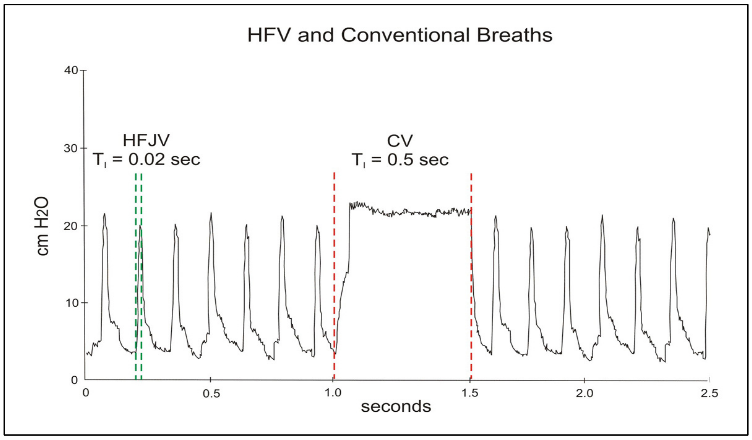
WHY the LifePulse HFV Works

Having a clear understanding of why the LifePulse works is essential to maximize its benefits. The keys to understanding the LifePulse are appreciation of short inspiratory times, jet nozzles, and passive exhalation.

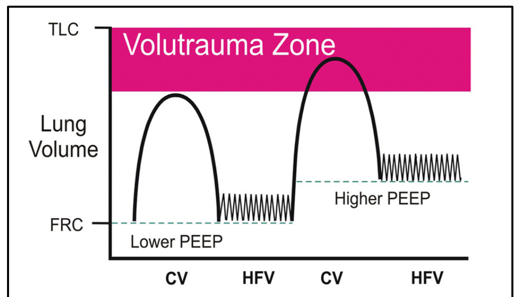
Inspiratory Time:



The 0.020 sec. I-time (T_I) used with the LifePulse is 25 times shorter than a 0.5 sec T_I used during conventional ventilation. As a result, tidal volumes delivered with the LifePulse are significantly smaller than those delivered during CMV. These very small tidal volumes (~ 1 mL/kg) allow higher levels of PEEP to be used safely, keeping lungs open with sufficient mean airway pressure (MAP) for oxygenation.

Short T_Is also provide another important benefit of HFJV: low alveolar pressures. Small tidal volumes (V_T), when delivered with short T_Is, make it impossible for the peak pressure used during HFV to be transmitted to alveoli.

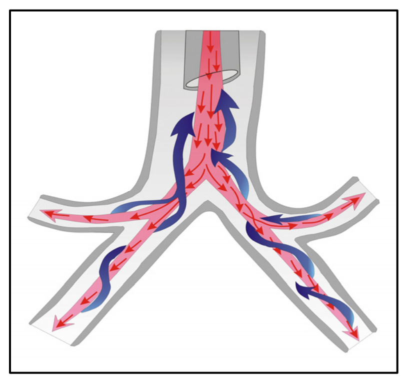
LifePulse T_I is set, unlike HFOV where the T_I is a consequence of rate and set percentage of the respiratory cycle. Therefore, as the LifePulse rate is adjusted, the only thing that changes is exhalation time (T_E). The LifePulse I:E ratio varies from 1:3.5 at 660 bpm to 1:12 at 240 bpm. Giving patients more T_E is critical for patients with hyperinflation or excessive secretions. Trapped gas and secretions have a much better chance of moving up and out of lungs with the longer T_Es achieved at lower HFJV rates.



The Life Pulse uses small tidal volumes that avoid the "Volutrauma Zone" at almost any level of PEEP.

Jet Nozzle:

A second key to understanding the LifePulse is the jet nozzle built into the LifePort ET tube adapter. Squirting gas into the ET tube at high velocity allows gas to penetrate deeper into the lungs with each breath, penetrating through dead space gas instead of pushing it ahead of fresh gas. Delivering fresh gas in this way minimizes the size of each breath and the pressure needed to deliver it to the alveoli.



