Queensland Clinical Guidelines

Translating evidence into best clinical practice

Maternity and Neonatal **Clinical Guideline**

Neonatal respiratory distress including CPAP

Queensland Government

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- 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

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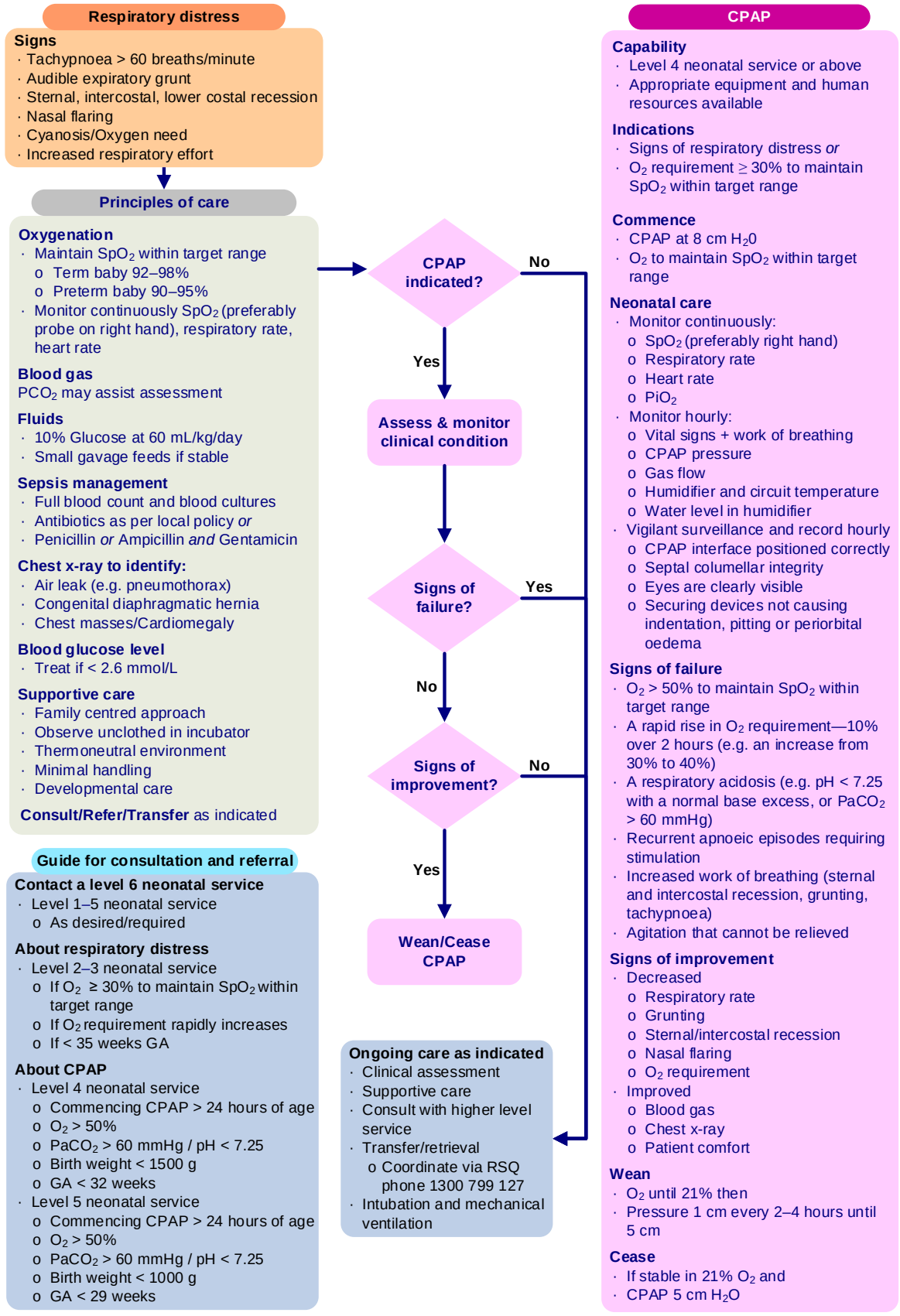
Flow Chart: Neonatal respiratory distress and CPAP ≥ 32 weeks GA



cm H_2O: centimetres of water; **CPAP:** continuous positive airway pressure; **GA:** gestational age; **mmol/L:** millimoles per litre; **O_2:** oxygen; **PiO_2:** partial pressure of inspired oxygen; **$PaCO_2$:** arterial partial pressure of carbon dioxide; **PCO_2:** partial pressure of carbon dioxide; **RSQ:** Retrieval Services Queensland; **SpO_2:** peripheral capillary oxygen saturation; **>:** greater than; **<:** less than; **≥:** greater than or equal to

Flowchart: F14.3-1-V6-R19

Abbreviations

BGL	Blood glucose level
CSCF	Clinical services capability framework
CPAP	Continuous positive airway pressure
HHHFNC	Heated humidified high flow nasal cannula
ICC	Intercostal catheter
IV	Intravenous
OGT	Orogastric tube
$PaCO_2$	Arterial partial pressure of Carbon Dioxide
PiO_2	Partial pressure of inspired Oxygen expressed as a percentage
RSQ	Retrieval Services Queensland
SpO_2	Peripheral capillary oxygen saturation

Definition of terms

Term	Definition
Family centred care	Is an approach to the planning, delivery and evaluation of health care that is grounded in mutually beneficial partnerships among health care providers, patients and families.[1,2] It incorporates the core concepts of respect and dignity, information and sharing, participation and collaboration.[1]
Neonate	A baby who is less than 28 days old.[3]
Preterm	Less than 37+0 weeks gestation
Term	37+0 or more weeks gestation
Oxygen saturation target range	· In the absence of good quality evidence, Queensland Neonatal Services Advisory Group (QNSAG) endorse the following consensus recommendation for oxygen saturation targets for babies after 10 minutes of age o For term babies the target SpO_2 range is 92–98% o For preterm babies the target SpO_2 range is 90–95%

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1 Introduction

Respiratory distress in a neonate presents as tachypnoea after birth. Symptoms can last from hours to days. Correct diagnosis and management of respiratory distress in the neonate is extremely important to minimise morbidity. Respiratory distress is one of the most common problems seen in neonates.

