INITIATION OF MECHANICAL VENTILATION

Indications for Mechanical Ventilation

The goal -

- to maintain acceptable gas exchange with a minimum of adverse effects and to wean from invasive support at the earliest opportunity.
- reducing the work of breathing, and minimizing oxygen consumption.

Category	Specific Findings or Values
Inadequate/absent respiratory effort	Absent, weak, or intermittent spontaneous effort Frequent (>6 events/hour) or severe apnea requiring PPV
Excessive work of breathing (relative)	Marked retractions, severe tachypnea >90–100/min
Severe respiratory acidosis	pH <7.2 and not improving, PCO2 >65 on days 0–3,>70 beyond day 3
Moderate or severe respiratory distress *and contraindications* for noninvasive support	Intestinal obstruction; intestinal perforation; recent gastrointestinal surgery; ileus; CDH
Postoperative period	Residual effect of anesthetic agents; fresh abdominal incision; need for continued muscle relaxation (e.g., fresh tracheostomy)
High oxygen requirement	FiO2 >0.40–0.60; labile SpO2 if PPHN is suspected

Situation when MV is employed.

Situation	Example
Lung disease	
Diffuse alveolar disease	•Preterm infant with RDS •Term or preterm infant with hemorrhagic Pulmonary edema
Obstructive	•Term infant with meconium aspiration syndrome
Pulmonary hypoplasia	•Preterm infant born after prolonged Oligohydramnios •Term infant with congenital diaphragmatic hernia
Air leak	•Preterm infant with pulmonary interstitial Emphysema • Pneumothorax

Cardiac Disease	
Left to right shunts	• Preterm infant with patent ductus Arteriosus •Term infant with large ventricular septal defect
Vulnerable pulmonary circulation	•Pulmonary atresia with duct-dependent pulmonary circulation •Hypoplastic left heart syndrome, post Norwood operation
Neuromuscular Disease	•Term infant with myopathy
Airway Obstruction	
Large airway obstruction	•Tracheobronchomalacia

Small airway obstruction	•Former preterm infant with BPD
Postoperative Support	
Abdominal surgery	•Term infant with gastroschisis repair
	•Preterm infant s/p laparotomy for Necrotizing enterocolitis

Initial setting

The initial ventilator settings should consider-

- the gestational age, underlying pulmonary pathology, and the clinical response to settings used during ventilation with a portable device.
- an immediate assessment of their effectiveness, guided by a combination of careful clinical evaluation, observation of waveforms, and other displayed parameters on the ventilator screen and early evaluation of arterial blood gases.

- PEEP level is a key determinant of end-expiratory lung volume (EELV)
- An initial level of 5 to 7 cm H2O is a reasonable starting point for most infants,

The key considerations to guide PEEP setting :

(1) There is no universal PEEP setting that is appropriate for all patients and all lung diseases.

(2) Very low PEEP (<4 cm H2O) is inappropriate in the diseased lung, predisposing the infant to low EELV, poor oxygenation, impaired pulmonary mechanics, greater turnover of surfactant, and a risk of greater lung injury.

(3) PEEP level that is set too high leads to overdistention of the lung, incomplete exhalation with hypercapnia, increased pulmonary vascular resistance, and impairment of venous return with decreased cardiac output.

(4) PEEP is not, by itself, a recruitment tool; PEEP increments will not recruit the lung optimally without an adequate inflating pressure that must reach the critical opening pressure to reinflate nonaerated lung units.

Choice of the inflation time (Ti) should be based on the

- time constant of the infant's respiratory system (how quickly gas gets in and out)
- It should be set at around 0.4 to 0.5 seconds for term infants and 0.25 to 0.35 seconds for a preterm infant and quickly adjusted if needed based on the analysis of the flow-time curve displayed on most modern neonatal ventilators.

- Setting PIP should be guided by a visual appreciation of a just adequate chest rise, audible breath sounds, and preferably the measured exhaled VT, which should range between 4 and 6 mL/kg, depending on the patient size, age, and diagnosis.

