

3100B Clinical Training Program

3100B HFOV
VIASYS Healthcare




HFOV at Alveolar Level



- Nieman, G, SUNY 1999

Who DO We Treat?

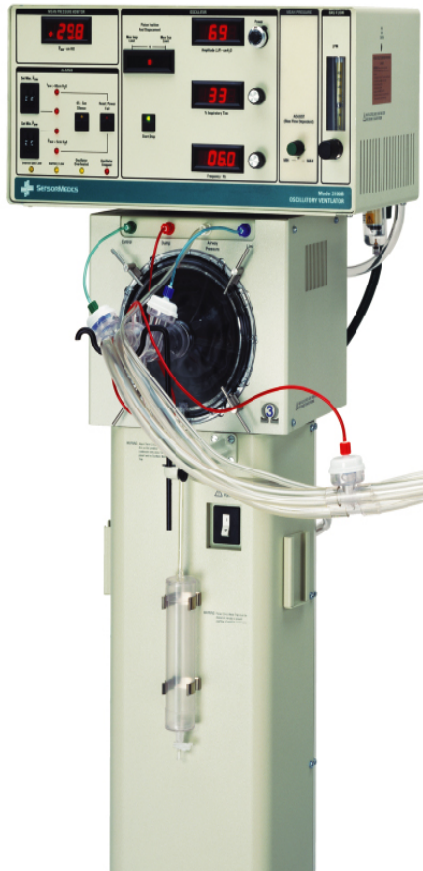
- Only Pathology studied to date has been ARDS
 - Questions about management of adults with massive airleak and BP fistula?
 - Questions about management of Respiratory Failure based on any other disease process
- 

HFOV: One More Tool in the Management of ARDS

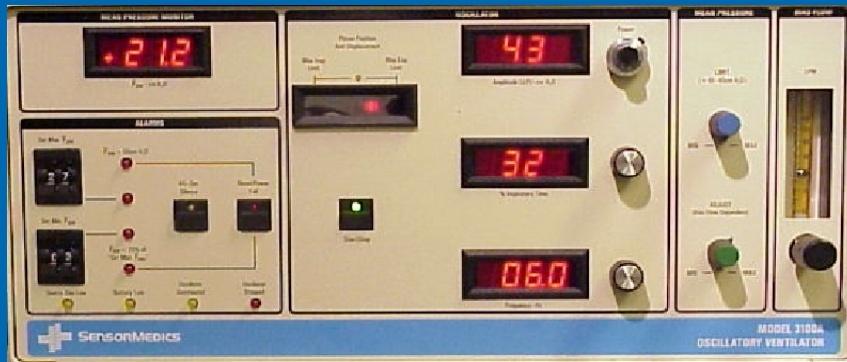
➤ How does it work?

- Reduces the risk of further lung destruction.
- Keeps lung open alveoli at constant pressure.
- Ventilates very rapidly at very small volumes.
- Early intervention is key to success.