Although resource intensive[4], continuous positive airway pressure (CPAP) is a relatively simple and effective therapy for respiratory distress and the complications and expected clinical course under a variety of circumstances are well understood. The use of CPAP is increasing in regional non-tertiary hospitals.[5]

CPAP is the application of positive pressure to the airways of spontaneously breathing patients throughout the respiratory cycle.[6] The correct application of CPAP has been shown to decrease the work of breathing, reduce the requirement for Oxygen, help establish and maintain functional residual capacity, prevent collapse and upper airway obstruction, reduce apnoea, bradycardia and cyanotic episodes, reduce reintubation rates in infants extubated from mechanical ventilation [6-9] and prevent the need for transfer to tertiary facilities in a target group of babies.[10]

1.1 Purpose

This guideline is primarily intended for the care of neonates greater than or equal to 32 weeks gestational age with respiratory distress receiving care in level 2–6 neonatal services (as defined by Queensland's Clinical Services Capability Framework[11]). Aspects may also be relevant to neonates at lower gestations.

1.2 Family centred care

Maintain a family centred approach to care that incorporates psychological, spiritual and social support.[1]

- Educate parents about respiratory distress and the administration of CPAP
- Share complete and unbiased information with parents and families
- Involve parents in decision making about their baby

1.3 Clinical standards

- Provide care in accordance with Queensland's Clinical Services Capability Framework (CSCF)[11]
- Refer to Appendix A: Resource requirements for CPAP
- (human and equipment) for service level requirements related to the provision of CPAP
- Provide access to clinician education for the management of respiratory distress and CPAP[4]

1.4 Consultation and referral

Table 1. Consultation, retrieval or transfer

Aspect	Consideration
Level 1–5*	· Contact a level 6 neonatal service for advice as required · Provide care according to the CSCF11
Level 2 or 3*	· Contact higher level neonatal service to discuss respiratory distress: o At initiation of treatment for respiratory distress o If Oxygen requirements reach 30% to maintain SpO2 for § Term baby between 92–98% § Preterm baby between 90–95% o If Oxygen rapidly increases (e.g. 10% or more over 2 hours) o If less than 35 weeks gestational age o Daily for on-going advice and support
Level 4*	· Contact higher level neonatal service to discuss CPAP management if: o Commencing CPAP at greater than 24 hours of age o Oxygen requirement greater than 50% o Partial pressure of carbon dioxide ($PaCO_2$) greater than 60 mmHg o Birth weight less than 1500 g o Gestational age less than 32 weeks o Insufficient medical or nursing resources
Level 5*	· Contact level 6 neonatal service to discuss CPAP management if: o Commencing CPAP at greater than 24 hours of age o Oxygen requirement greater than 50% o $PaCO_2$ greater than 60 mmHg o Birth weight less than 1000 g o Gestational age less than 29 weeks o Insufficient medical or nursing resources
Retrieval or transfer	· Contact Retrieval Services Queensland (RSQ) Phone: 1300 799 127 o Coordinate all retrievals via RSQ[12] o Follow locally agreed processes for advice

* Level of neonatal service as defined in the Clinical Services Capability Framework[11]

2 Respiratory distress

Table 2. Respiratory distress

Aspect	Consideration
Signs	· Tachypnoea—more than 60 breaths/minute · Audible expiratory grunt · Sternal, intercostal and lower costal recession · Nasal flaring · Cyanosis/Oxygen need · Increased respiratory effort
Causes	· Hyaline membrane disease/Respiratory Distress Syndrome (RDS) · Infection [refer to Queensland Clinical Guideline: *Early onset Group B Streptococcal disease*[13]] · Retained fetal lung fluid (transient tachypnoea of the newborn) · Aspiration (meconium, blood or liquor) · Pneumothorax · Congenital abnormalities including: o Pulmonary hypoplasia o Diaphragmatic hernia o Airway obstruction o Congenital cardiac disease

2.1 Principles of care

- Commence CPAP if there are signs of respiratory distress ***or***
- If Oxygen requirement greater than or equal to 30%
- Do not wait for deterioration in the clinical condition

Table 3. Care principles

Aspect	Consideration
Oxygenation	· Give Oxygen to maintain SpO_2 within target ranges: o Term baby 92–98% o Preterm baby 90–95% · If Oxygen requirement 30% or more refer to Section 3 CPAP · Monitor delivered Oxygen concentration continuously · Monitor SpO_2 continuously, with probe preferably on the right upper limb · Monitor respirations and heart rate continuously if equipment available
Fluids	· Insert IV cannula and commence 10% Glucose at 60 mL/kg/day · Consider an umbilical venous catheter if peripheral cannulation is difficult (e.g. if peripheral cannulation not achieved with three attempts) · Start small trophic feeds (e.g. 2 mL/kg 3 hourly) in stable neonates with mild to moderate respiratory distress
Blood cultures	· Collect blood for blood culture and full blood count o Collect surface swabs if clinically indicated · Check blood culture result at 24 hours o If negative and respiratory distress resolved with no other sign of infection, give the 24 hour antibiotic dose and then cease (i.e. giving coverage for 36 hours) o If there was a delay in sample entry into a blood culture machine, then continue antibiotics for 48 hours · Check blood culture result again at 48 hours · If blood culture is positive contact higher level neonatal service to discuss duration of antibiotic coverage
Antibiotics	· Aim to give antibiotics within 30 minutes of identification of respiratory distress · Give antibiotics *as per local policy*, otherwise give: o Penicillin 60 mg/kg/dose 12 hourly ***or*** Ampicillin 50 mg/kg/dose 12 hourly **and** o Gentamicin 2.5 mg/kg § If greater than or equal to 30 weeks then give Gentamicin daily § If less than 30 weeks then give Gentamicin every 36 hours: § Check Gentamicin level before giving third dose · Refer to Queensland Clinical Guideline: *Early onset Group B Streptococcal disease*[13]
Chest x-ray	· To identify pathology especially: o Pneumothorax o Congenital diaphragmatic hernia o Chest masses/cardiomegaly · Level 3 and below services to arrange for level 5 or 6 service to view film
Blood glucose	· Refer to Queensland Clinical Guideline: Newborn hypoglycaemia[14] · Aim for a blood glucose level (BGL) 2.6 mmol/L or greater · Treat BGL less than 2.6 mmol/L · Monitor BGL 4–6 hourly for 24 hours until stable *or as indicated by BGL*
Blood gases	· Determine blood gas frequency based on individual clinical circumstances o Not routinely required, o If stable it may be preferable to leave neonate undisturbed · Manage weaning on clinical grounds
Supportive care	· Observe neonate unclothed in an incubator where possible · Maintain temperature within the normal range o Axillary 36.8–37.2˚C and skin 36–36.2˚C · Disturb neonate only when absolutely necessary (“Minimal necessary handling”)

