Yorkshire & Humber Neonatal ODN (South) Clinical Guideline

Title: Ventilation

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This clinical guideline has been developed to ensure appropriate evidence-based standards of care throughout the Y&H Neonatal ODN. The appropriate use and interpretation of this guideline in providing clinical care remains the responsibility of the individual clinician. If there is any doubt discuss with a senior colleague.

Best practice recommendations represent widely used evidence-based practice and high quality standards that all Neonatal Units across the Network should implement. Subsequent suggested recommendations may be put into practice in local units. However, alternative appropriate local guidelines may also exist.

A. Summary page

The aim of this guideline is to provide guidance on adjusting ventilation settings according to blood gases and changes in an infant's condition. It is not possible to provide guidance for all eventualities, and if uncertain, the practitioner should always seek support from experienced senior personnel. Blood gas results should always be interpreted in conjunction with clinical history and observation of the infant. Please also refer to the Network "Triggers for Transfer" Guideline.

Starting ventilator settings for preterm infant

- Volume targeted ventilation[19] eg. PCAC (or SIPPV) with VG
- Tidal volume 5ml/kg
- PEEP 4 cmH_20
- Inspiratory time 0.35 seconds
- Respiratory rate 60
- PIP (max) 22 (adjust according to VT achieved). For VG should be at least 4 cmH_20 higher than the average peak pressure required

In the case of deterioration consider "DOPE"

