Evaluation of the Accuracy of Delivered Tidal Volumes in Critical Care Ventilators at Various Settings

Methods:
Ventilators tested: Covidien Puritan Bennett 840 (PB 840), Covidien Puritan Bennett 980 (PB 980), Maquet Servo-i (Servo-i), Maquet Servo-U (Servo-U), Dräger Evita XL (XL), Dräger Evita V500 (V500), and CareFusion Avea (Avea). Ventilators were connected to a Michigan Instruments Adult/Infant Training Test Lung (TTL): compliance 0.05 L/cm H₂O; Rp 20 Pneuflo Resistor. Two TSI Certifier FA+ 4081 High Flow Modules (TSI Certifier) were attached on the inspiratory limb of the circuit to the TTL. Set VT and expiratory VT (VTₑ) were measured and compared to the VT set at each setting.

Results:
- None of the ventilators had average differences greater than or less than what is set.
- A flow of 70 LPM generally resulted in a slightly less accurate VT than a flow of 50 LPM. Lower VT's were generally less accurate than larger VT's. Apart from the PB 980, the ventilators studied are generally more accurate in a decelerating flow waveform than a square flow waveform. Additional research is needed to determine the clinical implications of delivering tidal volume (VT) greater than or less than what is set.

Discussion:
- Accurate volume delivery to mechanically ventilated patients is a critical part of quality care. However, there is a lack of research on the accuracy of delivered tidal volume (VT) as compared to set VT.
- This study evaluated the accuracy of delivered VT across all settings (+8%, +7%, and +4%, respectively) for the Servo-i and PB 980; +6%, +5%, and +4% for the Avea; and +5%, +4%, and +3% for the XL. With the exception of the PB 980, the ventilators studied were generally more accurate in a decelerating flow waveform than a square flow waveform. The Servo-i was the most accurate in decelerating flow waveform (±1% at each set VT and flow rate). The PB 840 was the least accurate with a difference of +13% in a square flow waveform, VT 300 mL. When using the XL and V500, Leakage Compensation was turned off. VTs of 300, 500 and 700 mL were evaluated at a peak flowrate of 50 LPM in a square flow waveform. Then, flowrate was increased to 70 LPM and data were gathered as before at each volume. The trials were then repeated.

Limitations:
- This study was a bench study; additional research is needed to determine the clinical implications of delivering tidal volume after it is corrected to BTPS. Therefore, the VT displayed in the ventilator may be different from the VT actually delivered to the patient.
- Also results in the displayed exhaled VT being less than the displayed inspiratory VT and is seen, by the ventilators, as a leak in the system, even when a leak is not present. Ventilators that deliver either too high or too low of tidal volume after it is corrected to BTPS may also result in the patient not receiving the appropriate level of ventilation. Therefore, clinicians need to be cognizant of the actual delivered tidal volume.

No authors have a conflict of interest related to this research.

References: