

Queensland Clinical Guidelines

Translating evidence into best clinical practice

Maternity and Neonatal **Clinical Guideline**

Neonatal resuscitation

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Endorsed by:	Queensland Clinical Guidelines Steering Committee Queensland Maternity and Neonatal Clinical Network
Contact:	Email: guidelines@health.qld.gov.au URL: www.health.qld.gov.au/qcg



Cultural acknowledgement

We acknowledge the Traditional Custodians of the land on which we work and pay our respect to the Aboriginal and Torres Strait Islander Elders past, present and emerging.

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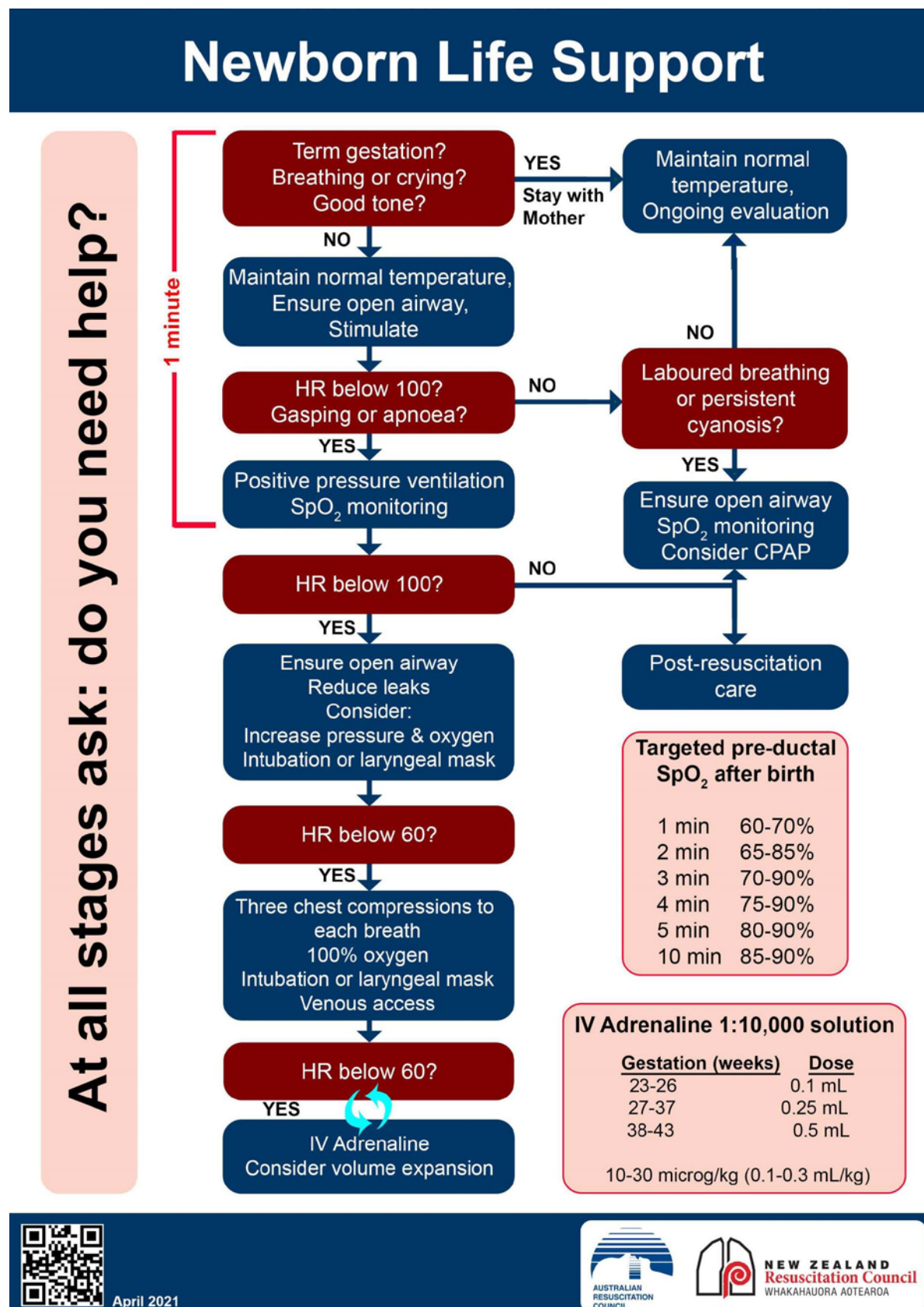
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Flowchart: Neonatal resuscitation



CPAP: continuous positive airway pressure; **HR** heart rate; **SpO₂:** peripheral capillary oxygen saturation, **IV:** intravenous
NOTE: A laryngeal mask is a supraglottic airway

Flowchart: F22.5-1-V5-R27

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Abbreviations

ANZCOR	Australian and New Zealand Committee on Resuscitation
bpm	Beats per minute
CPAP	Continuous positive airway pressure
DCC	Delayed cord clamping
ECC	Early cord clamping
ETT	Endotracheal tube
FiO₂	Fraction of inspired oxygen
HIE	Hypoxic ischaemic encephalopathy
HR	Heart rate
IO	Intraosseous
IV	Intravenous
LMA	Laryngeal mask airway™
NEWT	Newborn early warning tool
PEEP	Positive end expiratory pressure
PIP	Peak inspiratory pressure
PPV	Positive pressure ventilation
PPROM	Preterm prelabour rupture of membranes
RSQ	Retrieval Services Queensland
SpO₂	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.
Moderate hypothermia	Temperature between 35.5 °C and 35.9 °C.
Mild hypothermia	Temperature between 36.0 °C and 36.4 °C.
pCO₂	Partial pressure of carbon dioxide.
pH	Potential hydrogen—measure of acidity and alkalinity of blood.
pO₂	Partial pressure of oxygen.
Supraglottic airway	Airway device (e.g. laryngeal mask airway™) that can be inserted into the pharynx for ventilation and oxygenation, where endotracheal tube insertion is not possible.
Woman	In QCG documents, the terms <i>woman</i> and <i>women</i> include people who do not identify as women but who are pregnant or have given birth.

