Technology & Clinical REPORT

Advances in pulmonary management of the critically ill infant

bunnell
INSPIRED INFANT CARE

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Optimizing PEEP for PIE

High-Frequency Jet Ventilation (HFJV) first gained recognition in the neonatal population for the treatment of airleaks including Pulmonary Interstitial Emphysema (PIE). We used to recommend minimizing all airway pressures when treating infants with PIE. While this practice is advisable for resolving airleaks, we learned that in some cases it was not tolerated by patients.

In the past few years, we have discovered the value of optimizing PEEP during the treatment of PIE, much as we did previously for the treatment of atelectasis. When PEEP is optimized, good oxygenation is possible. When PEEP is too low, maintaining adequate oxygenation can be difficult.

As is true with most of our HFJV knowledge, we learned the value of optimizing PEEP with PIE from clinicians. One of these opportunities arose a few years ago at St. Joseph's Hospital in Phoenix, Arizona.

Bert Bunnell was in Phoenix to provide a training update lecture at St. Joseph's Hospital. When he arrived, the NICU was a flurry of activity and the staff was extremely busy caring for a group of very sick patients. There were numerous infants on ventilators including several on HFOV and HFJV, and two babies were about to be placed on ECMO.

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Dr. Monty Hart apologized for the unfortunate timing and asked Bert if he wanted to spend some time in the unit as long as he was there. It seemed like a great opportunity to gain some first-hand experience so he decided to stay and see what he could learn. As it turned out one of the cases provided a most valuable lesson.

A 700-gram newborn had started out on HFOV and was getting harder and harder to oxygenate. At about 8 hours of age, he developed severe, bilateral PIE. Following their established protocol, the clinicians decided to switch the infant to HFJV due to its proven success in treating this disorder.[1]

As the RTs were preparing to make the switch from HFOV to HFJV, there was a discussion about what settings were appropriate for HFJV. Bert suggested that they use the LifePort adapter as a means of monitoring the pressure being delivered by the oscillator. With the Jet in Standby,

they could monitor the pressures via the LifePort and determine the PIP, PEEP, and mean airway pressure.

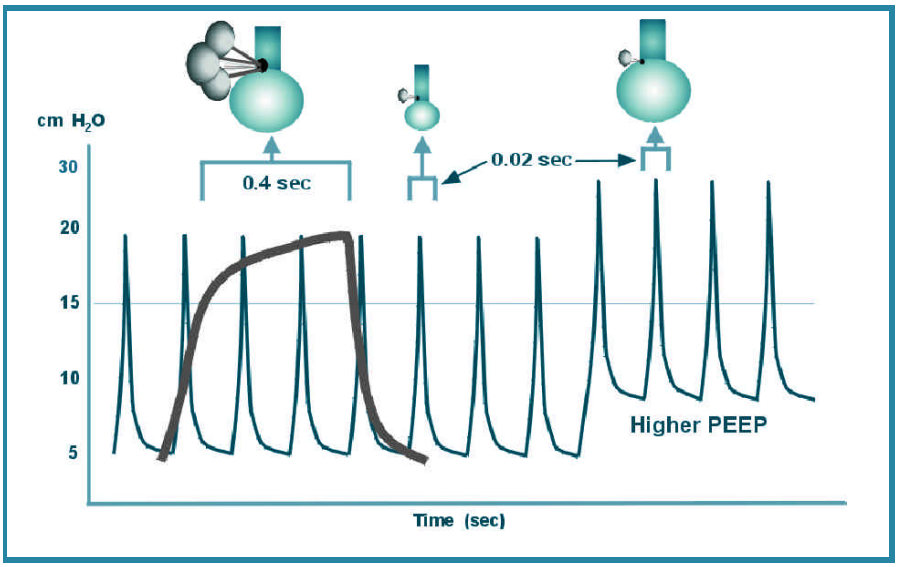
The Jet measured a PIP/PEEP of 36/16 during HFOV. Dr. Hart decided to start HFJV at 32/10. He reasoned that these settings would produce a reduction in mean airway pressure that, hopefully, would lead to improvement in the infant's PIE. Mean airway pressure did go down with the switch from HFOV to HFJV. However, the first arterial blood gas taken after the switch revealed a much improved oxygen level and moderate hyperventilation. The Jet PIP was quickly reduced to allow the $PaCO_2$ to come up to normal. PEEP, however, was kept constant at 10 cm H_2O.

