East Midlands Neonatal
Operational Delivery Network

NETWORK GUIDELINE

Guideline:	**Respiratory Care: Mechanical Ventilation in Neonates**
Version:	**2 (Reviewed by Dr Dushyant Batra)**
Date:	**April 2020**
Review Date:	**April 2023**
Approval:	**EMNODN Clinical Governance Group**
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Consultation:	**EMNODN Clinical Governance Group**
Distribution:	**Neonatal Units within EMNODN**
Risk Managed:	**Inappropriate ventilation and relevant complications**

This document is a guideline. Its interpretation and application remains the responsibility of the individual clinician, particularly in view of its applicability across the different Trusts in the East Midlands Neonatal Operational Delivery Network. Please also consult any local policy/guideline document where appropriate and if in doubt contact a senior colleague.

This guideline was previously a Trent Perinatal Network Guideline.

Caution is advised when using guidelines after a review date.

REVIEW AND AMENDMENT LOG

Version	Type of Change	Date	Description of Change
1	-	Jun 2015	-
2	Minor	April 2020	

Content

1. Background

Mechanical ventilation constitutes an integral part of modern neonatal intensive care. The key elements for the mechanical ventilation must be optimal respiratory care and prevention/ minimising of the respiratory morbidity. This guideline is not intended to be adhered to rigidly, but provides a generic guidance for the patient groups that may need mechanical ventilation and different ventilation strategies. Ventilation practices are based on individual experience, types of ventilator used and on evaluating changes in blood gas parameters and the clinical condition of the baby in response to changes in ventilation settings.

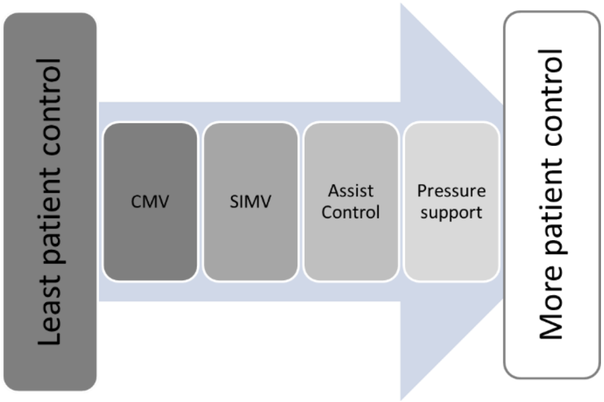
2. Patient Group/Indications

1. Parenchymal lung disease or Ventilation-perfusion (VQ) mismatch - e.g. RDS, Meconium aspiration, Pneumonia, PPHN, Pneumothorax etc.
2. Poor respiratory drive - e.g. apnoea of prematurity, hypoxic ischaemic encephalopathy (HIE), sepsis, neuromuscular disorders, seizures etc.
3. Lung malformations - e.g. diaphragmatic hernia, Congenital Pulmonary airway malformation (CPAM)
4. Mechanical - e.g. abdominal distension, airway obstruction
5. Cardiovascular compromise - i.e. hypotension requiring inotropes
6. Maintenance of safe airway - e.g. reduced consciousness or patient about to undergo surgery

3. Setting up Ventilator/Initiation of Ventilation

- Neonates should be intubated with an appropriate size uncuffed endotracheal tube. Endotracheal tube should be secured as per local policy at an optimum length aiming to minimise leak, while at the same time balance the risk of pressure necrosis (consult local guidance). The tube position should be confirmed on x-ray.
- The initial ventilation settings should be guided by the gestational age, nature of lung disease, infant's own respiratory efforts, pressures (PIP/ PEEP) needed with the T piece or previous mechanical ventilation experience with the baby.
- The initial mode of ventilation (see section 4) should be decided based on the local practice, degree of ventilatory support required, expected duration of ventilation and infant's own respiratory effort. Figure 1 shows common conventional mechanical ventilation modes and its interaction with patient effort.

