnormalities which may affect breathing, cardiovascular function or other aspects of perinatal transition • Intrauterine infection • Hydrops fetalis
Intrapartum¹	<ul style="list-style-type: none"> • Abnormal fetal patterns on cardiotocograph (CTG) <ul style="list-style-type: none"> ◦ Refer to Queensland Clinical Guideline: <i>Intrapartum fetal surveillance</i>³ • Abnormal fetal presentation • Prolapsed cord • Prolonged first or 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 • Assisted vaginal birth—forceps or vacuum (ventouse) • Maternal general anaesthesia

3 Preparation: staff, equipment, medications and environment

The requirements and preparation for neonatal resuscitation will vary dependent on circumstances such as gestation and weight of baby, birthing environment and skill and availability of clinicians.

Table 4 Preparation

Aspect	Good practice points
Staff	<ul style="list-style-type: none"> • At least one person is responsible for the care of the baby only • Newborn resuscitation training should include the necessary individual and teamwork skills which are reinforced through regular practice <ul style="list-style-type: none"> ○ Effective teamwork is essential to the success of neonatal resuscitation, particularly advanced resuscitation⁴ • Refer to Table 2 Clinicians
Equipment and medications	<ul style="list-style-type: none"> • Ensure resuscitation equipment and medications are available for all births regardless of risk and in all areas of hospital where neonatal care is provided¹ • Ensure all relevant staff are familiar with equipment, medications and resuscitation trolley layout • Standard kits: <ul style="list-style-type: none"> ○ Prior preparation of standardised kits containing equipment for procedures (e.g. umbilical catheterisation and thoracentesis) can save considerable time in emergencies • Refer to Appendix A Equipment and medications for neonatal resuscitation
Environmental temperature	<ul style="list-style-type: none"> • Provide a warm, draft free environment and warm blankets • Have resuscitation cot with overhead radiant warmer available • Additional preparation and management may be required for more vulnerable babies at increased risk of heat loss • Aim for birthing room temperature for baby: <ul style="list-style-type: none"> ○ Less than 32 weeks: 23 °C to 25 °C ¹ ○ Less than 28 weeks: at least 26 °C • Babies less than 32 weeks gestation or suspected very low birth weight also require a combination of additional measures that may include: <ul style="list-style-type: none"> ○ Warm blankets ○ Plastic wrapping/polyethylene bag (food grade)—particularly for babies less than 28 weeks gestation¹ ○ Hat/bonnet (pre-warmed) ○ Thermal mattress⁵ (if available) • Have pre-warmed cot available for transfer of preterm or term baby requiring admission to neonatal unit⁴

3.1 Communication and information sharing

Where possible ensure discussions between clinicians (maternal care givers and those who will be resuscitating the baby after birth) and the parents occur before birth and include relevant key issues. Refer to Table 5 Communication and information sharing.

Table 5 Communication and information sharing

Aspect	Consideration
Maternal	<ul style="list-style-type: none"> • Include details of: <ul style="list-style-type: none"> ○ Pre-existing or pregnancy related medical condition and treatment that may affect the resuscitation or management of the baby ○ Antenatal ultrasound diagnoses that may affect immediate postnatal management ○ Assessments of fetal wellbeing (e.g. fetal heart rate monitoring)⁶ ○ Maternal risk factors for infections including fever in labour and the results of screening if known (e.g. Group B Streptococcus) <ul style="list-style-type: none"> § Refer to Queensland Clinical Guideline: <i>Early onset Group B streptococcal disease</i>⁷ ○ Maternal medication
Neonatal	<ul style="list-style-type: none"> • Minimum information required includes: <ul style="list-style-type: none"> ○ Gestational age ○ Number of expected newborns, if multiple birth ○ Reason for high risk birth ○ Expected/estimated fetal weight ○ Presence of meconium in the liquor ○ Assessments of fetal viability ○ Any known congenital abnormalities
Parent(s)	<ul style="list-style-type: none"> • Whenever possible, the team who will resuscitate the baby introduce themselves to the parent(s) before the birth to: <ul style="list-style-type: none"> ○ Outline the proposed plan for care of baby ○ Enquire and respond to parent's questions ○ Include parents in decisions about the extent of the resuscitation especially in cases of potentially lethal fetal malformations or extreme prematurity⁴ ○ Discuss potential transfer of baby to higher level facility if indicated ○ Refer to Queensland Clinical Guideline: <i>Neonatal stabilisation and retrieval</i>⁸ ○ Refer to Table 30 Ethical considerations
Documentation	<ul style="list-style-type: none"> • Make contemporaneous documentation of discussions and plans for care and management

4 Assessment and management of baby

Eighty five percent of babies who are term or near term commence breathing within 30 seconds of birth and 95% commence within 45 seconds of birth. Immediate and ongoing assessment of the baby starts at birth and continues throughout the resuscitation process.

4.1 Initial assessment and management

Make initial assessment within 15 seconds of birth. Regular breathing that can maintain the heart rate (HR) above 100 beats per minute (bpm) should occur within one to two minutes after birth. The aim of resuscitation is to establish effective spontaneous or assisted ventilation of the lungs by one minute of age.⁶ Refer to Flow Chart: Neonatal resuscitation

Table 6 Assessment and initial management at birth

Aspect	Consideration
Initial assessment	<ul style="list-style-type: none"> • Tone • Breathing • HR⁶
Tone and response to stimulation¹	<ul style="list-style-type: none"> • Subjective and dependent on gestation • If good tone—moving limbs and flexed posture: <ul style="list-style-type: none"> ○ Less likely to be compromised • If poor tone/floppy—not moving and extended posture: <ul style="list-style-type: none"> ○ More likely to need active resuscitation
Initial management¹	<ul style="list-style-type: none"> • Ensure baby's head and neck are supported in neutral position especially if muscle tone is low⁶ • If term or near term baby with weak or absent responses: <ul style="list-style-type: none"> ○ Brisk, gentle drying with soft warm towel ○ Replace towel with warm dry one to prevent heat loss • If preterm and placed in polyethylene bag²: <ul style="list-style-type: none"> ○ Head only needs drying and warm hat/bonnet applied ○ Provide tactile stimulation through bag • If baby exposed to meconium refer to Table 10 General principles

4.2 Subsequent assessment and management

Subsequent assessment and management occurs within the first minute after birth.

Table 7 Subsequent assessment and management

Aspect	Consideration
Subsequent assessment¹	<ul style="list-style-type: none"> • HR • Breathing • Tone • Oxygenation (measured by pre-ductal pulse oximetry)⁶ <ul style="list-style-type: none"> ○ Refer to Table 8 Oxygen saturation monitoring
Breathing⁶	<ul style="list-style-type: none"> • In the presence of apnoea or ineffective respirations, commence respiratory support within one minute of birth at a rate of 40–60 breaths per minute • Establishment of breathing should maintain HR above 100 bpm within 1–2 minutes after birth • If HR greater than 100 bpm and good tone: <ul style="list-style-type: none"> ○ Maintain patency of airway by correct positioning of neck, head and jaw • If HR not maintained above 100 bpm: <ul style="list-style-type: none"> ○ Assess airway for signs of obstruction and suction if airway obstructed ○ Commence PPV • Presence of rib or sternal recession, retraction or indrawing or persistent expiratory grunting may indicate the baby requires support from continuous positive airways pressure (CPAP) at 5–8 cm H₂O or PPV • Persistent apnoea especially with hypotonia and bradycardia (HR less than 100 bpm) is serious sign of urgent need for PPV • Refer to Section 5 Airway management
Heart rate⁶	<ul style="list-style-type: none"> • Auscultate HR with stethoscope <ul style="list-style-type: none"> ○ Count HR for 6 seconds and multiply by 10 to give rapid HR estimation ○ Tap out HR with finger to give visual indication to other clinicians whether to commence/ continue PPV ○ Continue until reliable pre-ductal oxygen saturation and HR displayed on pulse oximeter • Normal HR: <ul style="list-style-type: none"> ○ Between 110 and 160 bpm ○ Should be consistent • Pulse oximetry: <ul style="list-style-type: none"> ○ Provides continuous display of HR within one minute of birth ○ Is recommended for any baby requiring resuscitation ○ Refer to Table 8 Oxygen saturation monitoring • Electrocardiography (ECG) can provide a measure of heart rate more quickly and reliably than an oximeter, so it may be a useful adjunct <ul style="list-style-type: none"> ○ The aim should still be to obtain a reliable pulse oximeter reading because this also provides important information about oxygenation¹ ○ ECG may be an option if a pulse oximeter is not available • Refer also to Section 6 Chest compressions
Colour⁶	<ul style="list-style-type: none"> • Subjective and an unreliable means of judging oxygenation • Typically babies are blue at birth and can remain so for a few minutes • Cyanosis: <ul style="list-style-type: none"> ○ Difficult to recognise ○ Determined by examining gums and mucous membranes in good ambient light ○ If suspected and persistent past a few minutes of age, check oxygen saturation (SpO₂) with pulse oximeter even if baby appears to be breathing normally • Acrocyanosis is normal after birth