3 CPAP

- Manage CPAP in a neonatal service level 4 or above and as specified in the Clinical Services Capability Framework[11]
- The usual nurse: patient ratio is 1:2
  - If the neonate is very unstable 1:1 may be required

3.1 CPAP administration

Table 4. CPAP administration

Aspect	Consideration
Context	· Early versus delayed initiation of CPAP reduces the need and duration of mechanical ventilation[9,15] · The optimal pressure source for the delivery of nasal CPAP is unknown[8] · Binasal prongs are more effective than short single nasopharyngeal CPAP[8] but the evidence is equivocal on the most effective type of binasal prong · There is very limited evidence about optimal commencement pressure[8] o One small study showed the highest end expiratory lung volume/ tidal volume and lowest respiratory rate and thoracoabdominal asynchrony with a pressure of 8 cm water as compared to 0, 2,4, and 6 cm water[16] o Clinical experience suggests that starting at higher pressures and reducing with clinical improvement is more effective at decreasing the work of breathing than starting at lower pressures and increasing with deterioration · There is limited evidence about withdrawal of CPAP in relation to[17,18]: o The optimal strategy for CPAP withdrawal [refer to 3.2 Expected clinical course] o The criteria to determine when a neonate is stable enough to withdraw CPAP o What constitutes a failed attempt at withdrawal
Indications	· Signs of respiratory distress are present[6] [refer to Table 2. Respiratory distress] · Oxygen requirement 30% or more to maintain SpO_2 within target range o CPAP may be appropriate at lower Oxygen concentrations depending on signs of respiratory distress
Indications for increased ventilatory support	· Severe cardiorespiratory instability · Unstable respiratory drive with frequent apnoeic episodes resulting in desaturation and/or bradycardia · Inability to maintain $PaCO_2$ less than 60 mmHg
Contraindications	· Bilateral choanal atresia · Unrepaired gastroschisis · Congenital diaphragmatic hernia[6] · Tracheoesophageal fistula
Delivery mechanism	· CPAP systems contain three basic components: o CPAP generator (means of creating a positive pressure in the circuit) o Circuit for continuous flow of humidified inspired gases o Patient interface (device to connect the circuit to the neonate's airway) · Use binasal prongs unless there are clinical circumstances necessitating single nasal prong use (e.g. facial anomalies)[8] · Nasal mask may provide equivalent CPAP[19]
Commencement	· Commence CPAP with a pressure of 8 cm water · Give sufficient Oxygen to maintain SpO_2 within target range o Turn Oxygen up if SpO_2 is continually below target range o Turn Oxygen down if SpO_2 continually above target range · Use gas flow at lowest level that achieves desired pressure

3.2 Expected clinical course

Table 5. Clinical course

Aspect	Consideration
Signs of improvement	· Reduction in the work of breathing as indicated by decreased[6,17] o Respiratory rate o Grunting o Sternal/intercostal recession o Nasal flaring · Stabilization or reduction in Oxygen requirement to maintain SpO_2 within target range[6] · Improving blood gas (if measured) · Improvement in lung volumes and chest x-ray appearance[6] · Increased patient comfort as assessed by care provider[6]
Weaning	· Commence weaning when: o Oxygen SpO_2 consistently above target range o Respiratory rate stabilized, grunting ceased and recession reduced o Blood gas improved (if measured) · Wean Oxygen before pressure o Wean Oxygen until 21% **then** o Wean pressure by 1 cm every 2–4 hours until 5 cm water achieved § If signs of respiratory distress (increased work of breathing or increased oxygen requirement), wean as tolerated
Ceasing	· Consider when stable in 21% Oxygen **and** · CPAP pressure 5 cm water
Recommencing	· Undertake careful clinical assessment to exclude other complications requiring additional management (e.g. pneumothorax) · Recommence CPAP if: o Work of breathing increases o Oxygen requirements increase
Signs of failure	· Oxygen requirement greater than 50% to maintain SpO_2 within target range in 8 cm CPAP · A rapid rise in Oxygen requirement[17]—an absolute 10% rise in Oxygen over 2 hours (e.g. an increase from 30% to 40%) · Respiratory acidosis (e.g. pH less than 7.25 with a normal base excess, or $PaCO_2$ greater than 60 mmHg[17]) · Recurrent apnoeic episodes requiring stimulation[17] · Increased work of breathing[17] (sternal and intercostal recession, grunting, tachypnoea) · Agitation that cannot be relieved: o Narcotic analgesics should not be administered to unventilated neonates as these drugs cause respiratory depression o Consider containment, nesting, dummy, or sucrose to settle the neonate
Failure of CPAP	· If there are signs of failure of CPAP: o Immediate medical assessment and chest x-ray is required o Transillumination may be used, (but be aware that negative transillumination is not meaningful in babies greater than or equal to 32 weeks gestational age) o Consult with a higher level neonatal service as retrieval/transfer may be required