Figure 1: Conventional mechanical ventilation modes and patient control[1]
CMV=continuous mandatory ventilation; SIMV = Synchronised intermittent mandatory ventilation



- Once confident of the pre-requisites of volume targeted ventilation are met (see section 5), volume target can be added (typically 4-6ml/kg).
- Different ventilators are used across the network. It is important that local guidance and training is provided to all the healthcare professionals caring for ventilated infants. Different ventilators use different technology and nomenclature for different modes e.g. Assist control mode on one ventilator is same as synchronised intermittent positive pressure ventilation (SIPPV) on another. It is beyond the scope of this guideline to address all these differences.
- Preterm infants may need loading with Caffeine citrate (please consult your local caffeine guidance) especially if they are on trigger modes (e.g. Assist Control); if the ventilation period is expected to be short; or when contemplating weaning. Infants receiving ventilation with low back up rates (especially on Assist control or Pressure support ventilation) will benefit from use of maintenance Caffeine citrate even when the extubation is not imminently planned. Consider weaning or stopping opiates.

4. Ventilation Parameters, Modes and Physiology

Ventilator parameters:
Ventilators currently used in neonatal clinical practice provide pressure-controlled ventilation. From a baseline residual pressure, an increased pressure is delivered for a set time to deliver the breath. Fall of pressure to the residual level allows expiration. Clinician sets up various parameters on the ventilator to deliver the tidal respiration. These can be altered in response to changes in physiology and input from monitoring (see section 5).

These parameters include[2]:

1. **Positive End Expiratory Pressure (PEEP)** - PEEP is the continuous distending pressure that helps maintain the functional residual capacity. Typically used settings are 4-6cm of H_2O. Higher PEEP of up to 8cms of H_2O may be needed in some instances, e.g. pulmonary haemorrhage, significant abdominal distension. Increasing PEEP is a powerful way of improving the lung recruitment but overdistension can have harmful effects. Optimal lung expansion (Functional residual capacity or lung recruitment) can be evaluated clinically by looking at the chest expansion and movements, tidal volumes in pressure-controlled mode, stability in FiO_2, blood gases and radiologically by chest x-ray.

2. **Peak Inspiratory pressure (PIP)** - The difference between PIP and PEEP dictates the amount of gas flowing into the baby's lungs. However, overdistension with an overzealous

PIP may compromise the systemic venous return paradoxically reducing oxygenation and additionally carries a risk of pulmonary air leaks.

3. **Inspiratory time (Ti) -** It is the time for which the PIP is maintained. The commonly used inspiratory times in neonates varies from 0.3-0.4 seconds. The normal newborn breathes with a fast rate and a short Ti (0.2-0.3s) with I: E ratio of 1:1.5 to 1:2. Term babies with poor oxygenation may benefit from longer Ti e.g. 0.5s. When adjusting the Ti consideration needs to be given to the rate to ensure that there is adequate time for expiration.

4. **Flow** - The rate of rise from PEEP to PIP is determined by flow rate to the ventilator (or slope in some ventilators). The faster the rise, higher the mean airway pressure and oxygenation. Too high flow rates will show as square waves on the pressure against time curve on ventilator displays and may result in alveolar shear stress. Inadequate flow may not allow adequate PIP to be achieved within the set Inspiratory time and increases patient discomfort through flow hunger. Please consult your local guidance.

5. **Tidal Volume (TV)** of 4-6mls/Kg and a Minute Volume (MV) of 200-360mls/kg should generally provide adequate ventilation. Tidal volume depends on difference between PIP and PEEP. The lung volume generated is in turn dependant on;

   Lung compliance: A measure of lungs' ability to expand and stretch. It is affected by the lung pathology (low in respiratory distress syndrome) and treatment (changes with surfactant administration).

   Lung resistance: A measure of obstruction to airflow. It is affected by internal diameter of ETT, secretions and calibre of small airways. Ventilate using the biggest size ETT tube that will not cause trauma or pressure necrosis. Minimise dead space by shortening the length of extra-oral segment of ETT if required. All these parameters may need to be considered or altered to improve ventilation.