1 Introduction

Neonatal resuscitation is aimed at supporting the baby's transition to independent breathing and circulation. Approximately 85% of babies born at term initiate spontaneous respirations with an additional 10% responding to drying and stimulation. Around 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.^{1,2}

1.1 Preparation for resuscitation

1.1.1 Clinical standards

Table 1. Clinical standards

Aspect	Good practice point
Context	<ul style="list-style-type: none"> All facilities providing maternity services require appropriate preparation for neonatal resuscitation <ul style="list-style-type: none"> Refer to relevant Requirements and preparation will vary dependent on circumstances (e.g. gestation and weight of baby, birthing environment, and skill and availability of clinicians)
Standard care	<ul style="list-style-type: none"> Refer to Queensland Clinical Guideline: <i>Standard care</i>³ for care that is considered 'usual' or 'standard' <ul style="list-style-type: none"> Includes, for example privacy, consent, decision making, sensitive communication, medication administration, staff education and support, culturally appropriate care and documentation
Specific documentation	<ul style="list-style-type: none"> Whenever possible, appoint one person to be responsible for documentation during the resuscitation Use a standard form to record resuscitation events² Record observations, interventions and times during the resuscitation² Assess and record the Apgar score: <ul style="list-style-type: none"> At one and five minutes after birth and then, Every five minutes until heart rate (HR) is normal and respiration has been established or Full ventilator assistance is being given
Retrieval Services Queensland (RSQ)	<ul style="list-style-type: none"> If required contact RSQ as soon as possible for: <ul style="list-style-type: none"> Discussion with neonatologist Advice and activation of retrieval Refer to Queensland Clinical Guideline: <i>Neonatal stabilisation and retrieval</i>³

1.1.2 Equipment

Table 2. Equipment

Aspect	Good practice point
Equipment and medications²	<ul style="list-style-type: none"> Undertake regular checks to ensure equipment is complete and operational Refer to Queensland Clinical Guidelines: <i>Neonatal resuscitation equipment checklist</i>⁴ and Appendix A Equipment and medications for neonatal resuscitation Ensure all relevant staff are familiar with equipment, medications and resuscitation trolley layout
Preparation	<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 provided Prior preparation of standardised kits containing equipment for procedures (e.g. umbilical catheterisation and thoracentesis) can save considerable time in emergencies Provide reference information for use during resuscitation <ul style="list-style-type: none"> Refer to Queensland Clinical Guidelines: <i>Neonatal resuscitation reference chart</i>⁵

1.1.3 Environment

Table 3.Environment

Aspect	Good practice point
Environmental temperature	<ul style="list-style-type: none"> Aim for birthing room temperature for baby⁶: <ul style="list-style-type: none"> Less than 32 weeks gestation: 23 to 25 °C Less than 28 weeks gestation: at least 26 °C
Context	<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 Refer to Table 9 Temperature management
Preterm or very low birth weight babies	<ul style="list-style-type: none"> Babies less than 32 weeks gestation or with 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 gestation^{6,7} Hat/bonnet (pre-warmed) Thermal mattress^{7,8}if available) Have pre-warmed cot available for transfer of preterm or term baby requiring admission to neonatal unit

1.2 Communication

Where possible, ensure discussions between clinicians (maternal care givers and those who will be resuscitating the baby after birth) and with the parents occur before birth and include relevant key issues.

Table 4. Communication

Aspect	Consideration
Maternal	<ul style="list-style-type: none"> Communicate details of: <ul style="list-style-type: none"> Pre-existing or pregnancy related medical condition/s and treatment/s 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)⁹ Maternal risk factors for infections including fever in labour and the results of screening if known (e.g. Group B streptococcus) [refer to Queensland Clinical Guideline: <i>Early onset Group B streptococcal disease</i>¹⁰] Maternal medication antenatally and in labour
Neonatal	<ul style="list-style-type: none"> Minimum information required includes: <ul style="list-style-type: none"> Gestational age and expected/estimated fetal weight (if known) If multiple birth, number of expected babies Reason for high risk birth Presence of meconium in the liquor Assessments of fetal viability Any known congenital abnormalities
Parent(s)	<ul style="list-style-type: none"> Whenever possible, introduce the team who will resuscitate the baby to the parent(s) before the birth Discuss the proposed plan for care, respond to parent's questions and document discussions If applicable, include parents in decisions about the extent of the resuscitation especially in cases of potentially lethal fetal malformations or extreme prematurity¹¹ <ul style="list-style-type: none"> Refer to Queensland Clinical Guideline Perinatal care of the extremely preterm baby¹² Refer to Table 34 Ethical considerations If indicated, discuss potential transfer of baby to higher level facility <ul style="list-style-type: none"> Provide relevant parent information (e.g. Queensland Clinical Guidelines: Newborn resuscitation¹³and Baby needing transfer¹⁴)

1.3 Clinicians

Appropriately trained and available clinical staff is required for neonatal resuscitation.

Table 5. Clinicians

Aspect	Good practice point
Context²	<ul style="list-style-type: none"> At least one person is responsible for the care of the baby only Effective teamwork is essential to the success of neonatal resuscitation, particularly advanced resuscitation
Low risk births^{2,15}	<ul style="list-style-type: none"> A clinician trained in basic neonatal resuscitation is in attendance and responsible only for the care of the newborn A clinician trained in advanced neonatal resuscitation is available in case required
High risk births^{2,15}	<ul style="list-style-type: none"> A clinician trained in advanced neonatal resuscitation is in attendance and responsible only for the care of the newborn More than one experienced person is present to care for the newborn An advanced trained clinician for unplanned high risk births may not be available at non-tertiary facilities
Caesarean birth²	<ul style="list-style-type: none"> If there are no antenatally identified risk factors and regional anaesthesia has been used, the clinician skills include ability to perform basic neonatal resuscitation including assisted ventilation Intubation skills are not a requirement
Unplanned high risk birth	<ul style="list-style-type: none"> An advanced trained clinician for unplanned high risk births may not be available at non-tertiary facilities Contact RSQ for immediate support

1.3.1 Clinician training

Table 6. Clinician skills

Aspect	Good practice points
Context	<ul style="list-style-type: none"> During neonatal resuscitation training, include the necessary individual and teamwork skills and reinforce these through regular practice Clinicians responsible for neonatal resuscitation have knowledge and skills to use available neonatal resuscitation equipment
Training programs²	<ul style="list-style-type: none"> Basic neonatal resuscitation consists of: <ul style="list-style-type: none"> Airway support, ventilation via face mask/laryngeal mask and chest compressions Advanced neonatal resuscitation includes all of the following: <ul style="list-style-type: none"> Basic neonatal resuscitation skills Endotracheal intubation Vascular cannulation (umbilical/peripheral) Medication and fluid use
Recommended training requirements²	<ul style="list-style-type: none"> At least annual training and competency assessment Formal refresher courses every two years Regular drills—training by simulation and regular debriefings as an adjunct to other education methods² Regular reinforcement in clinical practice more frequently than annually may involve brief, on-site activities to support technical skills, knowledge and teamwork Include the necessary individual and teamwork skills and reinforce these through regular practice

2 Risk factors for neonatal resuscitation

There are a number of factors that increase the risk of resuscitation at birth. The list in Table 7 Risk factors is not exhaustive and the magnitude of the risk varies depending on the number and severity of the risk factor.²

Table 7 Risk factors

Aspect	Consideration
Maternal²	<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, selective serotonin reuptake inhibitor) • 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
Fetal²	<ul style="list-style-type: none"> • Multiple gestation • 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 movements before onset of labour • Congenital abnormalities which may affect breathing, cardiovascular function or other aspects of perinatal transition • Intrauterine infection • Hydrops fetalis
Intrapartum²	<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>¹⁶ • Abnormal fetal presentation • Cord prolapse • 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 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.² Immediate and ongoing assessment of the baby starts at birth, and continues throughout and after the resuscitation process.¹⁷