Theory of Operation and Controls

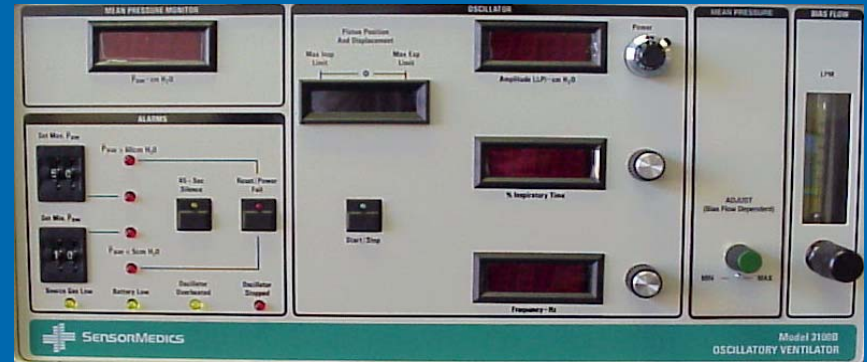


3100 A



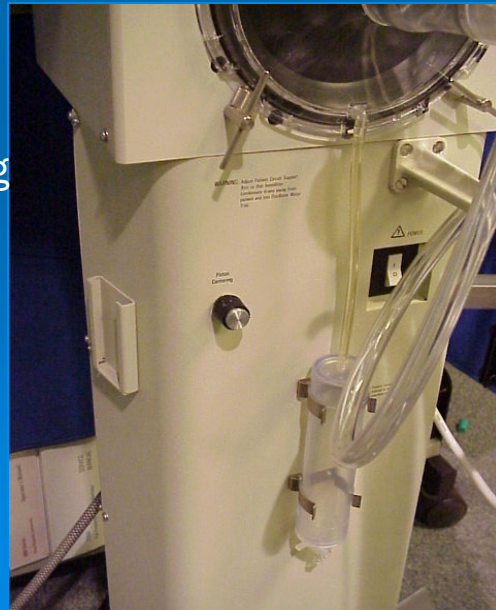
Limit Adjust Button

3100 B



No Limit Adjust Button

Piston centering adjustable



Piston centering connected to I/E Ratio



Decoupling of Ventilation and Oxygenation

➤ Controls for Oxygenation

- P_{aw}
- FiO_2

- Alveolar recruitment maneuver

➤ Controls for Ventilation- takes time!

- Amplitude
- Hertz
- % I time

- Cuff Deflation
- Permissive Hypercapnea

Oxygenation

- **Oxygenation is primarily controlled by the Mean Airway Pressure (Paw) and the FiO₂.**
- **Mean Airway Pressure is a constant pressure used to inflate the lung and hold the alveoli open.**
- **Since the Paw is constant, it reduces the injury that results from cycling the lung open for each breath**

Oxygenation Strategies

- Initial Paw 5 cms > CMV Paw
- ↑ Paw until you are able to ↓ FiO₂ to 60% with a SaO₂ of 90% or >
- Avoid hyperinflation - CXR
- Optimize preload, myocardial function
- Mean Arterial Pressure > than 75 mmHg