With fresh gas shooting down the center of the airways, slower moving, passively exhaled gas moves out along airway walls. This countercurrent pattern facilitates airway clearance as shown in the illustration.

Passive Exhalation:

The final key to understanding LifePulse effectiveness is passive exhalation. In addition to enhancing airway clearance, passive exhalation allows the LifePulse to run at a lower MAP compared to those used during high-frequency oscillatory ventilation, which uses active exhalation.

MAP must be kept at a high enough level during HFOV to keep the negative pressure generated during active exhalation from causing airways collapse. Negative pressure never occurs with passive exhalation. Therefore, the LifePulse can usually provide adequate oxygenation at lower MAP compared to HFOV.

Patient Management Implications:

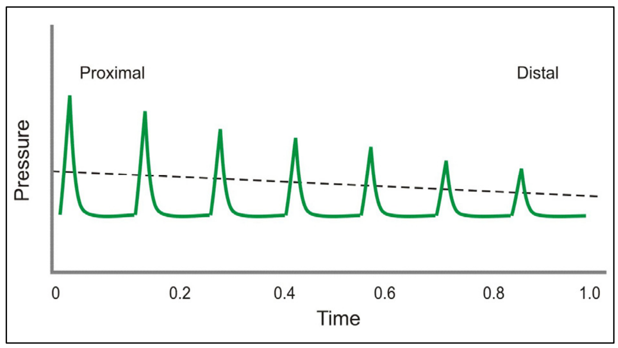
Staying focused on the primary control variables, MAP for oxygenation and pressure amplitude (PIP-PEEP) for ventilation, is essential. Once appropriate PEEP is adjusted to produce optimal MAP, LifePulse PIP controls pressure amplitude and ventilation.

The MAP required for adequate oxygenation determines PEEP. There should be no pre-conceived maximum level of PEEP based on patient size. Likewise, the pressure amplitude required for adequate ventilation determines the LifePulse PIP, and there should be no pre-conceived maximum PIP.

PEEP controls MAP with the LifePulse, and MAP determines mean lung volume. Optimal PEEP/MAP facilitates oxygenation without the use of continual CMV breaths. This strategy relegates CMV breaths to intermittent use for alveolar recruitment. However, if higher PEEP decreases cardiac output in hemodynamically challenged patients, one may use the LifePulse with lower PEEP and intermittent CMV sigh breaths to keep the lungs open and improve cardiac function.

CMV breaths should be delivered using the minimum PIP and T_I necessary to provide an effective "sigh" (watch chest wall movement). In most cases this PIP will be lower than the LifePulse PIP, which will not interrupt delivery of HFJV breaths. (The LifePulse is most effective when it runs uninterrupted.) When used, sigh breaths rates should be 2-5 bpm with T_Is appropriate for the lung pathophysiology.

If LifePulse rate is set low enough to avoid gas trapping and inadvertent PEEP, PEEP will be constant from ETT adapter to alveoli. However, HFJV PIP drops dramatically as its tiny V_Ts approach the alveoli. So, there is little chance that HFJV breaths will over-expand alveoli.



The best approach for an infant with hyperinflated lungs is to eliminate delivery of all the bigger CMV V_Ts and extend time for exhalation of the smaller HFV V_Ts by lowering LifePulse rate.

A solid understanding of why the LifePulse works will help you discover the keys to superior patient management. Remember:

- Very short T_Is result in V_Ts that are much smaller than those used during conventional ventilation, so higher PEEP levels can be used safely.
- T_I is set rather than being a percentage, so V_T does not change with changes in HFJV rate.
- Adjusting LifePulse rate lets you control T_E and I:E ratio to address hyperinflation.
- Longer T_Es and passive exhalation enhance clearance of airway secretions.

Keeping these concepts in mind as you use the LifePulse will guide you to patient management strategies that deliver the most effective and gentle ventilation possible.

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