3.3 Complications

Table 6. Complications

Aspect	Consideration
Context	· Assessment of morbidity associated with the manner in which CPAP is currently used in neonates greater than or equal to 32 weeks gestational age is difficult to determine due to[4] : o Age of studies and their applicability to current practice o Predominance of studies involving neonates less than 32 weeks gestational age in a tertiary setting o Increased use of antenatal corticosteroids o Increased availability of surfactant
Air leak syndromes	· Includes pneumothorax, pneumomediastinum, pneumopericardium or pulmonary interstitial emphysema (PIE)[6] · Requires urgent medical assistance [refer Appendix B: Emergency management of pneumothorax · May occur due to disease process, high pressures or when the lungs are improving and lung compliance increasing [refer to 3.2 Expected clinical course] · Clinical signs *may* include: o Increasing respiratory distress/rising PCO_2 o Oxygen desaturation o Decreased air entry o Asymmetrical chest movement or appearance o Hyperesonance on auscultation o Positive transillumination · Absence of clinical signs does not exclude pneumothorax · Pneumothorax is not a contraindication to the use of CPAP
Pressure injury	· Results from local pressure of CPAP devices applied to the nasal area, ears, forehead and/or other pressure points o Increased risk from incorrect selection of size and/or device type · Represents a source of discomfort, possible site of infection, risk of long term functional and/or cosmetic sequelae[20] · Greatest risk for nasal trauma associated with[20] o Gestational age less than 32 weeks o Birth weight less than 1500 g o Duration of CPAP greater than 5 days · Requires vigilant clinical surveillance to avoid pressure, traction on circuit/tubing, friction and moisture [refer to Table 7. Neonatal care] · There is equivocal evidence about the use of nasal protection devices o Follow locally agreed policies
Abdominal distension	· Results when delivered gas enters the stomach and gastrointestinal tract[6] · Use lowest possible flow of gas to achieve desired pressure · Reduced with insertion of an orogastric tube (OGT) on free drainage or regular aspiration (size 8 FG) o If neonate is receiving OGT feeds, open OGT to free drainage half hour after feed
Over inflation	· Use of excessive pressures can: o Increase the work of breathing o Reduce cardiac output secondary to impeded venous return[6]

3.4 Neonatal care and CPAP

Table 7. Neonatal care

Aspect	Consideration
Monitoring	· Continuously[6]: o Oxygen saturation o Respiratory rate o Heart rate o Inspired Oxygen concentration(PiO_2) · Hourly: o Vital signs including the work of breathing o CPAP pressure o Gas flow o Humidifier and circuit temperature o Water level in humidifier o Gentle bubbling if using bubble circuit device (no bubbling indicates suboptimal pressure) · Vigilant clinical surveillance and record hourly o CPAP interface is positioned correctly (not distorting features or pushing nasal structures upwards) o Inspect circuit and patient interface for any accumulated condensation – empty as required to prevent aspiration o Septal columellar integrity o Eyes are clearly visible o Securing devices are not causing indentation, pitting or periorbital oedema o Orogastric tube positioned at correct length o Abdominal distension
Suction	· Gentle nasal suction as required o Oral suctioning usually more frequently required
Pressure injury prevention	· Measure and size the interface device appropriately for each neonate · Position binasal prongs 2 mm from the nares and so they are not in contact with the septal columella · Binasal prongs should fit nares firmly but without blanching skin · With cares inspect: o Nasal redness, skin breakdown, bruising, indentation, bleeding, altered nasal shape o Ears for pressure areas, creases or folds o Forehead if using midline device (mask or prongs) o Nasal bridge mid-facial indentation (mask) · Remove hat to inspect head with cares · Document the presence/absence location, nature and extent of pressure injuries · If present, review interface, delivery mechanisms and interventions aimed at reducing injury
Supportive care	· Perform cares as indicated by the neonate's clinical condition; usually 4–6 hourly with one or two people · Position the neonate to avoid inadvertent tension to the interface and/or accumulation of condensate at the nares (e.g. cot propping) · Insert CPAP circuit through lowest insertion port of cot to promote drainage of condensation away from neonate · Insert an OGT to minimise abdominal distension and aspirate 4–6 hourly or leave on free drainage as required · Optimal CPAP is achieved when mouth is closed (e.g. use pacifier, chin strap) · Incorporate principles of developmental care individualised to the needs of the neonate · Incorporate a family centred approach to care and parental involvement · Provide information/education to parents regarding disease process/treatment as required

3.5 Other therapies

Table 8. Other therapies

Therapy	Recommendation
Prophylactic CPAP	· There is no evidence to support the use of prophylactic CPAP[21] (i.e. initiating CPAP before signs of respiratory distress are evident) · Prophylactic CPAP is not recommended
Heated humidified high flow nasal cannula (HHHFNC)	· HHHFNC is increasingly being used as a non-invasive mode of respiratory support[22] · There is insufficient high-quality evidence[22-24] to recommend routine use of HHHFNC in place of CPAP for acute lung disease · May be considered by experienced neonatal units/practitioners in specific clinical circumstances
Surfactant and CPAP	· Routine use of the INSURE technique (technique (IN–*intubate*, SUR–*surfactant*, E–*extubate*) followed by CPAP is not recommended for premature neonates greater than or equal to 32 weeks gestational age o Most evidence about the INSURE technique is in relation to neonates less than 32 weeks gestational age[25] o There is insufficient high-quality evidence to support routine use of the INSURE technique for premature neonates greater than 32 weeks gestational age o In very premature neonates less than 32 weeks gestational age, routine use of the INSURE technique after birth has not been shown to be more effective than routine stabilisation on CPAP with selective intubation and surfactant administration[25] · If the neonate is intubated for respiratory distress and surfactant is administered– it is recommended that lower level neonatal services consult with higher level services prior to extubation

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Appendix A: Resource requirements for CPAP