- Dislodged tube
- Obstructed tube
- Pneumothorax
- Equipment failure

The Yorkshire and Humber **Neonatal** Operational Delivery Network

NHS

Target values Preterm infant

Until 36/40

O_2 saturations 91-95%

First week pH >7.22

After first week, pH >7.2

D1 -3 CO_2 4.5-8.5kPA

D4 onwards CO_2 4.5-10 kPa

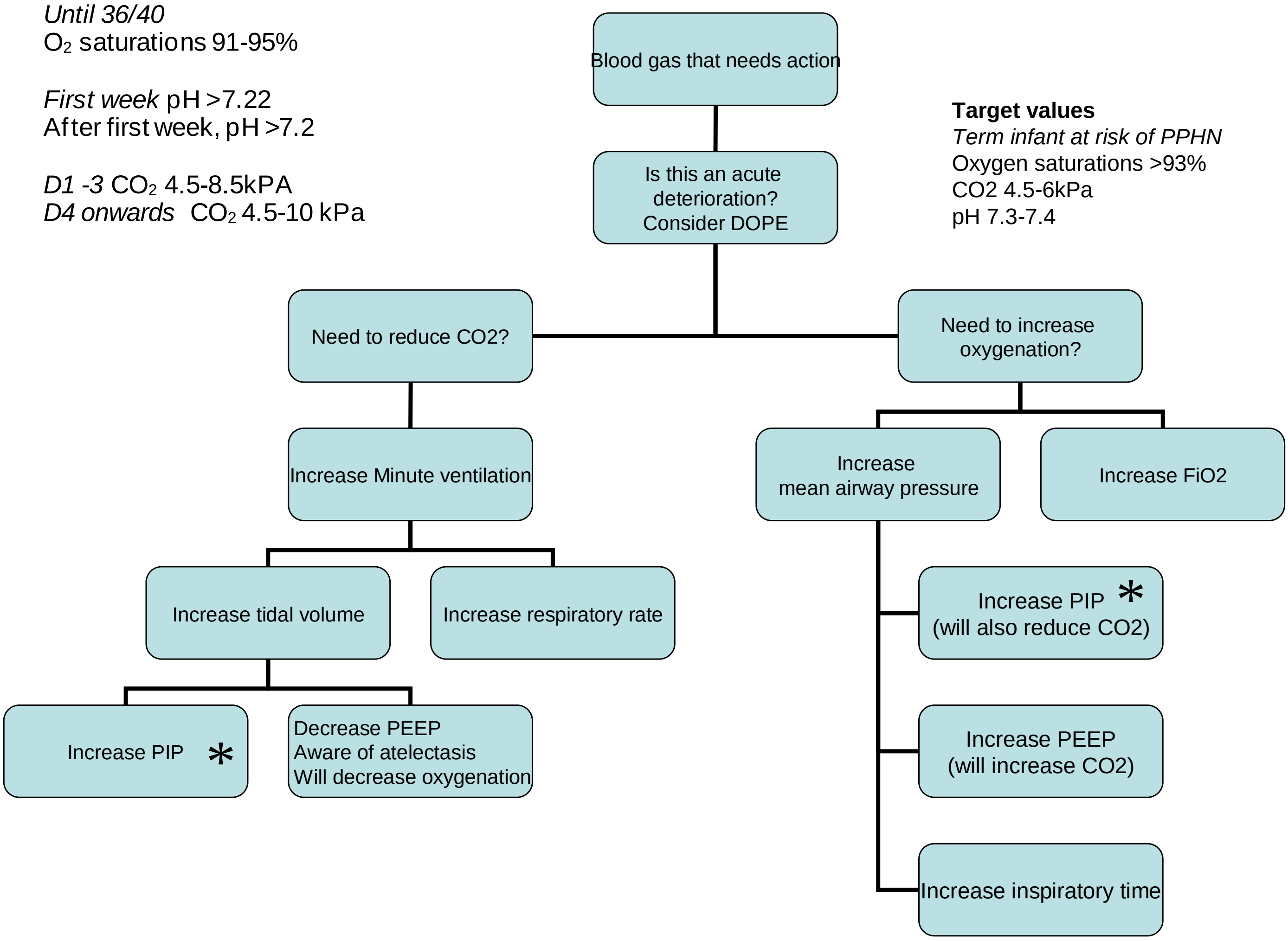
Target values

Term infant at risk of PPHN

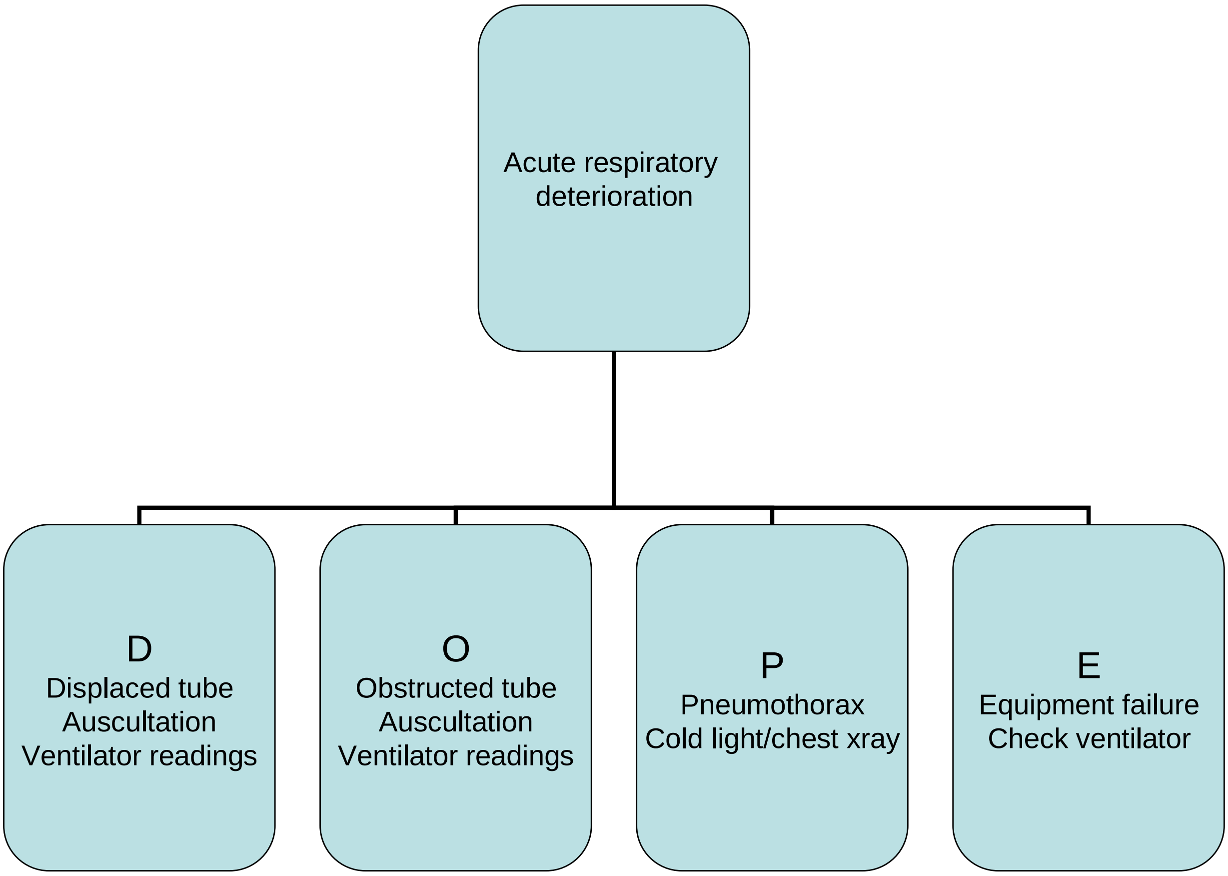
Oxygen saturations >93%

CO2 4.5-6kPa

pH 7.3-7.4



***When using volume targeted modes of ventilation, increase the tidal volume which will increase the PIP achieved.**


Acute respiratory deterioration
D
Displaced tube
Auscultation
Ventilator readings
O
Obstructed tube
Auscultation
Ventilator readings
P
Pneumothorax
Cold light/chest xray
E
Equipment failure
Check ventilator

B. Full guideline

1) Background

2) Aim

The aim of this guideline is to provide guidance on adjusting ventilation settings according to blood gases and changes in an infant's condition. It is not possible to provide guidance for all eventualities, and if uncertain, the practitioner should always seek support from experienced senior personnel. See also "Triggers for Transfer" Guideline.

