Queensland Clinical Guidelines

Translating evidence into best clinical practice

Maternity and Neonatal **Clinical Guideline**

Respiratory distress and CPAP

Queensland Government

Document title:	Respiratory distress and CPAP
Publication date:	December 2024
Document number:	MN24.3-V10-R29
Document supplement:	The document supplement details development processes and implementation activities, and is integral to and should be read in conjunction with this guideline
Amendments:	Full version history is supplied in the document supplement
Amendment date:	December 2024
Replaces document:	MN20.3-V9-R25
Author:	Queensland Clinical Guidelines
Audience:	Health professionals in Queensland public and private maternity and neonatal services
Review date:	December 2029
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

Acknowledgement

The Department of Health respectfully acknowledges the Traditional Owners and Cultural Custodians of the lands, waters, and seas across Queensland. We pay our respects to Elders past and present, while recognising the role of current and future leaders in shaping a better health system.

Disclaimer

This guideline is intended as a guide and provided for information purposes only. The information has been prepared using a multidisciplinary approach with reference to the best information and evidence available at the time of preparation. No assurance is given that the information is entirely complete, current, or accurate in every respect.

The guideline is not a substitute for clinical judgement, knowledge and expertise, or medical advice. Variation from the guideline, taking into account individual circumstances, may be appropriate.

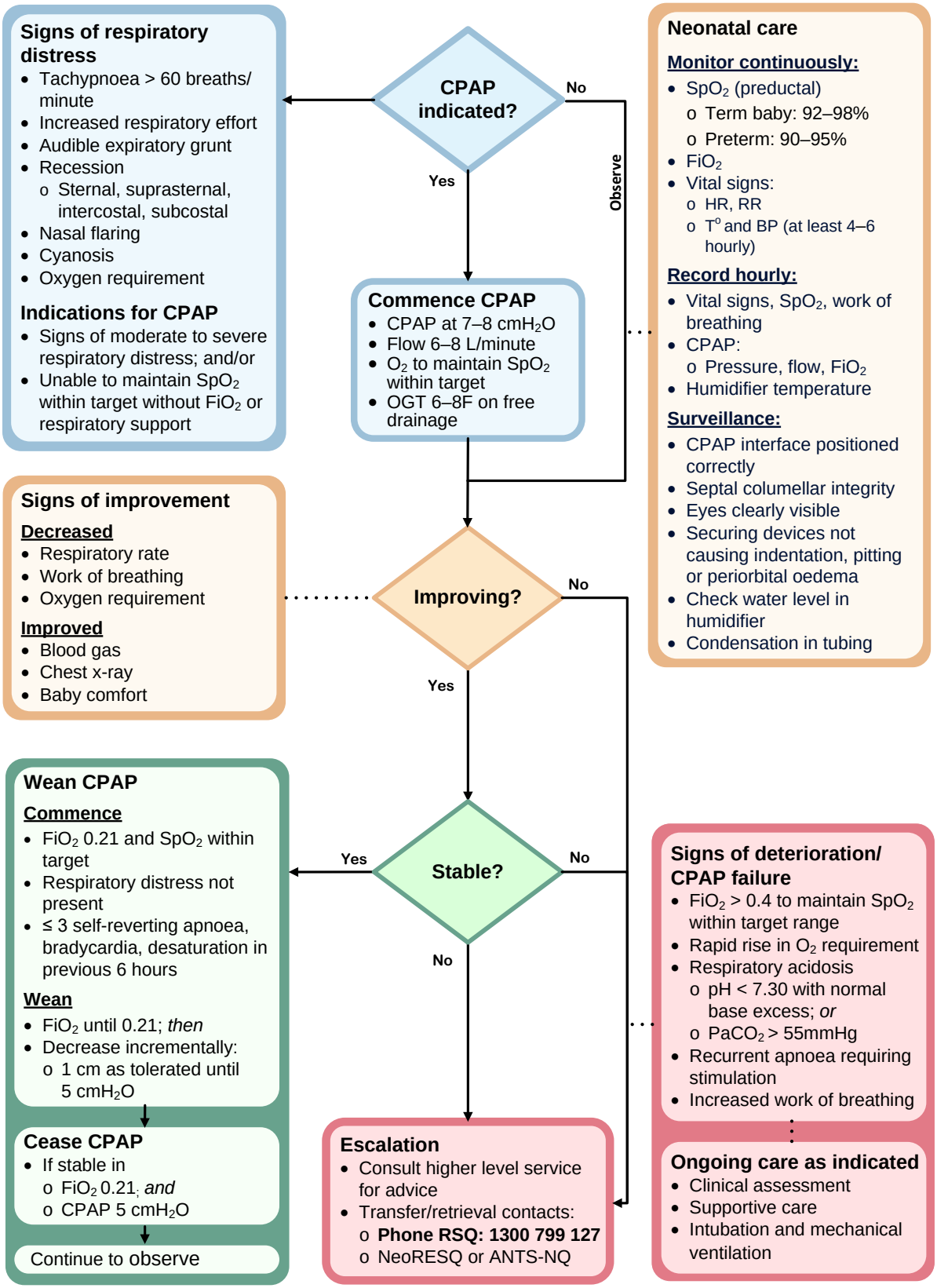
This guideline does not address all elements of standard practice and accepts that individual clinicians are responsible for:

- Providing care within the context of locally available resources, expertise, and scope of practice
- Supporting consumer rights and informed decision making, including the right to decline intervention or ongoing management
- Advising consumers of their choices in an environment that is culturally appropriate and which enables comfortable and confidential discussion. This includes the use of interpreter services where necessary
- Ensuring informed consent is obtained prior to delivering care
- Meeting all legislative requirements and professional standards
- Applying standard precautions, and additional precautions as necessary, when delivering care
- Documenting all care in accordance with mandatory and local requirements

Queensland Health disclaims, to the maximum extent permitted by law, all responsibility and all liability (including without limitation, liability in negligence) for all expenses, losses, damages and costs incurred for any reason associated with the use of this guideline, including the materials within or referred to throughout this document being in any way inaccurate, out of context, incomplete or unavailable.

Recommended citation: Queensland Clinical Guidelines. Respiratory distress and CPAP Guideline No. MN24.3-V10-R29 Queensland Health. 2024 Available from: http://www.health.qld.gov.au/qcg

Flowchart: Neonatal respiratory distress and CPAP in babies ≥ 32 weeks gestation



ANTS-NQ: Advanced Neonatal Transport Service-North Queensland, **BP**: blood pressure, **CSCF**: Clinical Services Capability Framework, **CPAP:** continuous positive airway pressure, **F:** French gauge, **FiO_2:** fraction of inspired oxygen, **HR**: heart rate, **NeoRESQ**: Neonatal Retrieval Emergency Service Southern Queensland, **OGT:** orogastric tube, **$PaCO_2$:** partial pressure of carbon dioxide, **RSQ:** Retrieval Services Queensland, **RR**: respiratory rate, **SpO_2:** peripheral capillary oxygen saturation, **T°**: temperature, **>:** greater than, **≥:** greater than or equal to, **<:** less than; **≤:** less than or equal to

Flowchart: F24.3-1-V9-R29

Table of Contents

List of Tables

Abbreviations

CPAP	Continuous positive airway pressure
CSCF	Clinical Services Capability Framework
FiO_2	Fraction of inspired oxygen
FRC	Functional residual capacity
IV	Intravenous
OGT	Orogastric tube
$PaCO_2$	Partial pressure of arterial carbon dioxide
PaO_2	Partial pressure of arterial oxygen
pCO_2	Partial pressure of carbon dioxide
pO_2	Partial pressure of oxygen (unreliable on venous or capillary samples)
PEEP	Positive end expiratory pressure
PPHN	Persistent pulmonary hypertension of the newborn
RDS	Respiratory distress syndrome
RSQ	Retrieval Services Queensland
TTN	Transient tachypnoea of the newborn
SpO_2	Peripheral capillary oxygen saturation

Definitions

Acrocyanosis	Peripheral cyanosis around the mouth and of the extremities (palms of hands and soles of feet). Benign in the absence of central cyanosis.
Parents or baby's family	The individual(s) who has/have the primary responsibility for the emotional and physical care of a baby. For example, mother, father, parent, caregiver, legal guardian, primary care giver, kinship relationship, surrogate parent, birth parent.
Functional residual capacity	Volume of air in the lungs at the end of passive expiration.
Hypoxaemia	PaO_2 less than 60 mmHg.
Hypercarbia	$PaCO_2$ greater than 45 mmHg.
Tachypnoea	Respiratory rate greater than 60 breaths per minute.
Pulse pressure	Difference between the systolic and diastolic blood pressure.
Ventilation-perfusion mismatch	When either the ventilation (delivery of gas flow) or perfusion (blood flow) in the lungs is not matched equally—good blood flow to poorly ventilated regions, or good ventilation to areas of the lung with poor blood flow.
Vital signs	Temperature, heart rate, respiratory rate, blood pressure, SpO_2.
Work of breathing	Tachypnoea, chest recession (sternal, intercostal, subcostal); nasal flaring; expiratory grunt.
Woman/women	QCG recognise that individuals have diverse gender identities. In QCG documents, although the terms *woman* and *women* are used, these guidelines are inclusive of people who are pregnant or give birth and who do not identify as female.[1]

1 Introduction

Respiratory distress at birth is a common reason for newborn admission to the neonatal unit and can result from a range of different pathologies. Respiratory distress syndrome (RDS), generally affecting premature neonates due to lung immaturity, remains a significant cause of morbidity and mortality worldwide despite advances in neonatal care. Other common causes of respiratory distress include challenges in the transition from fetal to neonatal life, infections, retained fetal lung fluid and aspiration during birth. The management of RDS, as well as other causes of respiratory distress, involves supportive care measures such as oxygen therapy, continuous positive airway pressure (CPAP), exogenous surfactant replacement therapy, and careful monitoring of fluid and electrolyte balance.

This guideline is primarily intended for the care of neonates who are 32 weeks gestational age or more with respiratory distress and who are receiving care in a level 2–6 neonatal service, as defined by the Queensland Clinical Services Capability Framework (CSCF). Some aspects may also be relevant to neonates at lower gestations.