If resuscitation is not indicated, place baby skin to skin ensuring airway patency and warmth of baby. Refer to Queensland Clinical Guidelines *Normal birth* and *Standard care*.^{3,18}

3.1 Cord clamping

Table 8. Delayed cord clamping

Aspect	Consideration
Vigorous baby greater than or equal to 34 weeks gestation	<ul style="list-style-type: none"> Recommend cord clamping at 60 seconds or more after birth² <ul style="list-style-type: none"> Also known as delayed or deferring cord clamping (DCC) Is associated with^{2,19,20}: <ul style="list-style-type: none"> Increased placental transfusion Increased cardiac output Higher and more stable blood pressure Higher haemoglobin levels and improved iron status later in infancy²¹ Potential increase incidence of jaundice requiring phototherapy¹⁹ No difference between early cord clamping (ECC) and DDC for 30 seconds or more for¹⁹: <ul style="list-style-type: none"> Neonatal mortality Need for resus Admission to neonatal unit Increase in phototherapy Anaemia at four to six months of age Child neurodevelopmental outcomes Maternal outcomes (e.g. postpartum haemorrhage) Insufficient evidence to recommend a physiological approach to timing of cord clamping (e.g. when pulsation ceases)¹⁹
Non-compromised preterm baby less than 34 weeks gestation	<ul style="list-style-type: none"> DCC (for at least 30 seconds) is associated with^{2,22,23}: <ul style="list-style-type: none"> Improved neonatal survival Increased blood volume Reduce need for inotropes Increased blood pressure during stabilisation and at four hours of age No effect on major neonatal morbidities (e.g. intraventricular haemorrhage (IVH), necrotising enterocolitis (NEC), chronic lung disease)²³ Improvement in some haematologic measures—reduced need for blood transfusion Increased peak bilirubin level but without increased need for phototherapy
Compromised baby	<ul style="list-style-type: none"> Resuscitation takes precedence over DCC until further evidence is available² <ul style="list-style-type: none"> If cord is unclamped and low resistance placenta still connected, chest compressions will not improve systemic and coronary perfusion² Consider maternal, fetal and placental conditions regarding cord management based on severity of the condition, and risk to the woman and baby² (e.g. severe maternal postpartum haemorrhage (PPH), twin anaemia polycythaemia syndrome, bleeding vasa praevia are all relative contra-indications) Insufficient evidence for reliable conclusions about immediate care for the term or preterm baby beside the mother with the cord intact²⁴⁻²⁶
Cord milking intact or cut cord	<ul style="list-style-type: none"> If greater than or equal to 34 weeks gestation—insufficient evidence of benefit to recommend² If 28+0 to 33+6 weeks gestation and immediate resuscitation after birth not required—intact cord milking may be a reasonable alternative to deferred cord clamping²⁷ If less than 28+0 weeks—not recommended²

3.2 Temperature management

Table 9 Temperature management

Aspect	Consideration
Context	<ul style="list-style-type: none"> 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—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 palsy² If criteria are met for therapeutic hypothermia for hypoxic ischaemic encephalopathy (HIE) refer to Queensland Clinical Guideline: <i>Hypoxic ischaemic encephalopathy (HIE)</i>²⁸
Temperature management	<ul style="list-style-type: none"> Additional measures to consider⁷: Establish suitable ambient temperature [refer to] Provide warm humidified resuscitation gases to preterm baby (if available) Cover the baby's head (except the face) with hat/bonnet or folded bedding If well baby and term or near term: <ul style="list-style-type: none"> Recommend skin to skin contact during transitional period (at least 1–2 hours after birth) If preterm baby, refer to Table 27 Preterm baby 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
Temperature of baby	<ul style="list-style-type: none"> Target normal body temperature for all babies during resuscitation: <ul style="list-style-type: none"> Maintain temperature between 36.5 °C and 37.5 °C Consider measuring skin temperature with skin sensor if resuscitation greater than 5 minutes Measure baby's temperature: <ul style="list-style-type: none"> As soon as possible post-resuscitation and/or no later than by 30 minutes of age Measure baby's temperature on admission to maternity ward or neonatal unit² When resuscitation is completed or not required: <ul style="list-style-type: none"> Keep the baby warm by skin to skin contact and covering the mother and baby—cover baby's back with warm wrap/blanket Maintain close visual monitoring of baby for airway patency²

3.3 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 age²⁹. Refer to Flow Chart: Neonatal resuscitation

Table 10 Assessment and initial management at birth

Aspect	Consideration
Handling and skin protection	<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^{30,31} <ul style="list-style-type: none"> ◦ Refer to Table 27 Preterm baby • Temperature management—refer to Table 9 Temperature management
Initial assessment¹⁷	<ul style="list-style-type: none"> • Tone • Breathing • HR
Tone and response to stimulation¹⁷	<ul style="list-style-type: none"> • Subjective and dependent on gestation • If good tone (i.e. moving limbs and flexed posture) <ul style="list-style-type: none"> ◦ Less likely to be compromised • If poor tone/floppy (i.e. not moving and extended posture) : <ul style="list-style-type: none"> ◦ More likely to need active resuscitation
Initial management²⁹	<ul style="list-style-type: none"> • 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 baby and placed in polyethylene bag⁸: <ul style="list-style-type: none"> ◦ Head only needs drying and warm hat/bonnet applied ◦ Provide gentle tactile stimulation through bag • Use same approach to positioning and tactile stimulation regardless of whether amniotic fluid contains meconium or is clear [refer to Table 14. Meconium stained liquor] • If resuscitation is required commence pulse oximetry monitoring <ul style="list-style-type: none"> ◦ Refer to Table 12 Oxygen saturation monitoring

3.4 Subsequent assessment and management

Subsequent assessment and management occurs within the first minute after birth. Continue vigilant assessment of all babies after birth regardless of need for resuscitation. Adaptation to extrauterine life may present as secondary apnoea, persistent cyanosis, or persistence or onset of difficulties with breathing.² Commence observations using the applicable newborn early warning tool (NEWT).

