High Frequency Oscillation (HFO)

Servo-n

GETINGE

Contents

Introduction

High frequency oscillatory ventilation (HFOV) is a type of mechanical ventilation that uses a constant distending pressure: mean airway pressure (Pmean) with pressure variations oscillating around the Pmean at very high rates.

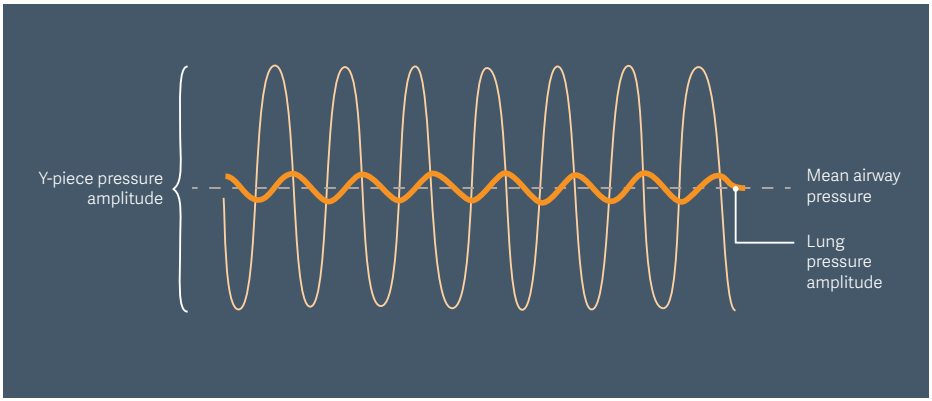
HFOV implies ventilation with frequencies in the range 5–20 Hz. The high frequency tidal volume (VT_{HF}) is ideally 1–3 ml/kg.

In Servo-n, high frequency HFOV is available in two modes:

- HFO Pressure amplitude control
- HFO (VTGT) Volume target

HFOV delivers a pressure signal with:

- a mean airway pressure of Pmean (cmH_2O) at the Y piece
- a peak-to-peak amplitude required to deliver a high frequency tidal volume of VT_{HF} (ml) at the Y piece
- a ratio between inspiratory and expiratory flow durations of $I:E_{HF}$
- an oscillation frequency of f (oscillation frequency f is expressed in Hz), i.e. with a cycle duration of 1/f (s)



Servo-n HFOV operating principle

Inertia powered HFOV

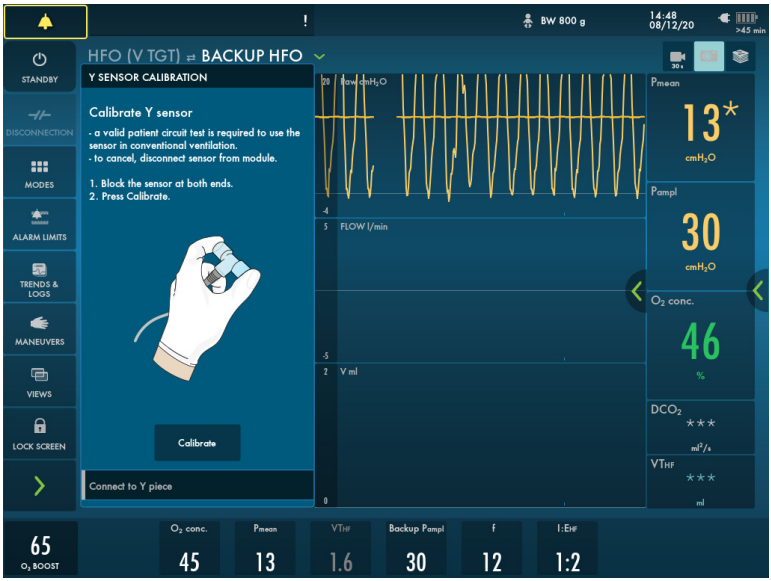
Both positive and negative pressures are created using standard gas chain. The inertia of the air, together with fast and well-synchronized control of valves creates the negative pressure.