1.1 Clinical standards

Table 1. Clinical standards

Aspect	Consideration
Standard care	• Refer to Queensland Clinical Guideline: *Standard care*[2] for care considered 'usual' or 'standard' o Includes for example: privacy, consent, decision making, sensitive communication, medication administration, staff education and support, culturally appropriate care • Refer to Queensland Clinical Guidelines consumer information *Respiratory distress and CPAP*[3]
Escalation of care	• Consult with a neonatologist via Retrieval Services Queensland (RSQ) any time: o For questions and/or concerns o For advice regarding care treatment and/or options o For retrieval to a higher level of service
Family centred care	• Provide care within a family centred model • Refer to Queensland Clinical Guideline: *Standard care*[2]:
Prevention	• Antenatal corticosteroids reduce the risk of RDS in the preterm baby by: o Enhancing maturation of the lungs o Improving lung function[4-8] • Refer to Queensland Clinical Guidelines: o *Antenatal corticosteroids*[9] o *Preterm labour and birth*[10]
Principles	• Recognition, assessment and diagnosis of respiratory distress is the key principle to effective management • CPAP is the gold standard non-invasive ventilation mode o Refer to Section 3 Continuous positive airway pressure
Clinical service capability framework (CSCF)	• Provides a standard set of minimum capability criteria for service planning and delivery • Refer to CSCF service module Neonatal services[11]

2 Respiratory distress

Although respiratory distress in babies may sometimes be temporary, cases of recurrent or prolonged distress require a systematic approach to both diagnosis and treatment. This facilitates identification of the underlying cause and its treatment and helps to optimise recovery and reduce the risk of long-term complications. Prompt, accurate intervention is crucial to prevent further deterioration and to limit potential morbidity, ensuring the best possible outcomes.[6]

2.1 Diagnosing respiratory distress

Table 2. History

Aspect	Consideration
Context	• Clinical presentation overlaps with a wide range of illnesses occurring in the neonatal period • Clinical history, laboratory evaluation, and imaging can help confirm diagnosis
Maternal history[6,12]	• Antenatal risk factors, including but not limited to: o Diabetes o Obesity o Asthma o Smoking • Infection status • Diagnosis of pregnancy related conditions • Previous and/or current medical history • Medications (antenatal and intrapartum)
Baby[6,12]	• Gestational age • Postnatal age • Antenatally diagnosed abnormalities • Timing of rupture of membranes—at birth or prolonged o If prolonged, how long ago? • Mode of birth o Caesarean with no labour o Precipitous vaginal birth • Presentation of liquor—clear, blood stained, chorioamnionitis, meconium • Resuscitation required at birth
Investigations	• Venous, capillary, or arterial blood gas (depending on access available) o If metabolic acidosis and history suggestive of hypoxic ischaemic encephalopathy (HIE), refer to Queensland Clinical Guideline: *Hypoxic-ischaemic encephalopathy*[13] • Other bloods o Refer to Table 4. Infection Screening • Chest X-ray o Refer to Table 5. X-ray interpretation

2.2 Examination and investigations

Table 3. Signs of respiratory distress

Aspect	Consideration
Colour	• Pale *or* • Cyanosis (excluding acrocyanosis) due to: o Central and/or peripheral due to right-to-left intra and extrapulmonary shunting[6] o Respiratory failure/inadequate ventilation
Oxygen saturations (SpO_2)	• Targets after 10 minutes of age* o Term baby: 92–98% • Preterm: 90–95%Measure pre-ductal on right hand • Hypoxaemia—usually due to ventilation perfusion mismatch[14]
Respiratory	• Tachypnoea o More than 60 breaths per minute[5] o Most common presenting sign[4] • Apnoea • Decreased breath sounds on auscultation[6] • Expiratory grunt[5] • Increased work of breathing due to use of accessory respiratory muscles o Recession[6] (sternal, suprasternal, intercostal, subcostal) o Nasal flaring[6] o Head bobbing • Asynchrony of chest wall appearance—pneumothorax
Cardiovascular	• Peripheral pulses diminished[6] • Prolonged capillary refill time—greater than two seconds • May be tachycardic • May have bradycardic episodes[6] • Extra-pulmonary shunting may occur across the foramen ovale and patent ductus arteriosus[14]
Respiratory acidosis	• Measure blood gas: o According to individual clinical presentation o If signs of deterioration or CPAP failure ▪ Refer to Table 14. Signs of deterioration and considerations o pCO_2 may assist assessment o pCO_2 greater than or equal to 55 mmHg and pH less than 7.30 indicates respiratory acidosis • Degree of hypoxaemia[12] (as shown by a low pO_2) is unreliable on a capillary or venous sample
Urine output	• May be low in first 24–48 hours[15] • Hyponatraemia may develop • If recovering from RDS, spontaneous diuresis occurs on second to fourth day of life and precedes improved pulmonary function[15]
Other	• Specific signs that may indicate presence of congenital respiratory anomalies o Scaphoid abdomen, deviated heart sounds—suggestive of congenital diaphragmatic hernia (CDH) o Significant and continued excess of oral secretions, coughing, choking on secretions—suggestive of tracheooesophageal fistula (TOF) or oesophageal atresia (OA) o Cyanosis when mouth closed, pink when crying—suggestive of bilateral choanal atresia • Refer to Table 9. Congenital anomalies

*In the absence of good quality evidence, Queensland Neonatal Services Advisory Group (QNSAG) endorsed, by consensus, these recommended oxygen saturation targets for babies after 10 minutes of age (2018)

2.3 Infection screening

Table 4. Infection Screening

Aspect	Consideration
Infection screening	• Full blood count • Blood culture[16] o Collect at least 1 mL of blood for an optimal sample • Regularly review blood culture result at 24 hours and 48 hours o If positive (at any time)—refer to Table 1. Clinical standards: Escalation of care
Antibiotics	• Empirical antibiotics until cultures and clinical course known o Benzylpenicillin **OR** amoxicillin/ampicillin **AND** gentamicin • If blood culture negative after 24 hours o Administer 24 hour antibiotic dose and then cease—actual coverage provided is 36 hours • If delay in processing blood cultures—continue antibiotics until 48 hours of treatment • If deteriorating clinical course, regardless of blood culture status: o Continue antibiotics o Refer to Table 1. Clinical standards: Escalation of care • Refer to neonatal monographs o NeoMedQ: *Benzylpenicillin*[17] o NeoMedQ:*Ampicillin*[13,18] o NeoMedQ:*Gentamicin*[10,19] • Refer to Queensland Clinical Guidelines: *Neonatal medicines*[20]and *Early onset Group B Streptococcal disease*[20] • Refer to local policy

2.4 Chest X-ray

Refer to Table 6. Differential diagnosis of respiratory distress

Table 5. X-ray interpretation

Aspect	Consideration
Purpose	• Anteroposterior (AP) chest X-ray is appropriate for diagnosis[21] • Confirms position of tubes and lines o Including orogastric tube (OGT)[22]—ideally inserted prior to X-ray • Assists assessment of pulmonary inflation[21] • Excludes undiagnosed congenital abnormality[21] o Refer to Table 9. Congenital anomalies • Excludes pulmonary air leaks[22] • Unless clinically indicated earlier, perform after 4 hours of age to avoid unnecessary X-ray exposure o If respiratory distress is severe and not improved rapidly with CPAP—consider performing early X-ray
Normal	• Symmetrically aerated lung fields • Diaphragm is at level of the 8th rib anteriorly and 10th rib posteriorly • Heart size—transverse cardiothoracic ratio less than 60%[21] o Measure at the widest point of heart shadow o Thymic shadow is at the upper border of the heart and may provide an impression of a larger cardiac shadow[21]
RDS	• Small lung volumes and vertically oriented ribs[21] • Diffuse reticulogranular ground glass appearance[6] • Air bronchograms from hilum to periphery[21] • Severe cases may have white out lung appearance[21]
Transient tachypnoea of the newborn (TTN)	• Normal or slightly increased lung volumes with flat diaphragms • Bilateral perihilar linear streaking[4,6,21]extending into peripheral lung fields • Normal or mildly enlarged heart[6] • Fluid in the horizontal fissure • Small pleural effusions may be present[6]
Pulmonary air leaks	• Presence of radiolucent area(s) of air in the lung fields • Refer to Table 7. Types of pulmonary air leaks for differentiation between air leaks
Meconium aspiration syndrome (MAS)	• Asymmetric patches of opacification and streaky linear densities • Hyperinflation of lungs • Flattening of the diaphragm[23]
Congenital diaphragmatic hernia (CDH)	• Mediastinal shift • Absence of diaphragm—depending on the side of hernia • Visible bowel gas in chest cavity[24]

2.5 Differential diagnosis

Table 6. Differential diagnosis of respiratory distress

Type	Risk factors	Clinical features	Management
Respiratory distress syndrome (RDS)	• Less than 34 weeks gestation[4] • Maternal diabetes • Caesarean section without labour • Infection • Genetic surfactant dysfunction disorder[15] • MAS[23]	• Respiratory distress within first minutes after birth[6] • Worsens over 48–72 hours[6] • Increased work of breathing • Auscultation o Uniformly decreased breath sounds • If untreated, may become lethargic and apnoeic	• Early CPAP is indicated[25] • May require exogenous surfactant with/without intermittent positive pressure ventilation[26] o Refer to NeoMedQ: *CUROSURF® (poractant alfa)*[27] o Refer to Table 16. Special circumstances • Refer to Table 1. Clinical standards: Escalation of care
Transient tachypnoea of the newborn (TTN)	• Twin pregnancy[28] • Large for gestational age/macrosomia • Precipitous delivery • Caesarean section without labour	• Signs present within the first 6 hours after birth[29] • Barrel-shaped chest • Tachypnoea/increased work of breathing[5] • Auscultation o Breath sounds clear[4,5] • Less than FiO_2 0.4 usually required[5]	• May not require CPAP or FiO_2 greater than 0.4 however: o CPAP can facilitate lung fluid clearance[30] o May be required in cases with sufficient respiratory distress • Fluid restriction may be beneficial[4,5] • Fluid is eventually cleared by lymphatic drainage or absorbed into small blood vessels • Usually resolves by 48–72 hours[29]
Meconium aspiration syndrome (MAS)	• Meconium stained liquor • Perinatal asphyxia • Preeclampsia • Post-term pregnancy • Poor intrauterine fetal growth • Small for gestational age	• Presence of meconium • Some babies can be critically unwell with: o Hypoxaemia due to ventilation-perfusion mismatch o Respiratory failure • Auscultation o Rales and rhonchi	• CPAP may help in maintaining functional residual capacity (FRC) in neonates with MAS[30] • Monitor preductal and postductal SpO_2 • Invasive ventilation may be indicated • Refer to Table 1. Clinical standards: Escalation of care
Persistent pulmonary hyper-tension (PPHN)	• Selective serotonin reuptake inhibitor (SSRI) and non-steroidal anti-inflammatory drugs (NSAID) taken greater than or equal to 33+0 weeks[31] • Maternal aspirin during late pregnancy—can cause in-utero closure of ductus arteriosus[31] • Chorioamnionitis • Oligohydramnios • Chronic in-utero asphyxia • MAS	• Significant hypoxaemia and respiratory failure in first 12 hours • SpO_2 difference of greater than 5% between preductal and postductal measures[31] • Auscultation o Prominent precordial impulse, accentuated second heart sound, systolic murmur consistent with tricuspid regurgitation • If septic may present with refractory hypotension, multiorgan failure, and coagulopathy[32]	• Echocardiogram: gold standard29 • If PPHN suspected, requires early recognition and aggressive management to prevent complications • Aim to keep SpO_2 at greater than 97% • Refer to Table 1. Clinical standards: Escalation of care • Refer to Queensland Clinical Guideline: *Stabilisation for retrieval–neonatal*[33]