Table 11 Subsequent assessment and management

Aspect	Consideration
Subsequent assessment¹⁷	<ul style="list-style-type: none"> • HR • Breathing • Tone • Oxygenation (measured by pre-ductal pulse oximetry) <ul style="list-style-type: none"> ◦ Refer to Table 12 Oxygen saturation monitoring
Breathing¹⁷	<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 [refer to Table 13 General principles of airway management] • 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 airway pressure (CPAP) at 5–8 cmH₂O 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 4 Airway management
Heart rate¹⁷	<ul style="list-style-type: none"> • Normal HR: <ul style="list-style-type: none"> ◦ Consistent rate between 110 and 160 bpm • Refer to Section 6 Chest compressions <p>Auscultate HR with stethoscope:</p> <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 • Consider verbal feedback of HR (e.g. less than 100 bpm, or less than 100 bpm but greater than 60 bpm, or less than 60 bpm) • Continue until reliable pre-ductal oxygen saturation and HR displayed on pulse oximeter <p>Pulse oximetry:</p> <ul style="list-style-type: none"> • Provides continuous display of HR within one minute of birth • Is recommended for any baby requiring resuscitation—shows efficacy of cardiac output • Refer to Table 12 Oxygen saturation monitoring <p>Electrocardiography (ECG):</p> <ul style="list-style-type: none"> • Use for heart rate assessment if available • If ECG unavailable, not functioning or when pulseless electrical activity is suspected—obtain a reliable pulse oximeter reading because this also provides important information about oxygenation
Colour¹⁷	<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 • Acrocyanosis is normal after birth • Cyanosis is difficult to recognise, and best determined by examining gums and mucous membranes in good ambient light <ul style="list-style-type: none"> ◦ 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

3.5 Oxygen saturation monitoring

Oxygen saturation monitoring is recommended for all babies requiring resuscitation.¹⁷

Table 12 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 	
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 For fastest signal acquisition attach oximeter sensor to baby's right wrist or hand as soon as possible after birth and before connecting lead to oximeter cable³² 	
Measurement	<ul style="list-style-type: none"> Australian and New Zealand Council on Resuscitation (ANZCOR)²⁹ 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 resuscitation	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"> Oxygen saturation upper limit targets are only applicable if the baby is receiving fractional inspired oxygen (FiO₂) greater than 21% <ul style="list-style-type: none"> If breathing spontaneously or receiving assisted ventilation with room air the upper limit is 100% 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%³³ If baby is known to have a cyanotic congenital heart defect, determine oxygen saturation targets in consultation with a paediatric cardiologist 	

4 Airway management

4.1 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 PPV²⁹

Table 13 General principles of airway management

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 • Improve patency of the airway by ensuring correct positioning to maintain patency of the airway by: <ul style="list-style-type: none"> ◦ Placing a 2 cm thick roll of blanket or towel under the shoulders ◦ Support of lower jaw and opening the baby's mouth²⁹
Suctioning	<ul style="list-style-type: none"> • Routine intrapartum suctioning of mouth, nose or pharynx is not recommended and may delay normal rise in oxygenation²⁹ • Pharyngeal suctioning may: <ul style="list-style-type: none"> ◦ Cause laryngeal spasm, trauma to soft tissues and bradycardia ◦ Prolong cyanosis and delay onset of spontaneous respirations • 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) ◦ When the vocal cords need to be visualised during intubation²⁹ ◦ Using a large bore suction catheter (8–12 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 mmHg • If indicated, suction briefly and with care
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 distress²⁹ ◦ The baby who is breathing but whose oxygen saturation is not meeting targets • Refer to Flow Chart: Neonatal resuscitation • and Table 10 Assessment and initial management at birth
PPV	<ul style="list-style-type: none"> • Refer to Table 20 Positive pressure ventilation
Supplemental oxygen	<ul style="list-style-type: none"> • Commence resuscitation in air rather than 100% oxygen [refer to Table 18 Suggested oxygen/air flows at 10 litres per minute and Table 19 Suggested oxygen/air flows at 8 litres per minute] <ul style="list-style-type: none"> ◦ 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. • Use supplemental oxygen only when: <ul style="list-style-type: none"> ◦ Oxygen saturation has failed to improve with effective ventilation of the lungs and ◦ Chest compressions are commenced • In the preterm baby less than 32 weeks, commence assisted ventilation in air to 30% oxygen⁷ • Titrate supplemental oxygen according to pre-ductal pulse oximetry <ul style="list-style-type: none"> ◦ Refer to Table 12 Oxygen saturation monitoring

4.1.1 Meconium stained liquor

Table 14. Meconium stained liquor

Aspect	Recommendation/good practice point
Meconium exposed baby	<ul style="list-style-type: none"> In all meconium-exposed babies, the priority is to establish and maintain effective aeration of the lungs In the depressed baby (non-vigorous—low tone, not breathing or crying, low heart rate) immediately commence appropriate resuscitation manoeuvres as needed Assess the baby exposed to meconium in amniotic fluid as there is an increased risk of needing resuscitation and for later complications²⁹
Depressed baby	<ul style="list-style-type: none"> Routine direct laryngoscopy (with or without suctioning) birth^{17,29,34}, or endotracheal tube (ETT) suctioning (following intubation) is not recommended as it is not supported by available evidence²⁹ Rarely the baby may require laryngoscopy and laryngeal suctioning, or intubation and tracheal suctioning to relieve airway obstruction³⁴ Oral suctioning is only suggested if the baby has an obvious sign of obstruction and it can be achieved without delaying the commencement of PPV Refer to Table 13 General principles of airway management
Vigorous baby	<ul style="list-style-type: none"> If vigorous baby (breathing, crying and with good muscle tone) ,routine oropharyngeal, nasopharyngeal or ETT suction provides no benefit, may cause harm and is not recommended²⁹ Commence skin to skin contact and observe for signs of respiratory compromise

4.2 Airway and positive pressure ventilation (PPV) delivery devices

Table 15 Interface for PPV

Aspect	Good practice point
Facemasks²⁹	<ul style="list-style-type: none"> • Use cushioned or inflatable rim face mask • Select optimal mask size for the size of the face—must seal around mouth and nose • Ensure the jaw is supported • Apply the mask using a rolling motion from chin to nose bridge <ul style="list-style-type: none"> ◦ Ensure the mask is placed over the mid-face ◦ Avoid the eyes ◦ Ensure no leaks between mask and face—do not overlap chin ◦ Do not use excessive force to maintain seal • 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 inflations²⁹
Supra-glottic airway³⁵	<ul style="list-style-type: none"> • Includes, for example, LMA™ and other similar devices • Consider: <ul style="list-style-type: none"> ◦ For term and near term baby (greater than or equal to 34 weeks or more than 2000 grams)³⁵ ◦ As an alternative to PPV via face mask or endotracheal tube ◦ For any situation where adequate ventilation is not being achieved, and or face mask ventilation is insufficient or relatively contraindicated (e.g. congenital diaphragmatic hernia, clinician is untrained or has been unsuccessful at intubation) • Size 1 mask suitable 2–5 kg baby • Colour change in paediatric colorimetric end tidal CO₂ (carbon dioxide) detector (as for ETT) to confirm correct placement • Use during chest compressions has not been evaluated
ETT	<ul style="list-style-type: none"> • Endotracheal tubes (sizes 2.5, 3.0, 3.5, and 4.0 mm internal diameter)³⁵: <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 Section 4.6 Intubation