Ventilation

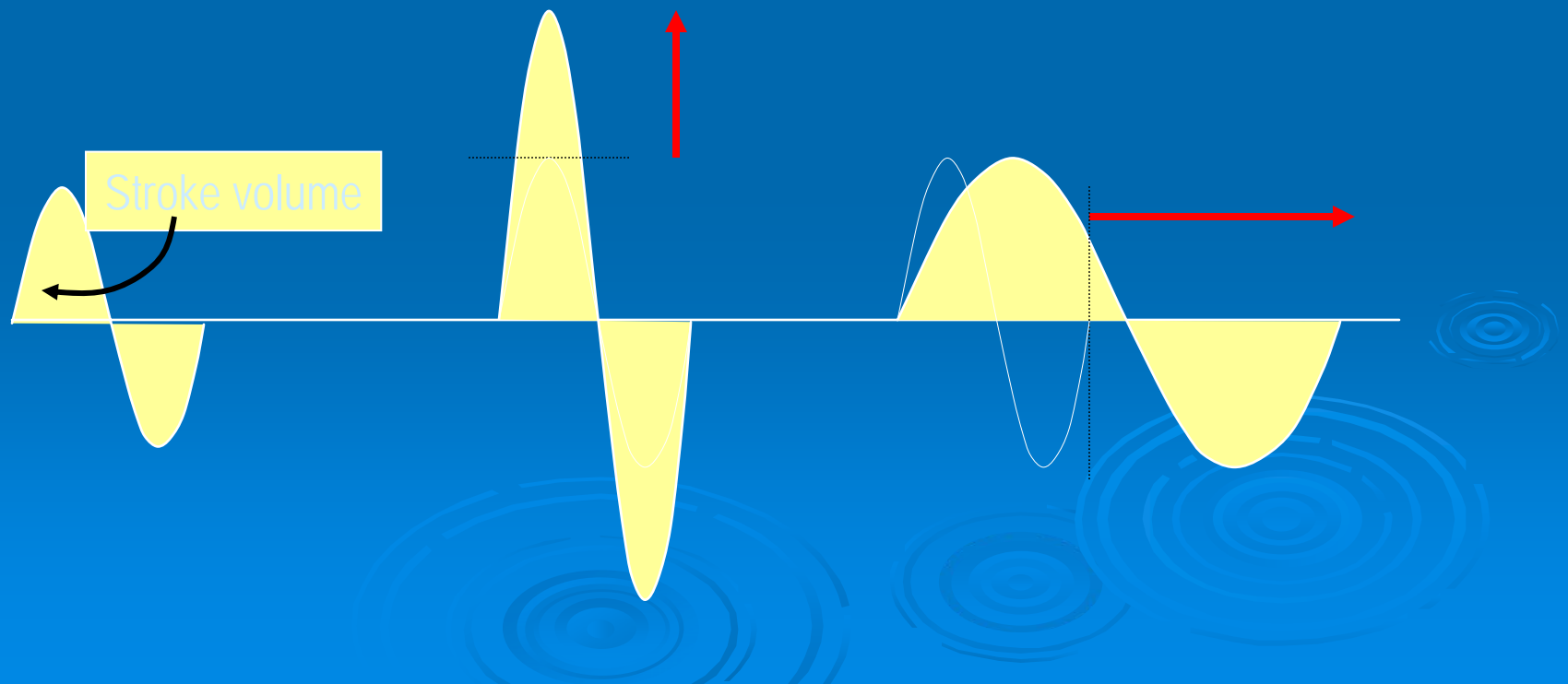


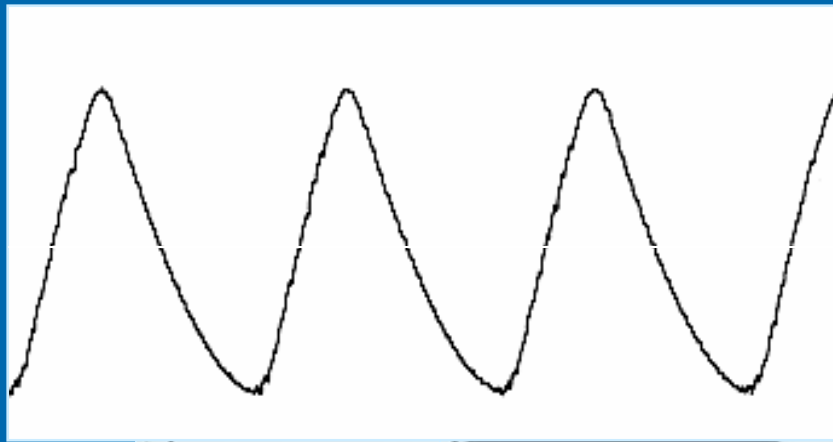
- Controlled by the movement of the pump/piston mechanism
- Alveolar ventilation during CMV is defined as: $f \times V_t$
- Alveolar ventilation during HFV is defined as $f \times V_t^2$
- Therefore changes in volume delivery (as a function of Delta-P, Frequency or % Insp. Time) have the most significant affect on ventilation.

Regulation of stroke volume

The stroke volume will increase if

- The amplitude increases (higher ΔP)
- The frequency decreases (longer cycle time)
- There is an increase in Inspiratory Time % (time in forward motion)