2.6 Pulmonary air leaks

Table 7. Types of pulmonary air leaks

Type	Description	Risk factors	Clinical features	X-ray features/blood gas	Management
Pneumo-thorax	• Occur at any time • Following alveolar rupture into the pleural space—extra pleural pressure exceeds intrapleural pressure causing lung collapse	• Infection • Aspiration • Lung deformity • Ventilation causing barotrauma • Significant pulmonary hypoplasia	• May be asymptomatic • Unexpected deterioration in: o Oxygenation o Ventilation o Cardiovascular status • On affected side: o Chest asymmetry o Decreased breath sounds o Shift of heart sounds away	• Air in pleural space, atelectasis	• Refer to local policy • Transillumination (small baby) or CXR • If not causing significant respiratory distress—treat conservatively • If significant respiratory distress o Needle thoracocentesis; *and/or* o Intercostal catheter (ICC) insertion • Refer to Queensland Clinical Guideline: *Stabilisation for retrieval–neonatal*[33] • Refer to Table 1. Clinical standards: Escalation of care
Tension pneumothorax	• Occur any time • Increases intrathoracic and central venous pressures • Decreases venous return	• Intermittent positive pressure ventilation (IPPV)	• Rapid clinical deterioration • Profound desaturation • Hypotension • Bradycardia • Narrowed pulse pressure on invasive BP waveform	• Air in pleural space • Atelectasis • Flattening of the diaphragm on affected side • Shift of mediastinum away from the pneumothorax • Hypoxaemia	• Transillumination • Requires emergency management o Needle thoracocentesis; and/or o ICC insertion • Refer to Queensland Clinical Guideline: *Stabilisation for retrieval–neonatal*[33] • Refer to Table 1. Clinical standards: Escalation of care
Pneumo-mediastinum	• Air in the mediastinal space	• IPPV with high peak airway pressure	• Usually asymptomatic • May be detected by cardiac auscultation (distant heart sounds) • Large collections of air may result in tachypnoea and cyanosis	• Radiolucent halo over the cardiac outline or retrosternal or mediastinal radiolucency (on lateral view)[34] • Thymus gland lifted giving ‘angel wing’ or ‘spinnaker sail’ appearance[34]	• Usually not required as resolves spontaneously • Conservative management is recommended • Continue to observe for other air leaks
Pneumo-pericardium	• Air surrounding the pericardium	• Active resuscitation • Assisted ventilation in preterm	• Signs of cardiac tamponade[35] o Cyanosis, tachycardia or bradycardia, hypotension • Muffled heart sounds on auscultation	• In anterior posterior (AP) view air surrounds the heart shadow within the pericardium[34] • Air in the pericardial space	• Observe for signs of cardiac tamponade • May require pericardiocentesis • Refer to Table 1. Clinical standards: Escalation of care

2.7 Other causes of respiratory distress

Table 8. Infection and aspiration

Aspect	Consideration
Respiratory infection	• Bacterial pneumonia[4] o Can be indistinguishable and coexist with all causes of respiratory distress o Blood cultures assist diagnosis[6] • Viral respiratory tract infection • X-ray may demonstrate patchy opacities and/or lobar consolidation
Other aspiration[36]	• May be caused by aspiration of: o Blood or liquor (from birth)[15] o Water (if water birth)[37] o Milk (if feeding)[15] o Saliva—in neonates with oesophageal atresia
Non-respiratory causes[4,15]	• Hyperthermia from overheating resulting in tachycardia, tachypnoea and increased oxygen consumption • Sepsis—including meningitis • Congenital infections—TORCH infections • Cardiac disease • Metabolic derangements from inborn errors of metabolism • Hydrocephalus • Intracranial haemorrhage • Neonatal abstinence syndrome (NAS) • Neuromuscular disorders

2.8 Congenital anomalies

Table 9. Congenital anomalies

Aspect	Consideration
Congenital heart disease[4]	• Usually presents with less respiratory distress unless persistent pulmonary hypertension also present[6] o Refer to Table 6. Differential diagnosis of respiratory distress • Chest X-ray characterised by absence of diffuse reticulogranular ground glass appearance with air bronchograms o Awareness of cardiac anomaly appearance on X-ray • Respiratory support and surfactant *do not* improve clinical condition[15] o Refer to Table 1. Clinical standards: Escalation of care.
Pulmonary hypoplasia[4,6]	• May occur in isolation or associated with other congenital anomalies—such as congenital diaphragmatic hernia[38] • Unilateral: o Chest X-ray characterised by small lung with reduced vascularity and ipsilateral heart displacement[21] • Bilateral: o Associated with oligohydramnios and prolonged preterm rupture of membranes o Chest X-ray may show bell shaped thorax, reduced inflation, increased pulmonary shadowing and pulmonary air leaks[21]
Congenital diaphragmatic hernia[6,15]	• Usually diagnosed antenatally by ultrasound scan • Signs include scaphoid abdomen, diminished breath sounds ipsilateral to the side of the hernia, displacement of heart sounds contralateral to the side of the hernia[24] • Refer to Table 5. X-ray interpretation
Airway[15]	• Pierre Robin sequence • Choanal atresia[4] • Tracheooesophageal fistula[4] • Oesophageal atresia • Laryngeal web
Other[6]	• Congenital pulmonary adenomatoid malformation (CPAM) o Chest X-ray characterised by large isolated cystic area above diaphragm—not always identifiable immediately after birth

3 Continuous positive airway pressure

A continuous pressure is applied to open the baby's airways and facilitate improved breathing.[39] The baby must maintain own breathing. If there are clinical concerns, Refer to Table 1. Clinical standards: Escalation of care.

3.1 CPAP principles

Table 10. CPAP principles

Aspect		Consideration
Indications		• Treat o Respiratory failure in babies with respiratory distress[40] ▪ Refer to Table 3. Signs of respiratory distress o Airway obstruction[40] • Prevent respiratory failure (e.g. apnoea of prematurity)[40] • Standard and preferred respiratory treatment over invasive intubation[4]
Benefits	**Reduces**[41-43]	• Oxygen requirement • Work of breathing • Obstructive apnoea due to upper airway splinting[44] • Intrapulmonary shunting[45] • Utilisation of endogenous surfactant pool[43] • Atelectasis and airway closure[46] • Need for mechanical ventilation
	Improves	• Transition to extrauterine life by facilitating lung fluid clearance[47] • Lung compliance and stabilises the compliant chest wall • Functional residual capacity (FRC): decreasing the work of breathing, distends the larynx and reduces subglottic airway resistance[39 48] • Oxygenation and maintains lung volume[49] • Thoracoabdominal synchrony
Contraindications		• Frequent and prolonged apnoeas[50] • Certain cleft palates • Bilateral choanal atresia o Single nasopharyngeal tube may be used in unilateral choanal atresia • Other craniofacial abnormalities which would prevent application of the CPAP interface[50] • Tracheooesophageal fistula and/or oesophageal atresia[50] • Congenital diaphragmatic hernia • Post-abdominal surgery[50] • Gastroschisis or omphalocele[51] • Necrotising enterocolitis (suspected or confirmed)[52] • Significant loss of skin or septal columella integrity following use of bi-nasal CPAP[53] • Congenital lung/airway lesions (e.g. congenital lobar emphysema, congenital pulmonary airway malformation) • Neuromuscular disorders associated with severe respiratory depression[50]

3.2 CPAP administration

Table 11. CPAP administration

Aspect		Consideration
Driver	**Bubble device**[49]	• Uses water column as a source of resistance[54] • Pressure maintained by immersing distal end of expiratory tubing in water • Depth of tubing in water determines the CPAP generated • Increased vigour of bubbling has no effect on the neonate's gas exchange—aim for gentle bubbling • Does not alarm if loss of pressure/bubble—vigilance is required to observe bubbling
	Ventilator[55]	• Constant flow device which uses expiratory valve to generate PEEP[54] • Internal regulators to set pressure and flow • Airway pressure generated by nasal interface o Alarms when set pressure not achieved
Device	**Binasal prongs**	• Standard of care for babies of all gestations who breathe spontaneously and require continued respiratory support[56] • Measure and size the interface device for each baby o If the device has a specific measurement guide, use when fitting prongs o Refer to manufacturer instructions o Accurate sizing of nasal prongs is crucial to maintain positive end expiratory pressure (PEEP) and prevent air leaks[57] • Reduces airflow resistance—preventing intubation and/or reintubation[58] • Refer to Table 17. Pressure area injuries
	Nasal mask	• Choose correct size mask o If the device has a specific measurement guide, use when fitting mask o Refer to manufacturer guidelines • Vigilance in placement and positioning are crucial • Avoid mask sliding up and occluding nares[56] • May relieve trauma from prongs[59] • Consistent, excessive mask pressure can hinder facial growth o Long-term aesthetic/functional complications may occur
Device management		• Gas output must be warmed and humidified before it reaches the baby[55] • Insert circuit through lowest insertion port on incubator to: o Assist drainage of condensation away from the baby[48,56] o Reduce aspiration risk • Position inspiratory limb (blue) above expiratory limb (white) • Sit snorkel tubing parallel to baby's face o Add or remove extra foam pieces to achieve the correct position of device[60] • If the baby's mouth habitually remains open, use a chin strap to maintain CPAP o Position the strap under the bony portion of the chin and not over the fleshy portion of the hypopharynx region—may cause airway obstruction and increase risk of aspiration[56]
Troubleshooting		• If loss of pressure (loss of bubbles on bubble device or positive end-expiratory pressure (PEEP) on a ventilator) o Check mouth position o Consider a chin strap • Check movement and/or fit of binasal prongs o If prongs move freely, or have a wide gap around nares, consider upsizing • Inspect hydrocolloid nasal barrier dressing o If moist or poorly fitted—consider replacement dressing o If not utilised, consider application of a hydrocolloid dressing o Refer to Table 19. Pressure area management • Check integrity of the circuit o Check connections are tight o If using a bubble device, increase the flow to achieve a constant bubble