4.3 Oxygen saturation monitoring

Oxygen saturation monitoring is recommended for all babies requiring resuscitation.¹

Table 8 Oxygen saturation monitoring

Aspect	Consideration	
Context	<ul style="list-style-type: none"> · Reliable measurement of SpO₂ and HR can be achieved 90 seconds from birth with an oxygen saturation monitor · Pre-ductal values from right hand or wrist: <ul style="list-style-type: none"> ○ Provides a better estimate of brain and coronary artery oxygen saturation in the minutes after birth when there is typically a right to left shunt through the ductus arteriosus which lowers the saturations measured in other extremities ○ Higher than post-ductal values immediately after birth · Obtained more rapidly due to pre-ductal vessels being better perfused, and having higher blood pressure and higher oxygenation⁹ 	
Procedure	<ul style="list-style-type: none"> · Use pulse oximeter designed to reduce movement artefact from a neonatal sensor · Plug cable into machine without sensor lead attached and turn machine on · Attach oximeter sensor to baby's right wrist or hand as soon as possible after birth and before connecting lead to oximeter cable¹⁰ 	
Measurement	<ul style="list-style-type: none"> · Australian and New Zealand Council on Resuscitation (ANZCOR)¹ suggests the following SpO₂ target range for babies requiring resuscitation: <ul style="list-style-type: none"> ○ For baby receiving supplemental oxygen the upper limit of 90% SpO₂ (in the first 10 minutes after birth) is to avoid risks from excessive oxygen administration ○ Some babies will have an SpO₂ greater than 90% without supplemental oxygen 	
Target oxygen saturations during resuscitation¹	Time from birth (minutes)	Target oxygen saturations during resuscitation (%)
	1	60–70
	2	65–85
	3	70–90
	4	75–90
	5	80–90
10	85–90	
SpO₂ targets beyond 10 minutes of age	<ul style="list-style-type: none"> · In the absence of good quality evidence, Queensland Neonatal Services Advisory Group (QNSAG) endorse the following consensus recommendation for oxygen saturation targets for preterm and term babies after 10 minutes of age <ul style="list-style-type: none"> ○ For term babies the target SpO₂ range is 92–98% ○ For preterm babies the target SpO₂ range is 90–95% 	

4.3.1 Care of baby during resuscitation

Table 9 Care of baby

Aspect	Consideration
Handling and skin protection¹	<ul style="list-style-type: none"> • Handle all babies with care and support the head and neck in a neutral position especially if muscle tone is poor • Preterm babies are at greater risk of skin and internal organ damage • Use antiseptic solutions sparingly especially those containing alcohol <ul style="list-style-type: none"> ○ Avoid pooling of solutions in groin and under baby ○ For umbilical catheterisation: <ul style="list-style-type: none"> § Apply small amount of solution to sterile gauze and clean cord and small area of skin only § Use sterile drapes to cover other areas
Temperature management^{1,5}	<ul style="list-style-type: none"> • Ensure area is warm and draft free • If well baby and term or near term: <ul style="list-style-type: none"> ○ Skin to skin contact is recommended during transitional period (i.e. 1-2 hours after birth) • If preterm baby refer to Table 23 Preterm baby • Target normal body temperature for all babies: <ul style="list-style-type: none"> ○ Consider measuring skin temperature with skin sensor if resuscitation greater than 5 minutes ○ Maintain temperature between 36.5 °C and 37.5 °C ○ Measure temperature as soon as possible in birth suite post-resuscitation ○ Measure baby's temperature on admission to neonatal unit¹ • Hypothermia (temperature less than 36 °C) or cold stress (temperature between 36 °C and 36.5 °C) may increase oxygen consumption impeding effective resuscitation • Hyperthermia: <ul style="list-style-type: none"> ○ No studies on effects to babies of hyperthermia after resuscitation ○ Babies born to febrile women (temperature greater than 38 °C) are at increased risk of death, perinatal respiratory depression, neonatal seizures and cerebral palsy¹ • Induced hypothermia for hypoxic ischaemic encephalopathy (HIE): <ul style="list-style-type: none"> ○ Refer to Queensland Clinical Guideline: <i>Hypoxic ischaemic encephalopathy (HIE)</i>³ • Do not apply hot water bottles or heat packs/stones directly to a baby and only use to warm linen when no other means available
Delayed cord clamping^{1,5,11}	<ul style="list-style-type: none"> • Insufficient evidence to recommend optimal timing of cord clamping¹ • Delayed cord clamping in a non-compromised term baby (for at least 60 seconds) may result in: <ul style="list-style-type: none"> ○ Increased placental transfusion ○ Higher haemoglobin levels and improved iron status later in infancy¹² ○ May increase incidence of jaundice requiring phototherapy • Delayed cord clamping in non-compromised preterm baby may result in: <ul style="list-style-type: none"> ○ Increased blood pressure during stabilisation and at four hours of age ○ Reduced risk of periventricular leukomalacia and intraventricular haemorrhage ○ Lowered incidence of necrotising enterocolitis ○ Increased blood volume ○ Reduced need for blood transfusion ○ Evidence for this is weak and further research is currently underway ○ May increase peak bilirubin level but without increased need for phototherapy • Compromised baby: resuscitation takes precedence over delayed cord clamping until further evidence is available <ul style="list-style-type: none"> ○ Cardiac compressions will not improve systemic and coronary perfusion if cord unclamped and low resistance placenta still connected • Cord milking is not recommended in babies as there is insufficient evidence of benefit

5 Airway management

5.1 General principles

- Effective ventilation is the key to successful neonatal resuscitation
- Drying and stimulation are both assessment and resuscitative interventions
- If the baby fails to establish spontaneous effective respirations and HR does not increase to more than 100 bpm then commence PPV¹

