Background:
Automatic Tube Compensation (ATC) has been shown to assist patients’ ventilation during spontaneous breathing trials (SBT). However, the level of support offered by this feature in different ventilators has not been determined. This bench study aimed to determine how the ATC on the CareFusion Avea (AAC), Covidien PB 840 (TC), and the Dräger Evita XL (ATC) each affect tidal volumes at various inspiratory demand levels.

Methods:
After calibrating each ventilator and the lung simulator, the Avea, Evita XL, and the PB 840 were joined with the Hans Rudolph 1101 Electronic Lung Simulator (HR 1101) using the same large bore circuit and a Trilexx Isot HV7.0 and 7.5 and a Rusch 8.0 ET. The HR 1101 was set to mimic a ‘normal’ pulmonary system Resistance 15 cm H₂O/L/s; Compliance 40 mL/cm H₂O; Rate 20/minute; Inspiratory Time Percent 30; Load Effort NO/L/s; Maximum Volume 3000 mL. The HR 1101 amplitude or ‘patient effort’ was set at 5, 10, 20, and 40 cm H₂O with each ET and with each ventilator with ATC off and then on. The Evita XL was assessed with ATC at 80% and 100%. Each ventilator was placed in CPAP; Pressure Support 0 cm H₂O and PEEP 2 cm H₂O. After allowing for stabilization, video recordings of the HR 1101 displayed values were made at each combination of settings. While reviewing the video playback, data for six consecutive breaths were collected and averaged.

Results:
Using the 7.5 ET as a medium value, the Avea’s AAC resulted in minimal changes in the delivered tidal volume, with the largest percentage being 5.56% at Amplitude of 5 garnering an 8 mL change per breath. In contrast, the Evita XL at 100% ATC resulted in a 5.34% increase in delivered tidal volume, delivering an additional 467.25 mL per breath at the maximal Amplitude of 40. Overall, the use of ATC increased delivered tidal volume by 2.24% on the Avea, 12.1% on the PB 840, 11.36% on the Evita XL at 80% and 24.96% on the Evita XL at 100%.

Conclusion:
While a patient is undergoing an SBT, the use of ATC may be required to provide more support than initially thought or desired. ATC results in increased tidal volume and a presumed reduction in work of breathing. Currently, the level of support to be used during an SBT is being questioned by other authors and it has now been shown that resistance may increase after extubation, rather than decrease. Therefore, the use of ATC, designed to reduce the work of breathing of the ETT, needs to be carefully considered during an SBT.

Introduction:
The purpose of Automatic Tube Compensation (ATC) is to deliver the set pressure at the airways instead of the mouth and to reduce the work of breathing imposed by the artificial airway. To do this, the ventilator must calculate the added resistance of the endotracheal tube (ETT), and then deliver a higher pressure to overcome this resistance. The CareFusion Avea, Covidien PB 840, and the Dräger Evita XL all have this feature available, yet the valve mechanics and additive pressure algorithms for each differ; this difference in additive pressure calculation accounts for the varying levels of support delivered by each individual ventilator. The purpose of this bench study was to evaluate the differences in tidal volume as simulated patient effort is increased when using ATC on the CareFusion Avea (AAC), Covidien PB 840 (TC), and the Dräger Evita XL (ATC).

Methods and Materials:
After calibrating each ventilator and the lung simulator, the Avea, Evita XL and the PB 840 were joined with the Hans Rudolph 1101 Electronic Lung Simulator (HR 1101) using the same large bore circuit and a Trilexx Isot HV7.0 and 7.5 and a Rusch 8.0 ET. The HR 1101 was setup with: Resistance 15 cm H₂O/L/s; Compliance 40 mL/cm H₂O; Rate 20/minute; Inspiratory Time Percent 30; Load Effort NO/L/s; Maximum Volume 3000 mL. The HR 1101 amplitude or ‘patient effort’ was set at 5, 10, 20, and 40 cm H₂O with each ET and with each ventilator with ATC off and then on. The Evita XL was assessed with ATC at 80% and 100%. Each ventilator was placed in CPAP; Pressure Support 0 cm H₂O and PEEP 2 cm H₂O. After allowing for stabilization, video recordings of the HR 1101 displayed values were made at each combination of settings. While reviewing the video playback, data for six consecutive breaths were collected and averaged. These values were then recorded and averaged. These recorded values were entered into an Excel Worksheet.

Results:
As patient effort (simulated by amplitude) increased, the amount of additional tidal volume increased due to ATC (Graph 1, Table 1). For a simulated patient with a 7.0, 7.5, or 8.0 ETT, the highest average additional tidal volume at different amplitudes with ATC active was provided by the Dräger Evita XL at 100%. Dräger acknowledges this and recommends using ATC at 80% clinically; the Evita XL at 80% still provided a greater tidal volume increase than the PB 840 or the Avea on two of the three ETT sizes. When testing with the 7.5 ETT, the PB 840 provided a larger tidal volume (12.1%) than the Evita XL (11.5%), while the Avea resulted in the smallest increase (2.9%). The average tidal volume increase when using the Avea ranged from 7.9 – 4.2%, depending on the ET size. The PB 840 tidal volume increase ranged from 10.2 – 13.1%, and the Dräger Evita XL tidal volume increase ranged from 11.4 – 15.5% and 14.1 – 24.5% with ATC set at 80% and 100%, respectively (Graph 2, Table 2).

Conclusions:
When evaluating the effect of ATC on the level of support provided to the patient, it is important to realize that each manufacturer utilizes a different valve mechanism and compensation algorithm; therefore, the level of support ATC provides to the patient will vary among ventilator manufacturers. Clinically, this difference in support provided by ATC is vital to recognize during a patient’s spontaneous breathing trial (SBT). If the ATC feature is over-compensating for the ET resistance, the tidal volumes will be increased, thus risking a false positive SBT and leading, potentially, to an increase in the number of failed extubations. When reading the literature related to the effectiveness of ATC during an SBT, clinicians need to identify the ventilator used as this is likely to affect the results of the study.

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