3.3 CPAP settings

Table 12. CPAP settings

Aspect	Consideration
Pressure	• Commence at 7–8 cmH_2O o PEEP greater than 8 cmH_2O has the potential to reduce pulmonary blood flow and cause pneumothorax o Use PEEP greater than 8 cmH_2O with caution[61]— discuss with a neonatologist via RSQ
Flow	• Generally, 6–8 L per minute[60] depending on CPAP device • Use lowest level possible to deliver desired pressure—generally not less than 6 L per minute • Refer to manufacturer's instructions
Oxygen	• Deliver oxygen to maintain SpO_2 within target levels[29] • Refer to Table 22. Supportive care
Humidification	• Inspired gas is always humidified and warmed before delivery to baby[62] o Reduces the thickening of pharyngeal/bronchial secretions o Reduces potential for airway plugging and obstruction • Set temperature according to manufacturer's instructions—generally temperature set to 37 °C to be fully humidified when entering baby

3.4 CPAP improvement and weaning

Table 13. CPAP improvement and weaning

Aspect	Consideration
Context	• Lung compliance changes occur between 48–96 hours of age due to surfactant secretion[39] • If CPAP is discontinued prematurely, risk of[63]: o Atelectasis o Apnoea and bradycardia[39] • If CPAP is continued unnecessarily, risk of complications include[63] o Gastric distension; nasal trauma; agitation o Alveolar over distension resulting in longer term consequences[63]
Signs of improvement	• Reduction and/or resolution in the work of breathing including: o Respiratory rate o Expiratory grunting o Chest recession o Nasal flaring[44] • Stabilised or reduced FiO_2 requirement to maintain SpO_2 within target range • Improvement in appearance and lung volumes on chest X-ray • Improvement in blood gas (if taken) • More settled baby
Weaning CPAP	• Reduce FiO_2 before reducing CPAP pressure o Maintain SpO_2 levels in target range[64] o Refer to Table 3. Signs of respiratory distress • Commence gradual CPAP weaning when: o FiO_2 0.21 o Respiratory distress improved o Apnoeas and bradycardic episodes are self-resolving • Wean incrementally by 1 cmH_2O as tolerated until 5 cmH_2O
Ceasing therapy	• Criteria to trial off: [65] o No signs of respiratory distress; *and* o CPAP 5 cmH_2O; *and* o FiO_2 0.21 • Dependent on: o Age and gestation ▪ The younger the gestation, the longer CPAP usually required o Length of time on CPAP or other ventilatory support ▪ Weaning a late preterm–term baby with respiratory distress is usually much faster than weaning a baby with chronic lung disease

3.5 Signs of deterioration

Table 14. Signs of deterioration and considerations

Aspect	Consideration
Context	• Defined as the need for endotracheal intubation and mechanical ventilation due to severe respiratory distress and high oxygen requirement within 72 hours of nasal CPAP initiation[66,67] • Associated with increased risk of chronic lung disease (CLD) and other morbidities[54]
Signs[68]	• Increased work of breathing • FiO_2 greater than 0.4 (or according to local protocols) to maintain target SpO_2 with 8 cmH_2O CPAP • Rapid increase of oxygen requirement • Recurrent apnoeic episodes requiring stimulation • Respiratory acidosis which is failing to improve and/or worsening o Refer to Queensland Clinical Guideline: *Stabilisation for retrieval–neonatal*[33] o Refer to Table 1. Clinical standards: Escalation of care
Nursing care	• Optimise CPAP: o Maintain set pressures ▪ If pressure not maintained, refer to Table 11. CPAP administration—troubleshooting o Try different mechanisms of CPAP generation (bubble device or ventilator) o Check and/or change patient interface (mask or binasal prongs)[54,69] • For agitation not settled by comfort measures o Assess for other causes and manage according to local policy o Refer to Section 4. Care of baby with respiratory distress
Medical review	• Urgent medical officer or nurse practitioner assessment • Optimise respiratory support o If weaning, increase CPAP back to last effective pressure • Urgent chest X-ray • Transilluminate chest to detect signs of pulmonary air leak o Refer to Table 7. Types of pulmonary air leaks • Blood gas—assess for hypercarbia or severe metabolic acidosis • If prolonged apnoea and bradycardic episodes persist—intermittent positive pressure ventilation (IPPV) may be required • Refer to Queensland Clinical Guideline: *Stabilisation for retrieval–neonatal*[33] • Refer to Table 1. Clinical standards: Escalation of care
Recommencing CPAP	• Recommence if: o Work of breathing increases o SpO_2 falls and/or frequent desaturations o Increase in prolonged apnoeas • Recommence at 7–8 cmH_2O and adjust accordingly

3.6 CPAP complications

Table 15. Complications of CPAP

Aspect	Consideration
Pulmonary air leaks	• CPAP increases risk of pneumothorax[29,34] o Refer to Table 7. Types of pulmonary air leaks
Pain and discomfort[70,71,72]	• Related to: o Flow of gas through nose and mouth o Restricted head movements o Obstructed vision o Painful procedures associated with intervention • Refer to Table 22. Supportive care
Abdominal insufflation	• Caused by delivered gas entering the stomach and gastrointestinal tract[56,71] • May cause feed intolerance[56] • At least 4 hourly aspirations of air from OGT o Refer to Table 21. Supportive care • Use lowest possible flow of gas to achieve required CPAP o Refer to Table 11. CPAP administration
Hyperinflation of lungs	• Caused by excessive pressure that results in increased work of breathing[73] • Reduced cardiac output secondary to impaired venous return
Pressure injury	• Nasal trauma and skin integrity issues[65] • Refer to Table 17. Pressure area injuries
Condensation	• Moisture accumulates in circuitry and binasal devices o Refer to Table 11. CPAP administration • Condensate may enter neonate's airway causing aspiration o Can lead to serious adverse events • Vigilance required to prevent condensate accumulation o Remove promptly from circuitry and prongs/masks o Avoid flicking or shaking condensate out of circuit

3.7 Special considerations

Table 16. Special circumstances

Aspect	Consideration
Context	• CPAP is the gold standard for the treatment of respiratory distress • Other modalities/treatments may be considered but are not considered standard care • Consultation with a neonatologist via RSQ is required before use
Heated humidified high flow nasal cannula[74] **(HHFC)**	• Not recommended as first line use for treatment of respiratory distress • Provides heated and humidified air and oxygen at 4–8 L/minute • May be considered if: o Inadequate CPAP supplies or clinician expertise available o Increased pressure area susceptibility from CPAP device • Requires o Gases to be heated and humidified o Air/oxygen blender o Prong size to be less than 50% of nasal passage diameter
Minimally and/or less invasive surfactant administration[29, 30,75-80]	• Not recommended unless in a tertiary facility o Consult with neonatologist via RSQ o May be considered by a clinician experienced with risks and benefits of administration • Clinician *and* team experienced in neonatal intubation required

3.8 Pressure area care

Pressure area care is vital to prevent skin pressure areas and trauma, particularly around the nasal area where the CPAP prongs or mask make contact. Proper management of pressure points reduces the risk of trauma and infection, supporting the baby's comfort and overall recovery.

3.8.1 Causes

Table 17. Pressure area injuries

Aspect	Consideration
Principles	• Most common complication of nasal CPAP[81,57] • Provide vigilant skin assessments[82] • First sign of skin breakdown is nasal erythema[83] • Assess regularly for signs of pressure injury • Hourly visual inspection with routine observations[58] • Comprehensive assessment every 4–6 hours with cares • Check positioning of device as well as prongs and/or mask • Provide protection against infections, discomfort, and nasal deformities[84]
Risk factors	• Nasal deformities • Length of therapy • Age, gestation, and size of baby • Environmental humidity and temperature • Inconsistent practice for assessing skin integrity[57]
Causes	• Incorrect sizing and positioning of binasal prongs • Constant pressure on nares, nasal septum, and forehead • Friction shear from ill-placed respiratory tubing[85] • Tight or loose fitting CPAP hat o Tight—can cause pressure areas around head and ears, periorbital oedema as well as head moulding o Loose—can cause the CPAP device to move, causing pressure on nose • Decreased blood flow to area and impaired tissue perfusion o Increased pressure around nares leading to skin breakdown

3.8.2 Assessment

Table 18. Pressure area assessment

Aspect	Consideration
Signs of pressure injury	• Redness and/or blanching • Bruising • Indentation • Skin breakdown • Bleeding • Necrosis
Nasal trauma	• Nasal hyperaemia • Excoriation of the septum columella • Necrosis and nasal erosion • Disfigurement of nasal size and shape • Functional airway obstruction[86,87]
Other trauma	• Ear ischaemia—resulting in necrosis or tissue loss • Pressure areas on forehead • Periorbital oedema • Head moulding
Assessment	• Nose: o Bridge o Columella o Nares—inside and out o Philtrum o Tip of nose • Head: o Remove CPAP hat during cares to assess o Forehead—if using midline device (mask or prongs) o Bony prominences o Shape of head • Ears: o Check routinely when CPAP hat off for cares o Creases of ears o Folds o Behind ears