Table 10 General principles

Aspect	Recommendation/good practice point
Positioning	<ul style="list-style-type: none"> • Place baby on back with head in neutral or slightly extended position (sniffing position) • If respiratory effort is present but effective ventilation is not present (HR is not rising above 100 bpm) the airway may be obstructed • Improvement in patency of the airway may be obtained by: <ul style="list-style-type: none"> ○ Ensuring correct positioning to maintain patency of the airway by: <ul style="list-style-type: none"> § Placing a 2cm thick roll of blanket or towel under the shoulders § Support of lower jaw and opening the baby's mouth⁴
Suctioning	<ul style="list-style-type: none"> • Routine intrapartum suctioning of mouth, nose or pharynx not recommended and may delay normal rise in oxygenation^{1,2} • Pharyngeal suctioning may cause laryngeal spasm, trauma to soft tissues and bradycardia, prolong cyanosis and delay onset of spontaneous respirations • If indicated—suction briefly and with care • Suction only: <ul style="list-style-type: none"> ○ Where there are obvious signs of obstruction to spontaneous breathing or PPV (e.g. spontaneous respiratory effort or assisted breaths without audible air entry to the lungs, or coarse crackles audible with or without a stethoscope which may be caused by particulate meconium, blood clots, tenacious mucous or vernix) ○ If the vocal cords need to be visualised during intubation¹ ○ Using a large bore suction catheter (10-12 F) passed no more than 5 cm from lips in term baby and only for a few seconds in duration ○ Using negative pressure limited to no more than 100 mmHg⁴
Meconium stained liquor	<ul style="list-style-type: none"> • Vigorous baby (breathing, crying and with good muscle tone) routine endotracheal tube (ETT) suction is discouraged as it provides no benefit and may cause harm¹ • Depressed baby (low tone, not breathing or crying, low heart rate) routine ETT suctioning is not recommended as it is not supported by available evidence^{1,5} <ul style="list-style-type: none"> ○ In all meconium-exposed babies, the priority is to establish effective aeration of the lungs <ul style="list-style-type: none"> § In the depressed baby do not hesitate to commence appropriate resuscitation manoeuvres as are needed • Carefully assess the baby exposed to meconium in amniotic fluid: <ul style="list-style-type: none"> ○ Increased risk of needing resuscitation and for later complications¹
CPAP	<ul style="list-style-type: none"> • A trial of CPAP is reasonable for: <ul style="list-style-type: none"> ○ The spontaneously breathing baby who has laboured breathing/respiratory distress¹ ○ The baby who is breathing but whose oxygen saturation is not meeting targets⁴ • Refer to Table 6 Assessment and initial management at birth
PPV	<ul style="list-style-type: none"> • Refer to Table 16 Positive pressure ventilation
Supplemental oxygen	<ul style="list-style-type: none"> • Use supplemental oxygen only when oxygen saturation has failed to improve with effective ventilation of the lungs and when chest compressions are commenced • In the preterm baby less than 32 weeks, commence assisted ventilation in air to 30 % oxygen • Titrate supplemental oxygen according to pre-ductal pulse oximetry • Refer to Table 8 Oxygen saturation monitoring and Appendix B Oxygen/air mix and target oxygen saturation

5.2 Airway and delivery devices

Table 11 Assist ventilation devices

Aspect	Recommendation/good practice point
Facemasks¹	<ul style="list-style-type: none"> • Appropriate size • Must seal around mouth and nose <ul style="list-style-type: none"> ○ Do not cover eyes or overlap chin ○ Use cushioned rim face mask ○ Do not use excessive force to maintain seal • Apply the mask using a rolling motion from chin to nose bridge • Ensure the jaw is supported • More effective mask ventilation may be achieved by two clinicians with one supporting the jaw and holding the mask in place with two hands and the other clinician providing positive pressure breaths
Laryngeal mask airway	<ul style="list-style-type: none"> • Consider for term and near term baby (greater than or equal to 34 weeks or greater than 2000 grams)⁵ • Consider for any situation where intubation or ventilation is not being achieved, that is where face mask ventilation is insufficient or contraindicated (for example, congenital diaphragmatic hernia) AND clinician is untrained or has been unsuccessful at intubation⁵ • Size 1 mask suitable up to 5 kg baby¹ • Effective ventilation indicated by chest wall movement, improvement in HR and improvement in oxygen saturations • Colour change in paediatric colorimetric end tidal CO₂ detector (as for ETT) to confirm correct placement • Use during chest compressions has not been evaluated¹
ETT	<ul style="list-style-type: none"> • Endotracheal tubes (sizes 2.5, 3.0, 3.5, and 4.0 mm internal diameter): <ul style="list-style-type: none"> ○ Uniform diameter without a cuff ○ No Murphy eye ○ Uncuffed ○ Standard curve ○ Clear or translucent ○ Radio-opaque ○ Centimetre markings along length • Refer to Table 17 ETT and suction catheters sizes, Table 18 Endotracheal intubation and Appendix C Endotracheal tube intubation

5.2.1 Delivery devices

Set the flowrate of gases being delivered (air and oxygen) and re-check the pressures if there has been any change to the flow rate. Regardless of the device used the suggested initial peak inspiratory pressure is 30 cm H₂O for term babies and 20–25 cm H₂O for preterm babies.¹ Pressure should subsequently be adjusted according to response.

Table 12 Delivery devices

Aspect	Consideration/good practice point
T-piece device	<ul style="list-style-type: none"> • Preferred device for neonatal resuscitation¹ • Requires pressurised gas source, therefore always have self-inflating bag available as a back up resuscitation device <ul style="list-style-type: none"> ○ Set up T-piece device at recommended pressures appropriate for the gestation of the baby and as determined and known by clinicians within the healthcare facility <ul style="list-style-type: none"> § Usually at 8–10 L /min • Recommended initial pressures: <ul style="list-style-type: none"> ○ Refer to Table 16 Positive pressure ventilation • Maximum pressure relief valve: <ul style="list-style-type: none"> ○ Set at 45–50 cm H₂O⁴ (depending on manufacturer's recommendations) <ul style="list-style-type: none"> § An upper limit of 35 cm H₂O is adequate for the majority of babies § Pressures greater than or equal to 45–50 cm H₂O (depending on manufacturer's recommendations) are rarely required at the beginning of resuscitation ○ Ensure all clinicians are trained to safely adjust pressure settings during resuscitation if required
Self-inflating bag	<ul style="list-style-type: none"> • Pressure release valve factory set at approximately 40 cm H₂O • Cannot effectively deliver CPAP, positive end expiratory pressure (PEEP) or sustained inflation breaths¹ <ul style="list-style-type: none"> ○ Only use for PPV and remove once respirations are established
Flow inflating (anaesthetic) bag	<ul style="list-style-type: none"> • Needs pressurised gas source • Always have self-inflating bag available as back up • Requires manometer • Effective delivery of PEEP, CPAP or sustained inflation breaths depends on user skills¹

5.3 Supplemental Oxygen

Table 13 Supplemental oxygen

Aspect	Good practice point
Goal	<ul style="list-style-type: none"> Regardless of the gestation, aim for oxygen saturations consistent with a healthy term baby¹ Refer to Table 8 Oxygen saturation monitoring and Appendix B Oxygen/air mix and target oxygen saturation
Priority	<ul style="list-style-type: none"> Ensure adequate lung inflation by auscultating lung fields Only increase fractional inspired oxygen (FiO₂) if CPAP or effective PPV have failed to achieve the target oxygen saturation Increase oxygen to 100% whilst chest compressions are occurring <ul style="list-style-type: none"> Titrate oxygen to the recommended oxygen saturation targets, once chest compressions have ceased
Term and near term baby¹	<ul style="list-style-type: none"> Use air initially and only administer oxygen to a baby whose SpO₂ does not meet the lower target range despite effective respiratory support Begin to wean oxygen concentration when SpO₂ reaches 90% if supplemental oxygen is being used
Preterm baby	<ul style="list-style-type: none"> Refer to Table 23 Preterm baby

5.4 Oxygen/air mix

An oxygen air blender is used to deliver greater than 21% or less than 100% oxygen. Facilities may have local guidelines regarding oxygen/air mix to deliver oxygen without a blender. Refer to Table 14 Suggested oxygen/air flows at 10 litres per minute and Table 15 Suggested oxygen/air flows at 8 litres per minute. These are suggested flows only. In the absence of capacity to provide an oxygen/air mix it may be necessary to resuscitate the baby in either room air or 100 % oxygen.