Ventilation modes:
For preterm babies who need invasive ventilation, NICE (National Institute of Health and Clinical Excellence) recommend use of volume-targeted ventilation (VTV) in combination with synchronised ventilation as the primary mode of respiratory support[3]. NICE compared VTV with different conventional modes of ventilation (without addition of VTV) and high frequency ventilation[3]. The VTV 'mode of ventilation' includes studies that have used different background modes with varying degree of synchronicity and support. VTV however is an additional adjunct to a mode rather than a mode of ventilation. NICE guideline does not compare VTV with different modes of background ventilation[3]. A recent Cochrane review reported Assist Control/ SIMV (Synchronised Intermittent Mandatory Ventilation) modes being associated with shorter duration of ventilation when compared to Continuous mandatory ventilation (CMV) suggesting that synchronisation can be a helpful strategy[4]. If VTV is not effective, consider high frequency oscillatory ventilation (HFOV)[3]. It is beyond the scope of this guideline to explore all different ventilation modes available on different ventilators used within the East Midlands Neonatal Operational Delivery Network (EMNODN).

The commonly used ventilation modes include:

1. **Continuous mandatory ventilation (CMV)** - Ventilator in this mode works completely independently of infant's own efforts. The clinician sets PIP, PEEP, Ti and rate. Asynchrony is very common and this mode should be only used in an inpatient set-up if the infant is muscle relaxed. This mode is also used during transport as the only currently available mode.

2. **Synchronised intermittent mandatory ventilation (SIMV)** - For SIMV, clinician sets PIP, PEEP, Ti and rate. The infant receives full ventilator support for the set number of breaths that are synchronised with infant's own respiratory effort. Any additional respiratory efforts only get support in the way of PEEP and residual ventilator gas flow. If the set respiratory rate is too low, there may be respiratory muscle fatigue, increase pCO_2 and possible increased chances of extubation failure. If using without volume targeting, NICE recommends this mode though this is based on low level of evidence[2].

3. **Synchronised intermittent positive pressure ventilation (SIPPV)** – also known as Assist Control (AC) or Patient Triggered Ventilation (PTV) - Clinician sets PIP, PEEP, Ti and a backup rate. Infant receives full ventilatory support for all his/her breaths. If he/she was apnoeic the ventilator will continue to provide backup rate. This mode is commonly used for weaning with low backup rate (typically 20-40)[3]. This mode has been shown to reduce the work of breathing and better pCO_2 control during weaning[4].

4. **Pressure support ventilation (PSV)** - It is a flow-cycled mode increasingly used for weaning. The ventilator flow determines the initiation of expiration, which provides the control of Ti to the infant. Clinician sets PIP, PEEP, Rate and Timax. The latter provides the upper limit of Ti. This mode can be used for weaning though to short Ti can contribute to derecruitment.

5. **High frequency oscillatory ventilation (HFOV)** - HFOV mode uses supraphysiological respiratory rates and is not used as a primary mode of ventilation within the EMNODN. Decision of its use should be discussed with the senior clinician.

Ventilation physiology:

There are important baby-ventilator and ventilation-circulation interactions that impact on oxygenation, ventilation (CO_2 removal) as well as pulmonary and systemic circulation. The goals of ventilation are to facilitate oxygenation, CO_2 removal with minimal impact on haemodynamic stability. Understanding these interactions helps in making changes to the ventilator settings, and facilitates the management of ventilation plans.

Determinants of gas exchange and adjustments to ventilation:

a) ***Oxygenation***: This is directly related to mean airway pressure (MAP) and FiO_2. Increasing MAP results in increase in oxygenation. MAP is affected by (see section 4):

1. **Peak Inspiratory Pressure (PIP)** – higher PIP increases MAP, be careful to avoid overdistension

2. **Positive End Expiratory Pressure (PEEP)** – Increasing PEEP increases MAP but again if excessive may compromise venous return

3. **Inspiratory time (Ti)** - Increased Ti increases the MAP, be careful of hyperinflation due to breath stacking.