4.2.1 Devices for PPV

Table 16 Delivery devices

Aspect	Consideration/good practice point
Initial peak inspiratory pressure (PIP)	<ul style="list-style-type: none"> • Adjust according to baby's response • Recheck after any change to air or oxygen flow rate • Refer to Table 20 Positive pressure ventilation for recommended pressures
T-piece device	<ul style="list-style-type: none"> • Preferred device for neonatal resuscitation <ul style="list-style-type: none"> ◦ Suitable for facemask, supraglottic airway (e.g. LMA™) or ETT ventilation²⁹ • Requires pressurised gas source, therefore always have self-inflating bag available as a back-up resuscitation device²⁹ • Set up T-piece device at recommended pressures <ul style="list-style-type: none"> ◦ Appropriate for gestational age of baby ◦ As determined and known by clinicians within the healthcare facility ◦ Usually at 8–10 L/min • Recommended initial pressures: <ul style="list-style-type: none"> ◦ Refer to Table 20 Positive pressure ventilation • Maximum pressure relief valve: <ul style="list-style-type: none"> ◦ Set at 45–50 cmH₂O—use manufacturer's recommendations ◦ An upper limit of 35 cmH₂O is adequate for the majority of babies ◦ Pressures greater than or equal to 45–50 cmH₂O (depending on manufacturer's recommendations) are rarely required at the beginning of resuscitation • Train all clinicians to safely adjust pressure settings during resuscitation in case required
Self-inflating bag	<ul style="list-style-type: none"> • Pressure release valve factory set at approximately 40 cmH₂O • Cannot effectively deliver CPAP, positive end expiratory pressure (PEEP) or sustained inflation breaths²⁹ <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 skills²⁹

4.3 Supplemental oxygen

Table 17 Supplemental oxygen

Aspect	Good practice point
Goal	<ul style="list-style-type: none"> Regardless of gestation, aim for oxygen saturations consistent with a healthy term baby undergoing transition²⁹ Refer to Table 12 Oxygen saturation monitoring for SpO₂ targets
Priority	<ul style="list-style-type: none"> Ensure adequate lung inflation by auscultating lung fields Only increase 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 baby²⁹	<ul style="list-style-type: none"> Use air initially and only administer oxygen to a baby whose SpO₂ does not meet the lower end of target range despite effective respiratory support If supplemental oxygen is being used, begin to wean oxygen concentration when SpO₂ reaches 90%
Preterm baby	<ul style="list-style-type: none"> Refer to Appendix A Equipment and medications for neonatal resuscitation Table 27 Preterm baby

4.4 Oxygen/air mix

- Use an oxygen air blender to deliver greater than 21% or less than 100% oxygen
- If an oxygen air blender is not available follow local facility guidelines regarding oxygen/air mix to deliver oxygen without a blender, or use suggested flows in Table 18 Suggested oxygen/air flows at 10 litres per minute and Table 19 Suggested oxygen/air flows at 8 litres per minute

Table 18 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 19 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

4.5 Positive pressure ventilation

Set the flowrate of gases being delivered (air and oxygen)²⁹, and if there has been any change to the flow rate re-check the pressures.

Table 20 Positive pressure ventilation

Aspect	Recommendation/good practice point
Indications	<ul style="list-style-type: none"> After stimulation if: <ul style="list-style-type: none"> HR less than 100 bpm and not improving 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 Refer to Table 15 Interface for PPV
Rate	<ul style="list-style-type: none"> 40–60 inflations per minute with inspiratory time of 0.3–0.5 seconds²⁹
Pressures²⁹	<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 Use PEEP greater than 8 cm H₂O with caution as this can potentially reduce pulmonary blood flow and cause pneumothorax Suggested initial pressures for term and near baby <ul style="list-style-type: none"> Positive inspiratory pressure (PIP)–30 cmH₂O PEEP–5 cm If pressures cannot be monitored, use the least pressure required to achieve physiological (not excessive) chest wall movement and an increase in HR and SpO₂ For preterm baby less than 32 weeks refer to Table 27 Preterm baby Higher inflation pressures may be required to aerate the lungs in first few inflations 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 If little or no chest wall movement, or SpO₂ and HR fail to increase, assess and improve the ventilation technique– <ul style="list-style-type: none"> Ensure the face mask fits well with minimal leak, and head and jaw position are correct—if required use two people Airway suction as required [refer to Table 13 General principles of airway management] Consider increasing the inspiratory pressures and inspired oxygen concentration An oropharyngeal airway or nasopharyngeal airway (if clinician skilled in its use) may be helpful especially for babies with facial malformations Consider tracheal intubation or supraglottic airway²⁹
Other care	<ul style="list-style-type: none"> Continue PPV until spontaneous breathing is established and HR is above 100 bpm Gastric decompression via nasogastric tube is indicated when mask ventilation continues for several minutes

4.6 Intubation

4.6.1 Intubation ETT size and length

- Based on weight and gestational age of baby for initial resuscitation at birth or corrected age during neonatal period
- **ETT internal diameter** in millimetres can be calculated by corrected age in weeks divided by 10³⁵
- Approximate **ETT length/depth** from middle of upper lip calculated as weight in kg + 6 cm³⁵⁻³⁷
- Check insertion depth as soon as possible after intubation
- Table 21 ETT and suction catheters sizes provides accurate guidance about ETT size and length^{35,36,38}

Table 21 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

4.6.2 Endotracheal intubation

Table 22 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 are deemed to be competent
Indications³⁵	<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 supraglottic airway ventilation Skill and experience of clinician Perform if: <ul style="list-style-type: none"> Unsuccessful ventilation via face mask or supraglottic airway HR remains low Oxygen saturation falling or failing to rise Face or supraglottic airway ventilation is prolonged Special circumstances (e.g. congenital diaphragmatic hernia (CDH)) or extremely low birth weight baby Baby has no detectable HR at birth (supraglottic airway can also be considered)
Position verification³⁵	<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 increases to above 100 bpm Oxygen saturations improve 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 if there is inadequate ventilation due to low pressures being delivered or very non-compliant lungs 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 position³⁵	<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 If asymmetrical chest movement, ETT may be too far down, or a pneumothorax or lung anomaly (e.g. diaphragmatic hernia) may be present
Corrective steps	<ul style="list-style-type: none"> 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
Suction catheter	<ul style="list-style-type: none"> Catheter size to be no more than half the internal diameter of ETT³⁹ Refer to Table 21 ETT and suction catheters

5 Chest compressions

If the lungs have been effectively aerated, chest compressions are not usually needed in neonatal resuscitation. Perform ventilation corrective steps **before** chest compressions are commenced [refer to Table 20 Positive pressure ventilation]. If chest compressions are indicated (adequate ventilation for 30 seconds **and** HR less than 60 beats per minute), urgent vascular access (preferably via umbilical vein) is required for administration of adrenaline (epinephrine).⁴⁰ Refer to Table 24 Medication and fluids and Table 25 Adrenaline (epinephrine) administration.

