

The Effect of Patient Circuit Compensation for Different Ventilator Modes

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Background

A key element of lung-protective ventilation is to control tidal volume within 4–8 mL/kg of predicted body weight.^{1,2} In volume-targeted modes, a portion of tidal volume is lost due to compression in the patient circuit.

Many critical care ventilators provide patient circuit compensation to counteract the loss of volume in ventilator circuits based on circuit compliance (C).^{3,4}

The purpose of the study was to assess how inspiratory effort affects volume delivery with or without circuit compensation.

Methods

The IngMar Active Servo Lung 5000 (ASL 5000) was programmed to simulate an adult patient with moderate ARDS and different inspiratory efforts (Table 1).^{5,6}

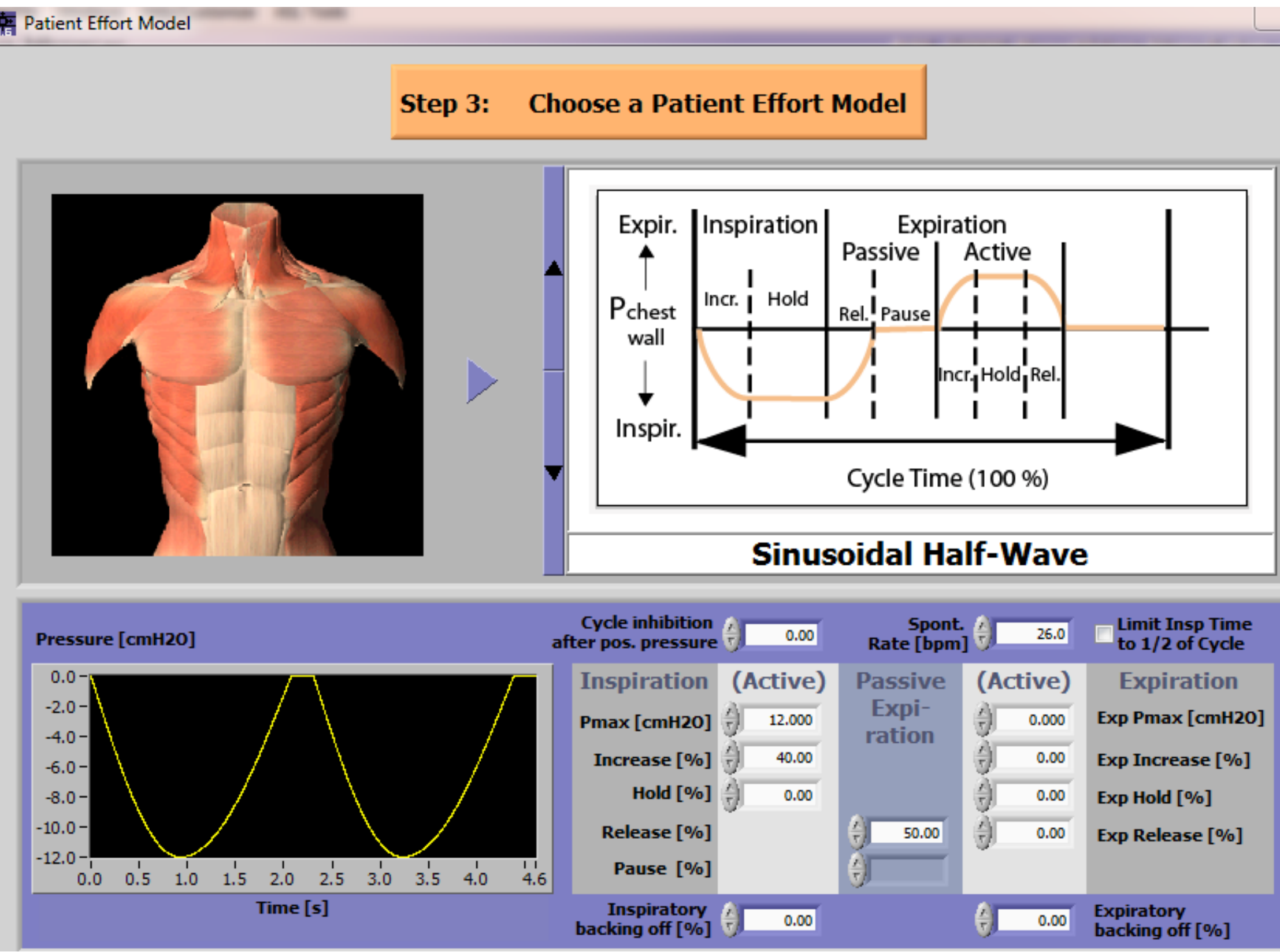


Table 1. Simulation parameters. R_{insp} = inspiratory resistance, R_{exp} = expiratory resistance, C = compliance, P_{max} = maximum value of the muscle pressure waveform. .