Bert had serious reservations about treating an infant with PIE using a PEEP of 10 cm H_2O. However, the infant's oxygenation problems were obviously improving on these settings, so he bit his tongue and waited to see if the PIE improved.

Over the next four hours, oxygenation continued to improve. F_IO_2 was reduced from 1.0 to 0.6. An xray also revealed dramatic improvement of the PIE. When Bert left the NICU after midnight, the infant was stable and doing remarkably well.

This infant continued to do well and went on to recover and leave the hospital. This case encouraged us to explore the possibility that higher PEEP could be used successfully to treat hypoxemia in difficult PIE cases.

Our experience with numerous "hotline" phone calls over the past few years has convinced us that Jet users are going to turn up something when their patients are not being properly oxygenated. More often than than not, their choice is to turn up the background IMV. While turning up the IMV rate or PIP is successful in improving oxygenation in the presence of atelectasis, it certainly is contraindicated in most PIE cases, since the larger tidal volume IMV breaths aggravate the injured areas of the lungs and prevent healing.



Another situation we encounter is PIE patients with lung hyperinflation. The typical response to hyperinflation is to decrease PEEP, but in may cases oxygenation suffers. These patients are usually on moderate PEEP settings of 4-6 cm H_2O and IMV rates of 5 bpm or more. Sometimes the hyperinflation is not caused by alveolar air, it is caused by accumulated interstitial air from the large tidal volume IMV breaths. Many of these patients respond to decreasing IMV PIP, decreasing IMV rate (0-2) and compensating for the drop in mean airway pressure by increasing PEEP 2-3 cm H_2O.

PEEP is the lowest pressure we apply to the lungs. Increasing any other pressure setting will therefore have a more damaging effect on the injured areas of the lungs. PEEP will maintain lung volume, stabilize alveoli and only modestly increase lung expansion. So, when oxygenation is inadequate, even in airleak cases, and you have to turn up something, why not turn up PEEP? Optimizing PEEP with HFJV appears to be an effective method of improving oxygenation and minimizing lung injury in all types of lung disease.

**** Visit the Clinical section of our website to view a flow chart on how to find Optimal PEEP.***

[1]. Keszler M, Donn SM, Bucciarelli RL, et al. Multicenter controlled trial comparing high-frequency jet ventilation and conventional mechanical ventilation in newborn infants with pulmonary interstital emphysema. J Peds. 1991; 119: 85-93.

Standby... *It's Important!*

Placing the Life Pulse in the Standby mode, after an operational test, is a critical step prior to connecting it to the patient. If the Life Pulse is not in Standby when attachments to the patient are made, the pressure it is generating will be delivered to the patient. This may result in inappropriately high pressure and large tidal volume delivery to the patient, which could cause severe injury.

The proper sequence for set-up are patient start-up are as follows:

1. Set up the ventilator and perform an internal and operational test using a test lung.

2. Following successful tests, place the Life Pulse in the **Standby** mode.

3. Remove the test lung and make attachments to the patient.

4. In the **Standby** mode, monitor the conventional or high frequency ventilator pressures via the Life Pulse.

5. Use the monitored pressures to determine the Life Pulse settings.

6. Set the controls on the Life Pulse and initiate the settings by pushing the Enter button.

7. Make adjustments to the conventional ventilator and monitor physiologic parameters while waiting for the first blood gas.