3.8.3 Management

Table 19. Pressure area management

Aspect	Consideration
Observation	• Monitor the positioning of the prongs, circuit, and baby to avoid pulling or twisting and/or pressure on the nose • Follow manufacturer guides for sizing and fit of all CPAP devices • Review interface and delivery mechanisms[56] o Check snorkel length doesn't extend over babies' forehead o Resize if necessary (3 sizes available 50,70 or 100mm)[60] • Rotation of interface between binasal prongs and mask, may reduce the risk of nasal injury[54]
Binasal prongs	• Position 2 mm from the nares to avoid o Contact with the septal columella o Pressure on the nasolabial sulcus and philtrum[57,58] • Correct size and position not to occlude nares or pressure on septum o Refer to Table 11. CPAP administration
Nasal mask[57]	• If nasal mask is used, position to cover entire nose • Do not occlude nostrils or touch eyes, lip or septum with the mask • Do not fit nasal mask tightly o Avoid indentations and pressure on nasal bridge o Can result in significant pressure injury/nasal bridge flattening
CPAP hat	• Avoid tight and/or loose fitting CPAP hat o Refer to Table 17. Pressure area injuries • Correct CPAP hat size minimises the occurrence of nasal injury[58] • Release CPAP hat for a few minutes with each routine handling and care episode o Assess skin, including scalp and behind ears
Circuit	• Twisting or tension on the CPAP circuit o Will cause incorrect positioning of the binasal prongs or nasal mask[58] o Associated with high occurrence of pressure injury[58]
Hydrocolloid dressings[29,82,88]	• Helps provide seal around device • Avoid use within the first 15 minutes of first application of nasal prongs o Inhibits visualisation of nares and septal columella o Increases pressure injury risk—blanching not able to be visualised • Will not prevent pressure being applied to the septal columella • Assess regularly for moisture[29] • Change at least every 12 hours or more frequent if: o Seal not created o Visualisation of the nasal skin is required o Moisture present • Remove during application of mask CPAP or when trialling off CPAP o Obstructs the airway and inhibit observation of respiratory distress o Use an adhesive dissolving wipe when removing[85,88] • Do not use if evidence of nasal trauma
Documentation	• Use wound assessment tool if available[84] o Refer to local policy • Document location, nature and extent of injury • Clinical photos may provide point of reference and assist assessment of progression and recovery[84,85]

4 Care of baby with respiratory distress

By optimising the care of babies with respiratory distress, healthcare providers can effectively reduce illness severity, minimise long-term complications, and improve the chances of a successful recovery.

4.1 General care

Table 20. Monitoring and observation

Aspect	Consideration
Principles	• Observe unclothed (with nappy only) o In an incubator or under a radiant warmer/open care system • Minimal handling • If significant work of breathing—consider CPAP • For staffing requirement for babies with respiratory distress +/- CPAP o Refer to Queensland Health CSCF module for: *Neonatal services*[11]
Monitoring	• Continuous monitoring and record every hour—or if change in condition[4] o Heart rate, respirations o Oxygen saturations—preferably on right hand/wrist (preductal) o Blood pressure and perfusion during cares—minimum 6 hourly • If PPHN suspected o Refer to Table 6. Differential diagnosis of respiratory distress o Pre and post ductal oxygen saturations ▪ On right hand/wrist (preductal) ▪ Left hand/wrist or either foot (postductal)
Oxygenation	• Give oxygen to maintain SpO_2 within target ranges o Refer to Table 3. Signs of respiratory distress • Monitor delivered FiO_2 concentration continuously o If oxygen requirement increasing, consider CPAP • If PPHN suspected o Refer to Table 6. Differential diagnosis of respiratory distress
Temperature	• Maintain temperature within normal range o Axilla 36.5–37.5 °C[29] • Refer to Queensland Clinical Guideline: *Stabilisation for retrieval–neonatal*[33] • Monitor and record temperature every 4–6 hours once stable
Blood glucose	• Refer to Queensland Clinical Guideline: *Hypoglycaemia–newborn*[89]
Blood gas	• Determine frequency based on clinical condition and respiratory support required • Aim for $PaCO_2$ 40–55 mmHg, with pH greater than 7.30 • If an arterial sample is obtained, aim for PaO_2 50–80 mmHg

4.2 Positioning

Table 21. Positioning babies on CPAP

Aspect	Consideration
Positioning principles	• A well-positioned baby helps reduce incidences of nasal trauma and other pressure injuries • Position to avoid: o Inadvertent tension to the interface[56] ▪ Refer to Table 17. Pressure area injuries o Accumulation of condensate to the nares ▪ Refer to Table 15. Complications of CPAP • If baby has umbilical lines in place, consider: o Position—refer to local policy regarding positioning baby with umbilical lines o If in prone position with umbilical lines, consider: ▪ Position of lines—not kinked, not pulling, secure ▪ Length of time required to be supine post insertion
Prone	• Suitable if: o Acute respiratory disease • Positive effect on respiratory mechanics by improving: o Oxygenation o Ribcage–abdominal synchrony o Consistency of breathing pattern[56] • Place infant with chin slightly tucked and head rotated to side • Flex arms and tuck arms into the sides so that hands are placed close to shoulders or face • Flex hips and knees up under the body as able
Quarter prone	• Beneficial for stabilising respiratory rate and increasing oxygen saturations[21,90,91] • Nest baby by supporting hips, uppermost arm and trunk with roll and knees and feet together
Lateral	• If acute lung disease, avoid lateral positioning o May reduce effective bilateral lung expansion o Increases the risk of atelectasis • Shown to reduce stress • Can be used to treat unilateral lung disease: o If atelectasis present—better oxygenation may be achieved by positioning the ‘good’ lung uppermost
Supine	• If positioned supine during cares, use peanut pillow to help maintain head in midline position • Encourage flexion of the arms to the midline and legs with the use of a rolled swaddle in a U-shape down the sides of the trunk and under the legs to support the legs in flexion
Positioning aids	• Use nest or swaddle for stability o Folded swaddle/sheet can act as ‘seatbelt' and can be used to help support babies • Provide boundary to mimic in-utero positioning, midline and flexion o Explain the use of positioning aids in relation to safe sleeping as appropriate–SIDS recommendations o Refer to Queensland Clinical Guideline: *Safer infant* sleep[92]

4.3 Supportive care

Table 22. Supportive care

Aspect	Consideration
Fluids	• Insert intravenous (IV) cannula o Commence 10% glucose IV at 60 mL/kg/day • If peripheral IV cannulation is difficult—not achieved after three attempts, consider umbilical venous catheter (UVC) o Consider telehealth support from neonatologist via RSQ for this procedure
Feeding	• Insert a size 6F OGT to alleviate gastric distension[56,71] o If significant abdominal distension an 8F OGT may be required o Leave on free drainage to vent stomach[56] o Cap for 30 minutes after a feed • If respiratory status is stable, consider: o Small gavage feeds o Enteral feeding from first day of life[29] • If respirations are greater than 80 breaths per minute do not feed
Pain management	• Minimise painful procedures • Assess and record pain every 4–6 hours using a validated pain management tool[71,84] • May require pharmacological intervention—refer to local policy o Sucrose 24% orally[93] [refer to NeoMedQ: *Sucrose*][94] o Refer to Queensland Clinical Guideline: *Neonatal medicines*[95] • Utilise non-pharmacological strategies o Reducing environmental and sensory stimuli (e.g. noise and light) o Positioning [refer to Table 21. Positioning babies on CPAP] o Non-nutritive sucking[96] [refer to Table 23. Developmental care]
Suctioning	• Routine suctioning not required • Wipe the lips as an alternative to suction o Minimises risk of creating oral aversion and distress • Avoid deep suctioning[56] • Risks from suctioning include: o Infection o Bradycardia o Laryngospasm o Blood pressure fluctuations o Hypoxaemia o Increased intracranial pressure o Cardiac arrhythmia o Nasal injury[97] • Provide comfort measures including facilitated tucking, swaddling and oral sucrose to reduce associated pain

4.4 Developmental care

Table 23. Developmental care

Aspect	Consideration
Developmental care	• Developmental positioning is important to: o Prevent pressure injury and deformational plagiocephaly[98] o Promote healthy neurodevelopment • Involve parents in the baby's cares (if clinically stable) o Refer to bonding opportunities below • Minimal handling—disturb only when necessary • Comfort and natural development provided by: o Gentle touch and midline positioning o Developmental positioning o Age appropriate stimulation o Cycled lighting o Decreased environmental stimuli including noise • Boundaries support and contain rather than restrict spontaneous movements • Position face to avoid pressure and distortion of the nasal septum columella • Correct (natural) alignment of head, trunk and limbs in all positions assists in preventing acquired postural deformity • Support and position to promote developmental care and comfort • Refer to Table 21. Positioning babies on CPAP
Cares	• Perform care according to clinical condition—usually 4–6 hourly by one or two people o Second person may be a family member • If fragile or compromised, two clinicians required, for example if: o Has acute lung disease o Weighs less than 1000 g o Requires greater than 7 cmH_2O CPAP o Requires greater than FiO_2 0.25 • Minimise time off CPAP • Encourage family collaboration[56,71]
Bonding opportunities if baby is unstable	• Encourage baby's family to assist with eye and mouth cares, and head massage o With assistance from clinician to maintain CPAP • Nappy changes • Encourage presence during painful procedures[70] o Explain that voice and touch are non-pharmacological interventions used for pain management[99] • Family bonding time[98] • Modified skin to skin and hand hugs
Skin-to-skin/ kangaroo care	• If unstable, not recommended[29] • Encourage as soon as clinical condition allows[64]
Non-nutritive sucking[100]	• Promotes physiological stability • Reduces stress • Aids relaxation during invasive procedures • Improves preparation for oral feeding • Improves oxygenation • Reduces air leak from mouth • Must have consent from parents/caregiver/guardian