LUNG MODEL

R _{insp} (cm H ₂ O-s-L ⁻¹)	10
R _{exp} (cm H ₂ O-s-L ⁻¹)	10
C (mL-cm H ₂ O ⁻¹)	40

EFFORT MODEL

Frequency (breaths/min)	20
P _{max}	0,5,10,15
Increase	27%
Hold	0%
Release	20%
Pause	0%

Two modes were used on a Servo-U ventilator: volume-controlled continuous mandatory ventilation with set-point targeting scheme (VC-CMV) and pressure-controlled continuous mandatory ventilation with adaptive targeting scheme (PC-CMV).⁷

The outcome variable was the difference between tidal volume with and without circuit compensation for each inspiratory effort (ΔV). We recorded the mean of inspired tidal volume as measured and analyzed by the ASL 5000 for 10 breaths after stabilization.

Results

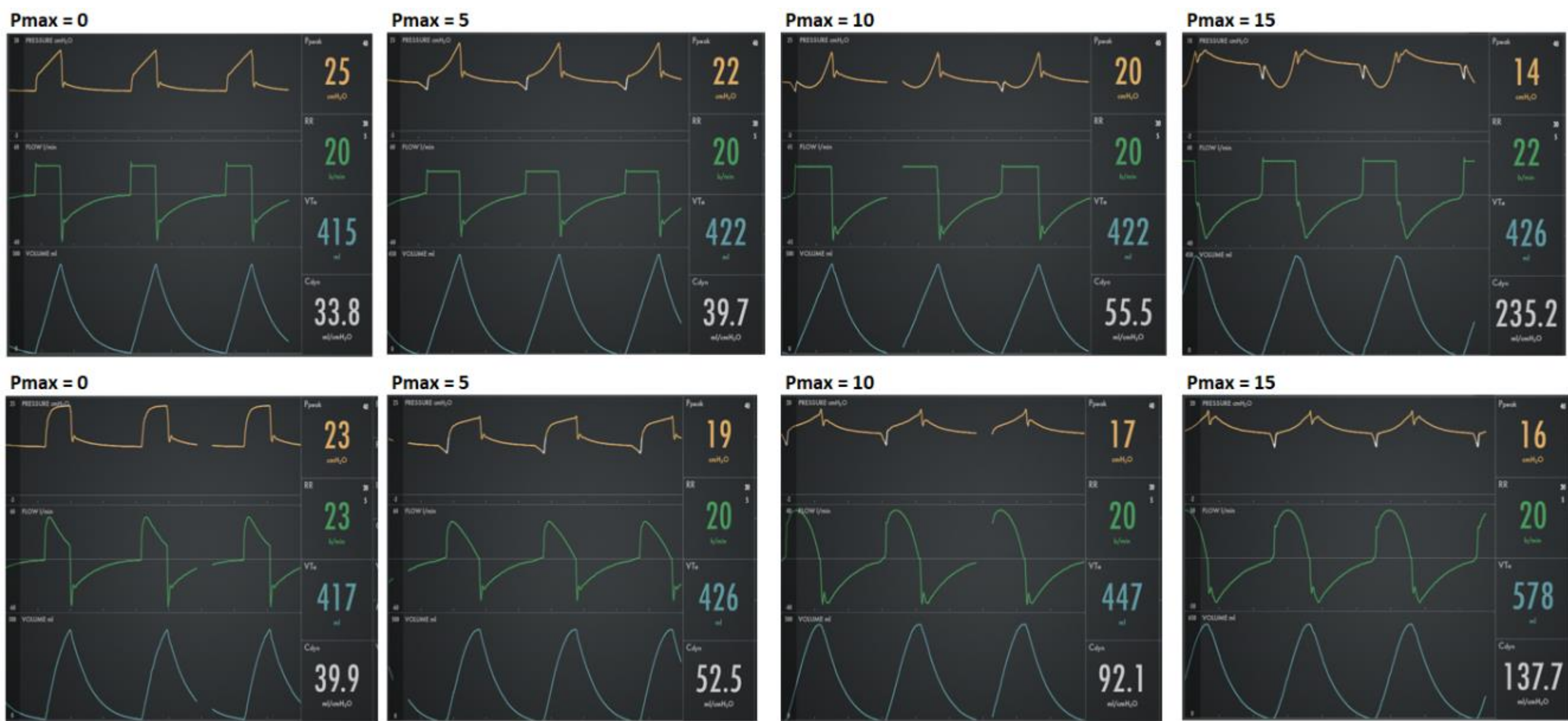


Figure 1. Pressure, volume, and flow waveforms with different levels of inspiratory effort, simulated as P_{max} (cm H₂O). The top row is VC-CMV and the bottom row is PC-CMV.

