Technology & Clinical REPORT

Advances in pulmonary management of the critically ill infant

bunnell INSPIRED INFANT CARE

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436 Lawndale Drive
Salt Lake City, UT 8 4115
1-800-800-4358
www.bunl.com

Back to the Basics

After more than 15 years of clinical use and dozens of clinical studies we sometimes lose focus of why we got involved in high frequency ventilation in the first place. Then it hits us like a bucket of cold water. An excited clinician calls to tell us about a patient who miraculously recovered on the Jet from a life-threatening refractory airleak (multiple pneumos, bilateral PIE, tracheal tear or bronchoplueral fistula, take your pick).

Right Ventilator

What they needed was a low volume, low pressure ventilator that would effectively oxygenate and ventilate the patient while allowing the lungs to recover. After failing on conventional ventilation and often high frequency oscillation they came back to the ventilator proven to most successfully treat airleaks, the Life Pulse High Frequency Jet Ventilator.[1]

In the late 1970's and 1980's pulmonary interstitial emphysema (PIE) and other airleaks were a death sentence with mortality rates of 80-100%. Many different ventilator strategies were tried with little improvement.

At this same time Bert Bunnell was working on a ventilator to overcome this devastating complication of mechanical ventilation.

Bert's work was stimulated by pulmonary function testing research using forced oscillations to determine airway resistance. It appeared that poor compliance could be circumvented by delivering small volumes of gas at high rates, rates that approached the natural frequency of the lung (300-800 br/min). Armed with this information Bert decided to build a high frequency ventilator.

Because high frequency ventilation was a departure from traditional mechanical ventilation, the FDA restricted initial clinical testing to infants with bilateral airleaks who were in the opinion of their physician were failing conventional ventilation (expected mortality 100%). Bert was able to demonstrate that use of the high frequency jet ventilator decreased mortality in this population to 53%, a significant improvement over conventional ventilation. Why did HFJV work so well?

One explanation for the Jet's success lay in the basic physics that led to its development. Small high velocity breaths do not overcome the high airway resistance created by tension pneumothoraces or PIE so gas is diverted away from these areas of the lung allowing them to rest and recover. However, these small tidal volumes effectively ventilate areas of the lung with poor to normal compliance without causing additional damage. *Continued on page 2*

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Right Strategy

With the exception of one significant addition, the basic strategy for treating airleaks on the Jet has not changed in the last 10 years.

- Starting Jet PIP is set at or 10% less than the conventional PIP as monitored by the Jet.
- Conventional ventilator PIP is set below the Jet PIP so it does not interrupt the Jet pulses.*
- Conventional ventilator Rate is set between 0-3 br/min with an Inspiratory Time of 0.30-0.35 seconds.*

* **Note:** The presents of atelectasis and how aggressively you want it to resolve determines the size and number of conventional breaths used. Use of conventional breaths to combat atelectasis may prolong airleak resolution.

Here is the one significant change!

PEEP is optimized to achieve better oxygenation. PEEP not PIP or conventional rate is used to maintain lung volume and prevent atelectasis.

So remember, when you have a patient with airleak go back to the basics; the basics of high frequency ventilation; the Bunnell Life Pulse Jet Ventilator. The only technology designed for and proven to treating airleaks.

1. Keszler M, Donn SM, Bucciarelli RL, et al. Multicenter Controlled Trial Comparing High-Frequency Jet Ventilation and Conventional Ventilation in New born Infants with Pulmonary Interstitial Emphysema. Journal of Pediatrics. 1991; 119/1:85-93

2. Bunnell JB. HFV of Infants. In Current Perinatology, Vol ll. Rathi M, ed. New York: Springer-Verlag: 1990: 172-200

A Case Report

Ventilation of a 7 year old Victim of Crush Injury to the Upper Chest with Tracheobronchial Tears Using High Frequency Jet Ventilation.

Joseph A. La Spada, Julie A. Long, Jorge Del Toro, and Jackson Wong, Division of Pediatrics and Division of Pediatric Surgery, Broward General Medical Center, Ft. Lauderdale, FL 33316.

A previsouly healthy 7 year old girl experienced a sever crush injury to the upper chest area resulting in sever bilateral lung contusions and pneumothoraces along with extensive tearing of the membranous portion of the trachea involving both the left and right mainstem bronchus. The patient required complicated and prolonged surgical repair of the airway. Ventilation of this patient proved extemely difficult post operatively due to the patient's extremely poor lung compliance and the need to keep her airway pressures at a minimum. Initial attempts to ventilate this patient included high frequency oscillation, conventional ventilation, and high frequency positive pressure ventilation. These attempts were unsuccessful with inability to decrease the patients $PaCO_2$ to less than 170 mm Hg or increase the patient's arterial pH to greater than 6.80.

Although the patient weighed nearly 25 kg, the patient was successfully ventilated using high-frequency jet ventilation (HFJV) via the Bunnell Life Pulse ventilator and a LifePort endotracheal tube adapter for use with the patient's standard 5.5 mm endotracheal tube. After one hour and 15 minutes of HFJV, arterial pH increased to 7.21 with a significant decrease of $PaCO_2$ to 72 mm Hg. The patient's overall respiratory status continued to improve following this allowing extubation 11 days after admission and discharge home 14 days after admission. Follow up bronchoscopy performed one week after surgery showed healing of the tracheobronchial tear without granuloma formation or presence of tracheitis.

HFJV has been used for years with success in infants and adults for various conditions where conventional ventilation has failed including bronchoplerual fistuals, sever ARDS and traumatic large airway disruption. Despite this fact, HFJV has traditionally not been considered for use in midrange pediatric patient due to limitations of the available high-frequency jet ventilators and associated accessories with respect to the patient's size and weight. In this case the high frequency jet ventilator used, although particularly indicated for use with infants, proved flexible enough for use in an older child with use of an adapter. Further studies should be considered to expand the age range for use of HFJV in children.

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HFJV Specialist:_____ Purchasing:_____

Others:_____