Comparison of Peak-Expiratory Flow Rate and End-Expiratory Pressure during Airway Pressure Release Ventilation with the Drager XL, Viasys Avea, PB 840 and Servo-i

Ross Armstrong BS RRT\textsuperscript{1}, David Strong BS RRT\textsuperscript{1}, Lonny Ashworth, MED, RRT\textsuperscript{2}
\textsuperscript{1}St. Luke's Regional Medical Center, Boise, ID \textsuperscript{2}Boise State University, Boise, ID

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**ABSTRACT**

**Background:** Airway Pressure Release Ventilation (APRV) is a mode of ventilation that is used by some clinicians in the management of patients with ARDS. By controlling two different levels of CMV, APRV allows the patient to breathe spontaneously at any point during the respiratory cycle. Frequently, during APRV the Time\textsubscript{EEP} is set to any percentage of the Peak Expiratory Flow Rate (PEFR) to reach. The purpose of this study is to measure PEFR during Time\textsubscript{EEP} and End-Expiratory Pressure (EEP) at the end of Time\textsubscript{EEP} in APRV while ventilating an electronic lung simulator at three different levels of compliance.

**Method:** The Hans Rudolph HR 1101 Electronic Lung Simulator was interfaced using a size 8.0 ETT, to the Drager XL, Viasys Avea, Puritan Bennett 840 and Servo-i. Settings on the HR 1101 were: Resistance 12 cm H\textsubscript{2}O/L/sec, Compliance 15, 20 and 25 mL/cm H\textsubscript{2}O. Rate 30/minute, Amplitude 0, Effort Slope 15, % Inhale 33, Target Volume 3000 mL, Load Effort Normal. Data were measured at intervals of 0.05 seconds. Each ventilator was placed in APRV at the following settings: Time\textsubscript{EEP} 8 seconds, Time\textsubscript{i} 0.3 seconds. Pressure\textsubscript{EEP} 25 cm H\textsubscript{2}O, Pressure\textsubscript{i} 0 cm H\textsubscript{2}O, Tube Compensation off. At each compliance setting, PEFR was measured as the greatest flowrate during Time\textsubscript{EEP} was measured when the point where Time\textsubscript{EEP} transitioned to Time\textsubscript{i}.

**Results:** At each compliance level the PB 840 had the highest PEFR measurements, the Viasys Avea had the lowest PEFR measurements. The lowest EEP was measured when using the Servo-i. The highest EEP varied depending upon the compliance level and the ventilator.

**Conclusion:** When using an electronic lung simulator at three different levels of compliance, the PEFR was within 1.5 cm H\textsubscript{2}O among the ventilators at each compliance level. However, the PEFR varied considerably among the ventilators. Because many clinicians and Time\textsubscript{EEP} based upon a percentage of PEFR, one should consider that the PEFR may vary depending upon the ventilator being used. Further studies are needed to determine the impact of our findings on actual patient's PEFR and EEP, and the associated clinical significance.

**Background:** Airway Pressure Release Ventilation (APRV) is a mode of ventilation that relies on two levels of pressure (P\textsubscript{EEP} and P\textsubscript{i}) to oxygenate and ventilate patients. The P\textsubscript{EEP} maintains alveolar recruitment, while a release of pressure to P\textsubscript{i} for brief periods facilitates alveolar ventilation. Additionally, spontaneous breathing is allowed throughout the respiratory cycle. The volume delivered varies depending on patient effort, the lung and chest wall compliance, the inherent resistance and the pressure change between P\textsubscript{EEP} and P\textsubscript{i}. The duration of the P\textsubscript{EEP} (Time\textsubscript{EEP}) and P\textsubscript{i} (Time\textsubscript{i}) is set by the clinician. Optimal Time\textsubscript{EEP} is usually found by measuring the peak expiratory flow rate (PEFR) and terminating the Time\textsubscript{EEP} at 55-75% of the PEFR. The purpose of this study was to compare four different ventilators and the different end-expiratory pressures (EEP) and PEFR during APRV.

**Results:** At each compliance level the PB 840 had the highest PEFR, and the Viasys Avea had the lowest PEFR. The lowest EEP was measured when using the Servo-i. The highest EEP varied depending on the compliance and the individual ventilator.

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**Methodology:** The Hans Rudolph HR 1101 Electronic Lung Simulator was interfaced, using a size 8.0 ETT, to the Drager XL, Viasys Avea, Puritan Bennett 840 and Servo-i ventilators. Settings on the HR 1101 were: Resistance 12 cm H\textsubscript{2}O/L/sec, Compliance 15, 20 and 25 mL/cm H\textsubscript{2}O. Rate 30 minute, Amplitude 0, Effort Slope 15, % Inhale 33, Target Volume 3000 mL, Load Effort Normal. Each ventilator was placed in APRV at the following settings: Time\textsubscript{EEP} 8 seconds, Time\textsubscript{i} 0.3 seconds. Pressure\textsubscript{EEP} 25 cm H\textsubscript{2}O, Pressure\textsubscript{i} 0 cm H\textsubscript{2}O, Tube Compensation off. All ventilators were allowed to stabilize by letting them run for five minutes prior to collecting data.

**Data Collection:** Data were measured at intervals of 0.05 seconds. At each compliance setting, PEFR was measured as the greatest flowrate during Time\textsubscript{EEP} was measured when the point where Time\textsubscript{EEP} transitioned to Time\textsubscript{i}.

**Conclusion:** When using an electronic lung simulator at three different levels of compliance, the PEFR was within 1.5 cm H\textsubscript{2}O among the ventilators with appropriate Time\textsubscript{EEP} settings. This study was performed on an electronic lung simulator with an amplitude of zero, mimicking an apneic patient. A proposed benefit of APRV is allowing the patient to breathe spontaneously at any time during the respiratory cycle. Further studies are necessary to determine the clinical significance of our findings on the PEFR and EEP of spontaneously breathing patients.