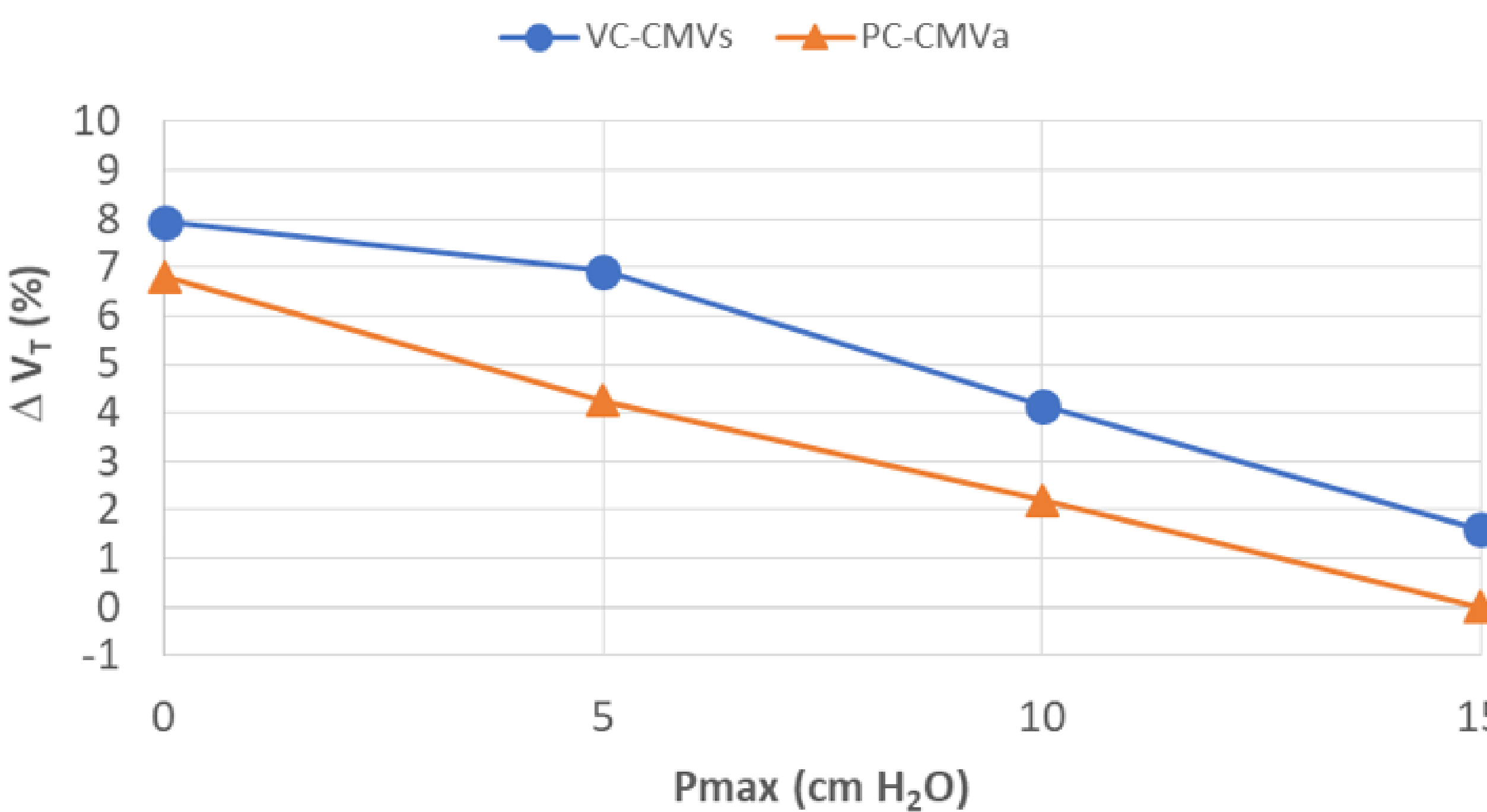


Figure 2. Patient Inspiratory tidal volume difference between with circuit compensation and without circuit compensation.

Conclusions

The effects of circuit compensation are affected by the simulated inspiratory effort, as expected. For volume-targeted modes, increasing effort decreases P. Decreasing P decreases ΔV .

References

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Disclosure

Mr. Chatburn is a consultant for IngMar Medical Inc, Vyair Medical Inc., and Promedic Consulting LLC.