References

1. Queensland Health. Women and Girls strategy [Internet]. 2024 [cited 2024 August 16]. Available from: https://www.health.qld.gov.au/.
2. Martin R, Deakins K. Respiratory support, oxygen delivery, and oxygen monitoring in the newborn. 2022. UpToDate Inc. Waltham MA. [Internet] [cited 2024 July 12]. Available from: https://www.uptodate.com.
3. Queensland Clinical Guidelines. Consumer information: Respiratory distress and CPAP. Guideline No. C24.3-1-V1-R29. [Internet]. Queensland Health. 2024. [cited 2024 December 12] Available from: https://www.health.qld.gov.au/qcg.
4. Hermansen CL, Mahajan A. Newborn respiratory distress. American Family Physician 2015;92(11):994-1002.
5. Johnson K. Transient tachypnea of the newborn. 2023. UpToDate Inc. Waltham MA. [Internet] [cited 2024 July 30]. Available from: https://www.uptodate.com.
6. Martin R. Respiratory distress syndrome (RDS) in the newborn: Clinical features and diagnosis. . 2023. UpToDate Inc. Waltham MA. [Internet] [cited 2024 July 30]. Available from: https://www.uptodate.com.
7. Mirzamoradi M, Hasani Nejhad F, Jamali R, Heidar Z, Bakhtiyari M. Evaluation of the effect of antenatal betamethasone on neonatal respiratory morbidities in late preterm deliveries (34-37 weeks). The Journal of Maternal-Fetal & Neonatal Medicine 2020;33(15):2533-40. doi:10.1080/14767058.2018.1554051.
8. Roberts D, Brown J, Medley N, Dalziel S. Antenatal corticosteroids for accelerating fetal lung maturation for women at risk of preterm birth. Cochrane Database of Systematic Reviews. [Internet]. 2017, [cited 2024 July 10]. Issue 3. Art No.: CD004454. doi:10.1002/14651858.CD004454.pub3.
9. Queensland Clinical Guidelines. Antenatal corticosteroids (ACS). Guideline No. MN21.64-V1-R26. [Internet]. Queensland Health. 2021. [cited 2024 July 15]. Available from: https://www.health.qld.gov.au/qcg.
10. Queensland Clinical Guidelines. Preterm labour and birth. Guideline No. MN20.6-V9-R25. [Internet]. Queensland Health. 2020. [cited 2024 July 30]. Available from: https://www.health.qld.gov.au/qcg.
11. Queensland Health. Clinical Services Capability Framework: Neonatal Services [Internet]. 2014 [cited 2024 July 16]; V3.2. Available from: https://www.health.qld.gov.au.
12. Reuter S, Moser C, Baack M. Respiratory distress in the newborn. Pediatric Review 2014;35(10):417-28. doi:10.1542/pir.35-10-417.
13. Queensland Clinical Guidelines. Hypoxic ischaemic encepathalopathy. Guideline No. MN21.11-V12-R26. [Internet]. Queensland Health. 2021. [cited 2024 August 12]. Available from: https://www.health.qld.gov.au/qcg.
14. Martin R. Respiratory distress syndrome (RDS) in preterm infants: Management. 2024. UpToDate Inc. Waltham MA. [Internet] [cited 2024 July 19]. Available from: https://www.uptodate.com.
15. Martin R. Overview of neonatal respiratory distress and disorders of transition. 2024. UpToDate Inc. Waltham MA. [Internet] [cited 2024 July 23]. Available from: https://www.uptodate.com.
16. Yadav S, Lee B, Kamity R. Neonatal Respiratory Distress Syndrome. In: National Library of Medicine. Treasure Island (FL): StatPearls Publishing; 2024.
17. Queensland Clinical Guidelines. NeoMedQ Benzylpenicillin. Guideline No. NMedQ20.013-V1-R25. [Internet]. Queensland Health. 2024. [cited 2024 August 12]. Available from: https://www.health.qld.gov.au/qcg.
18. Queensland Clinical Guidelines. NeoMedQ Ampicillin. Guideline No. NMedQ19.012-V1-R24. [Internet]. Queensland Health. 2021. [cited 2024 August 12]. Available from: https://www.health.qld.gov.au/qcg.
19. Queensland Clinical Guidelines. NeoMedQ Gentamicin. Guideline No. NMedQ20.038-V3-R25. [Internet]. Queensland Health. 2021. [cited 2024 August 02]. Available from: https://www.health.qld.gov.au/qcg.
20. Queensland Clinical Guidelines. Early onset Group B Streptococcal disease. Guideline No. MN22.20-V6-R27. [Internet]. Queensland Health. 2022. [cited 2024 October 08]. Available from: https://www.health.qld.gov.au/qcg.
21. Jain SN, Modi T, Varma RU. Decoding the neonatal chest radiograph: An insight into neonatal respiratory distress. Indian Journal of Radiology and Imaging 2020;30(4):482-92. doi:10.4103/ijri.IJRI_281_20.
22. Silveira Neves G, Silveira Nogueira Reis Z, Maia de Castro Romanelli R, Dos Santos Nascimento J, Dias Sanglard A, Batchelor J. The role of chest X-ray in the diagnosis of neonatal respiratory distress syndrome: A systematic review concerning low-resource birth scenarios. Global Health Action 2024;17(1):2338633. doi:10.1080/16549716.2024.2338633.
23. Garcia-Prats J. Meconium aspiration syndrome: Management and outcome. 2023. UpToDate Inc. Waltham MA. [Internet] [cited 2024 July 12]. Available from: https://www.uptodate.com.
24. Longoni M, Pober B, High F. Congenital Diaphragmatic Hernia Overview. In: National Library of Medicine. [Internet]. Seattle (WA): University of Washington; 2020.
25. Subramaniam P, Ho JJ, Davis PG. Prophylactic or very early initiation of continuous positive airway pressure (CPAP) for preterm infants. Cochrane Database of Systematic Reviews. [Internet]. 2021, [cited 2024 July 15]. Issue 10. Art No.: CD001243. doi:10.1002/14651858.CD001243.pub4.
26. Dini G, Santini MG, Celi F. Less invasive surfactant administration (LISA) versus INSURE method in preterm infants: A retrospective study. Medical Archives 2024;78(2):112-6. doi:10.5455/medarh.2024.78.112-116.
27. Queensland Clinical Guidelines. NeoMedQ Curosurf. Guideline No. NMedQ20.040-V1-R25. [Internet]. Queensland Health. 2020. [cited 2024 July 29]. Available from: https://www.health.qld.gov.au/qcg.
28. Bruschettini M, Hassan KO, Romantsik O, Banzi R, Calevo MG, Moresco L. Interventions for the management of transient tachypnoea of the newborn: An overview of systematic reviews. Cochrane Database of Systematic Reviews. [Internet]. 2022, [cited 2024 August 25]. Issue 2. Art No.: CD013563. doi:10.1002/14651858.CD013563.pub2.
29. World Health Organization. WHO recommendations on interventions to improve preterm birth outcomes. 2015. [cited 2024 July 11]. Available from: https://www.who.int.
30. Xu Y, Zhu X, Kong X, Li J. Outcomes of noninvasive neurally adjusted ventilatory assist and nasal continuous positive airway pressure in preterm infants: A systematic review and meta-analysis. Archivos Argentinos de Pediatria 2022;120(2):89-98. doi:10.5546/aap.2022.eng.89.
31. Stark A, Eichenwald E. Persistent pulmonary hypertension of the newborn. 2019. UpToDate Inc. Waltham MA. [Internet] [cited 2019 December 3]. Available from: https://www.uptodate.com.
32. Nandula P, Shah S. Persistent Pulmonary Hypertension of the Newborn. In: National Library of Medicine. [Internet]. Treasure Island (FL): StatPearls Publishing; 2023.
33. Queensland Clinical Guidelines. Stabilisation for retrieval–neonatal Guideline No. MN23.18-V5-R28. [Internet]. Queensland Health. 2023. [cited 2024 July 22]. Available from: https://www.health.qld.gov.au/qcg.
34. Fernandes C. Pulmonary air leak in the newborn. 2023. UpToDate Inc. Waltham MA. [Internet] [cited 2024 August 19]. Available from: https://www.uptodate.com.
35. Roychoudhury S, Kaur S, Soraisham A. Neonatal pneumopericardium in a nonventilated term infant: A case report and review of the literature. Case Reports in Pediatrics 2017;2017. doi:10.1155/2017/3149370.
36. Nolt D, O'Leary ST, Aucott SW. Risks of infectious diseases in newborns exposed to alternative perinatal practices. Pediatrics 2022;149(2). doi:10.1542/peds.2021-055554.
37. Fernandes C. Neonatal resuscitation in the delivery room. 2024. UpToDate Inc. Waltham MA. [Internet] [cited 2024 July 2024]. Available from: https://www.uptodate.com.