3.1 Newborn infants are ventilated for a number of indications:

1. Absent or inadequate respiratory drive (apnoea)
   In this situation, in addition to providing respiratory support, the reason for inadequate drive should be sought. Although it might simply reflect immaturity there are many other factors that might cause it (infection, hypoglycaemia, hypothermia and heart failure to name but a few).

2. Abnormal lung pathology
   Congenital e.g. diaphragmatic hernia, congenital pulmonary malformation (CPM), pulmonary hypoplasia
   Acquired - Respiratory distress syndrome (the most common reason infants are ventilated)
   Meconium aspiration syndrome
   Pneumonia

3. Airway protection e.g. infants with abnormal airways (rarely)

It is important to note that a combination of factors may contribute and all possibilities should be considered. Whatever the reason(s) for needing ventilation, the aim is the same – to provide support for oxygenation and carbon dioxide removal, while minimizing any lung injury. Neonatal units with the lowest rates of chronic lung disease also have the lowest rates of ventilation.

3.2 Adjusting the ventilator

The aim when ventilating a preterm infant is to minimise the time spent on the ventilator to minimise lung injury and therefore chronic lung disease. Having said this it is important that ventilation is continued if required and optimised so as to minimise any damage caused. For term infants, this will depend on the underlying diagnosis.

All changes in ventilation must be made taking into account all known factors for an individual baby. Changes suitable for one infant may not be for another. Care must be taken not to continue with changes that are not having the desired effect.

Tidal volume – used in volume targeted ventilation. This is usually between 4-8ml/kg, typically between 4-6ml/kg. It is usually adjusted in 0.5ml/kg increments. TV below 4ml/kg can lead to atelectasis and is not recommended.

PIP- in pressure controlled ventilation this is usually adjusted in steps of 2. The PIP used normally falls in the range of 14-26 but there are occasions when values both higher and lower may be needed. Usually if pressures below 14 are used the infant should be considered for extubation and at 26 or above high frequency oscillation should be considered, and particularly so if oxygenation remains problematic. Any baby with suboptimal ventilation at a peak pressure of 26 should be considered for discussion with the regional centre (See "Triggers for Transfer" Guideline)

PEEP- this is usually adjusted by 1. The range of PEEP normally used is 4-6 but higher and lower levels are occasionally needed.

Inspiratory time - this is usually 0.35-0.45 seconds. Care must be taken to avoid an inverse ratio where the time spent in inspiration is greater than that in expiration.

Rate - this depends on the mode of ventilation. Avoid respiratory rates of less than 30 for infants with SIMV, due to the risk of atelectasis and increased work of breathing, unless it is possible to provide pressure support for additional breaths above the set rate. This is not a concern for infants on SIPPV. Maximum rates rarely exceed 100, and ventilation usually becomes inefficient at as high a rate as this, and other modalities may be more appropriate. The rate can be adjusted by 5-10 breaths per minute.

Following a ventilator change, a blood gas should be taken. The frequency of this will depend on the abnormality and the clinical condition of the infant. Remember that carbon dioxide particularly may change very rapidly and swings in CO_2 may have a serious impact on cerebral perfusion.

3.4 Lung injury

This is caused by a number of processes:

- Barotrauma
  This is caused by the use of high pressure on the fragile lung, therefore the lowest pressure to achieve adequate ventilation should be used.

- Volutrauma
  This is caused by over-distension of the alveoli by the use of high lung volumes. Therefore, the lowest volume to achieve adequate ventilation should be used.

- Atelectotrauma
  This is caused by the intermitted collapse and re-expansion of the alveoli causing tissue damage e.g. with the use of too low PEEP.

- Oxygen toxicity
  The use of oxygen causes the creation of free radicals that damage the lungs and other tissues. Free radical damage is more likely with higher inspired oxygen but may also occur at relatively low oxygen concentrations, particularly with very immature infants who have reduced antioxidant defences. For preterm infants, increased FiO_2 has also been associated with retinopathy of prematurity.

3.5 Oxygenation

Oxygenation of the infant is influenced by the MAP (mean airway pressure) and fraction of inspired oxygen. The MAP is a product of the inspiratory time, PIP and PEEP.

See appendix 2 for flow diagram.