Table 14 Suggested oxygen/air flows at 10 litres per minute

Approximate oxygen%	Oxygen flowmeter L/min	Air flowmeter L/min
21%	0	10
30%	1	9
40%	2	8
50%	4	6
60%	5	5
70%	6	4
80%	7.5	2.5
90%	9	1
100%	10	0

Table 15 Suggested oxygen/air flows at 8 litres per minute

Approximate oxygen%	Oxygen flowmeter L/min	Air flowmeter L/min
21%	0	8
30%	1	7
40%	2	6
50%	3	5
60%	4	4
70%	5	3
80%	6	2
90%	7	1
100%	8	0

5.5 Positive pressure ventilation

Table 16 Positive pressure ventilation

Aspect	Recommendation/good practice point
Indications	<ul style="list-style-type: none"> • After stimulation: <ul style="list-style-type: none"> ○ HR less than 100 bpm and ○ Apnoea or inadequate breathing (e.g. gasping)
Technique	<ul style="list-style-type: none"> • Support the jaw, keeping the neck slightly extended in the 'sniffing position' • Mask ventilation: <ul style="list-style-type: none"> ○ Effectiveness indicated by improvement in HR ○ Ineffective chest wall movement may require two people as they can be more effective than one if mask leak continues <ul style="list-style-type: none"> § One person supports the jaw and holds the mask in place over the mouth and nose with two hands and second person provides positive pressure breaths¹
Rate¹	<ul style="list-style-type: none"> • 40–60 breaths per minute with inspiratory time of 0.3–0.5 seconds
Pressures¹	<ul style="list-style-type: none"> • If suitable equipment is available use PEEP of at least 5 cm H₂O during resuscitation to: <ul style="list-style-type: none"> ○ Assist lung expansion ○ Help establish a functional residual capacity ○ Improve oxygenation • PEEP greater than 8 cm H₂O can potentially reduce pulmonary blood flow and cause pneumothorax • Suggested initial pressures <ul style="list-style-type: none"> ○ Positive inspiratory pressure (PIP): <ul style="list-style-type: none"> § 30 cm H₂O for term babies § 20–25 cm H₂O for preterm babies less than 32 weeks gestation ○ PEEP: 5 cm ○ If pressures are not monitored, use minimal pressure to achieve physiological (not excessive) chest wall movement and an increase in HR • Higher inflation pressures may be required to aerate the lungs in first few inflation breaths • Ventilation can be accomplished for most babies with progressively lower pressures and rates as the resuscitation proceeds <ul style="list-style-type: none"> ○ Adjust the pressures according to the baby's response to PPV ○ Decrease ventilation pressures and rate when the baby is responding
Assessment of effectiveness	<ul style="list-style-type: none"> • Confirmed by observing: <ul style="list-style-type: none"> ○ HR increase to greater than 100 bpm ○ Slight rise of chest and upper abdomen with each inflation ○ Improvement in oxygenation saturations
Other care	<ul style="list-style-type: none"> • Continue PPV until spontaneous breathing is established • Gastric decompression via nasogastric tube is indicated when mask ventilation continues for several minutes

5.6 Intubation

5.6.1 ETT size and length

- Based on weight and gestational age of baby for initial resuscitation at birth or corrected age during neonatal period
- Table 17 ETT and suction catheters sizes provides accurate guidance about ETT size and length^{1,13,14}
- **ETT internal diameter** in millimetres can be calculated by corrected age in weeks divided by 10
- Approximate **ETT length/depth** from middle of upper lip calculated as weight in kg + 6 cm^{1,14,15}
- Check insertion depth as soon as possible after intubation

Table 17 ETT and suction catheters sizes

Corrected age (weeks)	Actual weight (kg)	ETT size-internal diameter (mm)	ETT mark at upper lip (cm)	ETT suction catheter size (F)
23–24	0.5–0.6	2.5	5.5	5–6
25–26	0.7–0.8		6.0	
27–29	0.9–1.0		6.5	
30–32	1.1–1.4	3.0	7.0	5–6
33–34	1.5–1.8		7.5	
35–37	1.9–2.4	3.5	8.0	6–8
38–40	2.5–3.1		8.5	
41–43	3.2–4.2	3.5–4.0	9.0	6–8

5.6.2 Endotracheal intubation

Table 18 Endotracheal intubation

Aspect	Recommendation/good practice point
Clinical standard	<ul style="list-style-type: none"> • Intubation is performed by clinicians who have completed appropriate training which includes supervised clinical practice and have been deemed to be competent
Indications¹	<ul style="list-style-type: none"> • Depends on: <ul style="list-style-type: none"> ○ Gestation of baby ○ Degree of respiratory depression ○ Response to face mask or laryngeal mask ventilation ○ Skill and experience of clinician • Perform if: <ul style="list-style-type: none"> ○ Unsuccessful ventilation via face mask or laryngeal mask ○ HR remains low ○ Oxygen saturation falling or failing to rise ○ Face or laryngeal mask ventilation is prolonged ○ Special circumstances (e.g. congenital diaphragmatic hernia (CHD)) or extremely low birth weight baby ○ Baby has no detectable HR at birth
Position verification¹	<ul style="list-style-type: none"> • It is good practice for at least two clinicians to agree by at least two methods that the ETT is correctly placed • Generally confirmed by three observations of baby in the following sequence: <ul style="list-style-type: none"> ○ Chest moves with each inflation ○ HR increase to above 100 bpm ○ Oxygen saturations improve • If chest wall movement does not occur and HR does not increase, re-evaluate ETT and ventilation technique: <ul style="list-style-type: none"> ○ May need to increase ventilation pressures and oxygen concentration ○ Use caution to avoid unnecessary extubation and re-intubation • Other signs of correct ETT placement: <ul style="list-style-type: none"> ○ Visual inspection of ETT passing through larynx ○ Condensation on inside of ETT during exhalation ○ Colour change in paediatric colorimetric end tidal CO₂ detector <ul style="list-style-type: none"> § Most reliable confirmation of ETT placement in neonates who have spontaneous circulation § False negative may present in baby with low or absent pulmonary blood flow or present if there is inadequate ventilation due to low pressures being delivered § False positive may occur if colorimetric device has prolonged exposure to humidity or is contaminated with adrenaline (epinephrine) or surfactant ○ Symmetrical air entry over lung fields auscultated with a stethoscope
Incorrect position¹	<ul style="list-style-type: none"> • Signs that suggest oesophageal insertion of ETT include: <ul style="list-style-type: none"> ○ Absent chest wall movement with inflations ○ HR less than 100 bpm that does not increase with intubation and ventilation ○ Expired CO₂ not detected ○ Oxygenation does not improve or deteriorates with PPV ○ Breath sounds absent in axillae ○ Increasing abdominal distension
Suction catheter	<ul style="list-style-type: none"> • Catheter size to be no more than half the internal diameter of ETT¹⁶ • Refer to Table 17 ETT and suction catheters

6 Chest compressions

Chest compressions are only uncommonly needed in neonatal resuscitation if the lungs have been effectively aerated. If chest compressions are indicated, urgent vascular access (preferably via umbilical vein) is required for administration of adrenaline (epinephrine).

Refer to Table 20 Medication and fluids and Table 21 Adrenaline (epinephrine) administration.

Table 19 Chest compressions

Aspect	Recommendation/good practice point
Position²	<ul style="list-style-type: none"> • Centre compressions over lower third of sternum <ul style="list-style-type: none"> ○ Above xiphisternum and just below nipples⁶
Depth²	<ul style="list-style-type: none"> • Depth of compression is one third anteroposterior diameter of chest
Ratio²	<ul style="list-style-type: none"> • Optimise the quality of compressions by minimising interruption • Compression-ventilation ratio 3:1 <ul style="list-style-type: none"> ○ Half second pause after each 3rd compression to deliver a breath ○ 90 compressions and 30 breaths in each minute • 120 compressions per minute can be delivered to intubated baby with no pause for breaths¹ • If cardiac aetiology is known or suspected in a baby consider using a two person compression-ventilation ratio of 15:2
Method^{1,2}	<ul style="list-style-type: none"> • Use 100% oxygen and perform in combination with adequate inflation breaths • Avoid simultaneous compression with breath • Rescuer's hands (fingers/thumbs) should not leave chest • Avoid interruption • Two thumb technique: <ul style="list-style-type: none"> ○ Use when two clinicians are available ○ Preferred as: <ul style="list-style-type: none"> § More advantageous in improving peak systolic pressure and coronary perfusion pressure over time § Perceived as easier and less tiring for the clinician ○ Position two thumbs on sternum (superimposed or adjacent) to each other according to size of baby and wrap fingers around thorax to support the back • Two finger technique: <ul style="list-style-type: none"> ○ Use when only one clinician is available ○ Two fingers are positioned with tips on sternum
Clinician^{1,2}	<ul style="list-style-type: none"> • Stand facing baby's head <ul style="list-style-type: none"> ○ This can be reversed if access to baby's abdomen is required
Effectiveness^{1,2}	<ul style="list-style-type: none"> • Pulsations will appear on oximeter if compressions delivered effectively • Interrupt compressions as little as possible and no more frequently than every 30 seconds <ul style="list-style-type: none"> ○ Check HR and cardiac output by auscultation and spontaneous pulsations on oximeter • Continue chest compressions until there are clear signs of return of spontaneous circulation <ul style="list-style-type: none"> ○ Note: Effective chest compressions will cause sufficient arterial pulsation for the pulse oximeter and will be an unreliable method to determine spontaneous (baby's own) heart rate • Refer also to Table 30 Ethical considerations