38. Diamond M, Peniston H, Sanghavi K, Mahapatra S, Doerr C. Acute Respiratory Distress Syndrome. In: National Library of Medicine. [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 [cited 2024 August 01].
39. Ho JJ, Subramaniam P, Davis PG. Continuous positive airway pressure (CPAP) for respiratory distress in preterm infants. Cochrane Database of Systematic Reviews. [Internet]. 2020, [cited 2024 July 12]. Issue 10. Art No.: CD002271. doi:10.1002/14651858.CD002271.pub3.
40. Alexiou S, Panitch HB. Physiology of non-invasive respiratory support. Seminars in Fetal and Neonatal Medicine 2016;21(3):174-80. doi:10.1016/j.siny.2016.02.007.
41. Bamat N, Jensen EA, Kirpalani H. Duration of continuous positive airway pressure in premature infants. Seminars in Fetal and Neonatal Medicine 2016;21(3):189-95. doi:10.1016/j.siny.2016.02.005.
42. Schmolzer GM, Kumar M, Pichler G, Aziz K, O'Reilly M, Cheung PY. Non-invasive versus invasive respiratory support in preterm infants at birth: Systematic review and meta-analysis. British Medical Journal 2013;347:f5980. doi:10.1136/bmj.f5980.
43. Kribs A, Roberts KD, Trevisanuto D, O'Donnell C, Dargaville PA. Surfactant delivery strategies to prevent bronchopulmonary dysplasia. Seminars in Perinatology 2023;47(6):151813. doi:10.1016/j.semperi.2023.151813.
44. Lemyre B, Deguise M-O, Benson P, Kirpalani H, Ekhaguere OA, PG. D. Early nasal intermittent positive pressure ventilation (NIPPV) versus early nasal continuous positive airway pressure (nCPAP) for preterm infants. Cochrane Database of Systematic Reviews. [Internet]. 2023, [cited 2024 July 10]. Issue 7. Art No.: CD005384. doi:10.1002/14651858.CD005384.pub3.
45. de Carvalho Nunes G, Barbosa de Oliveira C, Zeid M, Leone M, Mardakis S, Remmer E, et al. Early bubble CPAP protocol implementation and rates of death or severe BPD. Pediatrics 2024;154(1). doi:10.1542/peds.2023-065373.
46. Faal G, Eghbal F. Effect of bubble and ventilator-derived continuous positive airway pressure on the management of respiratory distress syndrome in premature neonates. Iranian Journal of Neonatology 2018;9(4):22-7. doi:10.22038/ijn.2018.25855.1341.
47. Bedwell S, Leasure AR, Gibson TL. Interventions for the management of respiratory distress in late preterm and term infants experiencing delayed respiratory transition: A systematic review. Dimensions of Critical Care Nursing 2019;38(4):192-200. doi:10.1097/dcc.0000000000000365.
48. Guerin C, Bailey SM, Mally PV, Rojas M, Bhutada A, Rastogi S. Randomised control trial comparing physiologic effects in preterm infants during treatment with nasal continuous positive airway pressure (nCPAP) generated by bubble nCPAP and ventilator nCPAP: A pilot study. Journal of Perinatal Medicine 2016;44(6):655-61. doi:10.1515/jpm-2015-0209.
49. Pinto VL, Sharma S. Continuous Positive Airway Pressure. In: National Library of Medicine. [Internet]. Treasure Island (FL): StatPearlsPublishing; 2023 [cited 2024 August 02].
50. Fedor KL. Noninvasive respiratory support in infants and children. Respiratory Care 2017;62(6):699-717. doi:10.4187/respcare.05244.
51. Bielicki IN, Somme S, Frongia G, Holland-Cunz SG, Vuille-Dit-Bille RN. Abdominal wall defects-current treatments. Children (Basel) 2021;8(2). doi:10.3390/children8020170.
52. Willis KA, Ambalavanan N. Necrotizing enterocolitis and the gut-lung axis. Seminars in Perinatology 2021;45(6):151454. doi:10.1016/j.semperi.2021.151454.
53. Fu Y, Li X, Yu Y, Li R, Shi T. Summary of the best evidence for the prevention of nasal injury in preterm infants with nasal noninvasive ventilation. Translational Pediatrics 2024;13(2):224-35. doi:10.21037/tp-23-465.
54. Jain D, Shah M. Current controversies and advances in non-invasive respiratory support for preterm infants. Current Treatment Options in Pediatrics 2022;8(3):262-77. doi:10.1007/s40746-022-00239-w.
55. Chatburn RL, Carlo WA. Common devices used for mechanical ventilation. In: Keszler M, Gautham KS, editors. Goldsmith's Assisted Ventilation of the Neonate. 7th ed. Philadelphia: Elselvier; 2022. p. 315-50.e1.
56. Guay JM, Carvi D, Raines DA, Luce WA. Care of the neonate on nasal continuous positive airway pressure: A bedside guide. Neonatal Network 2018;37(1):24-32. doi:10.1891/0730-0832.37.1.24.
57. Haymes E. The effects of continuous positive airway pressure (CPAP) on nasal skin breakdown. Journal of Neonatal Nursing 2020;26(1):37-42. doi:10.1016/j.jnn.2019.09.007.
58. Ribeiro DFC, Barros FS, Fernandes BL, Nakato AM, Nohama P. Nasal prongs: Risks, injuries incidence and preventive approaches associated with their use in newborns. Journal of Multidisciplinary Healthcare 2020;13:527-37. doi:10.2147/JMDH.S252017.
59. Cummings JJ, Gerday E, Minton S, Katheria A, Albert G, Flores-Torres J, et al. Aerosolized calfactant for newborns with respiratory distress: A randomized trial. Pediatrics 2020;146(5). doi:10.1542/peds.2019-3967.
60. Fisher and Paykel Healthcare. Bubble CPAP system set-up guide [Internet]. 2021 [cited 2024 August 11]. Available from: https://www.fphcare.com/au.
61. Australian and New Zealand Committee on Resuscitation (ANZCOR). Airway management and mask ventilation of the newborn [Internet]. 2021 [cited 2024 July 27]. Available from: https://www.anzcor.org/
62. Lavizzari A, Zannin E, Klotz D, Dassios T, Roehr CC. State of the art on neonatal noninvasive respiratory support: How physiological and technological principles explain the clinical outcomes. Pediatric Pulmonology 2023;58(9):2442-55. doi:10.1002/ppul.26561.
63. Eze N, Murphy D, Dhar V, Rehan VK. Comparison of sprinting vs non-sprinting to wean nasal continuous positive airway pressure off in very preterm infants. Journal of Perinatology 2017;38:164. doi:10.1038/jp.2017.161.
64. Sahni R, Schiaratura M, Polin R. Strategies for the prevention of continuous positive airway pressure failure. Seminars in Fetal and Neonatal Medicine 2016;21(3):196-203. doi:10.1016/j.siny.2016.02.008.
65. Shi Y, Muniraman H, Biniwale M, Ramanathan R. A review on non-invasive respiratory support for management of respiratory distress in extremely preterm infants. Frontiers in Pediatrics 2020;8:270. doi:10.3389/fped.2020.00270.
66. Al-Lawama M, Alkhatib H, Wakileh Z, Elqaisi R, AlMassad G, Badran E, et al. Bubble CPAP therapy for neonatal respiratory distress in level III neonatal unit in Amman, Jordan: A prospective observational study. International Journal of General Medicine 2018;12:25-30. doi:10.2147/IJGM.S185264.
67. Jasani B, Ismail A, Rao S, Patole S. Effectiveness and safety of nasal mask versus binasal prongs for providing continuous positive airway pressure in preterm infants: A systematic review and meta-analysis. Pediatric Pulmonology 2018;53(7):987-92. doi:10.1002/ppul.24014.
68. Jardine LA, Inglis GDT, Davies MW. Strategies for the withdrawal of nasal continuous positive airway pressure (nCPAP) in preterm infants. Cochrane Database of Systematic Reviews. [Internet]. 2011, [cited 2024 July 27]. Issue 2. Art No.: CD006979. doi:10.1002/14651858.cd006979.pub2.
69. Prakash R, De Paoli AG, Davis PG, Oddie SJ, McGuire W. Bubble devices versus other pressure sources for nasal continuous positive airway pressure in preterm infants. Cochrane Database of Systematic Reviews. [Internet]. 2023, [cited 2024 July 15]. Issue 3. Art No.: CD015130. doi:10.1002/14651858.CD015130.
70. Courtois E, Cimerman P, Dubuche V, Goiset M-F, Orfèvre C, Lagarde A, et al. The burden of venipuncture pain in neonatal intensive care units: EPIPPAIN 2, A prospective observational study. International Journal of Nursing Studies 2016;57:48-59. doi:10.1016/j.ijnurstu.2016.01.014.
71. Fraser D. Nursing care. In: Goldsmith J, Karotkin E, Keszler M, Suresh G, editors. Assisted Ventilation of the Neonate. Philadelphia: Elsevier; 2017. p. 310-21.e3.

72. Rodrigues L, Nesargi S, Fernandes M, Shashidhar A, Rao S, Bhat S. Analgesic efficacy of oral dextrose and breast milk during nasopharyngeal suctioning of preterm infants on cpap: A blinded randomized controlled trial. Journal of Tropical Pediatrics 2017;63(6):483-8. doi:10.1093/tropej/fmx017.
73. American Association for Respiratory Care. Application of continuous positive airway pressure to neonates via nasal prongs, nasopharyngeal tube, or nasal mask. Respiratory Care 2004;49(9):1100-8.
74. Singh R, Munian LP, Memela NA. Management of neonates with respiratory distress syndrome in resource-limited settings. South African Family Practice 2024;66(1):e1-e7. doi:10.4102/safp.v66i1.5938.
75. National Institute for Health and Clinical Excellence (NICE). Specialist neonatal respiratory care for babies born preterm. Clinical Guideline NG124. 2019. [Internet]. [cited 2024 July 18]. Available from: https://www.nice.org.uk.
76. Sweet DG, Carnielli VP, Greisen G, Hallman M, Klebermass-Schrehof K, Ozek E, et al. European Consensus Guidelines on the Management of Respiratory Distress Syndrome: 2022 Update. Neonatology 2023;120(1):3-23. doi:10.1159/000528914.
77. Liebers B, Ebenebe CU, Wolf M, Blohm ME, Vettorazzi E, Singer D, et al. Improved less invasive surfactant administration success in preterm infants after procedure standardization. Children (Basel) 2021;8(12):1145. doi:10.3390/children8121145.
78. Ge H, Qiao Y, Au F, Scrivens A, Roehr CC. Less invasive surfactant administration as a means to facilitate gentler transition for preterm infants? A narrative review. Pediatric Medicine 2021;5(27). doi:10.21037/pm-21-2.
79. Ramaswamy VV, Abiramalatha T, Bandyopadhyay T, Boyle E, Roehr CC. Surfactant therapy in late preterm and term neonates with respiratory distress syndrome: A systematic review and meta-analysis. Archives of Disease in Childhood: Fetal and Neonatal Edition 2022;107(4):393-7. doi:10.1136/archdischild-2021-322890.
80. De Luca D. Respiratory distress syndrome in preterm neonates in the era of precision medicine: A modern critical care-based approach. Journal of Pediatrics & Neonatology 2021;62(1):s3-s9. doi:10.1016/j.pedneo.2020.11.005.
81. Chen C-Y, Chou A-K, Chen Y-L, Chou H-C, Tsao P-N, Hsieh W-S. Quality improvement of nasal continuous positive airway pressure therapy in neonatal intensive care unit. Journal of Pediatrics & Neonatology 2017;58(3):229-35. doi:10.1016/j.pedneo.2016.04.005.
82. Imbulana D, Owen L, Dawson JA, Bailey J, Davis PG, Manley B. A randomized controlled trial of a barrier dressing to reduce nasal injury in preterm infants receiving binasal noninvasive respiratory support. The Journal of Pediatrics 2018;201:34-9.
83. Newnam KM, McGrath JM, Salyer J, Estes T, Jallo N, Bass WT. A comparative effectiveness study of continuous positive airway pressure-related skin breakdown when using different nasal interfaces in the extremely low birth weight neonate. Applied Nursing Research 2015;28(1):36-41. doi:10.1016/j.apnr.2014.05.005.
84. August D, Kandasamy Y, Ray R, New K, Lindsay D. Evaluation of the consistency of neonatal skin injury assessment using clinical images and the metric and graduated colour tool. Journal of Tissue Viability 2022;31(3):395-403. doi:10.1016/j.jtv.2022.05.002.
85. August D, Ullman A, Coyer F. Device related pressure injuries across the critical care lifespan. Nursing in Critical Care 2023;28(1):6-8. doi:10.1111/nicc.12874.
86. Badr L, Zeineddine M, Abbas H, Charafeddine L. NeoSeal to prevent nasal injury in preterm infants receiving oxygen therapy. Neonatal Network 2017;35(4):228-33. doi:10.1891/0730-0832.35.4.228.
87. Chao JW, Raveendran JA, Sauerhammer TM, Rogers GF, Oh AK, Boyajian M. Columellar reconstruction after nasal continuous positive airway pressure associated necrosis. The Journal of Craniofacial Surgery 2017;28(4):928-30. doi:10.1097/scs.0000000000003296.
88. Ribeiro DFC, Barros FS, Fernandes BL, Nakato AM, Nohama P. Hydrocolloid versus silicone gel for the prevention of nasal injury in newborns submitted to noninvasive ventilation: A randomized clinical trial. Heliyon 2020;6(7):e04366. doi:10.1016/j.heliyon.2020.e04366.
89. Queensland Clinical Guidelines. Hypoglycaemia-newborn. Guideline No. MN23.8-V13-R28. [Internet]. Queensland Health. 2023. [cited 2024 July 30]. Available from: https://www.health.qld.gov.au/qcg.
90. Montgomery K, Choy NL, Steele M, Hough J. The effectiveness of quarter turn from prone in maintaining respiratory function in premature infants. Journal of Paediatric Child Health 2014;50(12):972-7. doi:10.1111/jpc.12689.
91. Utario Y, Rustina Y, Waluyanti FT. The quarter prone position increases oxygen saturation in premature infants using continuous positive airway pressure. Comprehensive Child and Adolescent Nursing 2017;40(1):95-101. doi:10.1080/24694193.2017.1386976.
92. Queensland Clinical Guidelines. Safer infant sleep Guideline No. MN22.71-V1-R27. [Internet]. Queensland Health. 2022. [cited 2024 August 13]. Available from: https://www.health.qld.gov.au/qcg.
93. Liaw JJ, Yang L, Lee CM, Fan HC, Chang YC, Cheng LP. Effects of combined use of non-nutritive sucking, oral sucrose, and facilitated tucking on infant behavioural states across heel-stick procedures: A prospective, randomised controlled trial. International Journal of Nursing Studies 2013;50(7):883-94. doi:10.1016/j.ijnurstu.2012.08.021.
94. Queensland Clinical Guidelines. NeoMedQ Sucrose. Guideline No. NMedQ21.066-V1-R26. [Internet]. Queensland Health. 2021. [cited 2024 August 13]. Available from: https://www.health.qld.gov.au/qcg.
95. Queensland Clinical Guidelines. Neonatal medicines. Guideline No. MN19.54-V1-R24. [Internet]. Queensland Health. 2019. [cited 2024 August 15]. Available from: https://www.health.qld.gov.au/qcg.
96. Thakkar P, Arora K, Goyal K, Das RR, Javadekar B, Aiyer S, et al. To evaluate and compare the efficacy of combined sucrose and non-nutritive sucking for analgesia in newborns undergoing minor painful procedure: A randomized controlled trial. Journal of Perinatology 2016;36(1):67-70. doi:10.1038/jp.2015.122.
97. Sweet M, Armbruster D, Bainbridge E, Reiner B, Tan A, Chipps E. A pilot study of responses to suctioning among neonates on bubble nasal continuous positive airway pressure. Advances in Neonatal Care 2017;17(6):E3-E11. doi:10.1097/ANC.0000000000000442.
98. Flanagan KA. Noninvasive ventilation in premature neonates. Advances in Neonatal Care 2016;16(2):91-8. doi:10.1097/ANC.0000000000000273.
99. Belpınar A, Yayan EH. Effect of Yakson touch and mother's voice on pain and comfort level during nasal CPAP application in Turkey: A randomized controlled study. Explore (NY) 2023;19(5):743-8. doi:10.1016/j.explore.2023.02.010.
100. Ahmadpour-Kacho M, Zahed Pasha Y, Hahdinejad Z, Khafri S. The effect of non-nutritive sucking on transcutaneous oxygen saturation in neonates under the nasal continuous positive airway pressure (CPAP). International Journal of Pediatrics 2017;5(3):4511-9. doi:10.22038/ijp.2016.7498.