The servo controller system, senses and adjusts gas delivery extremely fast and accurate. Transducer refresh rate is 2000 times per second. This will lead to immediate response to patient efforts, smooth uninterrupted regulation during inhalation and a low resistance during exhalation.

Y sensor

The Y sensor module should be connected during HFOV, since it enables measurement of volumes and mean pressure at the Y piece.

In other modes it is recommended to use Y sensor for tidal volumes below 5 ml to increase the accuracy of gas delivery and monitoring. Y sensor measurement is not needed in NAVA mode.



When a new calibration is needed, a dialog appears on the screen with instructions.

Y sensor and pressure line

Pressure line connection on Getinge HFOV circuit.

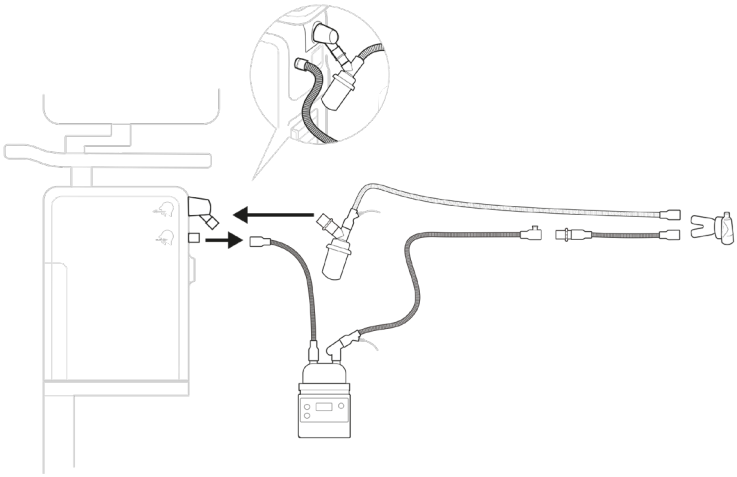
Note: For the F&P circuit, that is used with the F&P950 humidifier, the pressure line connection point is on the expiratory limb of the circuit.

The pressure line is needed during HFOV modes. In other modes the pressure line is not needed. If you forget to connect the pressure line a message and alarm will be activated.

Getinge HFO patient circuit

It is recommended to use the Getinge HFO patient circuit to obtain the maximum power performance of Servo-n HFOV. Using a non-recommended patient circuit will decrease the power of HFOV. This may lead to using higher amplitude settings and lower frequency to achieve the desired high frequency tidal volume and maintain acceptable ventilation.

The HFOV patient circuit is also suitable for all types of ventilation including conventional, non-invasive and High Flow therapy.



Patient circuit recommended for Servo-n HFOV to enhance the power during high frequency oscillation.

Note:

- The Getinge HFOV circuit is used with the MR850 humidifier. When using the F&P950 humidifier a dedicated F&P circuit must be used. This circuit can be used with expiratory filter heater, but not with the expiratory water trap.
- The 15 mm dual heated HFOV neonatal patient circuit can be used for all ventilation modes.
- It is recommended to use a thermoshell on the expiratory inlet.

Mounting the thermoshell

Emptying the water trap

The water trap is placed on the expiratory inlet. The water trap can be emptied without affecting the ventilation to the patient. By also adding the thermoshell on the expiratory inlet the risk of condensate in the circuit will be reduced.

Patient Circuit test (PCT)

CAUTION: The patient circuit test must be performed with a complete patient circuit, including all accessories (e.g active humidifier filled with water and water trap).

IMPORTANT: The active humidifier and the expiratory filter heater must be turned off during the patient circuit test. The Y sensor does not need to be connected when performing the PCT.