7 Medication and fluids

Medication and fluid are rarely indicated for neonatal resuscitation.⁶ Adrenaline (epinephrine) and volume expanders are generally the only medications required.

Naloxone is rarely used for newborn babies and should never be considered as a resuscitation drug but rather a drug used after stabilisation and admission to a neonatal unit. The priority for any baby who is suspected of having respiratory depression caused by maternal opiate administration is to provide PPV with T-piece device or bag and mask. Naloxone if required, is administered preferably intravenously once the baby's oxygen saturations and HR are stable. Naloxone is never administered to a baby exposed to intrauterine opioids. Refer to Queensland Clinical Guideline: *Perinatal substance use–neonatal*.¹⁷

Table 20 Medication and fluids

Aspect	Consideration/recommendation/good practice point
Context	<ul style="list-style-type: none"> • Establishing adequate ventilation is the most important step to improve HR • Bradycardia is usually caused by hypoxia and inadequate ventilation • Apnoea is usually caused by inadequate oxygenation of the brainstem • Administration of medications should not detract from the efficiency and continuity of ventilation and chest compressions
Administration routes	<ul style="list-style-type: none"> • Preferred intravascular access is via the umbilical vein^{1,2} • Alternative intravascular routes are peripheral vein or intraosseous (IO) route (if clinician trained in technique and unable to access umbilical vein or peripheral vein) <ul style="list-style-type: none"> ○ Endotracheal route is used when intravascular access cannot be obtained as there is lack of certainty about the effect of medication administered by this route
Umbilical vein	<ul style="list-style-type: none"> • Most rapidly accessible intravascular route for adrenaline (epinephrine) and fluid administration is via an emergency umbilical venous catheter (UVC) • UVC and 3-way tap are usually primed with 0.9% sodium chloride • Use for continued vascular access until alternative route established • Blood gases may be obtained from UVC and may guide treatment¹
ETT	<ul style="list-style-type: none"> • Not recommended¹ • Only adrenaline (epinephrine) is suitable to be administered via the ETT • Only use if vascular access not established <ul style="list-style-type: none"> ○ Do not delay attempts at vascular access
Peripheral vein	<ul style="list-style-type: none"> • Access may be difficult and time consuming especially in the hypovolaemic or shocked baby
Intraosseous	<ul style="list-style-type: none"> • Not commonly used for neonatal resuscitation because of: <ul style="list-style-type: none"> ○ A more readily accessible umbilical vein ○ Fragility of small bones ○ A small IO space especially in preterm baby • Can be used if umbilical venous access not available and resuscitation team proficient with • Preferred over ETT
Umbilical artery	<ul style="list-style-type: none"> • Not recommended for administration of medications¹

7.1 Adrenaline (epinephrine)

Table 21 Adrenaline (epinephrine) administration

Adrenaline (epinephrine) 1:10,000									
Aspect	Consideration								
Indication	<ul style="list-style-type: none"> If HR is less than 60 bpm and chest compressions are commenced establish vascular access and administer as soon as possible <ul style="list-style-type: none"> May improve cerebral blood flow¹ 								
Route	<ul style="list-style-type: none"> Use route most familiar to clinician Intravascular route (UVC, peripheral IV or IO) is strongly preferred UVC strongly preferable to peripheral or IO <ul style="list-style-type: none"> UVC has advantage of being a large visible vein, close to the heart Refer to Table 20 Medication and fluids 								
Intravenous (IV) dose and administration¹	<ul style="list-style-type: none"> Adrenaline (epinephrine) 1:10,000 contains 0.1mg per mL or 100 micrograms (micro) per mL IV adrenaline (epinephrine)1:10,000 (1mL=0.1 mg): <ul style="list-style-type: none"> 0.01–0.03 mg/kg (or 10–30 micro/kg) equates to 0.1–0.3 mL/kg¹ Follow with 2–3 mL 0.9% sodium chloride flush Can be repeated every 2–3 minutes if HR less than 60 bpm despite effective ventilation of the lungs using 100% oxygen and chest compressions Refer to Figure 1 Rounded doses of IV adrenaline (epinephrine) 1:10,000 for an urgent dose calculation based on the baby's gestation 								
	<table border="1"> <thead> <tr> <th>Corrected age (weeks)</th> <th>IV adrenaline (epinephrine) 1: 10.000 at 0.03 mg/kg¹</th> </tr> </thead> <tbody> <tr> <td>23–26</td> <td>0.1 mL</td> </tr> <tr> <td>27–37</td> <td>0.25 mL</td> </tr> <tr> <td>38–43</td> <td>0.5 mL</td> </tr> </tbody> </table>	Corrected age (weeks)	IV adrenaline (epinephrine) 1: 10.000 at 0.03 mg/kg ¹	23–26	0.1 mL	27–37	0.25 mL	38–43	0.5 mL
	Corrected age (weeks)	IV adrenaline (epinephrine) 1: 10.000 at 0.03 mg/kg ¹							
	23–26	0.1 mL							
	27–37	0.25 mL							
38–43	0.5 mL								
Figure 1 Rounded doses of IV adrenaline (epinephrine) 1:10,000									
<ul style="list-style-type: none"> Practice tip—For term baby: <ul style="list-style-type: none"> Draw up and administer 0.5 mL adrenaline (epinephrine) 1:10,000 (0.03 mg per kg dose) Administer by rapid bolus followed by 0.9% sodium chloride flush Repeat every two to three minutes while the HR is less than 60 bpm (despite adequate ventilation using 100 % oxygen and chest compressions) Higher doses are not recommended due to increased risk of post-resuscitation mortality and intraventricular haemorrhage¹ 									
Frequency	<ul style="list-style-type: none"> Repeat every two to three minutes while the HR is less than 60 bpm (despite adequate ventilation and cardiac compressions) 								
Dilution	<ul style="list-style-type: none"> Not required for 1:10,000 concentration 								
ETT dose and administration	<ul style="list-style-type: none"> Only use ETT route if IV access cannot be obtained or there is significant delay Do not delay attempts at vascular access as effectiveness of ETT adrenaline (epinephrine) has not been established If ETT route is used for administration of adrenaline (epinephrine) then suggested indication is: HR less than 60 bpm despite adequate ventilation and chest compressions ETT adrenaline (epinephrine) 1:10,000: <ul style="list-style-type: none"> 0.05–0.1 mg/kg (equates 0.5–1 mL/kg) Less preferred route <ul style="list-style-type: none"> Higher dose required¹ Follow with PPV <ul style="list-style-type: none"> Do not flush⁴ Administer IV dose as soon as vascular access obtained unless bradycardia has resolved 								

7.2 Volume expanding fluids

Use isotonic crystalloid (0.9% sodium chloride or Hartmann's solution) or Group O RhD negative blood if indicated.

