

The Use of Tube Compensation in Weaning Patients from Ventilators

Case Study
840™ Ventilation

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Profile

Our original weaning method involved placing the patient on Spontaneous breathing mode (SPONT) on the Puritan Bennett® 840™ Ventilator, with a PEEP of 5 cm H₂O and a Pressure Support (PS) of 10 cm H₂O. This level of PS was the standard minimum level of pressure from which the attending physician would extubate. Using this method, data for ventilator length of stay (VLOS), reintubation rate, self-extubation rate, and protocol use showed a

reintubation rate of approximately 12% to 14%. This high reintubation rate contributed to increased VLOS, increased Ventilator-Associated Pneumonia (VAP), and increased respiratory therapist workload.

A study of tube compensation (TC), approved by practicing physicians in the hospital, was developed and initiated to explore improvements in patient outcomes.

Clinical Course

Researchers documented that, during the weaning/extubation phase, significant changes in arterial blood gas (ABG) values were occurring. The use of PEEP and PS resulted in pre-extubation ABG values that did not give the physicians and respiratory therapists a clear understanding of what the patient's post-extubation ABG values would be.

Study design included a protocol to adjust the ventilator, using TC, to mimic extubation physiology conditions, and to then compare pre- and post-extubation ABG values. We randomly assigned 25 patients in our critical care units to three SPONT modes of ventilation for weaning: PS 10cm H₂O and PEEP of 5 cm H₂O, TC of 100% and PEEP of 5 cm H₂O, and TC (95% for patients with tracheostomies and 90% for endotracheal tube [ETT] patients) and no PEEP. Each ventilatory trial was done for a minimum of 30 minutes.

The ABG values were obtained on the selected modes at the end of the trials, and compared to the post-extubation ABG values. An average variance (Δ) was calculated in all parameters. A standard deviation (SD) was calculated to observe the spread of data within the group and to calculate and eliminate any outliers (>3SD from mean). Figure 1 demonstrates the average ABG parameter variance between the PS mode, the TC (90%- 100%) mode, and the post-extubation ABG values.

Figure 1

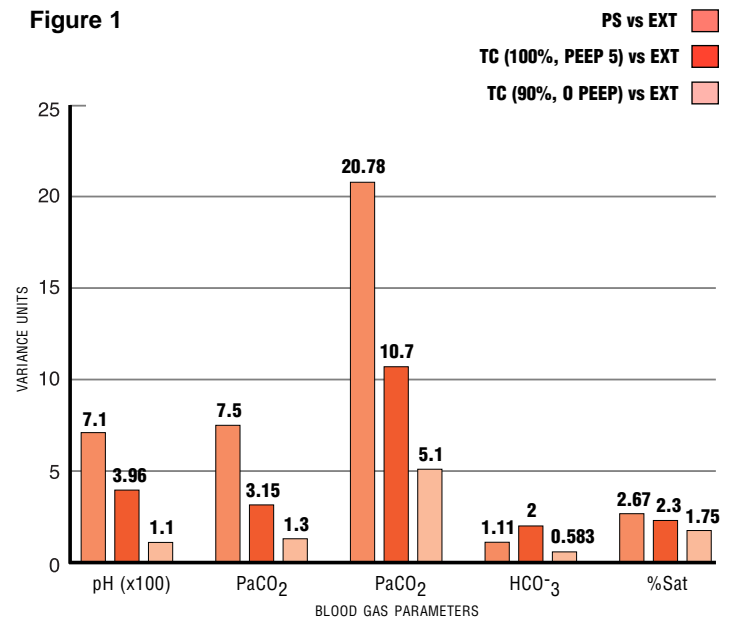


Figure 1 clearly shows that the use of Pressure Support (10 cm H₂O) and PEEP (5 cm H₂O) produced greater variances in the ABG values. The use of TC (100%) and PEEP (5 cm H₂O) produced smaller variances than the PS variances. Investigators then reduced the percent of TC support to 95% for trach patients, and 90% for patients with ETTs (PEEP 0), to allow the patient to exert a possible increase in work of breathing (WOB) arising from subglottic edema or increased airway resistance post extubation. This was observed to be most representative of actual patient conditions post-extubation. This change resulted in nearly identical pre- and post-extubation ABG values.

Figure 2

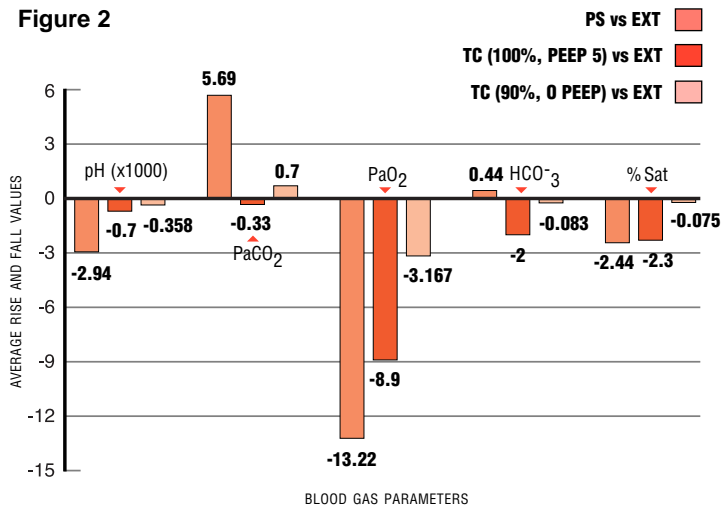


Figure 2 demonstrates the actual average rise and fall (+ or -) in the ABG values between the different SPONT modes and post-extubation values. Figure 2 also demonstrates the relationship between pH and PaCO₂ after extubation. Patients with PS and with PEEP showed the biggest decrease in pH and PaO₂, and increases in PaCO₂. Short term and long term-ventilated patients were included and averaged in this set of data to exclude bias. Of the 25 patients, only one was reintubated.

Discussion

Whether PS overcomes the WOB imposed by artificial airways sufficiently enough to mimic post-extubation conditions has been a question in clinical care. Studies have suggested two conclusions regarding PS: 1) Patients with low inspiratory flows received too much pressure and 2) Patients with high inspiratory flows received too little pressure.¹ We observed that a PS of 10 cm H₂O and a PEEP of 5 cm H₂O delivered over-assistance of pressure, thus presenting an unclear picture of how patients would handle a decrease in such support.

The 840 Ventilator, with its TC option, has provided us with a definitive way of mimicking post-extubation physiology and reducing the WOB imposed by the airway. Using TC, we reduced our reintubation rates from 14% to 3% (See note below). VLOS decreased from 5.56 days to 2.7 days (Median VLOS 1.9 YTD). We also reduced the number of ABG measurements by 52%.

Clinicians have now incorporated the TC option into two weaning protocols (fast and slow weaning). The TC option has provided us the “paint” needed to help create an artwork of weaning, as part of our ongoing effort to help deliver the best possible patient outcomes.

References

1. Oczenski W, Kepka A, et al: Automatic tube compensation in patients after cardiac surgery: Effects on oxygen consumption and breathing pattern. *Crit Care Med* 2002; 30 (7).

****Note****- Reintubations were calculated by dividing the number of patients reintubated by number of possible extubations, excluding expired patients and patients with tracheostomies.