

3100A High Frequency Oscillatory Ventilator

Neonatal disease-specific guidelines



CareFusion

Contents herein are courtesy of Donald Null, MD

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This clinician's guide describes patient management guidelines for the 3100A High Frequency Oscillatory Ventilator (HFOV).

Warning

Do not use this pocket guide as a substitute for (1) reading and understanding the operator manual, (2) proper training or (3) competent use of the 3100 HFOV device.

Use this document as a guide for initiating and managing patients on HFOV. Patient management on the 3100A HFOV must be altered based on the patient's individual clinical needs. This document is not intended to substitute clinical experience or medical guidance.

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Review of primary 3100A HFOV controls

Mean Airway Pressure (*mPaw*):

- Holds airways open.
- Increases lung volume.
- Improves oxygenation and minimally affects ventilation unless overinflated or underinflated. In these cases, oxygenation decreases and ventilation increases.

Increased frequency:

- Decreases peak to trough pressures in airway.
- Decreases tidal volume, leading to less recruitment and a decrease in lung volume (*unless air trapping occurs, which may increase lung volume inadvertently*).
- Minimally affects oxygenation and decreases ventilation. Alternatively, decreased frequency usually increases oxygenation slightly and increases ventilation.

Amplitude:

- Increases peak to trough pressures in airways.
- Increases tidal volume.
- Increases oxygenation, especially in areas of atelectasis, and increases ventilation.

Initial settings and management

Below are typical starting points for HFOV in various disease states. Also included are general management strategies and clinical tips that could be encountered when caring for these patients on HFOV. As always, the clinician at the bedside has the final responsibility for implementing these guidelines. Every patient is different, and some variation is expected.

Diffuse alveolar disease

Premature patient	
mPaw	1–2 cmH ₂ O greater than when on conventional ventilation
Frequency	10–15 Hz
Amplitude	Adequate for small chest wall movement
Guidelines	
<ul style="list-style-type: none">• If the patient is not on a conventional ventilator (<i>i.e.</i>, HFOV at birth), start the mPaw initiation at 2 to 3 cmH₂O greater than the continuous positive airway pressure (CPAP) on the patient (<i>typically</i>, 8 to 10 cmH₂O).• Increase the mPaw every two to five minutes until the SpO₂ reaches > 90%, and FiO₂ can be weaned. If surfactant is given, be ready to wean the mPaw.• Consider the general guideline that the average mPaw for patients treated with surfactant is 8 to 11 cmH₂O. The average for those who do not respond to surfactant is 11 to 15 cmH₂O.	

Troubleshooting

- When issues arise, the patient's lung tends to be overinflated when the mean is inadequately weaned; however, patients who do not respond to surfactant may need a mean in the high teens to 20s.
- Clinical tip (*mPaw*): If the PaCO₂ increases without the ventilator settings changing and PaO₂ remains stable, the lung is most likely overexpanded.
- Clinical tip (*frequency*): If the lung appears overdistended (*i.e., the diaphragm is at the 9.5 rib or greater*), but the PaO₂ decreases when the mPaw is decreased, the frequency is usually too fast. Also, if the overdistention is due to only a high mPaw, the lungs are clearer.
- Clinical tip (*amplitude*): Patients with airway disease do better with increased amplitude. Patients with atelectasis also do better with increased amplitude and/or decreased frequency.

Late pre-term and term

mPaw	2–4 cmH ₂ O greater than when on conventional ventilation
Frequency	8–10 Hz
Amplitude	Visible chest wall movement

Guidelines

- Choose a lower frequency because many of these patients have pneumonia with airway disease that may lead to air trapping.
- Consider the general guideline that the average mPaw for patients who slightly respond to surfactant is 12 to 18 cmH₂O. The average for those who do not respond or are not given surfactant is 18 to 30 cmH₂O.

Troubleshooting

- Follow the same as the premature patient steps on page 3.
- If the mPaw is not weaned, the lung overinflates. If the mPaw is not adequate, the lung poorly expands.
- Clinical tip (*mPaw*): Because many of these patients have pneumonia, frequencies > 10 Hz may lead to air trapping and overdistension. An overdistended lung that does not improve with a decreasing mPaw is on a frequency that is too fast.

- Clinical tip (*frequency*): Atelectatic areas are best opened by positioning the infant abnormal side up.
- Clinical tip (*CXR*): The user must look at the lung parenchyma, not just the rib counting (*diaphragm level on CXR*). Generally, hazy lung fields indicate a need for a higher mPaw.