Table 22 Administration of volume expanding fluids

Aspect	Recommendation/good practice point
Indications and fluid type	<ul style="list-style-type: none"> · Initially isotonic crystalloid (e.g. 0.9% sodium chloride or Hartmann's solution) for: <ul style="list-style-type: none"> ○ Suspected blood loss ○ Baby appearing to be in shock (i.e. pale, poor perfusion, weak pulse) and has not responded adequately to other resuscitative measures · Subsequently blood products (Group O RhD negative blood) may be required for an emergency transfusion when: <ul style="list-style-type: none"> ○ Critical blood loss—follow critical blood loss protocol <ul style="list-style-type: none"> § Refer to National Blood Authority (Australia) <i>Patient Blood Management Guidelines Module 6: Neonatal and Paediatrics</i> (2016)¹² ○ Baby not responding to resuscitation <ul style="list-style-type: none"> § Consider trial of volume administration as blood loss may be occult ○ Limited evidence of benefit and the potential for harm in absence of blood loss¹
Caution	<ul style="list-style-type: none"> · Routine fluid boluses during a resuscitation that is unresponsive to chest compressions and adrenaline (epinephrine) may be more harmful rather than beneficial¹
Route	<ul style="list-style-type: none"> · Intravascular—umbilical vein, intravenous, intraosseous · Refer to Table 20 Medication and fluids
Method	<ul style="list-style-type: none"> · IV push over several minutes¹
Dose	<ul style="list-style-type: none"> · 10 mL/kg¹
Frequency	<ul style="list-style-type: none"> · Observe response · Repeat if required after observation of the response

8 Special circumstances

8.1 Preterm baby

There are additional requirements for preterm babies.

Table 23 Preterm baby

Aspect	Consideration/recommendation/good practice point
Temperature management¹	<ul style="list-style-type: none"> • If preterm baby less than 28 weeks: <ul style="list-style-type: none"> ◦ Drying unnecessary and counter-productive as long as a polyethylene bag or sheet used ◦ Place baby in polyethylene bag or under polyethylene sheet up to the neck immediately after birth until alternative methods of thermal control available (e.g. pre-warmed humidified incubator) <ul style="list-style-type: none"> § Use medical or food grade and heat resistant polyethylene § Cover baby's head with hat/bonnet (pre-warmed) • Refer to Table 9 Care of baby for additional information
Skin protection and handling	<ul style="list-style-type: none"> • Refer to Table 9 Care of baby for information about handling and skin protection
Initiation of respiratory support	<ul style="list-style-type: none"> • ANZCOR suggests against the use of an initial sustained inflation (greater than five seconds) in the preterm baby¹ • Initiate PPV in the baby who does not breath spontaneously within first minute after birth • Refer to Table 10 General principles and Table 16 Positive pressure ventilation for additional information about respiratory support
CPAP	<ul style="list-style-type: none"> • Commence CPAP in the baby less than 32 weeks breathing spontaneously with signs of respiratory distress immediately after birth and in need of respiratory support • Use at least 5 cm H₂O and not more than 8cm H₂O • Deliver via facemask or nasal prongs <ul style="list-style-type: none"> ◦ Do not use self-inflating bag¹
PPV	<ul style="list-style-type: none"> • Suggested initial pressures are 20–25 cm H₂O • For a baby less than 32 weeks gestation deliver PEEP at least 5–8 cm H₂O¹ • Avoid high tidal volumes¹ • Aim for adequate/good chest wall movement
Oxygen	<ul style="list-style-type: none"> • Recommended to commence resuscitation using 21–30% oxygen • Adjust FiO₂ guided by pulse oximetry to meet target saturation¹ • If blended air and oxygen is not available commence resuscitation in air in preference to 100% oxygen • Refer to Table 13 Supplemental oxygen

8.2 Other special circumstances

Table 24 Other special circumstances

Aspect	Consideration/good practice point
Multiple births	<ul style="list-style-type: none"> • Always have at least one skilled resuscitator and a full set of resuscitation equipment for each baby • May be associated with: <ul style="list-style-type: none"> ○ Preterm birth ○ Abnormalities with placentation ○ Compromise of cord blood flow ○ Mechanical complications during birth ○ Discrepant blood volumes due to twin-to-twin transfusion syndrome in monozygotic fetuses¹
Pneumothorax	<ul style="list-style-type: none"> • Rare cause of failure to respond to resuscitation at birth • Signs (especially when deterioration occurs after initial response to resuscitation) include: chest recession/retraction, tachypnoea, unilateral decreased breath sounds, unilateral bulging chest wall • Confirm diagnosis by chest radiograph <ul style="list-style-type: none"> ○ Transillumination may be helpful in preterm babies but may be falsely negative in term babies • Emergency treatment (thoracentesis) may be required prior to chest radiograph in rapidly deteriorating baby • Prepare for bedside diagnosis and emergency treatment at birth if lung hypoplasia suspected from antenatal history¹ including: <ul style="list-style-type: none"> ○ Severe oligohydramnios or anhydramnios (e.g. secondary to PPROM many weeks before birth)
Pleural effusion/ascites/fetal hydrops	<ul style="list-style-type: none"> • Severe body wall oedema, pleural effusion, CDH, PPROM and ascites at birth can reduce chest wall compliance and diaphragmatic function and can cause lung hypoplasia • Can interfere with lung expansion <ul style="list-style-type: none"> ○ Ventilate with higher pressures if needed to achieve lung expansion ○ Higher than usual ventilation rates may be needed to achieve carbon dioxide elimination • Commence cardiorespiratory monitoring • Perform thoracentesis after radiographic or ultrasound examination unless emergency¹
Pneumonia/sepsis	<ul style="list-style-type: none"> • Congenital pneumonia presents like respiratory distress syndrome • May require high ventilation pressures to open poorly compliant lungs¹
Fetal haemorrhage	<ul style="list-style-type: none"> • Small volume of fetal blood loss may cause hypovolaemia • Exsanguinated baby may have a good HR but be very pale • May require IV fluids or blood products for effective resuscitation • Refer to Table 22 Administration of volume expanding fluids • Neonatal critical blood loss protocol may need to be activated to address restoration of oxygen carrying capacity and likely coagulopathy^{1,12}

8.3 Congenital anomalies

Table 25 Congenital anomalies

Aspect	Consideration
Congenital upper airway obstruction	<ul style="list-style-type: none"> • Assess baby who is pink when crying but cyanotic with or without laboured breathing when quiet for choanal atresia or other upper airway obstruction <ul style="list-style-type: none"> ○ Use of oral airway may relieve obstruction • Baby with small pharynx associated with small mandible <ul style="list-style-type: none"> ○ Position prone and/or place ETT into pharynx via nostril as mechanical stent • Baby with compromising craniofacial abnormalities may require a laryngeal mask airway <ul style="list-style-type: none"> ○ If tracheal intubation required consider expert assistance¹ (e.g. an otorhinolaryngologist or paediatric anaesthetist)
Congenital diaphragmatic hernia	<ul style="list-style-type: none"> • Do not give bag and mask ventilation • Intubate or insert laryngeal mask airway immediately if respiratory support required <ul style="list-style-type: none"> ○ Breath sounds may be asymmetrical • Insert wide bore orogastric tube and place on free drainage with intermittent suction to avoid air accumulation in intrathoracic small bowel and relieve lung compression • Use low inflation pressures as only one lung may be functional¹
Unexpected congenital anomalies	<ul style="list-style-type: none"> • Unless prior discussion has been had with parents, resuscitate baby completely and thoroughly¹ • Further evaluation and management decisions can be made in neonatal unit¹
Congenital heart disease	<ul style="list-style-type: none"> • Baby who remains centrally cyanotic despite adequate ventilation, oxygenation and circulation may have congenital heart disease or persistent pulmonary hypertension • Congenital heart block (very rarely) is the cause of bradycardia • Arrange early transfer to neonatal intensive care unit (NICU) and echocardiographic evaluation¹
Abdominal wall defects	<ul style="list-style-type: none"> • Baby with gastroschisis or large omphalocele will require protection to the exposed abdominal contents by a polyethylene (plastic) wrap (medical grade) or 'bowel bag' to reduce drying, heat loss or contamination <ul style="list-style-type: none"> ○ Enclose bowel lightly and position so that blood flow is optimised ○ Position baby on the right side and support the viscera • Avoid CPAP and PPV via a face mask • Ventilation via an ETT or laryngeal airway mask (LMA) is preferred if breathing is laboured or ineffective • Insert large bore (size F8) orogastric tube on free drainage and aspirate frequently to remove air¹