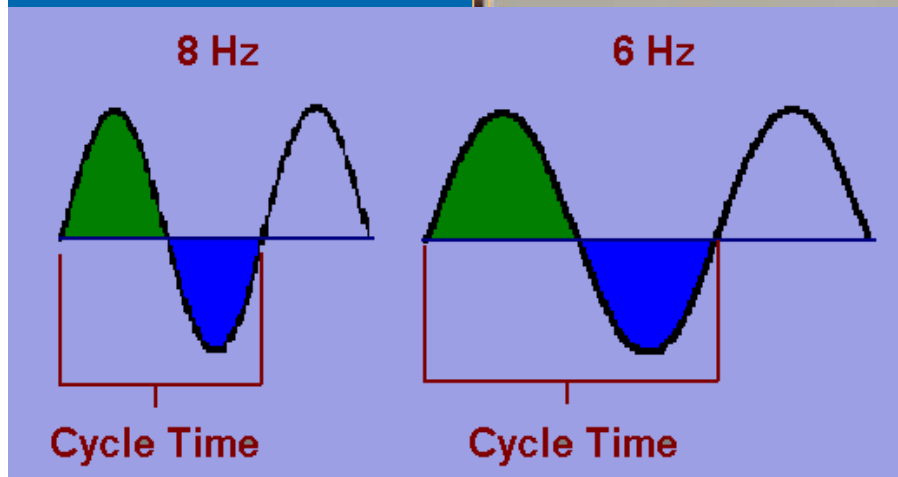


Model 3100B
OSCILLATORY VENTILATOR

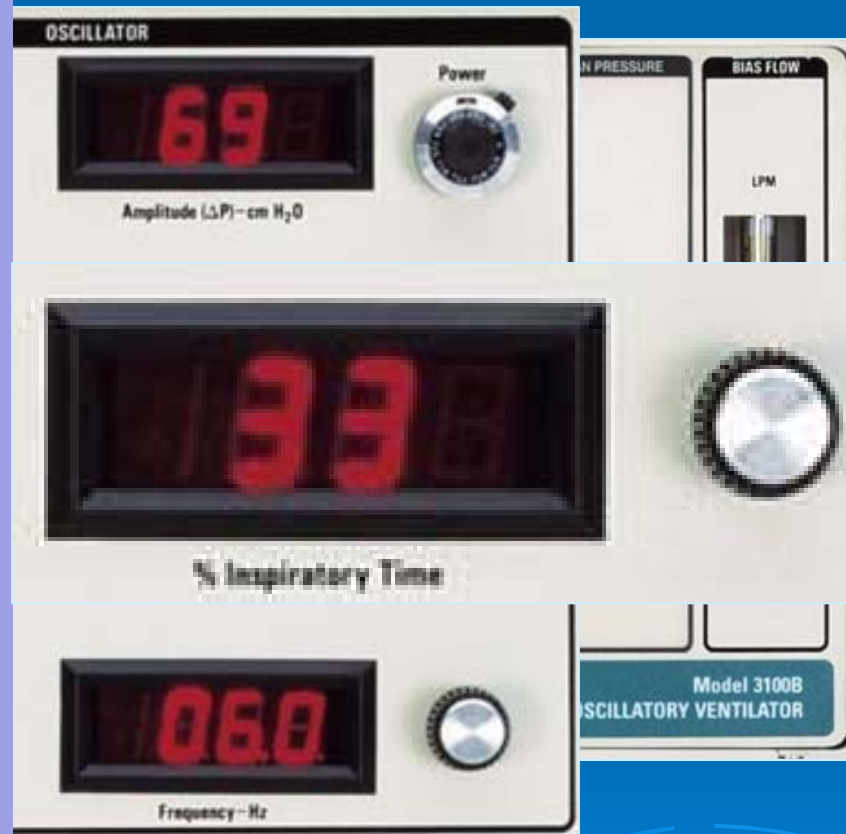
Amplitude is a measurement created by the force that the piston moves which is based on the **POWER setting**, resulting in a volume displacement and a visual CHEST WIGGLE.

It is represented by a peak-to-trough pressure swing across the mean airway pressure.

Secondary control of PaCO₂ is the Frequency set.