Oxygenation can be improved by:

1. Increasing the fraction of inspired oxygen (FiO_2) – remember oxygen toxicity is dose related
2. Increasing the PIP to increase MAP
3. Increasing the PEEP to increase MAP
4. Increasing the inspiratory time (without a proportionate increase in expiratory time). This increases the proportion of time spent at an elevated pressure and therefore increases the MAP.

The target oxygen saturations will vary depending on the reason for ventilating the infant. Recent data has suggested a survival advantage in preterm infants with higher oxygen saturation targets (1) or increased mortality with lower (2). Recommendations are therefore to target oxygen saturations of 91-95% for preterm infants.

For term infants at risk of persistent pulmonary hypertension (e.g. those with meconium aspiration syndrome or hypoxic ischaemic encephalopathy), higher saturation targets are set (e.g. above 93%). These infants are at much lower risk of oxygen toxicity and ROP.

3.6 Carbon Dioxide

The CO_2 clearance is affected by alterations in the alveolar minute volume (the amount of fresh gas entering the part of the respiratory system capable of gas exchange). This is a product of the tidal volume (size of each breath) and the rate (number of breaths in a minute).

See appendix 2 for flow diagram.

CO2 clearance can be increased by:

1. Increasing the tidal volume
2. Increasing the PIP- this will increase the size of each breath and therefore increase the tidal volume
3. Increasing the rate
4. Reducing the PEEP – this will increase the size of each breath and therefore increase the tidal volume. Be aware that too low a PEEP may cause atelectasis and therefore worsen oxygenation - rarely use below 3.

CO_2 levels can be increased by;

1. Reducing the tidal volume
2. Decreasing the PIP
3. Decreasing the rate
4. Increasing the PEEP (not above 5 unless in exceptional circumstances)

Altering these parameters in different modes of ventilation is discussed in section 3.8.

CO_2 targets again will depend on the indication for ventilation and the clinical status of the infant.

For all infants hypocarbia (low CO_2, below 4.5 kPa) must be avoided as this results in a reduction in cerebral blood flow and an increased risk of periventricular leukomalacia. Minute ventilation must be reduced without delay and the pCO2 checked within one hour of the low measurement being identified.[19.]

For preterm infants a strategy of permissive hypercarbia (higher CO_2) is often employed. This allows lower ventilatory pressures and volumes to be used so as to minimise lung injury, while allowing a moderate respiratory acidosis. Over time, an infant will develop metabolic compensation, retaining bicarbonate and reducing base excess thus allowing a higher carbon dioxide level with a relatively normal pH. Metabolic compensation is relatively slow and particularly so in preterm infants – possibly taking many days or even weeks to fully develop.

In general, in preterm infants in the days 1-3 of life, a CO_2 of 4.5-8.5 kPa to maintain the pH above 7.22 is acceptable. There is evidence from the SUPPORT trial and PHLEBI (8 kPa vs 10 kPa) trial that higher levels of CO_2 are detrimental.(3)

From Day 4 of life in preterm infants a pCO2 of 4.5-10kPa should be aimed for. (19)

From 14 days of life, a pH of above 7.20 is acceptable, and as CO_2 may increase with the increasing chronic lung disease a higher CO_2 may be tolerated provided that the pH does not continue to fall (4).

For term infants at risk of persistent pulmonary hypertension (PPHN) e.g. those with meconium aspiration syndrome or hypoxic ischaemic encephalopathy, a “normal” pH and CO_2 is required (eg pH 7.3-7.4, CO_2 4.5-6), to reduce the pulmonary pressures and reverse the shunting. Infants with PPHN may require nitric oxide or high frequency ventilation and therefore referral to the tertiary centre. (See also “Triggers for Transfer” Guideline.)

3.7 Acute deterioration of a ventilated infant

See appendix 3 for flow diagram. Interpretation of ventilator flow loops and other important information can be useful in assessment of the acutely deteriorating ventilated infant. A useful summary is available to download online (http://www.infantgrapevine.co.uk/journal_article.html?RecordNumber=6822) (5).

Ventilated infants can deteriorate very rapidly and without warning. Any change in parameters should trigger a clinical assessment with the “DOPE” mnemonic as a prompt:

D Displaced tube - has the endotracheal tube become dislodged? This can be assessed clinically by auscultation of the chest. The ventilator display will give very clear messages usually if the tube has become displaced, normally informing of a high leak or disconnected tube. Conversely normal flow patterns, tidal volumes and minute volumes make displacement unlikely

O Obstructed tube - is the endotracheal tube obstructed? This can be with secretions, blood, or the tube can be kinked. This can be assessed with auscultation and suction via ET tube. The ventilator may also alarm with “tube obstruction” or “low MV” alarms and flow waves will be abnormally flat and minute volume will fall. Again, normal ventilator measures should suggest that obstruction is unlikely.