4. **Flow/Slope**

5. **Tidal volume (TV)** (when using volume targeting)

b) ***CO_2 Elimination***: This is determined by Minute Ventilation (MV). More MV increases CO_2 clearance and vice versa.

MV = Tidal volume × Respiratory rate

1. **Tidal Volume (TV) -** TV of 4-6mls/Kg are typical. It is affected by PIP- PEEP gradient, in conjunction with inspiratory time (Ti), compliance and resistance.

2. **Respiratory Rate (RR)** - rates of 20-60 breaths per minute are commonly used. Caution should be taken when using longer Ti as faster rate may alter I:E ratio and may compromise time available for expiration. When altering back-up rate in response to pCO_2 results, care should be taken as in assist control or PSV modes, reducing back-up rate would not alter the ventilation if the infant's own respiratory drive exceeds the back-up rate.

5. Volume Targeted Ventilation

It is now well accepted that volume rather than pressure is primarily responsible for ventilation induced lung injury[5,6]. Advances in ventilator technology have enabled us to accurately measure tidal volumes in our smallest infants close to the infant's airway and use this information to target the tidal volume (volume targeted (VTV) or volume guarantee (VG) ventilation) at the cotside. A recent Cochrane review[7] showed reduced rate of death, BPD, pneumothorax and cranial ultrasound abnormalities with volume-targeted ventilation as compared to pressure-controlled ventilation. VTV reduces the variability of tidal volume (TV) delivery, volutrauma, atelectotrauma and CO_2 fluctuations[8,9]. NICE recommends it as preferred 'mode' of ventilation for preterm neonates[3]. Addition of volume target is beneficial in most situations though their use in certain situations/patient groups e.g. congenital diaphragmatic hernia may not be straightforward or universally accepted. If in doubt, discuss with the consultant. Volume-targeted ventilation should be added to pressure-controlled modes once we can ensure following pre-requisites are met[10]:

1. Lungs are well recruited
2. Endo-tracheal leak consistently <40-50% (refer to ventilator manual locally)
3. Pmax is set at 5-10cm of H_2O above working PIP
4. Ti long enough so that the PIP reaches a plateau before expiration
5. Optimum PEEP to keep a functional FRC

To set up volume-targeted ventilation you need to set up:

Basic pressure-controlled mode:

Volume targeting can be used with different modes of ventilation including continuous mandatory ventilation (CMV), Synchronised Intermittent Mandatory ventilation (SIMV), Assist Control (AC also known as SIPPV) and Pressure support ventilation (PSV) mode. The clinical condition of the infant should guide the background mode. Typically, SIMV is used in the initiation of ventilation and AC/PSV modes are used during maintenance and weaning phase of ventilation. As discussed above, NICE guidance suggests use of VTV as compared to synchronised mode alone[3]. Please consult your local departmental guideline for further guidance.

Settings for VTV[1]:

Pmax:
As the infant is started on background pressure-controlled mode, observe the peak inspiratory pressure (PIP) needed to generate the desired tidal volume. Pmax should be set at 5-10cm of H_2O above this working PIP.

Ti:
The inspiratory time needs to set in all modes except PSV Typical Ti used is 0.3-0.4sec. The Ti should be long enough for PIP to reach a plateau before the beginning of expiration. In PSV mode, maximum Ti needs to be set, Ti_{max}.

Tidal volume:
Neonates have tidal volumes (TV) of about 4-6ml/kg. Older preterm neonates with evolving or established chronic lung disease tend to need higher tidal volumes of 5-7ml/kg. The changes in tidal volumes should be guided by the clinical parameters and blood gases.

PEEP:
Adequate recruitment and functional residual capacity are essential for the success of the volume-targeted ventilation. Typical PEEP used is 4-6cm of H_2O. Infants with chronic lung disease, pulmonary haemorrhage, NEC may require higher PEEP.