9 Care after resuscitation

A baby with perinatal compromise or ongoing respiratory distress may have delayed or dysfunctional perinatal adaptation of the brain, heart, gastrointestinal tract, kidneys or other organs.¹

9.1 Cord blood sampling

Table 26 Cord blood gas sampling

Aspect	Consideration	
Indications	<ul style="list-style-type: none"> • Baby requiring resuscitation to objectively assess the condition just before birth⁶ • Apgar score: <ul style="list-style-type: none"> ○ Less than 4 at one minute ○ Less than 7 at five minutes¹⁸ • When fetal blood sampling has occurred in labour^{1,3} • Refer to Queensland Clinical Guideline: <i>Intrapartum fetal surveillance</i>³ 	
Procedure	<ul style="list-style-type: none"> • Collect paired samples from umbilical vein and umbilical artery³ • Effect of delayed cord clamping on values uncertain⁶ but some research has shown effect on acid-base parameters^{19,20} 	
Interpretation	<ul style="list-style-type: none"> • If there is a low cord arterial pH the relative risk of neonatal encephalopathy is increased • A normal pH does not rule out subsequent neonatal morbidity²¹ • Refer to Queensland Clinical Guideline: <i>Hypoxic ischaemic encephalopathy (HIE)</i>² • Refer to Table 27 Umbilical artery cord blood gases 	
	Relative risk (RR) of neonatal morbidity (CI 95%)²¹	
	Arterial pH	RR
	7.06–7.10	2.22 (1.06–4.62)
	7.01–7.05	3.63 (1.60–8.22)
	Less than or equal to 7.0	18.20 (10.51–31.70)
Lactate	<ul style="list-style-type: none"> • There may be a marginally better predictability of morbidity using lactate measures,²³ however: <ul style="list-style-type: none"> ○ Minimal difference between lactate and pH predictability ○ Better data available for pH for longterm outcomes²¹ • Normal lactate thresholds have not been agreed 	

9.1.1 Umbilical artery cord blood gases

Paired cord blood gases are the most objective means of assessing the condition of the baby just prior to birth. Paired cord samples from the umbilical vein and umbilical artery are advisable.^{1,3}

Table 27 Umbilical artery cord blood gases

Umbilical artery ¹	2.5th percentile	Mean	97.5th percentile
pH	7.1	7.27	7.38
Base excess	-11	-4	1
pO ₂ (mmHg)	6	17	30
pCO ₂ (mmHg)	35	52	74

9.2 Continuing clinical care

Table 28 Continuing clinical care

Aspect	Consideration
Documentation	<ul style="list-style-type: none"> • For clinical and medico-legal reasons document observations, interventions, care and times during resuscitation • Assess and record Apgar scores: <ul style="list-style-type: none"> ○ At one and five minutes ○ Sequentially every five minutes until Apgar score is greater than or equal to 8, or the HR is above 120 bpm and full ventilatory assistance is being provided ○ This quantifies and summarise the response to resuscitation over the first few minutes
Continuing care	<ul style="list-style-type: none"> • Following establishment of adequate ventilation and circulation, observe and assess baby in special care or intensive care nursery • Observe for delayed perinatal adaptation of brain, heart, gastrointestinal tract, kidneys or other organs • Monitor fluid balance and nutrition • Provide routine care if the baby is well including vigilance observations
Parents and family	<ul style="list-style-type: none"> • Keep parent(s) informed during and after resuscitation—ideally by a senior clinician • Encourage early contact between parent(s) and baby • Facilitate postnatal debrief and follow up
Stabilisation and transfer	<ul style="list-style-type: none"> • Transfer baby to higher level facility if birthing facility unable to provide appropriate level of post resuscitation monitoring and support • Refer to Queensland Clinical Guideline: <i>Stabilisation for retrieval</i>^β
Antibiotics	<ul style="list-style-type: none"> • Consider relevant investigations and antibiotic treatment
Induced hypothermia for hypoxic ischaemic encephalopathy¹	<ul style="list-style-type: none"> • Screening for need for induced hypothermia is indicated when baby greater than or equal to 35 weeks gestation has any of the following: <ul style="list-style-type: none"> ○ Mechanical ventilation or prolonged resuscitation (e.g. assisted ventilation and/or chest compressions at 10 minutes of age) ○ Apgar score at 10 minutes less than or equal to five ○ pH less than 7.00 or base excess worse than or equal to minus 12 mmol/L from cord blood gas or sample (arterial, venous or capillary) obtained within 60 minutes of birth • Assess neurological status for a minimum of six hours after birth and document hourly • Discuss early with neonatologist and organise for transfer of baby to tertiary facility <ul style="list-style-type: none"> ○ If recommended (because of signs of moderate or severe encephalopathy) commence induced hypothermia • Refer to Queensland Clinical Guideline: <i>Hypoxic ischaemic encephalopathy (HIE)</i>²²

9.3 Monitoring and management

Table 29 Monitoring and management

Aspect	Consideration/good practice point
Blood glucose management¹	<ul style="list-style-type: none"> • Check blood glucose soon after resuscitation as there is increased risk of hypoglycaemia • Maintain blood glucose level equal to or greater than 2.6 mmol/L • Usually glucose 4–6 mg/kg/minute is sufficient • Avoid large bolus doses of glucose (greater than 100–200 mg/kg) • Refer to Queensland Clinical Guideline: <i>Newborn hypoglycaemia</i>²⁴ • NOTE: 1 ml 10% glucose contains 100 mg glucose
Temperature¹	<ul style="list-style-type: none"> • Measure temperature with skin sensor if resuscitation greater than 5 minutes • Measure and record after resuscitation and on admission to nursery • Refer to Table 4 Preparation • Additional measures: <ul style="list-style-type: none"> ○ Provide warmed humidified resuscitation gases ○ Cover the baby's head (except the face) with hat/bonnet or folded bedding ○ Preterm and low birth weight babies require: <ul style="list-style-type: none"> § Ambient temperature of at least 26 °C (where possible) § Use of exothermic warming mattress, incubator or open care radiant heater bed
Monitoring (when assisted ventilation provided)¹	<ul style="list-style-type: none"> • Continuous monitoring may include: <ul style="list-style-type: none"> ○ Temperature ○ Oxygen saturation ○ HR ○ Respiratory rate and pattern ○ Blood glucose ○ Blood gas ○ Fluid balance and nutrition ○ Blood pressure ○ Neurological signs
Cardiorespiratory management¹	<ul style="list-style-type: none"> • If intubation and ventilation provided: <ul style="list-style-type: none"> ○ Make careful risk assessment of potential need to re-intubate prior to extubating baby • If assisted ventilation provided: <ul style="list-style-type: none"> ○ Monitor pressures, oxygen/air flows and oxygen concentration • Preterm baby may require surfactant administration