P Pneumothorax. This can be the cause of an acute and severe life threatening deterioration. Assessment is via "cold light" looking for transillumination of the chest on the side of the pneumothorax. Auscultation may help, but in the very small preterm infants, cannot be used to exclude pneumothorax. In the slightly more stable infants, a chest x-ray may be needed but this must not delay insertion of a chest drain in a deteriorating infant with "cold light" signs of pneumothorax.

E Equipment failure. This could be any piece of equipment. Hand ventilate the infant and assess for improvement. Check all the ventilation tubes are correctly inserted.

Note, for much of this assessment, disconnection from the ventilator is not necessary, and may lead to a reduction in information available, for example minute volume, tidal volume settings and flow settings. It also results in a loss of PEEP, which can cause a further deterioration.

If the infant does require "hand ventilation" this should be using a pressure controlled system (e.g. neopuff) to minimise barotrauma and to sustain PEEP wherever possible.

Ambubags should only be used in the event of gas failure as the pressures delivered by these can be extremely high and also no PEEP is generated which increases atelectasis and barotrauma. (6)

3.8 Modes of ventilation

Due to patent regulations, each company manufacturing ventilators uses different terms to describe the same modalities of ventilation. As the majority of neonatal units in the Y&H neonatal ODN use Drager ventilators, these terms have been used predominantly, however a description of the modality is also included.

The 2019 NICE guideline recommends use of VTV as the first choice for preterm infants. Where this is not available, or suitable, SIMV should be used.

Volume targeted ventilation can be used with SIPPV/PCAC and SIMV. The advantage to this mode of ventilation is a reduction in chronic lung disease and death. In addition, once appropriate settings have been established infants should be more stable, changes will be made automatically and less invasive monitoring should be needed.

In infants with a large leak on their endotracheal tube, technical problems in measuring the tidal volume may make this modality less reliable. Leak correction is incorporated in all ventilators offering VTV but may not be able to compensate adequately at higher leak rates. Small tidal volumes always mean that high leaks may compromise efficiency of ventilation, whatever the modality used.

i Volume targeted ventilation (VTV)-Pressure limited, volume guided ventilation Using SIPPV-VG/PCAC-VG

Starting settings for preterm infant:

- *VT 5ml/kg*
- *PEEP 4*
- *PIP (max) 22* (adjust according to VT achieved). For VG should be at least 4 cmH_20 higher than the average peak pressure required
- *Inspiratory time 0.35s*
- *Rate 60 breaths per minute*

The principle in volume guided ventilation, is to set the volume of gas required to ensure adequate CO_2 removal. This is in the range 4-8 ml/kg/breath and will vary between individuals and within an individual depending on the lung pathology, stage of disease and treatment administered.

In volume targeted ventilation, the PEEP, tidal volume, inspiratory time and rate are set. The maximum PIP is also set at a value 4-6 cmH_2O higher than the pressure that appears to be normally required. The ventilator varies the PIP automatically to achieve the set tidal volume depending upon lung compliance which can vary from breath to breath and where significant changes can be seen eg. after surfactant administration. Theoretically this should lead to either minimising of pressure delivered (for those with improving compliance), or a reduction in atelectasis (for infants with deteriorating compliance). A 2013 meta-analysis of published data supports use of this modality over conventional ventilation, with a reduction in death, chronic lung disease, pneumothorax, grade III and IV IVH and PVL in infants ventilated this way (7).

Weaning ventilation
To "wean" infants from this form of ventilation, the tidal volume can be reduced to a minimum of 4ml/kg (lower that this will lead to atelectasis). The rate can also be reduced. Reducing the respiratory rate will ensure that the infant is regularly breathing and triggering the ventilator. Note that, if the infant is breathing above the set rate consistently then reducing the rate is unlikely to decrease CO_2 clearance.

The predominant mode of weaning however is done by the infant, as the lung disease improves, the pressures used reduce and extubation can be attempted.

ii) Volume targeted, Pressure limited-time cycled ventilation SIMV (synchronised intermittent mandatory ventilation) +/- PS (pressure support) with volume targeted ventilation for the 'set' rate

Starting settings for a preterm infant:

- *TV 5ml/kg*
- *PEEP 4*
- *PIP (max) 22* (adjust according to VT achieved). For VG should be at least 4 cmH_20 higher than the average peak pressure require*d*
- *PS 8 (this will give additional breaths above the 'set' rate with PIP 12, PEEP 4) NB not available on all ventilators*
- *Inspiratory time 0.35 seconds*
- *Rate 60 breaths/minute*

In this synchronised volume targeted mode, the PEEP, tidal volume, inspiratory time and rate are set. The maximum PIP is also set at a value 4-6 cmH_2O higher than the pressure that appears to be normally required. Most ventilators allow pressure support to be set for additional spontaneous breaths above the set rate. Where this is not the case these additional breaths are unsupported and the work of breathing is increased. Pressure support reduces the work of breathing for the infant but allows less support to be given for these additional breaths.