Weaning volume-targeted ventilation
As the lung physiology improves, the weaning is automatically achieved for the infants on the volume-targeted ventilation. The set tidal volumes are achieved with lower PIP. The backup rate and Ti needs to be reviewed and optimised to increase patient comfort and synchrony. NICE guidance does not compare the different background modes when used with VTV[3]. With SIMV mode, weaning the rate below 30 may lead to increased work of breathing for unsupported breaths[4]. There is evidence that weaning is better established with patient triggered modes of Assist control/Pressure support ventilation with low back-up rates[11,12]. (See section 6).

6. Monitoring Babies being Ventilated[13]

Please refer to your local guidance with regards to monitoring and bedside care of infants being ventilated (see Figure 2). As a general guide, all ventilated infants should have:

1. Basic cardio-respiratory monitoring for -- heart rate, respiratory effort, saturation monitoring and blood pressure. This can be done using ECG electrodes, transthoracic impedance measures of respiratory rate, pulse-oximetery. Respiratory rate, heart rate should additionally be manually measured as per the local guidelines. Consider the use of intra-arterial access for invasive blood pressure monitoring in the preterm neonates born below 28 weeks gestation, infants receiving FiO_2 of more than 40% and infants with haemodynamic compromise. Non-invasive blood pressure monitoring should be measured periodically in other circumstances. Additional bedside monitoring like transcutaneous CO_2 monitoring may be initiated according to local practice/senior advice. Please consult local guidance for O_2 saturation limits for different gestation and age groups.

2. The set ventilator data including tidal volume, delivered PIP (P_{max} if volume guided), PEEP, Ti (Ti_{max} if on PSV mode), respiratory rate, flow/slope, FiO_2, Minute ventilation and resistance should be monitored and recorded hourly (see Figure 2). Humidification of inspired gases is extremely important for temperature maintenance and ventilation circuit humidification settings should be guided by local policy.

3. Blood gas
   Arterial (or capillary sample in absence of an arterial line) blood gas provides information about oxygenation, ventilation and acid-base status. Some blood gas machines provide additional information like blood glucose, lactate, haemoglobin and chloride. The frequency of blood gases should be guided by the infant's clinical condition, consultant advice and within 30-60min of making changes to the ventilator settings.

   Target blood gas values:
   Minimising the ventilator induced lung injury is one of the prime goals of mechanical ventilation. Although the evidence for objective benefits of permissive hypercapnoea in preterm infants is still weak[14–18], higher pCO_2 levels are increasingly accepted if the pH is ≥ 7.2. The clear exception would be term infants with persistent pulmonary hypertension of newborn (PPHN) where the aims are a normal pCO_2 (4-5kPa) and pH (7.4-7.45) (Please refer to the EMNODN PPHN guideline).