Important reminder:

If the patient circuit or accessories have been added or removed and no new patient circuit test is performed:

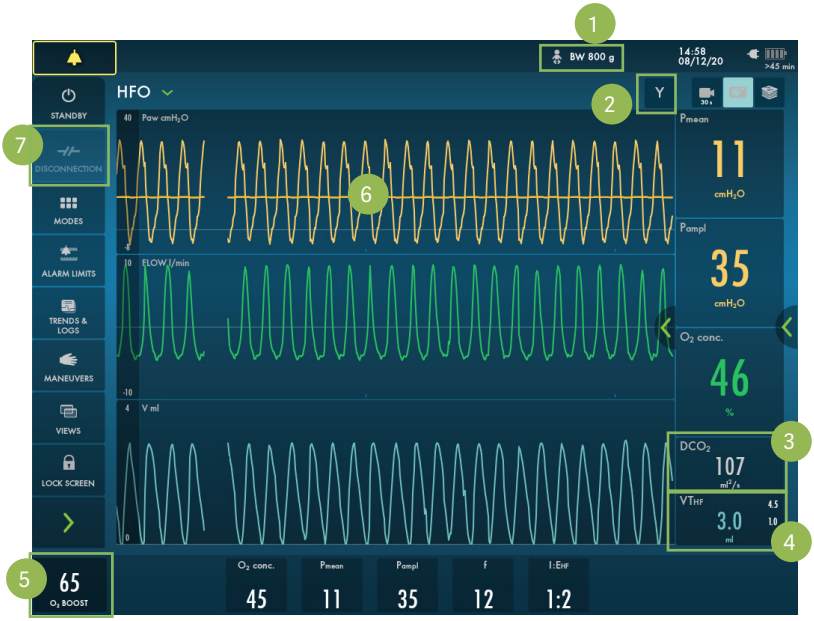
- The ventilator will compensate incorrectly based on the measurements of the previous patient circuit.
- In HFOV, mean pressure delivery and presented mean pressure estimations will be incorrect, volumes delivered to the patient are restricted and alarms falsely triggered.

Suctioning during HFOV

Closed suctioning can be performed in HFOV, but will impact volume measurement and delivered amplitude in HFO (V TGT). If suctioning is to be performed in HFO (V TGT) while maintaining appropriate amplitudes, it is necessary to:

- set tight pressure amplitude limits to maintain appropriate amplitudes or
- perform suctioning during a pause oscillation maneuver.

Servo-n user interface



1. **PATIENT DATA** – here you can enter patient's weight.
2. **Y SENSOR** active, if inactive the Y symbol is crossed out.
3. **DC0$_2$** is the CO_2 diffusion coefficient.
4. **VTHF** measured high frequency tidal volume.
5. **O_2 BOOST** – when tapped, O_2 boost delivers the oxygen setting displayed here for a period of 1 minute. The O_2 boost level can be changed under maneuvers. The value entered under O_2 boost (%) level specifies the number of percentage units that will be added to the value set for the O_2 concentration. All alarms will be silenced for 1 minutes when O_2 boost is activated.
6. **PMEAN** – the mean airway pressure, is superimposed on the pressure waveform during HFOV.
7. Some functions are not available in HFOV like **DISCONNECTION** support.

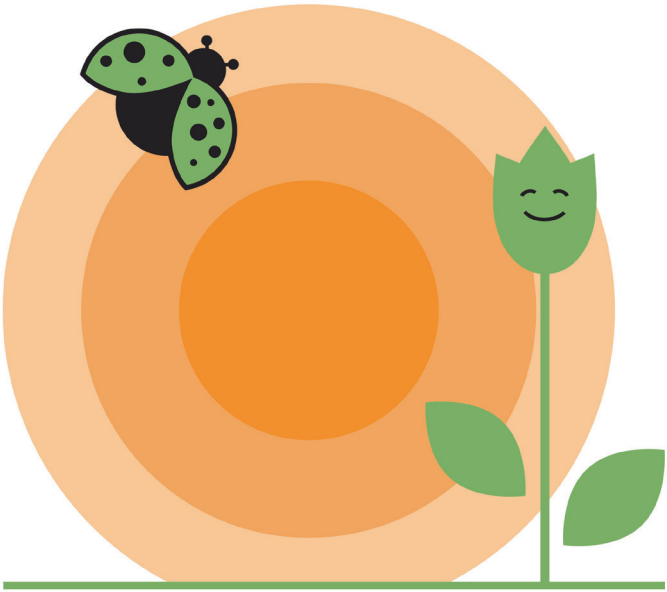
HFOV settings

Pmean
Mean airway pressure (cmH_20).