The rate set describes the exact number of breaths that will be supported at the set tidal volume by the ventilator irrespective of the infant's respiratory rate (i.e. if the rate is set at 60, and the infant is breathing at 70:
60 breaths at TV 5ml/kg and 10 breaths a minute will either be unsupported or, if the ventilator allows, supported at a set level (pressure support) above the PEEP).

The pressure support is usually set to achieve approximately 2/3 of the achieved PIP(when using VTV). For example, with the settings above for the additional 10 breaths the baby will receive PIP 12 (PEEP 4 + PS 8), which is assuming a PIP achieved of 18.
When Pressure support is not available the disadvantage of this mode is that infants breathing above the set respiratory rate can become tired and atelectasis occur due to the increased work of unsupported breathing via an endotracheal tube.

Weaning
The advantage of this mode is that the rate can be weaned. An agitated hyperventilating infant is less likely to become hypocarbic but it is much more appropriate to manage the agitation than to alter the ventilation modality.

The tidal volume can also be reduced to a minimum of 4ml/kg (lower that this will lead to atelectasis). Weaning is also done by the infant, as the lung disease improves, the pressures used reduce and extubation can be attempted.

A Cochrane review suggests a trend to shorter duration of weaning using PCAC compared to SIMV (9). However, the NICE guideline recommends use of SIMV rather than SIPPV when volume-targeted ventilation is not appropriate/available (eg. with air leak)(19). The rationale was that the evidence showed an increase in mortality before discharge on pressure-limited ventilation.

iii SIMV (synchronised intermittent mandatory ventilation) +/- PS (pressure support)

Starting settings for a preterm infant:

- *PIP 18*
- *PEEP 4*
- *PS 8*
- *Inspiratory time 0.35 seconds*
- *Rate 60 breaths/minute*

In this synchronised mode, the PIP, PEEP, inspiratory time and rate are set. Most ventilators will now give a pressure support above the PEEP for additional spontaneous breaths above the set rate.

The rate describes the exact number of breaths that will be supported by the ventilator irrespective of the infant's respiratory rate (i.e. if the rate is set at 60, and the infant is breathing at 70, 10 breaths a minute will either be unsupported or, if the ventilator allows, supported at a set level (pressure support) above the PEEP) The pressure support is usually set to achieve approximately 2/3 of the set PIP. For example, with the settings above if the for the additional 10 breaths the baby will receive PIP 12 (PEEP 4 + PS 8), which is 2/3 of the set PIP (18).

To 'wean' the rate and/or PIP can be reduced.

The advantages/disadvantages are the same as for SIMV-VG. See section 3.8 ii.

iv PCAC/SIPPV (synchronised intermittent positive pressure ventilation/Assist control)

Starting settings for a preterm infant:

- *PIP 18*
- *PEEP 4*
- *Inspiratory time 0.35 seconds*
- *Rate 60 breaths/minute*

Without VTV SIPPV/PCAC may cause more baro/volutrauma compared to SIMV without VTV and is not recommended for preterm babies in the NICE guideline (19).

The PIP, PEEP, inspiratory time and rate are set. Each breath is pressure supported (ie if the rate is set at 60 and the infant is breathing at 70 breaths per minute, all 70 will be supported – there is a safety mechanism in the form of a very brief inactive period that prevents inflation immediately after one inflation is completed). To wean from this mode, the PIP can be reduced. Reducing the respiratory rate will ensure that the infant is regularly breathing and triggering the ventilator. Note that, if the infant is breathing above the set rate consistently then reducing the rate is unlikely to decrease CO_2 clearance.

The advantage of this mode is that every breath is supported, and therefore the baby does not have to breathe "against" the endotracheal tube.

The disadvantages for this mode, are that an infant in pain may hyperventilate and develop hypocarbia and that the ventilator can “autotrigger”, especially if there is water in the ventilator circuit. These issues can be overcome with good pain management and surveillance of the ventilator circuit. (8) There can also be significant variation in the tidal volumes generated by a set pressure as lung compliance changes. This can lead to volutrauma.

v CMV/IMV Continuous mandatory ventilation, intermittent mandatory ventilation

This is a non-synchronised mode of ventilation. Some transport ventilators use this mode due to technical limitations.

The principle use of this modality in non-transport situations, is for muscle relaxed infants, where synchronisation of ventilation is not possible.