Appendix A Respiratory physiology

Aspect	Consideration
Context[1]	• Transition from intrauterine to extrauterine life depends upon multiple physiologic changes that occur at birth • Most newborns successfully transition without special assistance • Normal fetal alveolar development occurs in four stages o Embryonic period o Pseudoglandular stage o Canalicular stage o Saccular stage
Lung physiology at birth[1]	• Alveolar fluid clearance • Lung expansion • Decrease in pulmonary vascular resistance with corresponding increase in pulmonary blood flow • Increase in systemic blood pressure • Closure of the right–to–left shunts (foramen ovale and ductus arteriosus)
Physiology of RDS[1]	• Surfactant deficiency—primary abnormality in RDS • Inadequate surfactant activity leads to lung instability, low volume, and decreased compliance o Results in hypoxemia due to ventilation/perfusion mismatch • Surfactant deficiency causes lung inflammation and respiratory epithelial injury—causing pulmonary oedema and increased airway resistance • Abnormal fluid absorption results in inefficient liquid clearing—leading to oedema lung and impeded gas exchange
Pulmonary surfactant[1]	• Reduces alveolar surface tension • Facilitates alveolar expansion • Reduces the likelihood of atelectasis from alveolar collapse
Surfactant physiology[1]	• Pulmonary surfactant covers normal alveoli's inner lining • Surfactant production begins in alveolar type 2 cells around 20 weeks gestation • Surfactant is lipid-dense, comprising 70–80% phospholipids, 10% protein, and 10% neutral lipids • Surfactant lipoprotein complex forms inside lamellar bodies at the apical surface of type 2 cells • Lung forces are influenced by chest wall and lung parenchyma elasticity and air-fluid interface surface tension • Surfactant lipoprotein complex decreases surface tension on airways and alveoli, preventing alveoli collapse and fluid entry • Type 2 cells reabsorb secreted surfactant complex, recycling it back into multivesicular bodies and lamellar bodies • Process maintains the surfactant pool
Ventilation-perfusion mismatch[1]	• Changes in lung function cause ventilation–perfusion mismatch due to: o Collapse of portions of the lungs—atelectasis o Abnormal fluid absorption—due to inefficient clearing of liquid in damaged lung ▪ resulting in pulmonary oedema that impedes gas exchange due to reduced functional residual capacity
Hypoxaemia[1]	• Caused by: o Ventilation-perfusion mismatch from intrapulmonary shunting o Extrapulmonary shunting across foramen ovale and patent ductus arteriosus
Acidosis[2]	• Poor ventilation identified from: o Elevated pCO_2 and resultant respiratory acidosis • Metabolic acidosis caused by lactic acid production from anaerobic metabolism due to hypoxaemia and poor tissue perfusion • Blood gas—hypoxaemia and respiratory acidosis[3]

1. Martin R. Respiratory distress syndrome (RDS) in preterm infants: Management. 2024. UpToDate Inc. Waltham MA. [Internet] [cited 2024 July 19]. Available from: https://www.uptodate.com.
2. Martin R, Deakins K. Respiratory support, oxygen delivery, and oxygen monitoring in the newborn. 2022. UpToDate Inc. Waltham MA. [Internet] [cited 2024 July 12]. Available from: https://www.uptodate.com
3. Hermansen CL, Mahajan A. Newborn respiratory distress. American Family Physician 2015;92(11):994-1002.Martin R. Respiratory distress syndrome (RDS) in preterm infants: Management. 2024. UpToDate Inc. Waltham MA. [Internet] [cited 2024 July 19]. Available from: https://www.uptodate.com

Acknowledgements

Queensland Clinical Guidelines gratefully acknowledge the contribution of Queensland clinicians and other stakeholders who participated throughout the guideline development process particularly:

Working Party Clinical Lead

Ms Seija Argyros, Neonatal Nurse Practitioner, Royal Brisbane and Women's Hospital
Dr Kirsty Devine, Neonatologist, The Townsville Hospital

QCG Program Officer

Ms Melissa Johnson, Clinical Nurse Consultant

Working Party Members

Dr Pita Birch, Neonatologist, Mater Mothers' Hospital
Mrs Jessica Braby, Registered Midwife/Nurse, Buderim Private Hospital
Dr David Cantelmi, Neonatal Fellow, Royal Brisbane and Women's Hospital
Ms Mandy Colledge, Neonatal Nurse Educator, Royal Brisbane and Women's Hospital
Ms Li-an Collie, Neonatal Retrieval Nurse Educator, Royal Brisbane and Women's Hospital
Ms Eileen Cooke, Consumer Representative, Preterm Infants Parents Assoc. Inc. (PIPA)
Mrs Cerys Firth, Registered Nurse, Rockhampton Hospital
Ms Perri Frazer, Senior Paediatric Physiotherapist, Logan Hospital
Dr Matt Hale, Paediatrician, Caboolture Hospital
Dr Shivanand Hebbandi, Paediatrician, Redland Hospital
Mrs Julianne Hite, Neonatal Nurse Educator, Rockhampton Hospital
Ms Karen Hose, Neonatal Nurse Practitioner, Royal Brisbane and Women's Hospital
Mrs Donna Hovey, Clinical Nurse, Royal Brisbane and Women's Hospital
Mrs Jo La Spina, Neonatal Nurse Practitioner, Mt Isa Hospital
Mrs Jacinta Lawson, Registered Nurse, Royal Brisbane and Women's Hospital
Ms Donna Martin, Nurse Unit Manager, Cairns Hospital
Mrs Kate McFarlane, Clinical Nurse, Hervey Bay Hospital
Mrs Elise McMahon, Consumer Representative, Little Sparklers Ltd
Ms Megan Murphy, Neonatal Nurse Practitioner, Townsville University Hospital
Ms Naoni Ngenda, Physiotherapist GSNU, Royal Brisbane and Women's Hospital
Mrs Lisa Parfitt, Registered Nurse, Royal Brisbane and Women's Hospital
Dr Rebekah Schofield, General Paediatrician, Townsville University Hospital
Dr Janet Sharpe, Staff Specialist Neonatologist, Royal Brisbane and Women's Hospital
Mrs Deborah Wright, Clinical Coach, Sunshine Coast University Hospital

Queensland Clinical Guidelines Team

Professor Rebecca Kimble, Director
Ms Jacinta Lee, Manager
Ms Cara Cox, Clinical Nurse/Midwife Consultant
Ms Jacqueline Plazina, Clinical Nurse Consultant
Ms Jillian Clarke, Clinical Midwife Consultant
Ms Leah Vekve, Clinical Midwife Consultant
Ms Melissa Johnson, Clinical Nurse Consultant
Ms Elizabeth Milroy, Clinical Nurse/Midwife Consultant
Ms Hannah Billingsley, Program Support Officer
Steering Committee

Funding

This clinical guideline was funded by Healthcare Improvement Unit, Queensland Health