Inhaled Nitric Oxide (iNO) Delivery with High-Frequency Jet Ventilation (HFJV)

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Background: Previous investigators have demonstrated mixed success with delivering iNO therapy during HFJV. Since HFJV is used in tandem with conventional ventilation (CV), NO may be delivered via the CV patient breathing circuit, the HFJV circuit, or both. However, CV during HFJV is more important for providing CPAP rather than IMV breaths, which are delivered at low rates (1-5 breaths/min) for recruitment of collapsed alveoli. Thus, NO cannot be delivered reliably via CV during HFJV. Using knowledge gained from previous studies, this study sought to elucidate a practical and effective method of reliably delivering iNO during HFJV.

Methods: A simple method of introducing NO into the HFJV circuit was devised. The injector module of the INOvent delivery system (Datex-Ohmeda, Inc., Madison WI) was introduced into the Bunnell Life Pulse HFJV (Bunnell Inc., Salt Lake City UT) patient breathing circuit just upstream from the humidifier, and NO was sampled just proximal to the ET tube. A second sample was taken at the distal tip of an Uncuffed ET tube with Monitoring Lumen (Mallinckrodt Medical Inc., St. Louis) to evaluate the effect of gas entrainment from the CV circuit. NO concentrations were analyzed using the electrochemical sensor of the INOvent system. CV was provided by a Sechrist Model IV 100B (Sechrist Industries, Anaheim CA).

Data were collected using an infant model lung (Bunnell Inc.) with a 3.5-mm I.D. LifePort ET tube adapter (Bunnell Inc.) attached to a 3.0-mm I.D. ET tube. This model had a static compliance of 1.4 mL/cm H2O and an airway resistance of 0.02 cm H2O/mL/sec. Since HFJV gas delivery and entrainment are most sensitive to changes in airway resistance, a banded 3.0-mm ET tube was substituted for the normal ET tube to produce another infant lung model with higher resistance (0.10 cm H2O/mL/sec).

Experiments were conducted with both lung models. Pressure settings for HFJV/CV, were 15/3, 30/5 and 40/8. HFJV rate and inspiratory time were set at 420 breaths/min and 0.02 sec, respectively, and CV was set either in CPAP mode or with IMV set at 5 breaths/min with an inspiratory time of 0.5 sec. CV flow rate was set at 10 L/min. INOvent settings were 10, 20, 40, 60 and 80 ppm.

Results: Inspiratory iNO concentrations measured just proximal to the ET tube were different from the concentration set on the INOvent at some HFJV/CV settings. Fluctuations in iNO concentration caused by delivery of NO-free IMV breaths during HFJV were generally less than 10% of set concentrations. There was no consistent effect on iNO concentration when airway resistance was increased by 500%. Differences in iNO concentration between proximal and distal samples were 10% or less. In the therapeutic range of up to 20 ppm, differences were 1 ppm or less.

Conclusions: These data infer that iNO can be delivered reliably via HFJV. Set iNO concentrations may be adjusted clinically to produce desired concentrations at the proximal end of the ET tube. In the therapeutic range of up to 20 ppm, iNO concentrations at the distal end of the ET tube were consistently within 1 ppm of the proximal concentrations in this study. Clinical studies should be conducted to verify these findings. Datex-Ohmeda has not approved INOvent delivery system for use with the Life Pulse Ventilator, and it is not included in their FDA approved product labeling.