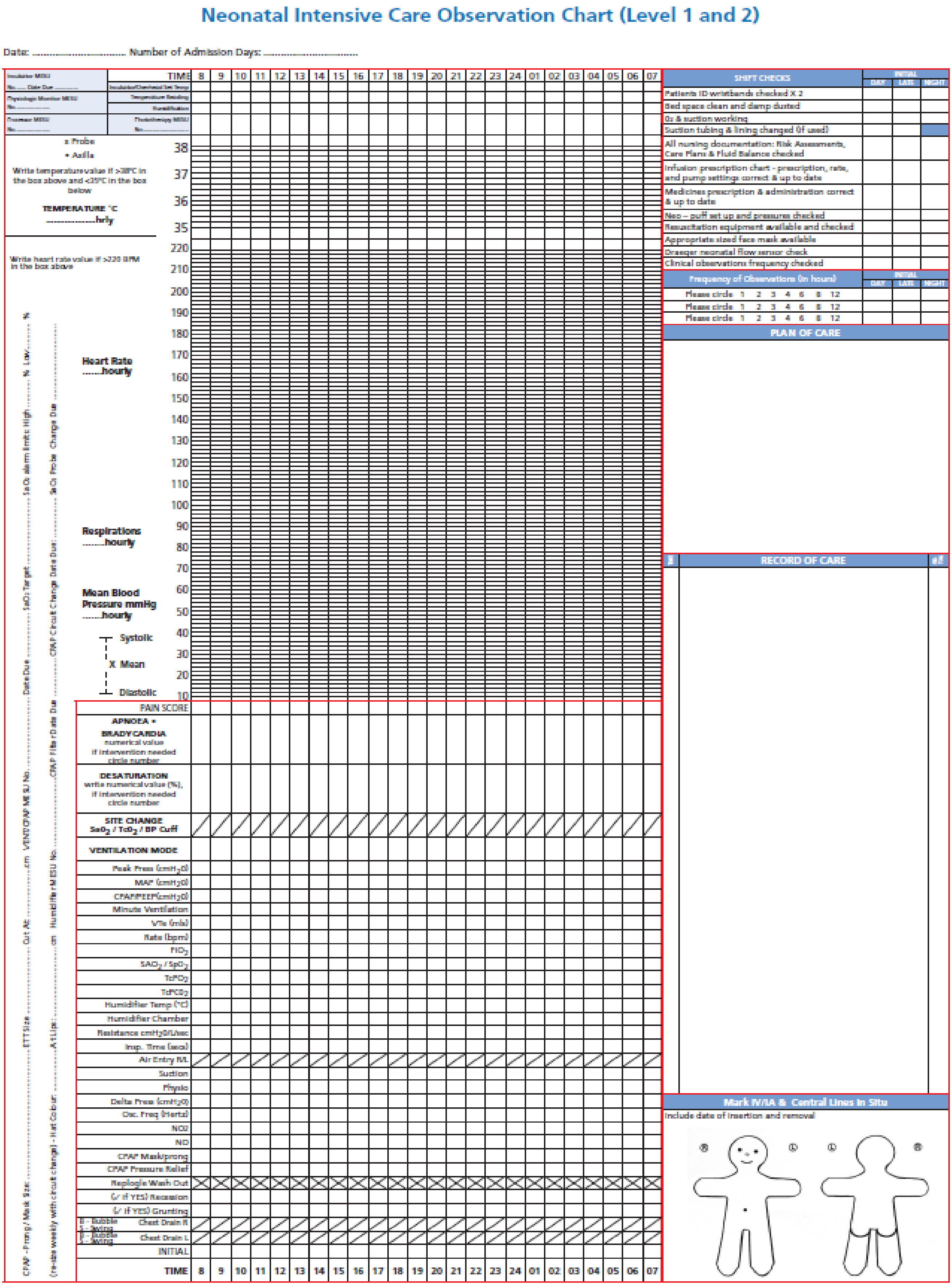
4. Oxygenation index (OI):
   Consider calculating Oxygen Index in term neonates with increasing FiO_2 requirements and in preterm infants with high oxygen requirements.
   It is an objective measurement of oxygenation. It is calculated as:

$$\mathbf{OI = \frac{FiO_2\ (\%) \times MAP\ (cm\ of\ H2O)}{PaO_2\ (kPa) \times 7.6}}$$

FiO_2 (Fraction of inhaled O_2); MAP: mean airway pressure; PaO_2: arterial pO_2

It should be calculated in infants on an arterial gas. A rising trend or if needing mean airway pressure of 12 cm of H_2O with FiO_2 of more than 40% in term baby, may indicate severe lung disease (e.g. severe PPHN) or an alternative cardiac diagnosis. Discuss with consultant, lead neonatal centre and consider urgent echocardiogram, discussion with ECMO centre (in eligible infants)/Cardiology and prostaglandin E_2 infusion. (Please refer to the EMNODN PPHN guideline).

