

HOW to Use the LifePulse HFV Seven Steps to Success

LifePulse HFV clinical strategies have evolved from the accumulated experience of treating tens of thousands of infants as well as randomized controlled studies. The following seven steps are a culmination of what Bunnell has learned over the past two decades of clinical use.

1. Start HFV ASAP

Many clinicians wait until an infant sustains significant lung injury before implementing HFV. Unfortunately, a failing respiratory system leads to failure of other organ systems, and once the patient reaches that point, chances for recovery are slim. The only significant difference between survivors and non-survivors in one LifePulse study was the time they spent on CMV prior to starting HFV (4 days vs. 10 days respectively). The sooner HFV is started, the better the patient's chance of recovery.

2. Select Start-Up LifePulse Settings Based upon Patient Size and Pathophysiology

Monitor and record current CMV or HFOV settings using the LifePort ET tube adapter with the LifePulse in Standby mode.

Rate: Select a rate to provide efficient ventilation without gas trapping. Using 420 bpm usually works fine for patients 2000 grams or less. Higher rates may be used in the smallest babies with uninjured lungs. Lower rates are indicated for larger infants and infants with pulmonary hyperinflation, severe PIE, and other lung conditions where exhalation is compromised by airway inflammation or obstruction. Lower rates create a longer exhalation time (T_E).

The lowest LifePulse rate (240 bpm), where $T_E > 0.2$ sec, is the best choice for pulmonary hyperinflation and severe PIE. Longer exhalation times facilitate diffusion of gas out of interstitial space, and allow hyperinflation to resolve. Minimizing the number and size of CMV breaths is paramount in such patients.

PIP: Start the LifePulse with PIP set 1-2 cm H₂O < the CMV or HFOV PIP monitored by the LifePulse. Press ENTER, verify the chest is vibrating, and adjust PIP as necessary to get appropriate PaCO₂.

On-Time: The default On-Time (T_I) setting of 0.020 sec. usually works best for preterms and infants with injured lungs, so leave it set there most of the time. Longer T_I s may be helpful when lung injury is more severe and diffuse, but combining longer T_I s with higher rates may cause gas trapping.

3. Maintain Pre-LifePulse MAP for Better Oxygenation at Start-Up

Focus on MAP instead of PEEP for oxygenation. PEEP provides the majority of MAP during HFJV, which is safe because the LifePulse uses very small tidal volumes (V_T) and short T_I s (0.020 to 0.034 sec.).

Once you have started the LifePulse, reduce CMV support to 5 bpm and increase PEEP as needed to match the monitored pre-LifePulse MAP. [If you are switching from HFOV to HFJV, you can sometimes use less MAP (-1 to -2 cm H₂O).] We will optimize PEEP and MAP in step 5.

4. Fine-tune PIP to Manage PaCO₂

Use transcutaneous CO₂ monitoring and get a blood gas sample within 20 minutes of starting the LifePulse to see if PIP is adequate. Adequate PIP may be surprisingly high at times, so remember: it is volume – not pressure – that creates lung injury, and the LifePulse uses extremely small V_{TS} (~ 1 mL/kg). HFV pressure amplitude decreases quickly as the tiny breaths approach the alveoli. So, raising PIP is the gentlest way to lower PaCO₂. A LifePulse V_T delivered with a PIP of 50 cm H₂O is still much smaller than a CMV V_T delivered with a PIP of 20 cm H₂O, due to the difference in T_I s.

If you are on HFJV PIP > 35 cm H₂O and PaCO₂ is still unacceptably high, consider increasing the LifePulse On-Time in 0.004 - 0.006 sec. increments (0.026, 0.030, 0.034 sec.) to increase delivered V_T . Patients with long inspiratory time constants (e.g., MAS and CLD patients) may respond better to this strategy than to further increases in PIP. To maintain an adequate T_E , consider decreasing the LifePulse rate (360, 300, 240) as you increase T_I .

5. Use CMV “Sigh” Breaths to Find Optimal PEEP

Sigh breaths are *contraindicated* in the presence of severe lung injury, and we can use the removal of the last 5 CMV bpm from step 3 to find optimal PEEP.