Synchronised modes of ventilation have been proven to reduce the length of time ventilated, therefore this mode cannot be recommended in routine practice. (8)

v HFOV (high frequency oscillation ventilation)

This mode of ventilation is used only in neonatal intensive care units and requires considerable ongoing exposure to maintain expertise. Occasional exposure is not recommended. Infants felt to require this mode of ventilation due to escalating pressure requirements should be referred early. HFOV works by re-expanding lungs which continue to become atelectatic with other modalities. In addition, CO_2 clearance is attained by a different mechanism of gas exchange induced by high frequency, high velocity breaths. It will only be effective if the lungs remain capable of gas exchange. Continued suboptimal ventilation by other means may make this impossible. (See Y&H ODN guideline ‘Triggers for Transfer’)

3.9 Extubation

Early extubation has been shown to result in a reduction in chronic lung disease. The acceptable failure rate has been quoted as 30-40% reintubation within 72 hours. (10-15)

Timing of extubation will depend on the clinical condition of the infant, however extubation at a mean airway pressure of 7-8 has been shown to reduce ventilator days for infants under the care of a respiratory therapist. This should not be viewed as a target, as some infants may be extremely unstable, despite a MAP of 7-8 while some infants with established chronic lung disease can be successfully extubated from a MAP as high as 12. Leaving infants on low rate ventilation has not been shown to increase chances of extubation success. There is also minimal evidence for the practice of using endotracheal CPAP to predict successful extubation.

To facilitate extubation, infants should be loaded with caffeine (early loading may also help with weaning from the ventilator). Start caffeine as soon as possible in all infants <30/40 and ideally before 3 days of age.(19)

For infants <30 weeks, CPAP should be used to reduce the need for reintubation.

Prior to electively extubating an infant, it is crucial that CPAP (if felt to be required) is ready and respiratory support is delivered to the baby throughout the episode- "keep the PEEP". To achieve this, it may be necessary to "neopuff" via the ET tube to allow the ventilator to be disconnected and CPAP driver set up and attached to the baby before removing the endotracheal tube.

For term infants, the indications for extubation will depend on the underlying pathology.

- Infants <30 weeks should be loaded with caffeine prior to extubation
- Infants <30 weeks should be commenced on CPAP following extubation
- Consider extubation in infants who are clinically stable with low pressures as early as possible

The introduction of an extubation checklist should be considered (see Appendix 4).

Best practice points

Best practice recommendations represent widely used evidence-based practice and high quality standards that all Neonatal Units across the Network should implement. Subsequent suggested recommendations may be put into practice in local units. However, alternative appropriate local guidelines may also exist.

Neonatal units should have written guidance for the following situations:

- What to do in the event of an acute respiratory deterioration
- Starting ventilator settings
- Use an extubation checklist