Pampl
Pressure amplitude (cmH_20).

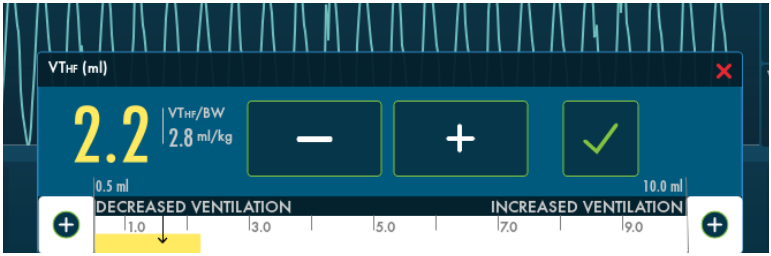
Frequency
High frequency respiratory rate (Hz = cycles per second, i.e. 10Hz =10 cycles/sec = 600 cycles/min).

I:EHF
Ratio between inspiratory and expiratory flow durations. In HFOV, an I:EHF ratio of 1:2 will yield a higher minimum pressure during the expiratory phase than an I:EHF ratio of 1:1. This makes the airways less likely to collapse.



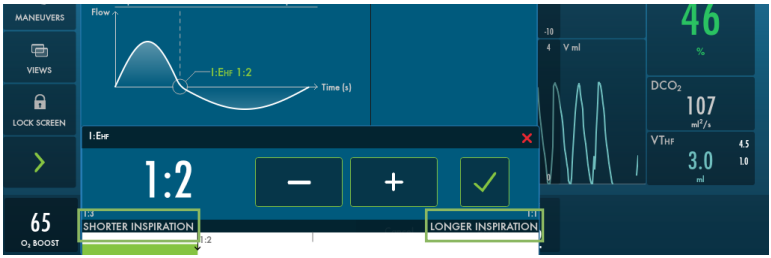
Safety scales

The bar displays the safety scale that is the range that is safe to use for most patients. If a setting is outside the normal range the color changes. The safety scale can be expanded by tapping ⊕.



Contextual help

Most of the settings have contextual help to guide you.



Note:
The following colors are used for settings:
RED Not recommended
YELLOW Use with caution
GREEN Normal

Tap on the waveforms to change the scale of the waveforms.

Tap on the arrow to open the short trends.

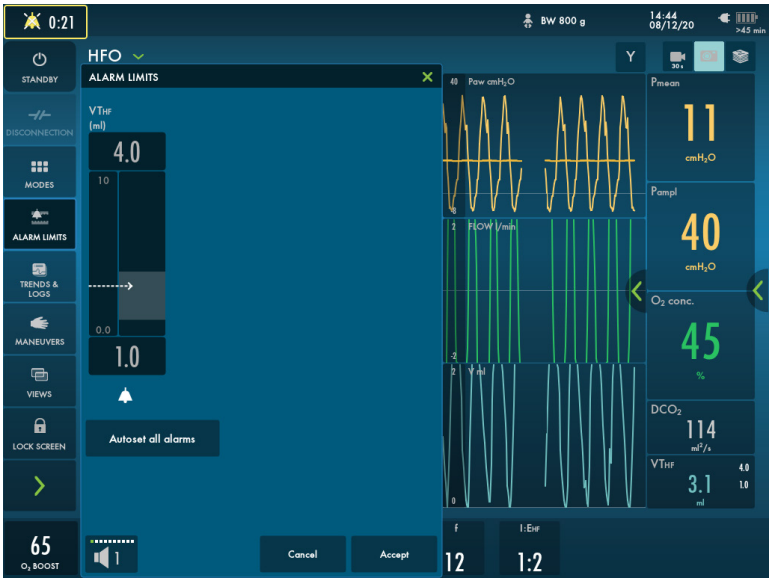
HFO

The following parameters to set:

- Oxygen concentration
- Pmean
- Pampl
- f
- I:EHF

EXAMPLE: If PC is used prior the HFO, the Pmean used there, plus an additional 2 cmH_2O, will be proposed as the Pmean setting for HFO.