Workforce	Requirement
Consultant medical staff	· No more than 30 minutes away and contactable by phone immediately · Neonatal resuscitation program trained or equivalent · Experienced in the management of CPAP · Knowledgeable of the indications for and contraindications of commencing a neonate on CPAP · Knowledgeable of the expected course of neonates on CPAP · Technically experienced in the management of a pneumothorax, intubation and the delivery of mechanical ventilation
Nursing staff	· Neonatal resuscitation program trained or equivalent · Experienced in the management of CPAP · Knowledgeable of the indications for and contraindications of commencing a neonate on CPAP · Knowledgeable of the expected clinical course of neonates on CPAP · Experienced nurse (nurse to patient ratio 1:2) available on every shift when treating a neonate with CPAP · Clinical competency assessment is recommended · Consider clinical placement to gain exposure to and experience with o Neonatal resuscitation training o Principles of CPAP management o Specialised nursing care o Management and problem solving associated with delivery equipment
Equipment	**Requirement**
CPAP generating system	· Emergency power available · Bubbles system *or* · Infant flow driver/infant flow nasal CPAP system *or* · Continuous flow mechanical ventilator set in the CPAP mode with high and low pressure, loss of power and gas alarms · Breathing circuit appropriate for CPAP system · Circuit for continuous flow of humidified inspired gases · Air and Oxygen gas supply · Air/Oxygen blender
Humidification	· Humidifier/sterile water (bottle or bag) · Set temperature: o Patient interface/circuit 40ºC o Humidifier 37ºC
Patient interface	· Short binasal prongs are the preferred interface for example: o Midline tubing interface o Side lying tubing interface · Nasal mask may provide equivalent CPAP
Emergency equipment	· Suction equipment - capable of generating negative pressure of 100 mm of mercury or less · Suction catheters (sizes 5, 6 and 8) · Intubation equipment · T Piece, Self-inflating or Flow-inflating devices (Neopuff ™ or equivalent resuscitation device, anaesthetic or Laerdal bag) and various mask sizes · Umbilical venous catheter(UVC) and insertion equipment · Transilluminator · Thoracocentesis equipment [refer to Appendix B: Emergency management of pneumothorax] · Intercostal catheter insertion equipment [Appendix B: Emergency management of pneumothorax]
Monitoring equipment	· Cardio-respiratory monitor · Pulse oximeter · Non-invasive blood pressure monitoring · Equipment for blood gas sampling and measurement · Arterial monitoring if arterial catheter used · Blood glucose level monitor
Thermal maintenance	· Open bed warmer with servo controlled heater or Incubator

Appendix B: Emergency management of pneumothorax

Needle thoracocentesis

Aspect	Consideration
Description	· An emergency procedure, used when the neonate is rapidly deteriorating. The procedure can be both diagnostic and therapeutic.
Equipment	· 23 gauge butterfly needle or 24 gauge intravenous cannula · 3-way stopcock · 10 or 20 mL syringe · Alcohol wipe for skin preparation - · Sterile dressing pack
Site	· Avoid the heart, internal mammary artery and the intercostal arteries · Use either: o 2nd intercostal space, mid-clavicular line **OR** o 4th intercostal space, anterior axillary line · Insert the needle as near as possible to the upper edge of the lower rib · Refer to Figure 1. Needle aspiration
Procedure	· Attach a 23 gauge butterfly needle to a 3 way tap and then attach this to syringe · Prepare the skin with an alcohol wipe and let dry · Insert the needle perpendicular to the chest wall 1–2 cm in this target group · Open the tap to the syringe and needle · Aspirate, if the syringe fills with gas then there is a pneumothorax · Close the 3-way tap to the needle and open to atmosphere and empty the syringe · Turn 3-way tap off to the atmosphere and repeat until there is no more air to aspirate. Record the amount of air aspirated · Remove the needle, no dressing is required
Notes	· There can be an ongoing air leak, which may necessitate ongoing aspiration of gas · After the procedure an ICC will usually need to be inserted

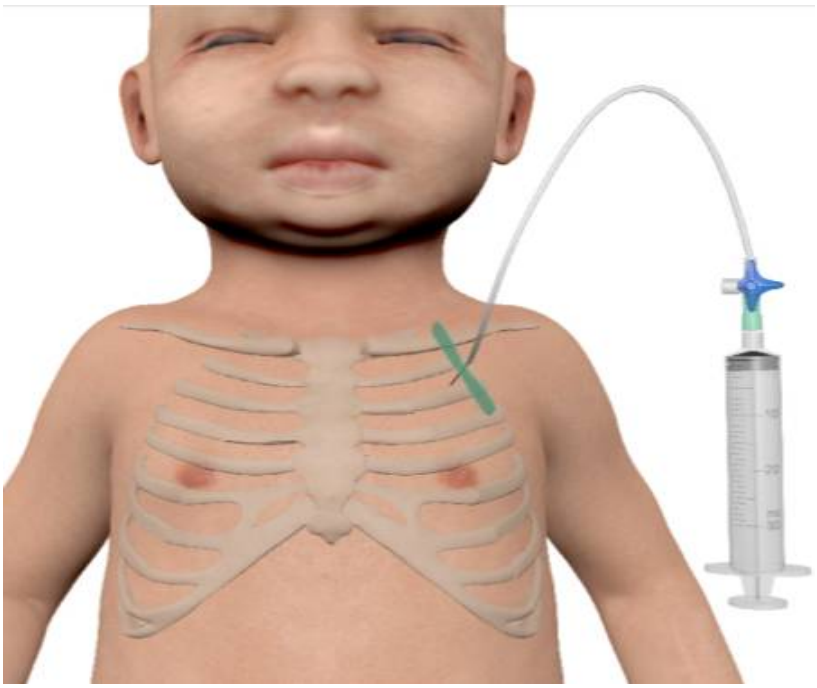

Figure 1. Needle aspiration

Images produced by: Herston Multimedia Unit, Metro North Hospital and Health Service, Queensland