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C. Appendices

Appendix 1

Example extubation checklist

Appendix 2

See below- flow chart for adjusting blood gases

Appendix 3

See below- flow chart for action during acute deterioration

Appendix 2 Example Neonatal Extubation Checklist

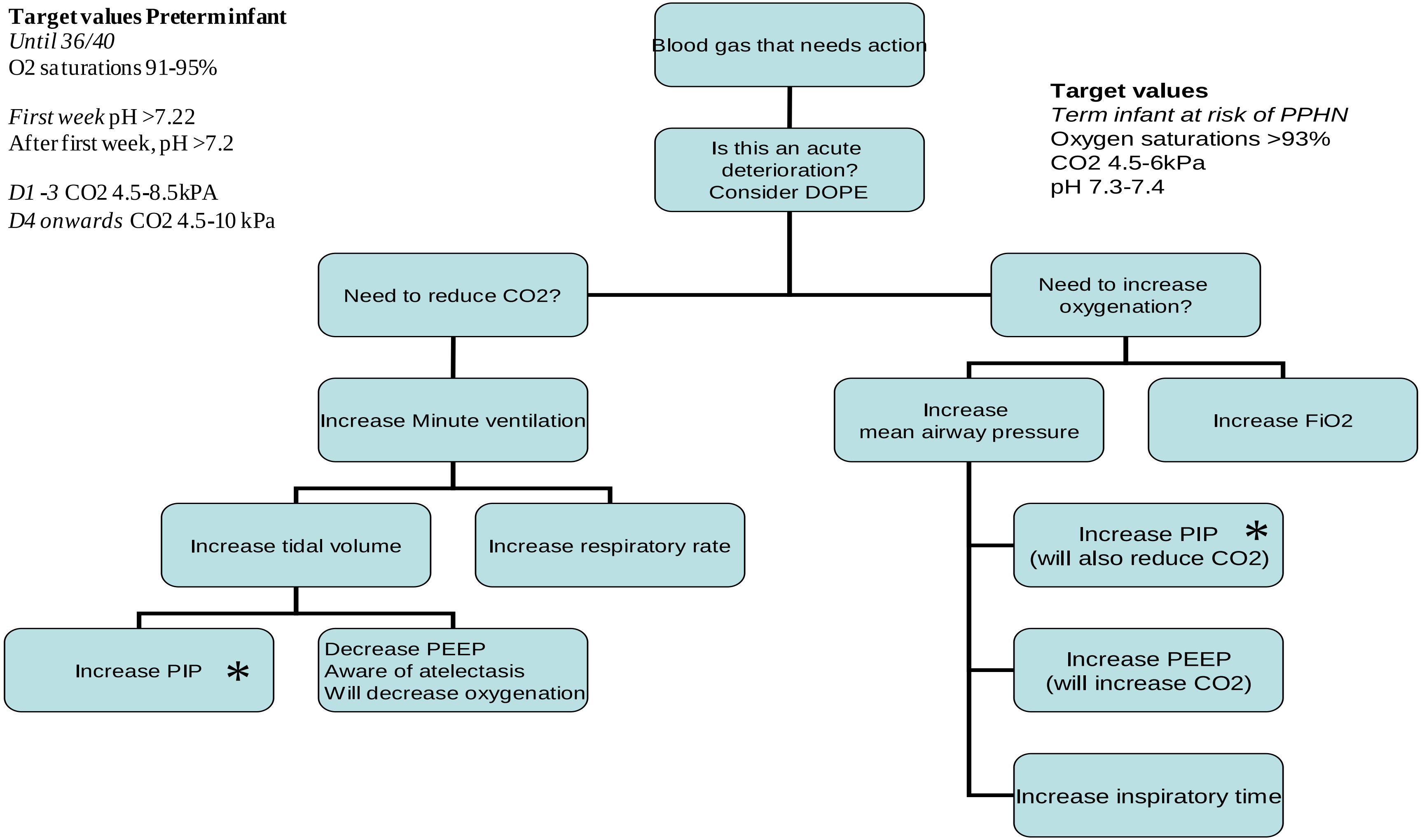
Decision making	✓
Consultant led decision to extubate to Draeger BiPAP/BiPAP/CPAP/high flow/incubator oxygen made by:………………………………………………………	
If known difficult airway, consultant to be present at time of extubation	
Nurse in charge aware of plan to extubate	
Parents aware of plan to extubate	
Pre-procedure	
Ensure morphine (and/or other sedation) stopped for adequate duration	
Load with caffeine if required	
Equipment checked and functioning:	
• Appropriate respiratory support calibrated and humidifier set up Draeger BiPAP/BiPAP/CPAP/High flow	
• Correct sized hat and mask/nasal prongs	
• iv cannula in situ and flushing	
Resuscitation equipment available and working:	
• Suction – black catheter & Yankauer	
• Neopuff with pressures set appropriately (see over)	
• Correct sized face mask	
• Intubation equipment available including premedications	
• Consider prescribing resuscitation drugs	
Complete cares prior to extubation	
Auscultate the chest & perform suction as required 10-15mins before extubation	
Change to oro-gastric tube to enable best nasal prong/mask seal to ‘keep the peep’	
Stop feeds, aspirate OGT and leave on free drainage 10-15mins prior to extubation	
Ensure medical staff available to assist and consultant present if known difficult airway	
Aim for 1:1 nursing available for at least one hour after extubation	
Procedure	
Non-invasive support checked, appropriate PEEP (min 5)/high flow set whilst baby on ventilator	
Ensure gas is humidified	
Place hat on baby and apply mask/nasal prongs whilst remains intubated to ‘keep the peep’, secure hat	
Consider oral suction	
Remove the ETT with suction attached, ensure OGT remains in situ	
Date / / Time of extubation _ _ : _ _ (and document on gas chart)	
Post-extubation:	
Aim for 1:1 nursing for at least one hour post-extubation	
Nurse prone – ensure umbilical lines secure and no risk of bleeding	
Observe for signs of respiratory compromise/increasing oxygen requirement	
Check blood gas 30-60 minutes post-extubation and assess clinical status	
Consider recommencing feeds if blood gas/clinical status imply no imminent re-intubation	
Update parents	
Form completed by:	
Name: Date:	Signature: Grade:

Target values Preterm infant
Until 36/40
O2 saturations 91-95%

First week pH >7.22
After first week, pH >7.2

D1 -3 CO2 4.5-8.5kPA
D4 onwards CO2 4.5-10 kPa

Target values
Term infant at risk of PPHN
Oxygen saturations >93%
CO2 4.5-6kPa
pH 7.3-7.4



* **When using volume targeted modes of ventilation, increase the tidal volume which will increase the PIP achieved.**

Avoid disconnecting from ventilator
If this is needed use of pressure controlled device eg neopuff is strongly recommended