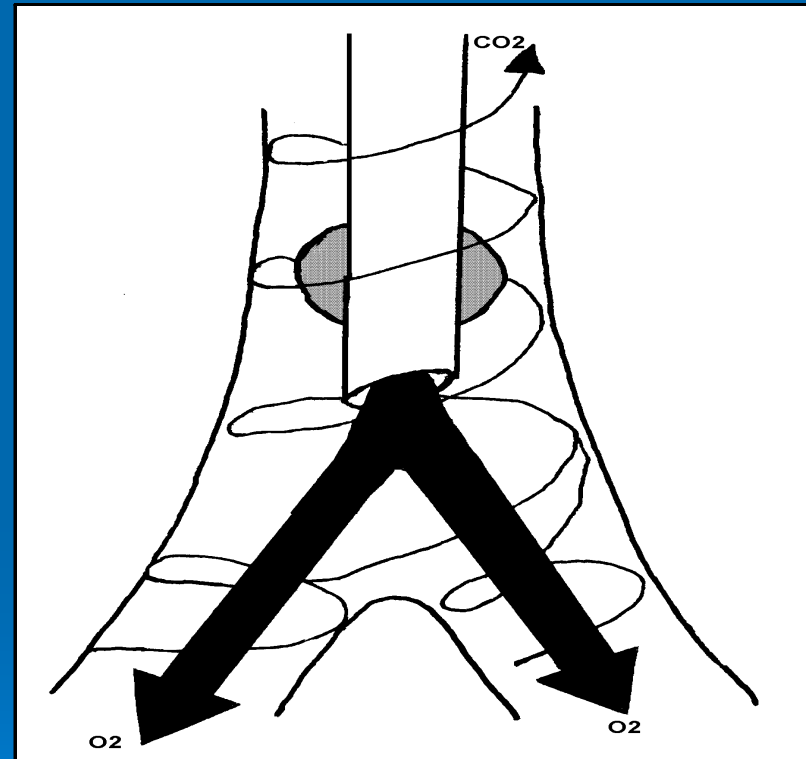


- ◆ The % Inspiratory Time also controls the time for movement of the piston, and therefore can assist with CO₂ elimination.
- ◆ Increasing % Inspiratory Time will also affect lung recruitment by increasing delivered Paw.



Clinical Tips

- With cuffed ET tubes, minimally deflating the cuff may allow airway wall CO_2 to exit the circuit at the tip of the tube



Key to Success for ANY Patient considered for HFV

- Choosing the RIGHT patient. HFV is NOT for every patient.
- When to Start?
 - Early application provides protection and reduces incidence of further lung damage
 - Rescue may or may not improve mortality chances. The later HFV is started the less chance of survival
- Gathering the right information before you start in order to make an informed and appropriate decision.
- Monitoring the patient is MANDATORY
- Assessment skills are necessary by everyone at the bedside.
 - **Rule #1 Patient tells ALL!**

When Do We Think about HFOV for the ARDS Patient?

- When to consider HFOV use?
 - As with all candidates, the earlier the better
 - $FiO_2 \geq 60$, $PEEP \geq 10$ with P/F ratio < 200
 - $>$ than 30 Plateau Pressure
 - $OI >$ than 24
 - $OI = (FiO_2 \times 100) \times MAP / PaO_2$
 - ARDS Net Protocol Failing
 - Refer to “outcome assessment” form

Initial Settings and Suggestions for Larger Patient Use On 3100 B

- Patients with ARDS >35 Kg
- Set Paw 5 cmH₂O above CV Paw
- FiO₂ 100%
- Set Hertz at 5-6
- Power 4.0, adjust for good chest wiggle
- I time % at 33%
- Set Bias Flow at >25 lpm, may need to go higher

Ventilator Strategies-Goals

- Normalize lung volume
- Minimize pressure change at alveolar level
- Wean FiO_2 to a safe level first
 - Physiological targets include:
 - Oxygen saturation $> 88\% < 93\%$
 - Delay weaning P_{aw} until $\text{FiO}_2 < 0.50$
 - $\text{pH} > 7.20$
 - PaCO_2 in the range of 40 -70 mmHg

Ventilation Strategies

- CWF- adjust Amplitude to target PaCO₂ to between 45-70
 - **Remember it is not uncommon to see an increase in PaCO₂ when first transitioned**
- ↓ frequency by 1Hz increments if unable to improve ventilation or if Power Setting is maximized
- Allow permissive hypercarbia if indicated, keeping pH > 7.25. If necessary, consider buffering pH for the transition phase.

HFOV: Adjusting the settings

➤ Hypercapnia

- ↑ delta P
- ↓ frequency
- ↑ I time
- (deflate cuff)

HFOV: Adjusting the settings

➤ Hypocapnia

- ↑ frequency
- ↓ delta P

HFOV Management

- Weaning -
 - Wean FiO₂ for arterial saturation > 90%
 - Once FiO₂ is 60% or less, re-check chest x-ray and if appropriate inflation, begin decreasing the P_{aw} in 2 - 3 cmH₂O increments
 - Wean Delta-P in 5 cmH₂O increments for PaCO₂
 - Once the optimal frequency is found, leave it alone

Clinical Tips

- Failure Criteria
 - Inability to decrease FiO₂ by 10% within the first 24 hrs.
 - Inability to improve ventilation or maintain ventilation (after optimizing both frequency and amplitude) with PaCO₂ < 80 with pH > 7.25. A transcutaneous CO₂ monitor or ABG's are imperative for monitoring CO₂ in larger patients.

Transition to conventional ventilation

- Mean airway pressure stable
- Tolerating position and nursing care
 - No substantial physiologic changes
- Stable blood gases
- Resolution of original lung pathology
- Switch to PCV (TV 6 ml/kg, 1:1 with PEEP 10)

Monitoring and Assessment

- SPO2
- CXR
- ABG- ½ follow Spo2
- HR and B.P.
- TCCo2 very effective
- Auscultation
- Wiggle
- Settings – measured
- Compliance changes
- This darn thing will enhance my assessment skills!