Table 23 Chest compressions

Aspect	Recommendation/good practice point
Context	<ul style="list-style-type: none"> Only indicated if baby remains bradycardic after establishing an adequate airway, and aeration and ventilation of the lungs No evidence to indicate exactly when in the neonatal period to change the compression to ventilation ratio to paediatric ratios
Position ^{40,41}	<ul style="list-style-type: none"> Centre compressions over lower third of sternum <ul style="list-style-type: none"> Above xiphisternum and just below nipples
Depth	<ul style="list-style-type: none"> Recommended depth of compression is one third anteroposterior diameter of chest⁴¹
Ratio ^{40,41}	<ul style="list-style-type: none"> 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 breaths If baby is more than a few hours old and not requiring neonatal intensive care, or cardiac aetiology is known or suspected in a baby consider using a two person compression-ventilation ratio of 15:2 (paediatric ratio)
Method ^{40,41}	<ul style="list-style-type: none"> Perform in combination with adequate inflation breaths using 100% oxygen Avoid simultaneous compression with breath Rescuer's hands (fingers/thumbs) should not leave chest Optimise the quality of compressions by minimising 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 position ⁴⁰	<ul style="list-style-type: none"> Stand facing baby's head <ul style="list-style-type: none"> If access to baby's abdomen is required this can be reversed
Effectiveness ^{40,41}	<ul style="list-style-type: none"> If compressions delivered effectively, pulsations will appear on oximeter 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 Effective chest compressions will cause sufficient arterial pulsation for the pulse oximeter to measure a HR <ul style="list-style-type: none"> Consequently will be an unreliable method to determine spontaneous (baby's own) HR except during a pause in chest compressions Refer also to Table 34 Ethical considerations

6 Medication and fluids

Medication and fluid are rarely indicated for neonatal resuscitation.³⁰ Adrenaline (epinephrine) and volume expanders are generally the only medications required.

6.1 Naloxone

- Rarely used for newborn babies, and is not considered a resuscitation medication
- Used only (if required) after stabilisation and admission to a neonatal unit
- If baby is suspected of having respiratory depression caused by maternal opiate administration the priority is to provide PPV with T-piece device, or bag and mask
- If required, naloxone is administered preferably intravenously once the baby's SpO₂ and HR are stable.
- Never administer to a baby chronically exposed to opioids
 - Refer to Queensland Clinical Guideline: Perinatal substance use: neonatal.⁴²

Table 24 Medication and fluids

Aspect	Consideration
Context³⁰	<ul style="list-style-type: none"> • Establishing adequate ventilation is the most important step to improve HR before consideration to medication and fluid administration <ul style="list-style-type: none"> ○ 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 vein³⁰ • Alternative intravascular routes are peripheral vein or intraosseous (IO) route (if clinician trained in technique and unable to access umbilical vein or peripheral vein)³⁰ • Endotracheal route only used when intravascular access cannot be obtained <ul style="list-style-type: none"> ○ 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 treatment³⁰ <ul style="list-style-type: none"> ○ Discard or reinfuse first one mL as sample will be mix of blood and 0.9% sodium chloride
ETT	<ul style="list-style-type: none"> • Not recommended³⁰ • 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 access³⁰
Peripheral vein	<ul style="list-style-type: none"> • Intravenous (IV) 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 intraosseous (IO) space especially in preterm baby <ul style="list-style-type: none"> ▪ Not recommended for preterm babies • Can be used if umbilical venous access not available, IO equipment is available and resuscitation team proficient with use³⁰ • Preferred over ETT (for adrenaline administration)
Umbilical artery	<ul style="list-style-type: none"> • Not recommended for administration of medications during resuscitation³⁰

6.2 Adrenaline (epinephrine)

Table 25 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 flow when used with chest compressions Refer to NeoMedQ Adrenaline (epinephrine) for dosing and administration guidance⁴³
Intervascular 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 24 Medication and fluids
Frequency³⁰	<ul style="list-style-type: none"> Repeat every three to five minutes while the HR is less than 60 bpm (despite adequate ventilation and chest compressions), or until resuscitation withdrawn [refer to Table 34 Ethical considerations] Higher doses are not recommended due to increased risk of post-resuscitation mortality and intraventricular haemorrhage
ETT route	<ul style="list-style-type: none"> Only use ETT route if IV access cannot be obtained or 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 <ul style="list-style-type: none"> HR less than 60 bpm despite adequate ventilation and chest compressions Administer IV dose as soon as vascular access obtained unless bradycardia has resolved³⁰

6.3 Volume expanding fluids

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

Table 26 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 measures³⁰ Subsequently blood products (Group O Rh D negative blood) may be required for an emergency transfusion if: <ul style="list-style-type: none"> Critical blood loss—follow critical blood loss protocol [refer to National Blood Authority (Australia) <i>Patient Blood Management Guidelines Module 6: Neonatal and Paediatrics</i> (2016)²¹] If 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 loss³⁰
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 than beneficial³⁰
Route	<ul style="list-style-type: none"> Intravascular—umbilical vein, intravenous, intraosseous Refer to Table 24 Medication and fluids
Method	<ul style="list-style-type: none"> IV push over several minutes³⁰
Dose	<ul style="list-style-type: none"> 10 mL/kg³⁰
Frequency	<ul style="list-style-type: none"> Observe response Repeat if required after observation of the response³⁰

7 Special circumstances

7.1 Preterm baby

There are additional requirements for preterm babies. Use size appropriate equipment (e.g. if required use a smaller gauge suction catheter). Refer to Appendix A Equipment and medications for neonatal resuscitation

Table 27 Preterm baby

Aspect	Consideration/recommendation/good practice point
Temperature management³⁰ (less than 28 weeks)	<ul style="list-style-type: none"> Drying is unnecessary and counter-productive as long as a polyethylene bag or sheet used Place baby up to the neck in polyethylene bag or under polyethylene sheet 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 for additional information
Skin protection and handling	<ul style="list-style-type: none"> Avoid drying baby with wraps/towels [refer to Table 10 Assessment and initial management at birth] Use antiseptic solutions sparingly especially those containing alcohol, detergent excipients or chlorhexidine^{30,31} <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 antiseptic solution to sterile gauze, and clean cord and small area of skin only Use sterile drapes to cover other areas Use small amounts of tape and remove with care to avoid skin tears
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 baby^{30,34} <ul style="list-style-type: none"> May be considered in individual clinical circumstances⁷ Initiate PPV in the baby who does not breathe spontaneously within first minute after birth Refer to Table 13 General principles and Table 20 Positive pressure ventilation for additional information about respiratory support
CPAP	<ul style="list-style-type: none"> Commence if: <ul style="list-style-type: none"> Less than 32 weeks gestation breathing spontaneously but with signs of respiratory distress immediately after birth In need of respiratory support Use at least 5 cmH₂O and not more than 8 cmH₂O Deliver via nasal prongs (preferable) or facemask <ul style="list-style-type: none"> Do not use self-inflating bag⁷
PPV	<ul style="list-style-type: none"> If baby less than 32 weeks gestation suggested initial pressures are PEEP at least 5–8 cmH₂O⁷ and PIP 20–25 cmH₂O Avoid high tidal volumes⁷ Aim for adequate/good chest wall movement
Oxygen	<ul style="list-style-type: none"> Recommended to commence resuscitation using 21–30% oxygen <ul style="list-style-type: none"> Adjust FiO₂ guided by pulse oximetry to meet target saturation⁷ If blended air and oxygen is not available commence resuscitation in air in preference to 100% oxygen Refer to Table 17 Supplemental oxygen