8. Titrate ventilator settings based on blood gases to achieve appropriate gas exchange.

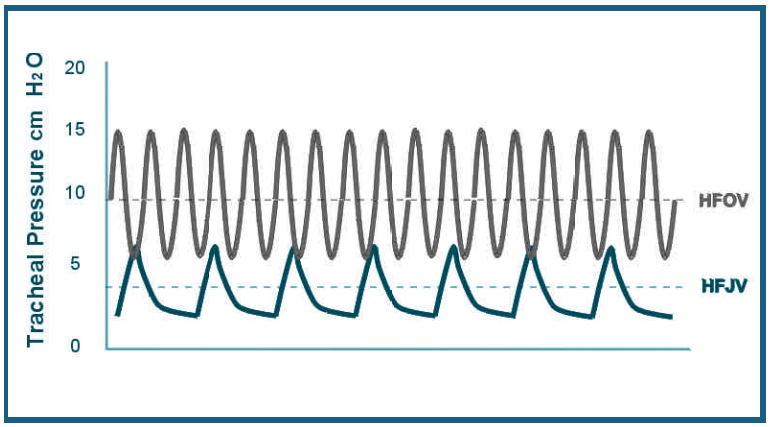
Never connect the Life Pulse to a patient in the Enter mode with the ventilator running! Doing so may result in severe injury to the patient.

Note: Three new Warnings have been posted on our website. One is related to this article. The other two are concerned with circuit overfill from gravity feed. To view these Warnings visit our website at ***www.bunl.com.***

Switching from HFOV to HFJV

High Frequency Oscillatory Ventilation (HFOV) is not an effective therapy for every patient. This does not mean that high frequency ventilation has failed! Many patients who do not respond to HFOV do respond to High Frequency Jet Ventilation (HFJV). Gas is delivered via a different mechanism and has a different velocity profile. You can see the differences by comparing the two pressure waveforms.
(See diagram)

When a clinician is confronted with making the switch from HFOV to HFJV the question arises, "How do I convert amplitude into PIP and PEEP?" The answer is



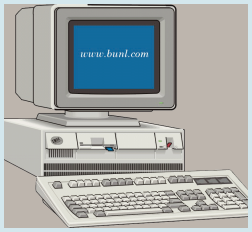
the LifePort™ adapter. Replacing the standard endotracheal tube adapter with the LifePort adapter allows HFOV settings to be monitored via the Life Pulse. The Life Pulse displays amplitude as PIP and PEEP. In addition, mean airway pressure (MAP) is also converted from the proximal measurement of HFOV to the more distal measurement reported by the Life Pulse. The values obtained by monitoring HFOV may not be the exact settings the patient needs on HFJV but they provide a reasonable starting point for making the transition. Observing the patient, watching the physiologic monitors (transcutaneous CO_2 and obtaining blood gases will allow the HFJV settings to be fine tuned.

To obtain more information on this process or additional information on the Life Pulse visit the Clinical section of our website at ***www.bunl.com.***

Bunnell's On-Line @ *www.bunl.com*

The beauty of the Internet is that you can access it any time day or night. Information is available on your timetable. Our goal in designing the Bunnell website was to give you as much information as possible in an easy to use format.

Our site is organized into six sections: About Us, Clinical, Parents, Products, Technical and Year 2000. Each sectioin can be previewed separately for content or the entire site can be previewed through the index. Feedback and request forms are included for your convenience. New information and announcements are highlighted on our Home Page.



Visit our website @

www.bunl.com

One of the unique aspects of our site is the Parents Page. We felt it was important to provide information about high frequency ventilation in a language that parents could relate to. In addition to information on the Life Pulse, we also provided links to neonatal, parent support group websites.

Feedback from clinicians and parents has been very favorable.

We could go on describing each section in detail but the best way to discover what's on the site is to experience it firsthand. Log on at ***www.bunl.com*** and take a tour. Let us know what you think. What works for you? What doesn't? What can we change or add to make it a better site? The better it works for you, the better it works for us. Surf on!