Air leak syndrome

Premature patient with gross air leak	
mPaw	0 or 1 cmH ₂ O greater than when on conventional ventilation
Frequency	10–15 Hz
Amplitude	Minimal chest wall movement
Premature patient with PIE	
mPaw	1 cmH ₂ O less than when on conventional ventilation
Frequency	10–15 Hz
Amplitude	Minimal chest wall movement
Late premature or term infant with gross air leak with generally poor inflation	
mPaw	1–2 cmH ₂ O greater than when on conventional ventilation
Frequency	8–10 Hz
Amplitude	Visible chest wall movement

Late premature or term infant with gross air leak adequate inflation

mPaw	0 or 1 cmH ₂ O less than when on conventional ventilation
Frequency	8–10 Hz
Amplitude	Visible chest wall movement

Non-homogeneous lung disease

Clinical tip (*mPaw*): The mPaw produces effects similar to preterm; however, the mPaw in these patients does not solely determine oxygenation. The patient needs an mPaw that adequately inflates the lung without significantly overdistending the more normal lung. Overdistention worsens the persistent pulmonary hypertension of the newborn (PPHN) frequent in these patients.

Clinical tip (*frequency*): These patients tend to have much more airway disease and therefore, require lower frequencies to avoid air trapping. Failure is often due to a frequency that is too fast.

Clinical tip (*amplitude*): In general, the user looks for minimal chest wall movement. However, these patients, because of their airway disease, require good chest wall bounce to be effective. This effectiveness is best accomplished with lower frequencies and higher amplitudes.

Meconium aspiration with air trapping

mPaw	Equal to when on conventional ventilation
Frequency	5–8 Hz
Amplitude	Good chest wall movement

Meconium aspiration diffusely hazy

mPaw	2–5 cmH ₂ O greater than when on conventional ventilation
Frequency	6–10 Hz, generally 8 Hz
Amplitude	Good chest wall movement

With a predominately low lung volume, patients frequently need a higher mPaw; however, use lower frequencies as meconium may be in the airways, leading to air trapping.

Focal pneumonia

mPaw	0 or 1 cmH ₂ O less than that on conventional ventilation
Frequency	8–10 Hz
Amplitude	Visible chest wall movement

Pulmonary hypoplasia

Uniform			
mPaw	0 or 1 cmH ₂ O greater than when on conventional ventilation. Increase by 1 cmH ₂ O every two to three minutes until SpO ₂ increases.	Frequency	10–15 Hz
		Amplitude	Minimal chest wall movement

Troubleshooting

- Clinical tip (*CXR*): An important issue is rib counting. Most of these patients have, by definition, small lungs; therefore, adequate inflation is often at the diaphragm, at 7 to 8 ribs. The user must look at the lung parenchyma. If it is clear, even at 7 ribs, then the mPaw may be adequate. Overdistention worsens the PPHN that a large majority of these patients have. Also, increasing the mPaw while the lung is well inflated may lead to air leak.
- Clinical tip (*frequency*): Because many of these patients have thick secretions due to low/absent amniotic fluid, they need lower frequencies to avoid air trapping.
- Clinical tip (*amplitude*): If the lung is kept overdistended with an mPaw that is too high or frequency that is too fast, higher amplitudes (*i.e.*, *tidal volumes*) are needed for adequate ventilation, increasing the risk of lung injury. Patchy densities are best treated by increasing amplitude and/or decreasing frequency, as increasing mPaw is likely to overinflate the more normal areas of the lung.

Non-uniform (*diaphragmatic hernia, typically*)

mPaw	0 or 1–2 cmH ₂ O greater than when on conventional ventilation. Dependent on normal lung.
Frequency	8–10 Hz
Amplitude	Visible chest wall movement

Guidelines

- Do not exceed an mPaw of 14 cmH₂O without a CXR demonstrating poor lung inflation, as the majority of these patients have persistent pulmonary hypertension.
- Consider the general guideline that the average mPaw for late pre-term/term infant with congenital diaphragmatic hernia (CDH) is 11–14 cmH₂O.

Troubleshooting

- Clinical tip (*mPaw*): The main problem is a reduced mPaw due to rib counting (*i.e., diaphragm at 10 ribs*). The key is to keep the upper lung inflated and the lower lung just below the heart border. The diaphragm will almost always be at least 10 ribs.
- Clinical tip (*amplitude*): Low mean airway pressure with larger amplitudes should be avoided, as it increases the risk of lung injury.

