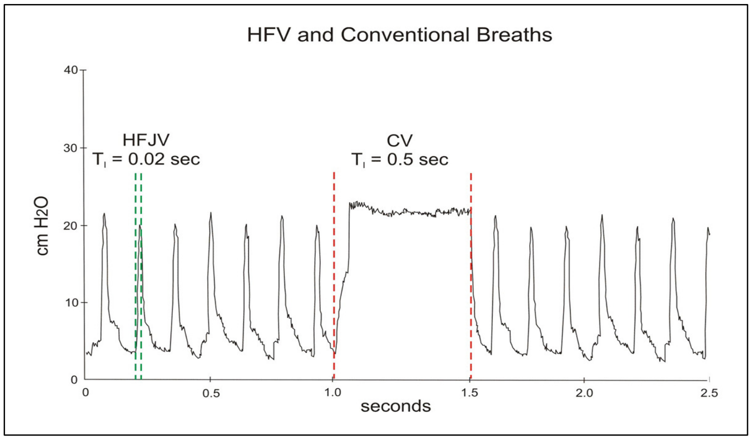
bunnell
INSPIRED INFANT CARE

WHY the LifePulse HFV Works

Having a clear understanding of how the LifePulse works is essential to maximize its benefits. The keys to understanding the LifePulse are an appreciation of inspiratory time (I-time), the jet nozzle, and passive exhalation.

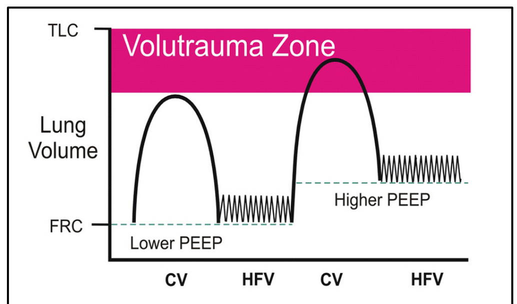
Inspiratory Time:



The 0.02 sec I-time used with the LifePulse is 25 times shorter than a 0.5 sec I-time used during conventional ventilation. As a result, tidal volumes delivered with the LifePulse are approximately 10 times smaller than those used during CMV. These very small tidal volumes allow higher levels of PEEP to be used safely, keeping the lungs open with sufficient mean airway pressure (MAP) to oxygenate.

Short I-times provide two of the most important benefits of HFV: small tidal volumes and low alveolar pressures. Small tidal volumes, when delivered with short I-times, make it impossible for the peak pressure used during HFV to be transmitted to alveoli.

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

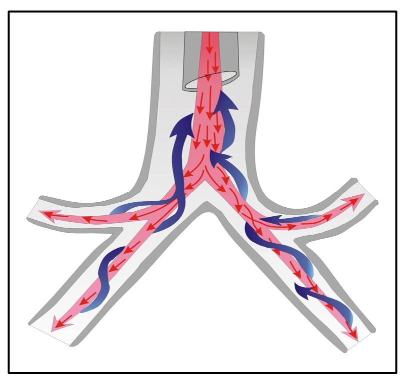


The Life Pulse uses small tidal volumes that avoid the "Volutrauma Zone" at almost any level of PEEP.

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 lung with each breath, penetrating through dead space gas instead of pushing it ahead of the 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 passive expiratory gas flow moves out along the airway walls. This countercurrent pattern facilitates airway clearance as shown in the following 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. This is never an issue with passive exhalation. Therefore, the LifePulse can usually provide adequate oxygenation at a lower MAP compared to HFOV.

Patient Management Implications:

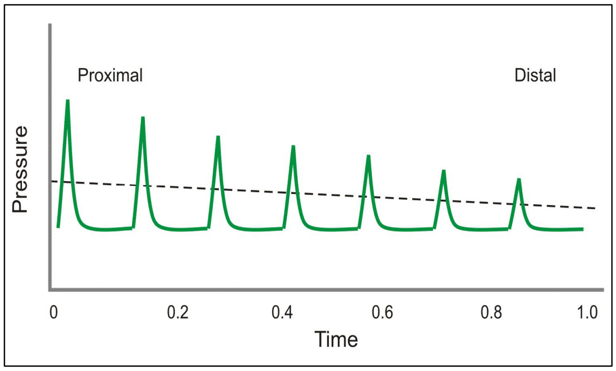
It is essential to stay focused on the primary control variables: MAP for oxygenation and pressure amplitude (PIP-PEEP) for ventilation. Once appropriate PEEP is set, the LifePulse PIP controls pressure amplitude and ventilation.

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 based on patient size.

PEEP controls mean airway pressure 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.

CMV breaths should be delivered using the minimum PIP 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 the delivery of HFV breaths. (The LifePulse is most effective when it is uninterrupted.) When used, sigh breaths rates should be 2-5 bpm with I-times appropriate for the lung pathophysiology.

If LifePulse rate is set low enough to avoid gas trapping and inadvertent PEEP, PEEP will be constant all the way out to the alveoli. However, HFV PIP drops dramatically as its tiny tidal volumes approach the alveoli. So, there is little chance that HFV breaths will over-expand alveoli.



The best approach for an infant with hyperinflated lungs is to eliminate delivery of all the bigger CMV tidal volumes and extend the time for exhalation of the smaller HFV tidal volumes by lowering LifePulse rate. If problems are encountered using higher PEEP on hemodynamically challenged patients, go back to using the LifePulse with lower PEEP and intermittent CMV sigh breaths to keep the lungs open and improve cardiac function.

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

- The very short I-time results in tidal volumes that are ~10 times smaller than those used during conventional ventilation, so higher PEEP levels can be used safely.
- I-time is set rather than being a percentage, so tidal volume does not change with changes in frequency.
- Adjusting LifePulse rate with its fixed I-time lets you control E-time and I:E ratio to address hyperinflation.
- Finally, longer E-times 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.