Adjust $F_{I}O_2$ to achieve the desired SaO_2 with the patient stabilized on the LifePulse with CMV at 5 bpm. Then switch CMV to CPAP mode and watch the pulse oximeter for several minutes. If SaO_2 drops, increase PEEP 1-2 cm H_2O , re-institute the 5 bpm, and repeat the sequence. Once SaO_2 is stable with CMV in CPAP mode, leave it in CPAP mode, or as close to CPAP as you can get, most of the time.

Switch CMV back to 5 bpm as needed to re-recruit collapsed alveoli after suctioning, repositioning, etc., and whenever you want to test for adequate PEEP as just described. Moving CMV back to CPAP mode once oxygenation improves (after 15 minutes or so) will minimize the size and number of larger V_T s delivered to the patient and help avoid “volutrauma.”

If cardiac output suffers with higher PEEP, keep it lower to improve venous return of blood to the heart and use a few CMV breaths per minute to maintain proper lung inflation. Remember: it is O_2 delivery to the tissues that determines optimal PEEP.

Some of the newest generation ventilators have apnea detection systems that make it difficult to keep the CMV in CPAP mode during HFJV. With these ventilators, use the lowest CMV rate, PIP, and T_I settings possible. Turn up each CMV setting as necessary when you want to provide effective sigh breaths for alveolar recruitment.

6. Be patient and use Servo Pressure, pulse oximetry, and transcutaneous CO_2 monitoring to stay on track

Recognize that weaning will only be possible when the patient’s medical condition is improving. There is a time for initial stabilization of the patient, and a time for weaning. In between those times, focus on maintaining good blood gases and let HFV “lung protective ventilation” facilitate healing and lung growth.

Servo Pressure responds to changes in the patient’s lung mechanics. Rising Servo Pressure is generally a good sign. Falling Servo Pressure may indicate deterioration and should be addressed quickly. Any time you get a Servo Pressure alarm you should investigate. Is the ET tube poorly positioned or plugged? Is the patient’s compliance getting worse? Or, is it just time to suction the airway?

If monitored PEEP on the LifePulse is higher than set PEEP on the CMV, you may have inadvertent PEEP, which will force Servo Pressure down and allow $PaCO_2$ to rise. Turn the LifePulse rate down in increments of 60 bpm until the inadvertent PEEP goes away. Then manage $PaCO_2$ by adjusting HFJV PIP as needed.

If hyperinflation is not present, you can increase LifePulse rate to lower $PaCO_2$ as you would with CMV. V_T is independent of rate with the LifePulse, so increasing rate increases minute ventilation and lowers $PaCO_2$.

Fight PEEPaphobia! PEEP is the primary determinant of MAP and oxygenation (PaO_2). It also helps splint airways open in older babies with hyperinflation, which should decrease expiratory resistance for more complete exhalation. Lowering PEEP to treat hyperinflation is often counterproductive.

When in doubt or whenever you need assistance with patient management strategies or troubleshooting, call the Bunnell Hotline (800-800-4358) for help. We are there to help you 24 hours a day, 7 days a week.

7. Wean Directly to Nasal CPAP

Once the patient has cleared his maintenance phase, weaning can begin. Our natural instinct is to wean patients from HFJV back to CMV at the first signs of improvement. At best, this approach may prolong your patient’s time on mechanical ventilation. At worst, whatever condition caused you to go the HFJV in the first place may reappear. Focus on maintaining lung protective ventilation all the way to CPAP.

Wean PIP in response to improved $PaCO_2$. When PIP is below 20 cm H_2O , you can lower LifePulse rate to minimize interference with spontaneous breathing. At 240 bpm, I:E = 1:12; therefore, the patient is spending most of his time on CPAP already.

Once HFJV chest vibrations are minimal (delta pressure 8-10 cm H_2O), $F_{I}O_2 < 0.30$, and the baby is breathing regularly, you should consider transitioning to CPAP. Don’t worry too much about weaning PEEP. A short trial of ET CPAP on the CMV will give you an indication of how the patient will tolerate NCPAP.

When you pull the ET tube, set your NCPAP close to the final LifePulse MAP. Your baby will breathe a lot easier without an ET tube.

Try these 7 steps to success on your next patient and let us know how they work for you. We are constantly seeking to improve our patient management strategies!