Return of neonatal CPAP resistance: The Medijet device family examined using in-vitro flow simulations

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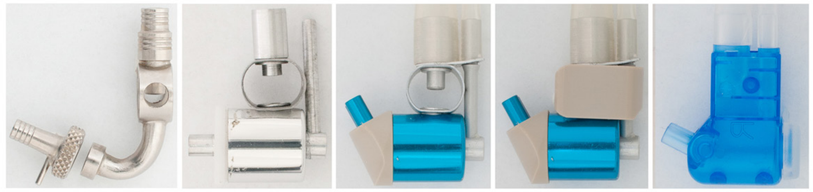
The disposable Medijet CPAP generator is a resistor system with high resistance, pressure instability and high imposed work of breathing (iWOB).

The generator should not be used in patients where pressure stable CPAP is believed to be clinically important.

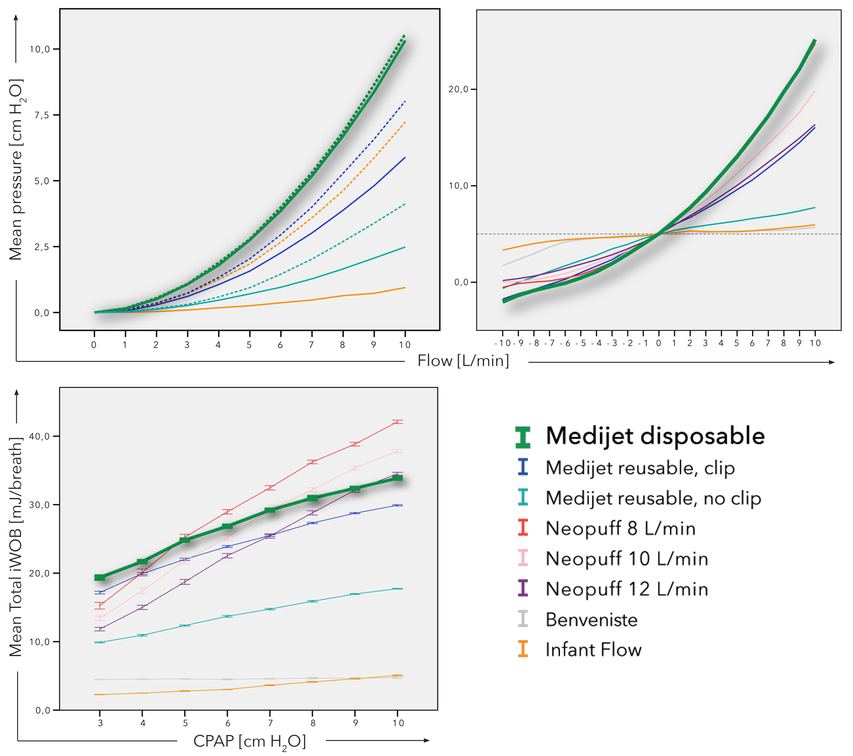
The high resistance of the generator will be of great value when examining the clinical importance of pressure stability.

Constant-flow generators, also called resistor devices, create pressure by adding resistance to the system outflow. During patient inspiration, the patient flow reduces the driver flow resulting in a pressure drop and the opposite occurs at expiration. The resulting system is pressure unstable with high imposed work of breathing.

Variable-flow generators jet the driver flow at the patient, creating pressure by air entrainment (Bernouille principle). The expirational flow diverts the jet away from the patient (Coanda effect) maintaining only the desired pressure. The resulting system is pressure stable with low imposed work of breathing.



The evolution of the Medijet nasal continuous positive airway pressure (CPAP) generators. From left to right: The Benveniste valve with detachable pressure port, the Huddinge adaptation, the Medijet reusable generator, the Medijet reusable generator with noise reducing clip and the disposable Medijet generator.



Upper left: Comparison of simulated airway flows and driver flows needed to generate a given CPAP level for selected systems. When one flow was tested, the other flow was zero. The solid lines represent driver flows and the dashed lines represent simulated airway flows. The disposable Medijet displays virtually identical curves indicating that the main generator of pressure is resistance. Graph plotted from mean values at intervals of 1 L/min.

Upper right: Effects of simulated airway flow on delivered pressure at 5 cm H2O CPAP. The slope represents pressure stability. Infant Flow and Medijet were tested with prongs. Graph represents means for intervals of 1 L/min with error bars (95% CI).

Bottom: Total Imposed Work of Breathing (iWOB) at increasing levels of CPAP. Simulations with a sinusoidal flow pattern (60 RR, I:E 1:1 and flow max of 6 L/min). Infant Flow and Medijet tested with prongs. Graph represents means for intervals of 1 cm H2O with error bars (95% CI).

Aims

The Medijet nasal continuous positive airway pressure (CPAP) generators are a family of devices developed from the Benveniste valve. Previous studies have shown that the in-vitro performance of the Medijet disposable generator was similar to the resistor system Neopuff. Although previously described as a variable-flow generator, we hypothesized that resistance is the main mechanism of CPAP generation in the disposable Medijet.

Methods

We compared three Medijet systems (reusable, reusable with clip and disposable) to the Benveniste valve, Infant Flow (variable flow) and Neopuff (constant flow) systems in static and dynamic in-vitro tests.

Results

Large differences in performance were found. The disposable Medijet has low pressure stability, high resistance and high imposed work of breathing (iWOB). By encapsulating the Benveniste valve it changes into a resistor system.

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Up next

Our upcoming project concerns leakage at the patient interface, a big obstacle on the path to achieving real-time and reliable respiratory monitoring.

We're currently enrolling patients in a randomized cross-over study comparing leakage using nasal mask and nasal prongs. Ask us and we'll tell you more!