- Very small infants may have very poor lung compliance and transiently need quite high PIP.
- Finally, expiratory time (Te) (determined by direct setting or indirectly by preset ventilator rate) is adjusted to achieve a sufficient level of support to reduce work of breathing and produce adequate minute ventilation.
- Care must be taken to ensure that the expiratory time is sufficient to allow for complete exhalation and avoid inadvertent PEEP as verified by inspection of the flow waveform.

Assessment After Starting Ventilation

- A thorough clinical evaluation after initiation of ventilation is essential, recognizing that further adjustments to ventilator settings may be indicated after evaluating the patient's response to the initial choices
- Careful note of the rate of spontaneous breathing and the effectiveness of triggering should be made as the infant recovers from the intubation and the effects of any sedative and muscle relaxant drugs used during the procedure.

- Observation of the chest rise and abdominal motion gives estimate of the adequacy of VT.
- Auscultation of both sides of the chest is essential to detect mainstem bronchus intubation, atelectasis, or pneumothorax.
- Low pitched sounds may indicate a large ETT leak or partial tube obstruction against the carina.

- Persistent increased work of breathing may reflect –

  inadequate VT,

  inadequate minute ventilation,

  or tube obstruction or malposition,

- which must be corrected promptly.

- To reduce gastric distention, especially after prolonged bag mask ventilation

- Venting of the stomach with an adequately sized nasogastric tube should be done.

Observations should be made over a number of cycles.

- The exhaled VT for a set PIP, or, conversely, the PIP required to deliver a set VT should be evaluated and adjustments made if necessary.
- In a volume targeted mode, the PIP limit may need to be increased if the desired VT cannot be delivered.

- Prompt assessment of the flow waveform is essential to detect insufficient Te, which is recognized by failure of the expiratory flow to return to zero before the next inflation.
- Tachypnea is sometimes because of pain or agitation, which should be recognized and treated if present, but more commonly reflects inadequate ventilator support.
- Increasing PEEP and/or PIP will typically achieve more adequate support and allow the infant's respiratory rate to return to more physiologic values.

- Trigger sensitivity may need to be adjusted to optimize patient-ventilator interaction.
- In general, the trigger threshold should be as low as possible without causing auto-triggering because a higher trigger threshold is associated with increased work of breathing and longer trigger delay.
- If a patient remains tachypneic despite apparently good support, an attempt should be made to confirm whether the ventilator is auto-triggering.

- condensed water collecting in the ventilator tubing, and can lead to hyperventilation and air-trapping, especially in modes that support every spontaneous breath (AC and PSV).

- A chest radiograph should always be performed to confirm the position of the ETT, evaluate the lung parenchyma, and assess lung inflation.

- The need for further sedation/analgesia should be assessed.
- Muscle relaxation is rarely indicated.
- Narcotic analgesia should be used judiciously, Evidence from a large, randomized trial indicates
- although morphine administration relieves pain in ventilated neonates, it may result in more feeding intolerance ,increase the risk of adverse neurological outcomes, and prolong the duration of ventilation.

- When an infant is “fighting the ventilator,” it is tempting to prescribe sedation.
- this sign typically means that support is inadequate, even if gas exchange as measured by a blood gas is satisfactory.
- When gas exchange is inadequate, sedation will only mask the clinical signs of inadequate support.

Subsequent Ventilator Adjustments

The therapeutic goals of mechanical ventilation include

- Adequate oxygenation,
- sufficient alveolar minute ventilation to achieve an acceptable range of pH and PCO2,
- avoidance of air-hunger, and
- reduction in the work of breathing.

Oxygenation

- oxygenation is a reflection of ventilation/perfusion matching and is most effectively addressed by manipulation of the EELV, commonly referred to as functional residual capacity.
- The most effective way of optimizing EELV during conventional ventilation and high-frequency jet ventilation is adjustment in PEEP.
- Increases in PIP also increase MAP and thus can improve oxygenation, but excessive PIP may lead to excessive VT and volutrauma.

Ventilation/Carbon Dioxide Elimination

- Ventilation is primarily determined by alveolar minute ventilation, which maintains the partial pressure gradient between blood and alveolar gas.
- Alveolar minute ventilation is the product of respiratory rate and the difference between VT and dead space volume.
- Increasing either rate or VT will increase alveolar minute ventilation,

THANK YOU