10 Ethical considerations

Table 30 Ethical considerations

Aspect	Consideration
Initiating resuscitation¹	<ul style="list-style-type: none"> • Consistent and co-ordinated approach from obstetric/midwifery and neonatal staff • High rate of survival and acceptable morbidity: resuscitation usually indicated • Borderline survival and high rate of morbidity with prognosis uncertain and the burden to the child high: support the parents' views regarding resuscitation • Almost certain early death and unacceptable high morbidity as indicated by gestation, birth weight or congenital anomaly: resuscitation is not indicated • When unexpected anomalies present, offer full resuscitation until full clinical picture available and discussions occur with parents • Clinicians and parents together decide to withhold or withdraw treatment based on futility and 'best interests' of baby • Refer to Queensland Clinical Guideline: <i>Perinatal care at the threshold of viability</i>²⁵
Discontinuing resuscitation¹	<ul style="list-style-type: none"> • May be influenced by: <ul style="list-style-type: none"> ○ Presumed diagnosis ○ Gestation of baby ○ Presence or absence of complications ○ Parent(s) views regarding acceptable risk of morbidity • Late preterm and term baby: <ul style="list-style-type: none"> ○ Undetectable or very low HR for 10 minutes likely survival and quality of survival deteriorate precipitously by this time • Absence of spontaneous breathing or Apgar score of 1–3 at 20 minutes of age in babies of 34 weeks gestation or greater with detectable HR are strong predictors of mortality or significant morbidity—requires discussion with neonatologist/paediatrician and parents • Withdrawal or withholding of resuscitation: <ul style="list-style-type: none"> ○ Focus on baby's comfort (if signs of life present) and support of the parents

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Appendix A Equipment and medications for neonatal resuscitation

Equipment	Comment
General	<ul style="list-style-type: none"> • Firm, horizontal, padded resuscitation surface • Overhead warmer • Light for the area • Clock with timer in seconds • Warmed towels or similar covering • Polyethylene bag / sheet—size for baby < 1500 g or < 28 weeks gestation • Stethoscope (neonatal preferred) • Pulse oximeter plus neonatal sensor (disposable with foam band tape or self-adherent bandage)
Documentation	<ul style="list-style-type: none"> • Resuscitation record sheet • Equipment check list
Airway management	<ul style="list-style-type: none"> • Suction unit (negative pressure 100 mmHg) • Suction catheters—sizes 5F, 6F, 8F and 10F or 12F • Suction tubing • Oropharyngeal airways—sizes 00 and 0 • Intubation equipment: <ul style="list-style-type: none"> ○ Compatible laryngoscope handles and blades ○ Laryngoscopes with neonatal blades—0 and 1 (and sizes 00 in level 5 and 6 neonatal units) ○ Spare batteries and bulbs (unless fibre optic laryngoscope) ○ Endotracheal tubes (ETT)—uncuffed, no Murphy eye, sizes 2.5, 3.0, 3.5 and 4.0 mm internal diameter ○ ETT introducer/stylet (optionally used for oral intubation only) ○ Supplies for fixing ETT (e.g. sterile scissors, tape, skin prep swabs and skin barrier) ○ Magill forceps—neonatal size (optional—for nasal intubation) ○ Paediatric end-tidal carbon dioxide (CO₂) detector • Meconium suction device (to apply suction directly to ETT) • Laryngeal mask airway—size 1 (suitable for neonates up to 5 kg)
Breathing support	<ul style="list-style-type: none"> • Face masks (cushioned rim)—range of sizes suitable for premature and term neonates <ul style="list-style-type: none"> ○ Positive Pressure Ventilation device either: <ul style="list-style-type: none"> § T-Piece resuscitation device (preferred), or § Flow-inflating bag with pressure safety valve and manometer, and § Self-inflating bag (240 mL) preferably with a removable oxygen reservoir and PEEP valve • Medical gases: <ul style="list-style-type: none"> ○ Source of medical oxygen (reticulated and/or cylinder) with flow meter and tubing—allowing flow rate of up to 10 L/min ○ Source of medical air with flow meter and tubing—allowing flow rate of up to 10 L/min ○ Air/oxygen blender • Feeding tubes for gastric decompression sizes 6F and 8F • 10 mL syringe for aspirating gastric contents • Emergency thoracentesis kit (alcohol swabs, 3-way tap, 24G butterfly needle or 24G soft cannula and 30 cm extension set and 20 mL syringe)
Circulation support	<ul style="list-style-type: none"> • Umbilical venous catheter (UVC) kit—UVC size 5F • Peripheral IV cannulation kit including cannulas and 3-way taps with extension • Skin preparation solution suitable for neonatal skin • Tapes/devices to secure UVC/IV cannula (e.g. arm board) • Syringes and needles—assorted sizes • Intraosseous needles
Medications and fluid	<ul style="list-style-type: none"> • Adrenaline (epinephrine) 1:10 000 concentration (0.1 mg/mL) • Volume expanders: <ul style="list-style-type: none"> ○ Normal saline (0.9% sodium chloride) or Hartmann's solution ○ Blood suitable for emergency neonatal transfusion (Group O RhD negative)—readily available if required for profoundly anaemic baby

Appendix B Oxygen/air mix and target oxygen saturation

Suggested oxygen/air mix in the absence of a blender

Oxygen/air mix at 10 L/min

Approximate oxygen%	Oxygen flowmeter L/Min	Air flowmeter L/Min
21%	0	10
30%	1	9
40%	2	8
50%	4	6
60%	5	5
70%	6	4
80%	7.5	2.5
90%	9	1
100%	10	0

Oxygen/air mix at 8 L/min

Approximate oxygen%	Oxygen flowmeter L/Min	Air flowmeter L/Min
21%	0	8
30%	1	7
40%	2	6
50%	3	5
60%	4	4
70%	5	3
80%	6	2
90%	7	1
100%	8	0

Target oxygen saturations

Target oxygenation saturations for the **first 10 minutes of life** are used when oxygen is administered during resuscitation i.e. an individual baby may have a higher reading when breathing spontaneously in air. These targets do not apply after the first 10 minutes of life.

Time from birth (minutes)	Target oxygen %
1	60–70
2	65–85
3	70–90
4	75–90
5	80–90
10	85–90

Reference: Australian and New Zealand Council on Resuscitation. Section 13 Neonatal Guidelines. 2016

Appendix C Endotracheal tube intubation

Equipment to prepare and perform endotracheal tube intubation (ETT) intubation

- T-piece infant resuscitator (or flow-inflating bag) and 240 mL self-inflating bag
- Neonatal face masks (cushioned rim) for preterm and term babies
- Medical gases:
 - Medical oxygen with flow meter and tubing
- Reticulated or cylinder allowing flow rate up to 10 L/min
 - Medical air plus oxygen/air blender
- Suction apparatus and suction catheters (6F, 8F and 10F/12F)
- Laryngoscopes with neonatal blades—0 and 1 (and sizes 00 in level 5 and 6 neonatal units)
 - Spare bulbs and batteries
 - Bright light source
- Endotracheal tubes (sizes 2.5, 3.0, 3.5, and 4.0 mm internal diameter)
 - Uniform diameter without a cuff
 - No Murphy eye
 - Uncuffed
 - Standard curve
 - Clear or translucent
 - Radio-opaque
 - Centimetre markings along length
- Endotracheal stylet or introducer (optional for oral intubation, not used for nasal intubation)
- Supplies to secure ETT (tapes, scissors)
- Neonatal stethoscope
- Paediatric end-tidal carbon dioxide (CO₂) detector
- Magill neonatal forceps (optional—used for nasal intubation only)

ETT size and length

- **ETT internal diameter** in millimetres calculated by corrected age* in weeks divided by 10
- Approximate **ETT length/depth** from middle of upper lip calculated as weight in kg + 6 cm
- Always confirm ETT position when baby is stable

Corrected age* (weeks)	Actual weight (kg)	ETT size-internal diameter (mm)	ETT mark at upper lip (cm)	ETT suction catheter size (F)
23–24	0.5–0.6	2.5	5.5	5–6
25–26	0.7–0.8		6.0	
27–29	0.9–1.0		6.5	
30–32	1.1–1.4	3.0	7.0	5–6
33–34	1.5–1.8		7.5	
35–37	1.9–2.4	3.5	8.0	6–8
38–40	2.5–3.1		8.5	
41–43	3.2–4.2	3.5-4.0	9.0	6–8

*Corrected age calculated by adding gestational age and postnatal age

Adapted from:

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