Intercostal catheter (ICC) insertion

Aspect	Consideration
Insertion site	· The best insertion site is the mid to anterior axillary line, 5–6th intercostal space · Always insert catheter just above the rib margin, not below · Stay well away from the nipple
Procedure	· This is a sterile procedure · Use local anaesthetic if there is time · Never use any force to insert the catheter through the chest wall · The procedure may be performed with or without a trocar · Ensure a chest x-ray is taken after insertion · A flutter valve should be adequate. It is usually not necessary to apply suction
Procedure without Trocar	· Incise down to and through the parietal pleura with a number 11 scalpel blade · Then blunt dissect to enlarge the hole created, and use curved artery forceps to insert the intercostal catheter · Direct the tip antero-infero-medially (towards the xiphisternum)
Procedure with Trocar	· This is only safe if the catheter with trocar is held in both hands with the forefingers on either side of the catheter 1–1.5 cm back from the tip and all movement is from the elbows [refer to Figure 2]. NEVER use the palm of the hand over the back end of the trochar · Incise down to and through the parietal pleura with a number 11 scalpel blade, insert the catheter with trocar as indicated above (some operators bend the trocar (1–1.5 cm from the tip) at 20–30^{o} to aid in directing the ICC tip anteriorly) · When in the pleural space, advance the catheter off the trocar, directing it antero-infero-medially (towards the xiphisternum) · Positioning the catheter anterior to the lung is critically important, and this may be facilitated by having an assistant roll the baby away from you after you have the catheter in the pleural space
Notes	· If drainage is ineffective contact higher level neonatal service · If choosing to suture the ICC, do not use a purse string suture as this will produce a puckered scar · Tape with transparent, bio-occlusive dressing by sandwiching the catheter between the two pieces [refer to Figure 6], or use two wide steristrips (25 mm) with sufficient tape length applied to the neonate's chest wall and the catheter · Place the external part of ICC tubing under the arm running up past the head · Refer to local guideline for the management of ICC for ongoing care

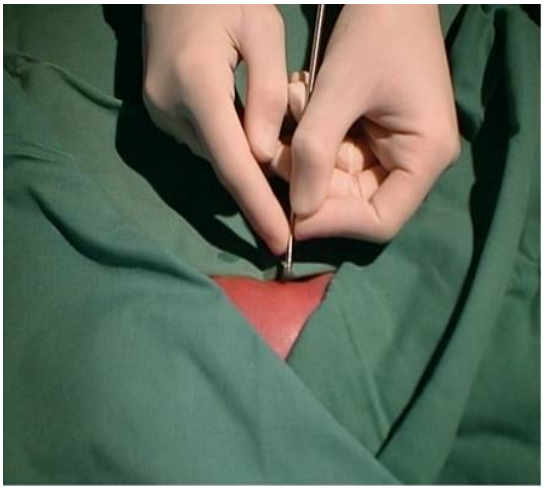

Figure 2. ICC insertion with trocar

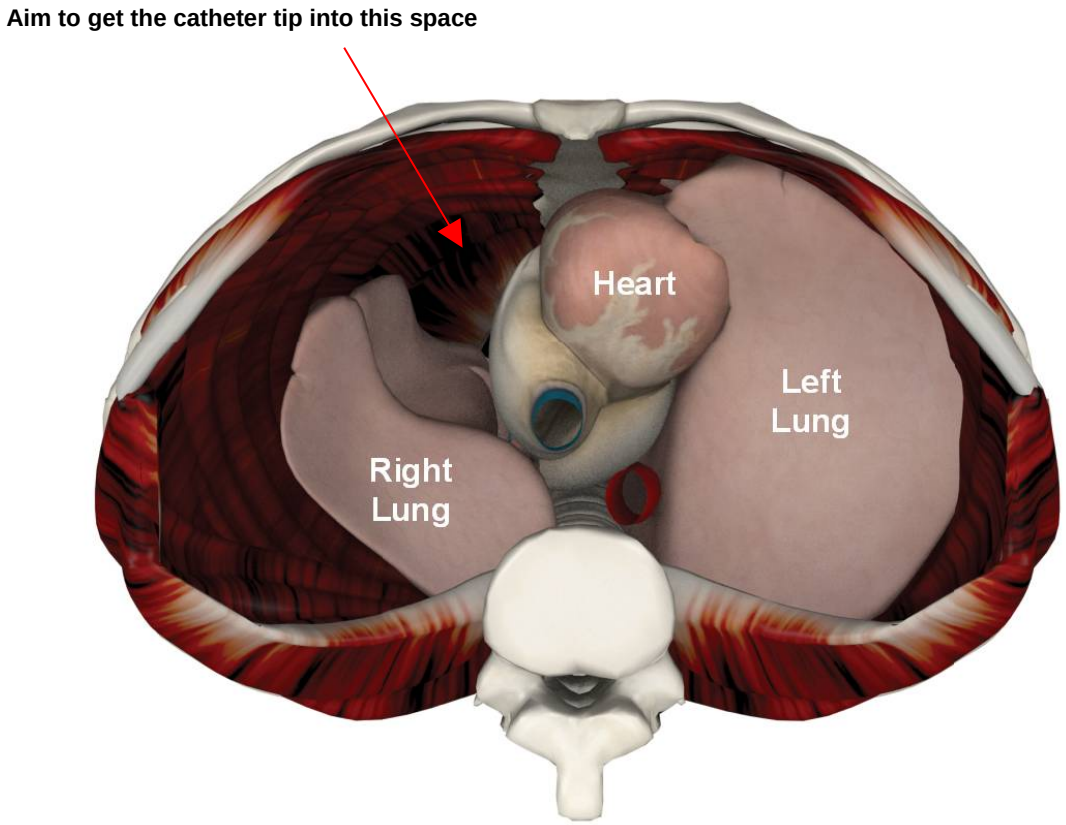

Figure 3. Anatomy of a pneumothorax. Cross sectional view looking up towards the head