Figure 2: A sample NICU monitoring chart for ventilated infants



7. Weaning Ventilation

Infants may need ventilation for variable period of time. Some infants may have an initiation phase and as their lung pathophysiology improves, they may soon be ready for weaning. In fact, many of these infants will automatically wean their pressures if on a volume-targeted mode. Some infants, however, may need ventilation for a protracted period of time e.g. certain surgical conditions, severe chronic lung disease, persistent cardiovascular compromise will need a clear cut maintenance phase before they can be weaned to be ready for extubation.

In the maintenance phase, patient triggered modes like AC, PSV with volume targeting (unless contraindicated) and a low back-up rate (25-40bpm) can help optimise stability and patient synchrony provided infants have a good respiratory drive. Other respiratory therapies like Caffeine (if indicated) should be continued even if the infant is on maintenance opioids for analgesia.

Factors to consider when planning to wean the ventilation, in preparation for extubation should include infant's overall clinical condition, respiratory status including PIP, mean airway pressure (MAP), FiO_2 and respiratory drive. When using volume targeting, the MAP will automatically wean as the lung condition improves. In contrast, when conventional ventilation is used without volume targeting, the PIP has to be manually reduced based on the feedback from infant's clinical parameters and information from blood gases.

8. Extubation

The readiness of extubation will be determined by infant's clinical progress and his/her clinical course. The exact ventilatory settings when the infant may be for extubation would be individual depending on the infant's age, gestation, lung pathophysiology and ventilation aims but the following checklist may be helpful[19]:

- Infant is stable on minimal ventilatory settings with a stable FiO_2.
- Is breathing comfortably off sedation
- Has been loaded with caffeine if appropriate (See your departmental guideline)
- Stomach emptied by aspirating the nasogastric tube
- Potential airway obstruction removed (secretions)
- CPAP immediately available if indicated or required
- Good respiratory drive

Once taken off the ventilator, CPAP may be particularly helpful in successful extubation in certain patient groups like extremely low birth weight infants, infants <28 weeks gestation and in infants with established chronic lung disease. (Please consult your local and the EMNODN CPAP guideline). A capillary or an arterial blood gas must be taken after extubation after 30-60min. Extubation should be followed by close monitoring of the infant including vital signs, O_2 saturations, work of breathing and blood gases. The criteria for re-intubation should be discussed and agreed with the senior medical and nursing team.

9. Ventilation for Neonatal Transport

This part of the guideline mainly focuses on preparation of infants about to be transferred out for any reason. The responsibility of stabilisation of the infant for transfer lies with the parent unit and optimisation of ventilation should be part of the stabilisation.

Transport of the young infants in or out of our network, presents certain challenges for the referring neonatal unit and the transport team managing such patients:

- Volume targeting ventilation may or not be available
- Inability to do blood gas analysis during journey
- Difficult transport environment
- Limited resources

The medical and nursing team of the referring unit, transport team as well as the medical and nursing team at the receiving unit must work together for a seamless transfer. Some infants, who may be otherwise managed on a non-invasive respiratory support, if managed within a neonatal unit set up, may need mechanical ventilation for transfer. This should be agreed between the referring neonatal team and the transport team. Please discuss the mode of ventilation, volume targeting and ventilatory settings with the transport team from the time of referral. This will reduce the time the transport team has to spend in the referring unit. Blood gas should be done after 30-60min of making any changes in the ventilation (including removal of volume targeting).

10. Acute Deterioration on Ventilator

All ventilator alarms should be attended to at the earliest opportunity and should follow a structured approach[1,20]:

- Review the infant, assess colour, chest movements, air entry, ET tube
- If in doubt, consider manual T-piece ventilation via ET tube or via an appropriate size mask if ET tube dislodged
- Colorimetric end-tidal CO_2 ($ETCO_2$) sensor can be useful adjunct in assessing dislodged tube (it should not be used as a sole determinant of successful intubation)
- Review the bedside monitoring: saturations, heart rate, monitoring probes
- Review the ventilator screen for information regarding tidal volume, FiO_2, resistance, leak and pulmonary graphics
- Review the ventilator circuit connections, power/gas supply

See Appendix 1 for approach to different causes of acute deterioration on ventilator[1].

