



Seven Ventilators Challenged With Leaks During Neonatal Nasal CPAP: An Experimental Pilot Study

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Objectives

Nasal CPAP is the most common respiratory support for neonates. Several variables influence its effectiveness, including leaks at the patient interface and the delivery of pressure-stable CPAP. Investigations of pressure stability during leaks should include both the change in the mean delivered CPAP and the pressure variation during each breath. The aim of this study was to examine the response of seven ventilators delivering nasal CPAP when challenged with leaks at the patient interface.

Study methods

Seven different CPAP systems with recommended tubing and humidifiers were tested using a ASL 5000 artificial lung and interposed simulated leak ranging from 1-4 L/min. The CPAP level was adjusted to 4 cm H₂O on each ventilator. Simulations of leaks were started at breath number 30 and stopped at breath number 45. Change in CPAP and change in the amplitude of pressure swings (calculated as the difference between lowest and highest pressure for each breath) were recorded. fabian™ ventilator was used with the Infant Flow™ generator.

Results

As the level of leak increased, the delivered CPAP decreases for most ventilators. Avea™ (CareFusion, San Diego, California) showed no reduction at 3 L/min. fabian (Acutronic, Hirzel, Switzerland) (statistically nonsignificant 2–3 L/min) and Servo-i (statistically nonsignificant 2–3 L/min) showed no decrease between the two levels of leak. The fabian, Avea, and Servo-i (Maquet, Solna, Sweden) produced the least reduction in delivered CPAP. The smallest amplitudes of pressure swings were recorded for the fabian, Evita XL (Dräger), and Servo-i ventilators (both with and without leak).

Ventilator	Decrease in CPAP (cmH ₂ O)	Pressure swing (cmH ₂ O)	Compensation speed
fabian	<0.5	1.4	<5 breaths
Avea	1.5	4.5	<5 breaths
Babylog VN500	1	4	<15 breaths
Engström Carestation	2	5	None*
Evita XL	1	2	None
Leoni Plus	1	8.5	None
Servo-i	0.5	2.5	None

Results of experiments. *None – ventilator did not compensate

What is leak compensation?

While nasal CPAP and noninvasive ventilation are becoming more important in support of patients with respiratory failure, a common problem is pressure leak at the patient interface. Contemporary ventilators compensate for leaks with varying effectiveness. Microprocessor algorithms to compensate for leak may be more or less effective and may be complicated by over- or under-compensating for intermittent leaks. A ventilator that maintains consistent CPAP pressures with rapid compensation for leaks may show improved clinical outcomes in patients. The fabian ventilator is equipped with highly precise electronic flow meters and innovative automatic leakage compensation.



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Take home messages

- The fabian ventilator outperforms all other devices in the test, both in leak compensation and in pressure stability.
- Avea and fabian showed no decrease in CPAP between the two levels of leak.
- The fabian and Avea ventilators showed compensation in less than 5 breaths, whereas the Babylog VN500 and Engstrom Carestation ventilators did not return to the pre-leak delivered CPAP after 15 breaths
- The smallest amplitudes of pressure swings were recorded for the fabian, Evita XL, and Servo-i ventilators (both with and without leak).
- The clinical importance of these findings should be clarified in a clinical study.

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