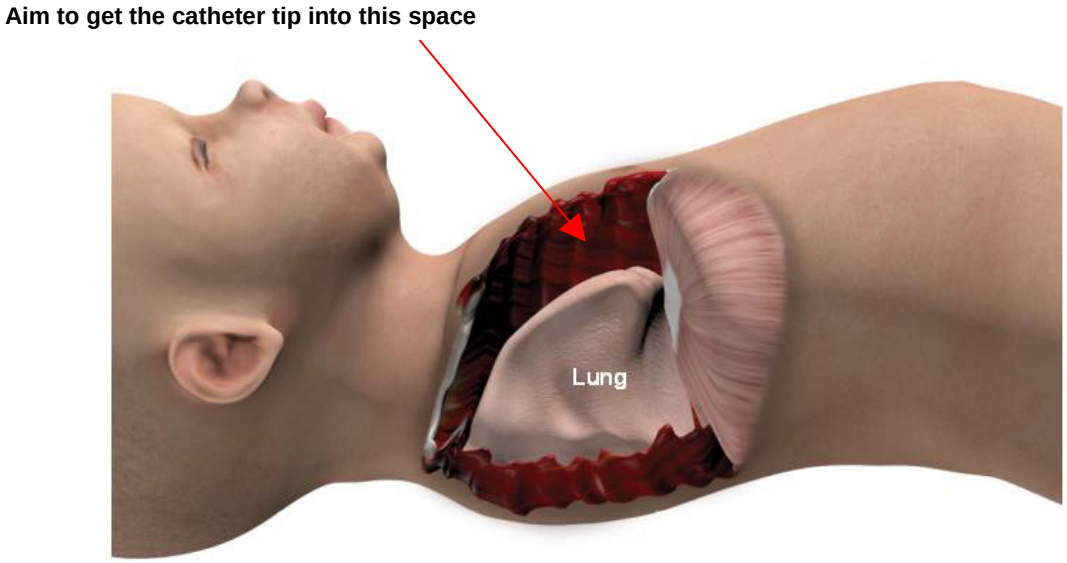

Figure 4: Anatomy of a pneumothorax. Lateral view

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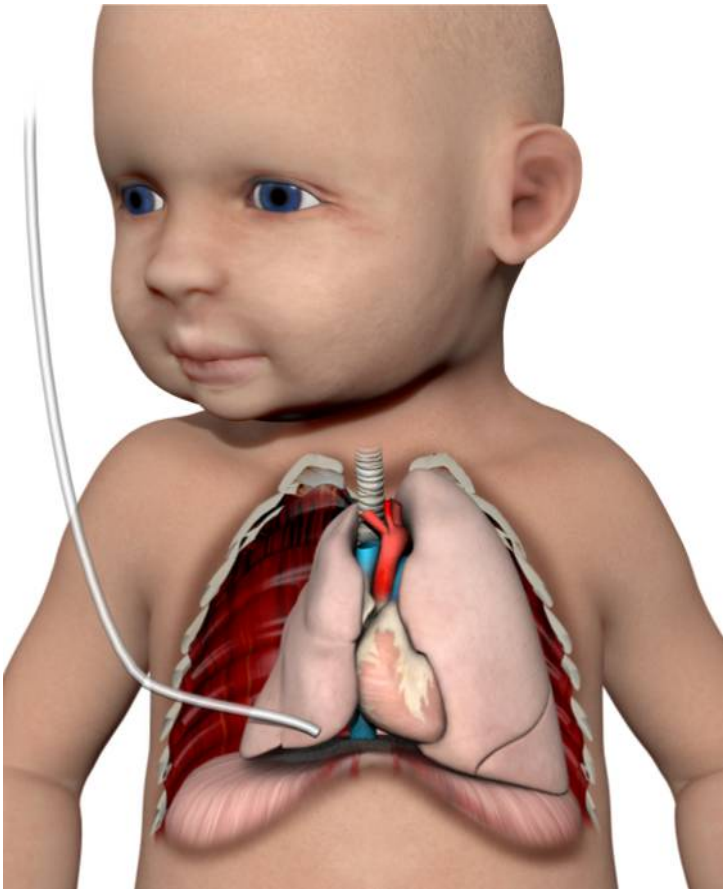

Figure 5. ICC insertion

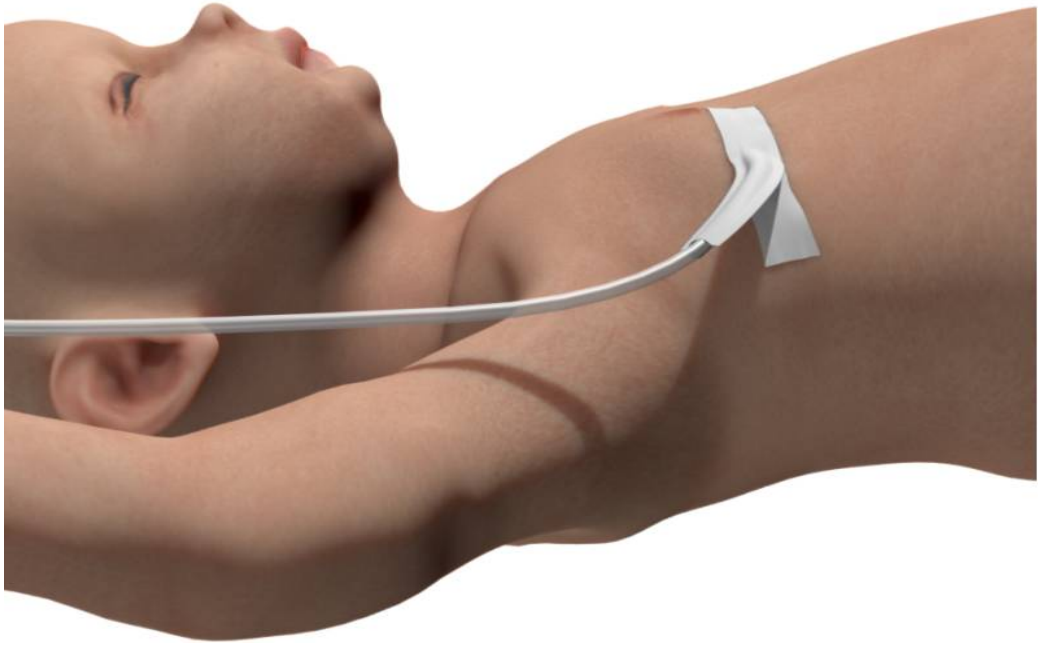

Figure 6. ICC insertion and taping

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Appendix C: Chest x rays neonatal respiratory distress