7.2 Other special circumstances

Table 28 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 fetuses⁷
Pneumothorax	<ul style="list-style-type: none"> • Uncommon cause of failure to respond to resuscitation at birth • Signs (especially when deterioration occurs after initial response to resuscitation) include: <ul style="list-style-type: none"> ○ 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 • if lung hypoplasia suspected from antenatal history⁷, prepare for bedside diagnosis and emergency treatment at birth <ul style="list-style-type: none"> ○ Includes for example, severe oligohydramnios or anhydramnios (e.g. secondary to preterm prelabour rupture of membranes (PPROM) many weeks before birth) • Refer to Queensland Clinical Guidelines <i>Respiratory Distress and CPAP</i>⁴⁴
Pleural effusion/ascites/fetal hydrops	<ul style="list-style-type: none"> • Severe body wall oedema, pleural effusion, CDH, PPRM 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 only if needed to achieve lung expansion ○ Higher than usual ventilation rates may be needed to achieve carbon dioxide elimination and higher than usual FiO₂ to achieve oxygenation • Commence cardiorespiratory monitoring • Perform thoracentesis after radiographic or ultrasound examination unless emergency⁷
Pneumonia/sepsis	<ul style="list-style-type: none"> • Congenital pneumonia presents like respiratory distress syndrome • May require high ventilation pressures to open poorly compliant lungs⁷
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 <ul style="list-style-type: none"> ○ Refer to Table 26 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^{7,21}

7.3 Congenital anomalies

Table 29 Congenital anomalies

Aspect	Consideration
Congenital upper airway obstruction 7,21	<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 with or without cleft palate <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 supraglottic airway <ul style="list-style-type: none"> If tracheal intubation required consider expert assistance (e.g. an otorhinolaryngologist or paediatric anaesthetist)
Congenital diaphragmatic hernia 7,21	<ul style="list-style-type: none"> Minimise use of bag and face mask ventilation If respiratory support required intubate or insert supraglottic airway immediately <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 functional
Unexpected congenital anomalies ^{7,21}	<ul style="list-style-type: none"> Unless prior discussion has been had with parents, resuscitate baby completely and thoroughly Further evaluation and management decisions can be made in neonatal unit
Congenital heart disease ^{7,21}	<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, and careful assessment of tone, respiratory effort and oxygenation will determine if other resuscitation is required Arrange early transfer to neonatal unit and echocardiographic evaluation
Abdominal wall defects ^{7,21}	<ul style="list-style-type: none"> Baby with gastroschisis or large omphalocele will require protection of 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 If breathing is laboured or ineffective, ventilation via an ETT or supraglottic airway is preferred Insert large bore (size F8) orogastric tube on free drainage and aspirate frequently to remove air

8 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.⁴⁵

8.1 Cord blood sampling

Table 30 Cord blood gas sampling

Aspect	Consideration	
Indications	<ul style="list-style-type: none">Any baby requiring resuscitation to objectively assess the condition just before birth^{7,21}Apgar score:<ul style="list-style-type: none">Less than 4 at one minuteLess than 7 at five minutes⁴⁶When fetal blood sampling has occurred in labour⁴⁶Operative birth for fetal compromise⁴⁶Consider if baby is small for gestational age (SGA)Consider for any non-elective operative birth regardless of indicationOther indications—refer to Queensland Clinical Guideline: <i>Intrapartum fetal surveillance</i>¹⁶	
Procedure	<ul style="list-style-type: none">Collect paired samples from umbilical vein and umbilical artery⁷Effect of delayed cord clamping on values uncertain⁷<ul style="list-style-type: none">May effect acid-base parameters^{47,48}A systematic review identified delayed cord clamping up to 120 seconds has no effect or only small effect on acid-base balance⁴⁹	
Interpretation	<ul style="list-style-type: none">If there is a low cord arterial pH the relative risk of neonatal encephalopathy is increased<ul style="list-style-type: none">A normal pH does not rule out subsequent neonatal morbidity⁵⁰Refer to Queensland Clinical Guideline: <i>Hypoxic ischaemic encephalopathy (HIE)</i>²⁸Refer to Table 31 Umbilical artery cord blood gases	
	Relative risk (RR) of neonatal morbidity (CI 95% ⁵⁰)	
	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">One study suggests there may be a marginally better predictability of morbidity using lactate measures⁵¹, however:<ul style="list-style-type: none">Minimal difference between lactate and pH predictionBetter data available for pH for long-term outcomes⁵⁰Normal lactate thresholds have not been agreed	

8.1.1 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.⁴⁶

Table 31 Umbilical artery cord blood gases

Umbilical artery ⁴⁵	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

8.2 Continuing clinical care

Table 32 Continuing clinical care

Aspect	Consideration
Continuing care	<ul style="list-style-type: none"> Following establishment of adequate ventilation and circulation, closely observe and assess baby in neonatal unit (if indicated) or maternity ward 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 and regular contact between parent(s) and baby Facilitate postnatal debrief and follow up Facilitate referrals to support services (e.g. social worker, perinatal mental health, postnatal support groups) Provide relevant parent information (e.g. Queensland Clinical Guidelines: <i>Newborn resuscitation</i>¹³)
Stabilisation and transfer	<ul style="list-style-type: none"> If preterm or resuscitation required, transfer baby to neonatal unit for closer observation according to local protocols If birthing facility unable to provide appropriate level of post resuscitation monitoring and support transfer baby to higher level facility⁴⁵ Refer to Queensland Clinical Guidelines: <ul style="list-style-type: none"> Stabilisation for retrieval³: Respiratory distress and CPAP⁴⁴
Antibiotics	<ul style="list-style-type: none"> Consider relevant investigations and antibiotic treatment <ul style="list-style-type: none"> Refer to Queensland Clinical Guidelines <i>NeoMedQ</i> Ampicillin, Gentamicin, Benzylpenicillin, Amoxicillin⁵²⁻⁵⁴ Refer to Queensland Clinical Guideline <i>Early onset Group B streptococcal disease (EOGBS)</i>¹⁰
Induced hypothermia for HIE⁴⁵	<ul style="list-style-type: none"> If baby is greater than or equal to 35 weeks gestation, consider indications for therapeutic hypothermia for HIE Refer to Queensland Clinical Guideline: <i>Hypoxic ischaemic encephalopathy (HIE)</i>²⁸ Discuss early with neonatologist by contacting RSQ, and organise for transfer of baby to tertiary facility <ul style="list-style-type: none"> If recommended commence induced hypothermia

8.3 Monitoring and management

Continue observations using the applicable NEWT or other observation chart.