Clinical Assessment

- Chest Wiggle factor (CWF) must be evaluated upon initiation and followed closely after that.
 - CWF absent or becomes diminished is a clinical sign that the airway or ET tube is obstructed.
 - CWF present on one side only is an indication that the ET tube has slipped down a primary bronchus or a pneumothorax has occurred. Check the position of the ET tube or obtain a CXR.
 - Reassess CWF following any position change.

Clinical Assessment

➤ Chest X-rays

- Obtain the first x-ray at 1 hour preferably, but no greater than 4 hour mark to determine the lung volume at that time. Paw may need to be re-adjusted accordingly.
- Always obtain a CXR , if unsure as to whether the patient is hyper-inflated or has de-recruited the lung.

Clinical Assessment

➤ Chest X-rays

- Stopping the piston, or re-positioning the head to shoot an appropriate film is not necessary.
- Do not remove the patient from HFOV and manually ventilate to shoot the film. The purpose of the x-ray is to verify the lung volume that the HFOV is producing.
- A physician, nurse, or therapist should be at bedside to assure the patency of the airway and the patient's position.

When Good Compliance Turns Bad

- Monitor B.P. and HR
- Wean Paws on low FiO_2
- Signs of hyperinflation or increased alveolar dead space
- Obtain frequent CXRs- 1 hour and Q6
- Pay close attention to CWF and Transcutaneous CO_2



Clinical Assessment

➤ Auscultation

- Heart Sounds - stop the piston, (the patient is now on CPAP); listen to the heart sounds quickly, and start the piston back up. Removing the patient from the ventilator may result in loss of lung volume.

Clinical Assessment

➤ Auscultation

- Breath sounds - identifying the normal “breath “ sounds is difficult, since HFOV is not ventilation with a bulk flow of gas through the airway.
 - Listen to the “intensity or sound” that the piston makes, it should be equal throughout.
 - If not the same sound, re-assess the patient to determine if a chest x-ray is necessary at this time.

Patient Care

- Suctioning
 - Indicated by decreased or absence CWF, decrease in O₂ saturation, or an increase in TcCO₂.
 - Remember that each time the patient is disconnected from HFOV, they will potentially de-recruit lung volume.
 - Closed suction catheters may mitigate de-recruitment, and you may have to adjust the delta P to compensate for the attenuation of the delta P due to the right angle adapter
 - It may be necessary to temporarily ↑ P_{aw}

Patient Care

➤ Bronchodilator Therapy -

- Patients who are actively wheezing or have RAD
- administration via bagging- try to coordinate with suctioning
- IV terbutaline for patients who do not tolerate disconnects

Patient Care


- Humidification of bias flow accomplished with a traditional heated humidifier
- Longer, flexible circuit allows patient positioning to prevent skin breakdown

Patient Care

- Sedation or Paralysis
 - Patients may require paralysis for initial transition and then may be sedated to be maintained on the 3100B. Limitation of flow on the 3100B to meet inspiratory demand of an ARDS patient is the reason.



Patient Care: Positioning

- Every position possible including PRONING
 - At least 1 therapist and 1 nurse (risk of disconnection)
 - After change of position, observation of chest wiggle, SpO₂ and tcPCO₂
 - Re-adjustment of ventilator parameters if needed
 - Check ET tube position
- 

Potential Complications

- Hypotension - may occur
 - Administer serial boluses of fluid until CVP or PCWP has increased by 5 - 10 mmHg
 - Vasopressors - may be necessary if hypotension persists following fluid boluses

Potential Complications

- Pneumothorax may occur during HFOV
 - Patient may exhibit with progressive hypotension and desaturation
 - CWF may be affected on the pneumothorax side, visual decrease
 - Auscultation may be affected on the pneumothorax side. Distant and dampened sound of piston in comparison to opposite side

Potential Complications

➤ Endotracheal Tube Obstruction

- An abrupt rise in PaCO₂ during HFOV in an otherwise stable patient may be the result of airway obstruction
- Suction catheter should be passed immediately to ensure patency of ET tube
- May consider bronchoscopy