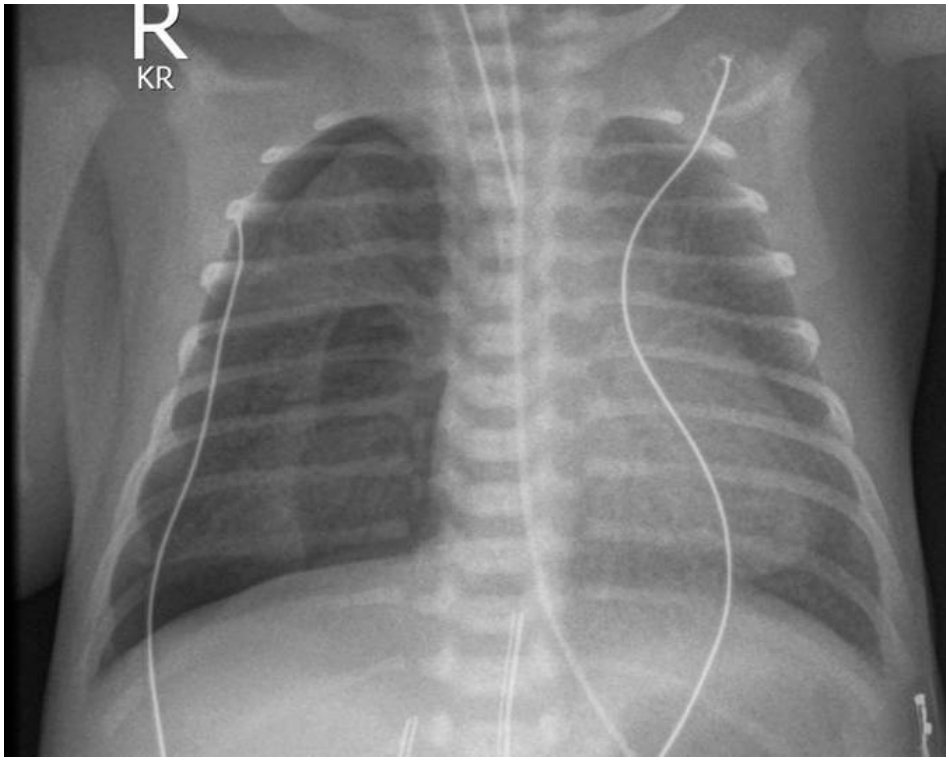

Figure 7: Pneumothorax

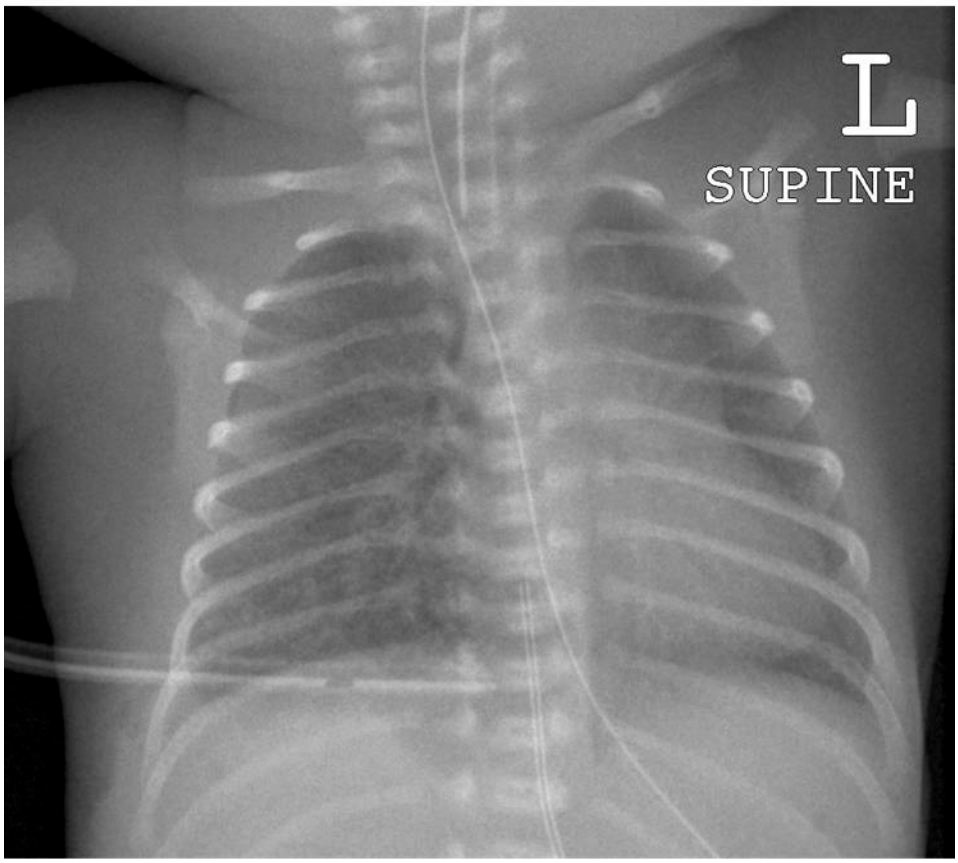

Figure 8: Pneumothorax with ICC

Appropriately placed ICC with tip position antero-infero-medially draining the pneumothorax

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