High Frequency Oscillation (HFO) mode, pressure amplitude control.



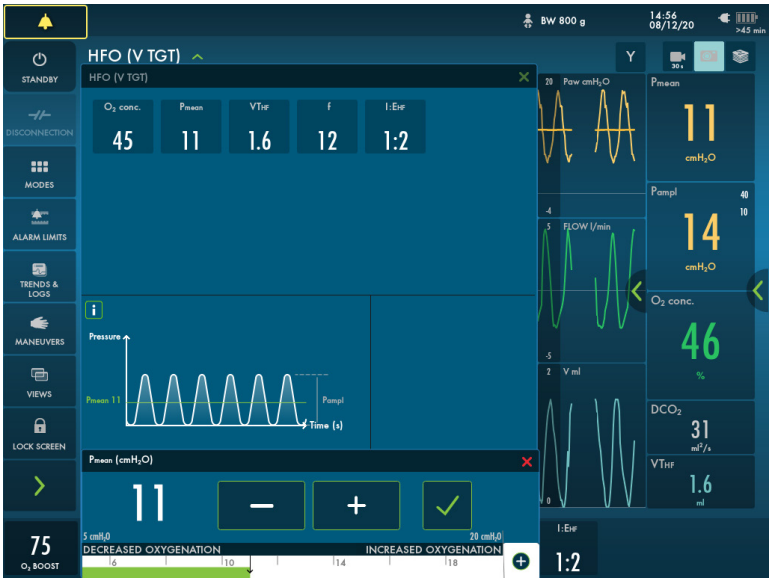
In HFO the high frequency tidal volume (VTHF) alarm is set.

HFO (V TGT)

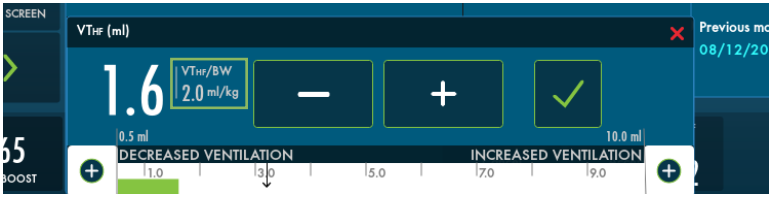
HFO (V TGT) is a high frequency volume targeting ventilation mode.

The following parameters to set in HFO (V TGT):

- Oxygen concentration
- Pmean
- VTHF
- f
- I:EHF



In HFO (V TGT) the volume is set. Note that ml/kg is displayed here.



If the Y flow sensor is disconnected from the Y sensor module, the ventilator system will automatically switch to backup ventilation (HFO).

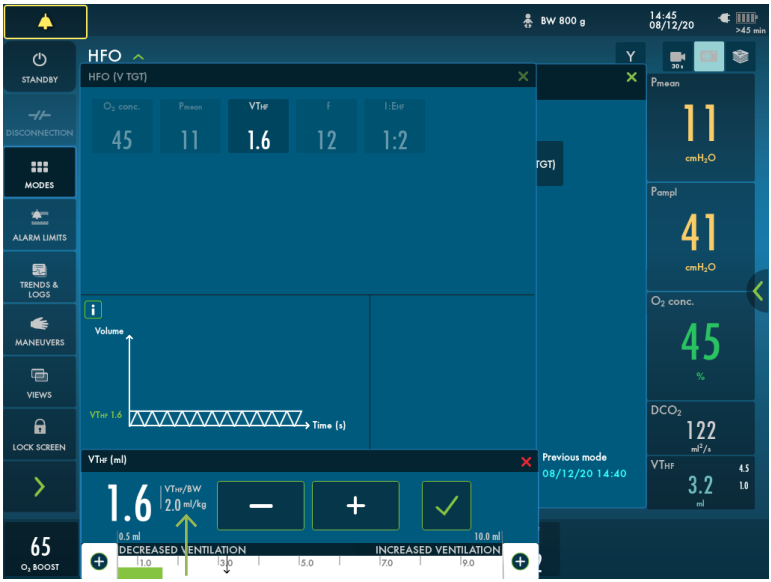
NOTE: During Backup HFO, a Backup Pampl parameter can be adjusted.