Summary Box and Level of Evidence

Summary	Reference	Level of evidence
Infants ventilated using volume targeted ventilation modes had reduced death and chronic lung disease compared with infants ventilated using pressure control modes	3,7	A
Triggered modes of ventilation benefit from shorter duration of ventilation	4	A
Lower back-up rates improve ventilator triggering in trigger modes (e.g. AC)	11, 12	B
A degree of permissive hypercapnia has potential to reduce the duration of ventilation and BPD	14-18	B

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Appendix 1 – Approach to Deterioration on Ventilator[16]

The success of meeting the aims of ventilation depends on complex interactions between patient, equipment as well as the staff looking after them. Ventilator alarms provide an important feedback on this interaction; must never be ignored and should warrant patient review. The mnemonic BOLDPEEP may help in gathering information and direct an approach to deterioration on ventilator (see table below).

B.O.L.D.P.E.EP	Common Findings
Bad RDS/lung disease	Significant lung disease on CXR History of worsening gases and rising oxygen Declining flow and volumes on trend waveform Flat V/P loop Minimal/no chest movement Reduced/squeaky air entry bilaterally Improvement seen over 30 seconds with Neopuff at higher pressures (improved expansion and air entry)
Obstructed ETT	Possibly, history of secretions, blood in ETT or bad BPD Declining flow and volumes on trend waveform Blunted flows in real time, Flat V/P loop Minimal/no chest movement Reduced/squeaky air entry bilaterally Rising resistance (>200) Minimal improvement with Neopuff at higher pressures, if obstruction is partial Look for water in ventilator tubing Look for response to suction
Long ETT	CXR evidence/previous use of dental rolls Asymmetrical air entry/chest expansion Agitated baby, never completely settled Improvement with easing ETT back
Dislodged ETT	Sudden change, sudden events Leak heard No chest movement with ventilator Gas flow in stomach Agitated baby Ventilator registers leak-high flows to compensate and low VTe (make sure low VTe alarm is on and set)

	No improvement with Neopuff No colour change on $ETCO_2$ sensor
Pneumothorax	Bad/worsening lung disease (RDS/Meconium) No antenatal steroids No Surfactant or late surfactant Asymmetric chest shape Decreased expansion/possibly asymmetrical Asymmetrical air entry Volume/time waveform doesn't return to base line V/P loop doesn't complete (subtle) 'Positive' Transillumination
Equipment problem	Water in tubing? Pneumotach left out of circuit (no volume or flow data!!) Water in pneumotachograph? Kinked ETT due to weight of pneumotach connection? Check waveforms, check alarm settings
Equipment/**P**atient interaction (sedation/paralysis)	Bad lung disease? Long ETT? Profound Acidosis? Consider use of more sedation or paralysis ONLY when you are clear what the underlying cause e.g. Bad RDS requiring higher pressures and control of pulmonary hypertension

Appendix 2 - Abbreviations used in the guideline

AC:	Assist control ventilation
BPD:	Bronchopulmonary dysplasia
CMV:	Continuous mandatory ventilation
CPAP:	Continuous positive airway pressure
EMNODN:	East Midlands Neonatal Operational Delivery Network
FiO_2:	Fraction of inspired O_2
FRC:	Functional residual capacity
MAP:	Mean airway pressure
NEC:	Necrotising enterocolitis
NICE:	National Institute of Health and Clinical Excellence
NGT:	Nasogastric tube
PEEP:	Peak end-expiratory pressure
PIP:	Peak inspiratory pressure
P_{max}:	Maximum peak inspiratory pressure
PSV:	Pressure support ventilation
SIPPV:	Synchronised intermittent positive pressure ventilation
SIMV:	Synchronised intermittent mandatory ventilation
Ti:	Inspiratory time
TV:	Tidal volume
VTV:	Volume-targeted ventilation
VG:	Volume guarantee