Summary

- CXRs are helpful but not always necessary.
- The user should always assess the position of the liver in regard to the right costal margin. As the lung overinflates, the liver falls 1 to 3 cm below its previous position. The user can then try weaning the mPaw or decreasing the frequency as indicated.
- Increasing the partial pressure of carbon dioxide (PaCO_2) with the liver easily palpable may suggest an overdistended lung.
- Increasing the PaCO_2 and decreasing the PaO_2 with the liver less palpable may suggest an inadequately inflated lung.
- Increasing the mPaw generally improves oxygenation. However, this is the case only if the lung is inadequately inflated. If the patient has PPHN, then the low PaO_2 is not fixed by increasing the mPaw unless the lung is poorly expanded, and will only worsen if the lung is already well inflated or overinflated.
- A common indicator that the mPaw is too low is when the amplitude is increased to a level approaching three times the mPaw. This indicates there may not be adequate lung inflation for proper gas exchange to occur. A CXR may be warranted to determine lung volume. Sometimes, a very high amplitude and a low mPaw may lead to inadvertent air trapping; rule this out on CXR.
- Appropriate management occurs when the user combines the correct ventilator settings to match the pulmonary pathophysiology being treated.

Basic weaning concepts

mPaw

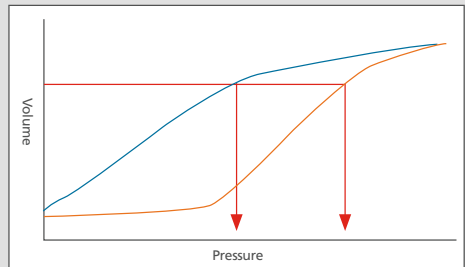
Once the CXR shows a well-inflated lung and the patient remains on less than 70% oxygen, begin to decrease the mPaw. If the patient has received surfactant on a low mPaw (*i.e.*, 10 or less for < 1,500 g, or 13 or less for > 1,500 g), the mPaw should be weaned once in 35–40% fraction of inspired oxygen (FiO₂). As depicted in the figure below, once the lung is recruited, the mPaw can be weaned without significantly changing the lung volume.

If the SpO₂ decreases, do not further wean the mPaw. If the FiO₂ increases, then the mean needs to be increased to 1 or 2 > than the previous setting.

The mPaw may be weaned every 15–30 minutes as tolerated.

Guidelines

- If the mPaw ≥ 20 , wean the mPaw by 2
- If the mPaw is 10–20, wean the mPaw by 1
- If the mPaw < 10, wean the mPaw by 0.5



Frequency

Generally, the frequency remains constant. However, if the PaCO₂ is < 45 mmHg and amplitude is less than 15, consider increasing the frequency by 0.5 Hz.

Amplitude

If the PaCO₂ is less than 50 mmHg and the pH > 7.25, decrease the amplitude.
If transcutaneous PaCO₂ is available, then the user may wean the amplitude every 3–5 minutes until it reaches a desired level.

Guidelines

- If the PaCO₂ is < 35 mmHg, decrease the amplitude by 2–3.
- If the PaCO₂ is 35–45 mmHg, decrease the amplitude by 1–2.

Typical extubation settings

A good indicator that the patient is ready to be extubated is when the underlying need for HFOV has resolved and the patient is stable and tolerating suctioning and procedures well.

	2 kg	1–2 kg	< 1 kg
mPaw	11–13.5 cmH ₂ O	9–11 cmH ₂ O	6–10 cmH ₂ O
Frequency	6–10 Hz	6–10 Hz	7–12 Hz
Amplitude	15–22 cmH ₂ O	12–20 cmH ₂ O	10–16 cmH ₂ O
Guidelines			
<ul style="list-style-type: none">• Patients may be weaned off to CPAP, NIPPV or HFNC per hospital protocol.• In general, consider CPAP or NIPPV for patients in the higher mPaw range.			

Useful information

Clinical and technical support for HFOV

Registered respiratory therapists are available for clinical and technical support during normal business hours and for emergency support 24 hours a day.

Call **800.520.4368** and follow the prompts.

The CareFusion HFOV rental program

The HFOV rental program is designed to assist customers who own the 3100A or 3100B HFOV and need additional units. Delivery will be within 24 hours in most cases.

This program is available 24 hours a day.

For more information, call **800.520.4368** and follow the prompts.

HFOV website

<http://www.carefusion.com/hfov>

Abbreviations

CDH	Congenital diaphragmatic hernia
CPAP	Continuous positive airway pressure
CXR	Chest x-ray
FiO ₂	Fraction of inspired oxygen
HFNC	High flow nasal cannula
mPaw	Mean airway pressure
NIPPV	Noninvasive positive pressure ventilation
PaCO ₂	Partial pressure of carbon dioxide
PPHN	Persistent pulmonary hypertension of the newborn
SpO ₂	Saturation level of hemoglobin by oxygen determined by pulse oximetry

Notes

 **WARNING**—U.S. Federal Law restricts this device to sale by or on the order of a physician.

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