The pressure amplitude is limited by the upper alarm limit that is set.

EXAMPLE: If the Y flow sensor is disconnected from the patient circuit during HFO (V TGT), the resulting Pampl increase will not be allowed to exceed the upper Pampl alarm limit. It is important to set the amplitude alarm appropriately, when the patient's lung condition changes the user will then be informed.

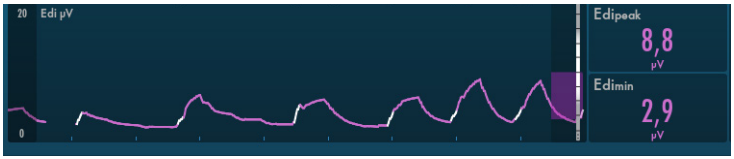
HFO (V TGT) is not suitable when the patient is vigorously breathing spontaneously. It will activate frequent volume alarms.

The HFO (V TGT) mode can be used to maintain stable V_{THF} delivery, by matching required amplitude to changes in compliance. Monitor and record the amplitude achieved, Servo-n displays this as Pampl on the screen.



During HFO (V TGT) mode shows how to set the volume target per body weight.

Edi monitoring during HFOV

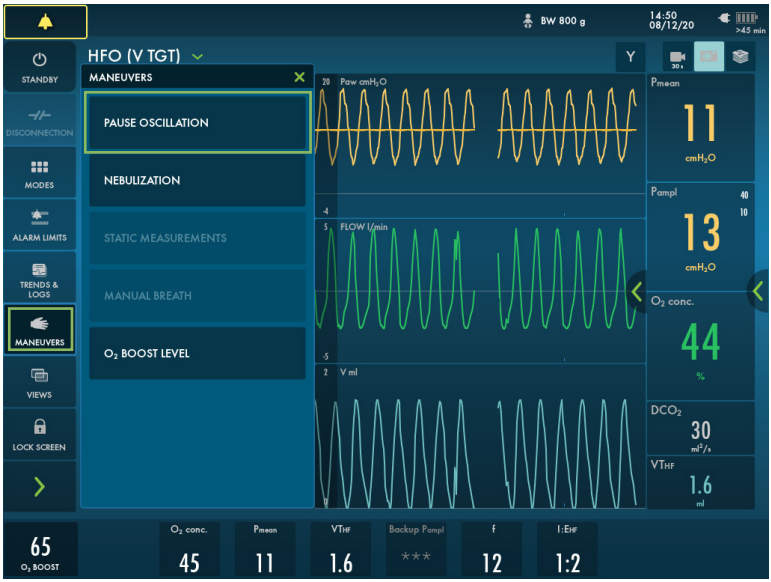


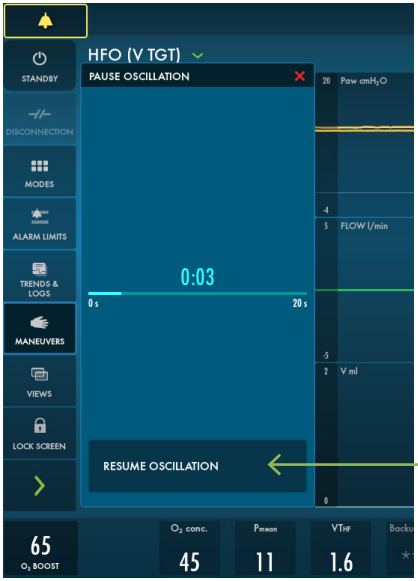
Edi

The Edi signal can be monitored during HFOV.