Table 33 Monitoring and management

Aspect	Consideration/good practice point
Blood glucose management⁴⁵	<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 • Refer to Queensland Clinical Guideline: <i>Hypoglycaemia–newborn</i>¹⁶
Temperature	<ul style="list-style-type: none"> • If possible, avoid unnecessary interruptions to skin to skin care for term and near term babies • Measure and record immediately after resuscitation and on admission to neonatal unit or maternity ward² • Transfer baby requiring admission to a neonatal unit in a pre-warmed cot • Preterm and low birth weight babies require: <ul style="list-style-type: none"> ◦ Ambient temperature of at least 26 °C (where possible) ◦ Incubator or open care radiant heater bed ◦ Use of exothermic warming mattress—use with caution and follow manufacturer's instructions • Refer to Table 9 Temperature management • Refer to Queensland Clinical Guideline: <i>Hypoxic ischaemic encephalopathy (HIE)</i>²⁸
Monitoring (when assisted ventilation provided)⁴⁵	<ul style="list-style-type: none"> • Continuous monitoring includes: <ul style="list-style-type: none"> ◦ Temperature ◦ Oxygen saturation ◦ HR ◦ Respiratory rate and pattern ◦ Blood glucose level ◦ Blood gas ◦ Fluid balance and nutrition ◦ Blood pressure ◦ Neurological signs
Cardiorespiratory management⁴⁵	<ul style="list-style-type: none"> • Review cord blood gases • 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 • Refer to Queensland Clinical Guidelines: <i>Respiratory distress and CPAP</i>⁴⁴

9 Ethical considerations

Table 34 Ethical considerations

Aspect	Consideration
Initiating or withholding resuscitation¹¹	<ul style="list-style-type: none"> • If in doubt, commence resuscitation until full clinical picture is available and suggests withdrawal of treatment <ul style="list-style-type: none"> ◦ Exceptions include extremely preterm babies (generally less than 23+0 days gestation), or those who are anencephalic, where little possibility of intact survival [refer to Queensland Clinical Guideline <i>Perinatal care of the extremely preterm baby</i>¹² ◦ Parents and clinicians (together) may choose to withhold or withdraw treatment in the best interests of the baby (e.g., weighing the potential effectiveness of medical interventions against risk of harm–pain, suffering, indignity, separation from parents) • If rate of survival is high and acceptable morbidity–resuscitation is usually indicated • If rate of survival is borderline and associated with early death (e.g. related to gestation, birthweight, congenital anomaly), high rate of morbidity with prognosis uncertain, and the burden to the baby is high–support the parents' views regarding resuscitation • If baby is less than 25 weeks gestation, discuss resuscitation with a neonatologist by contacting RSQ <ul style="list-style-type: none"> ◦ Refer to Queensland Clinical Guideline: <i>Perinatal care of the extremely preterm baby</i>¹²
Discontinuing resuscitation¹¹	<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 ◦ Length of resuscitative efforts • If, despite provision of all the recommended steps of resuscitation and excluding reversible causes, a newborn baby requires ongoing cardiopulmonary resuscitation (CPR) after birth, ANZCOR suggests discussion of discontinuing resuscitative efforts with the clinical team and family¹¹ • ANZCOR suggests that a reasonable time frame to consider this change in goals of care is around 20 minutes after birth¹¹ • Discuss with a neonatologist by contacting RSQ, as required • Withdrawal or withholding of resuscitation: <ul style="list-style-type: none"> ◦ Focus on baby's best interests, comfort and dignity (if signs of life present) and support of the parents
Care of family	<ul style="list-style-type: none"> • Provide a consistent and co-ordinated approach from obstetric/midwifery and neonatal staff, in communicating with the parents and developing an agreed management plan that is in the baby's best interests • Provide clear explanation about course of events • Refer to relevant support services and groups (e.g. social worker, perinatal mental health services, SANDS) • Provide relevant parent information (e.g. Queensland Clinical Guideline: <i>Grief after your baby dies, What to expect after your baby dies, Autopsy examination of your baby</i>⁵⁵⁻⁵⁷) • Facilitate post discharge follow up and debrief

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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 (e.g. resuscitation cot) Overhead warmer and skin temperature sensor Light source 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) and suction tubing Suction catheters—sizes 5F, 6F, 8F, 10F and 12F Oropharyngeal airways—sizes 0, 00, 000 Intubation equipment: <ul style="list-style-type: none"> Compatible laryngoscope handles and blades Laryngoscopes with neonatal blades—1 and 0, and 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, clear or translucent, radio-opaque, centimetre markings along length ETT introducer/stylet (optionally used for oral intubation only) Lubricant gel (sterile) Supplies for fixing ETT (e.g. sterile scissors, tape, skin prep swabs 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) Supraglottic airway (e.g. laryngeal mask airway™)—size 1 (2–5 kg baby)
Breathing support	<ul style="list-style-type: none"> Face masks (cushioned rim)—range of sizes suitable for premature and term neonates (reusable or disposable) <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 (reticulated and/or cylinder): <ul style="list-style-type: none"> Source of medical oxygen with flow meter rate of up to 10 L/min and tubing Source of medical air with flow meter rate of up to 10 L/min and tubing Air/oxygen blender Gastric tubes for decompression sizes 6F (< 1.5 kg) and 8F (≥ 1.5 kg) 10 mL syringe for aspirating gastric contents Emergency thoracentesis kit (alcohol swabs, 3-way tap, 24 G non-retractable butterfly needle or 24 G soft cannula and 30 cm extension set, and 20 mL luer lock syringe)
Circulation support	<ul style="list-style-type: none"> Umbilical venous catheter (UVC) kit <ul style="list-style-type: none"> UVC size 3.5 F (< 1.5 kg) and 5F (≥ 1.5 kg) Peripheral IV cannulation kit, 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 If available, intraosseous needles and insertion kit Blood filter
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"> 0.9% sodium chloride or Hartmann's solution Blood suitable for emergency neonatal transfusion (Group O Rh D negative)—readily available if required for profoundly anaemic baby

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Working Party Clinical Lead

Professor Helen Liley, Neonatologist, Mater Mothers' Hospital, South Brisbane

QCG Program Officer

Ms Stephanie Sutherns

Peer Review Members

Dr Neil Archer, Director Paediatrics, Cairns Hospital

Ms Maxine Ballinger, Clinical Nurse Consultant, Rockhampton Hospital

Ms Lynne Buetow, Nurse Educator, Royal Brisbane and Women's Hospital

Ms Li-an Collie, Nurse Educator, Royal Brisbane and Women's Hospital

Ms Eileen Cooke, Consumer Representative, Preterm Infants Parents Association

Dr Kirsty Devine, Neonatologist, Townsville University Hospital

Ms Anndrea Flint, Neonatal Nurse Practitioner, Redcliffe Hospital

Dr Jane Maher, Obstetrician, Sunshine Coast University Hospital

Ms Alecia Staines, Consumer Representative, Maternity Consumer Network

Ms Yoie Thomas, Midwifery Nurse Educator, Roma Hospital

Queensland Clinical Guidelines Team

Professor Rebecca Kimble, Director

Ms Jacinta Lee, Manager

Ms Stephanie Sutherns, Clinical Nurse Consultant

Ms Cara Cox, Clinical Nurse Consultant

Ms Emily Holmes, Clinical Nurse Consultant

Ms Janene Rattray, Clinical Nurse Consultant

Steering Committee

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