Pause oscillation

The Pause oscillation maneuver pauses the oscillation but maintains the Pmean. Tap and hold PAUSE OSCILLATION to activate the pause. Oscillations may be paused for up to 20 seconds.





Tap RESUME OSCILLATION to end the pause time.


HFO
STANDBY
DISCONNECTION
MODES
ALARM LIMITS
TRENDS & LOGS
MANEUVERS
VIEWS
LOCK SCREEN
Paw cmH2O
FLOW l/min
V ml
Pmean
11
Pampl
35
O2 conc.
46
DCO2
107
VTexp
3.0
65
O2 BOOST
O2 conc.
45
Pmean
11
Pampl
35
t
12
I:Exf
1:2
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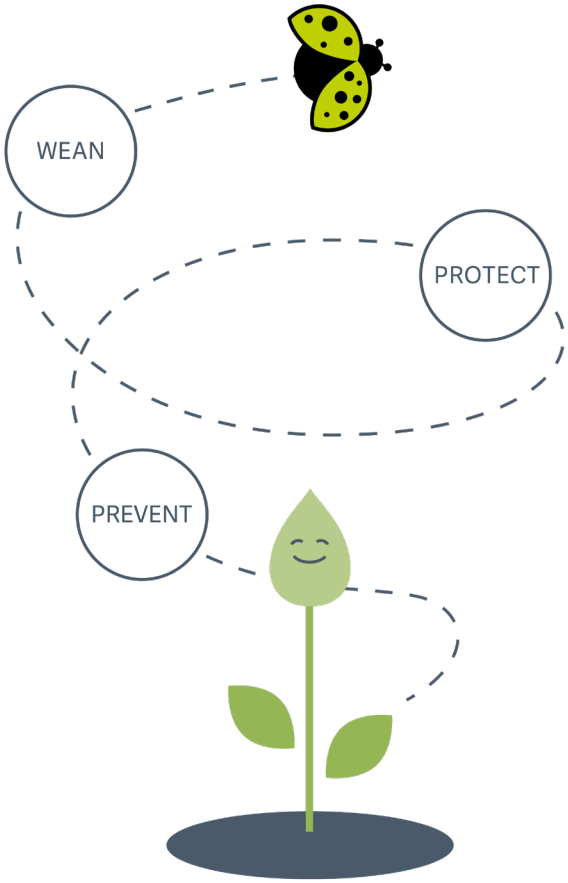
Terminology

Pmean (cmH_2O)	Mean airway pressure (cmH_2O).
Amplitude	A peak-to-peak amplitude of Pampl (cmH_2O) at the inspiratory outlet a ratio between inspiratory and expiratory flow durations of I:E HF around the Pmean.
Edi	Electrical diaphragm activity.
Frequency	High frequency oscillation ventilation rate. Frequency, f (Hz) where ; (Hz = cycles per second, i.e. 10Hz = 10 cycles/sec = 600 cycles/min).
HFO (VTGT)	High Frequency Oscillation Volume Target Ventilation.
VT_{HF}	High frequency tidal volume.
I:EHF	A ratio between inspiratory and expiratory flow durations of I:EHF.
DCO_2	The CO_2 diffusion coefficient or DCO_2 is calculated as f * VTHF2 and it is proportional to ventilation or CO_2 washout during HFO ventilation.
Oxygenation	Oxygenation is dependent on MAP and F_iO_2. MAP provides a constant distending pressure equivalent to CPAP. This inflates the lung to a constant and optimal lung volume maximizing the area for gas exchange and preventing alveolar collapse in the expiratory phase.
Ventilation	In HFOV, oxygenation can be separated from ventilation, as they are not dependent on each other as is the case with conventional ventilation. Ventilation or CO_2 elimination is dependent on amplitude and to a lesser degree frequency.

Disclaimer: The clinical management on HFOV stated in this guideline is a general practice guideline. It may differ in every Neonatal ICU. HFOV should be managed under a physician's order. This guide is referring to Servo-n® 4.4 ventilator.



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