

The Application of Proportional Assist™ Ventilation Plus (PAV™+) in Decompensated Congestive Heart Failure

Case Study
PAV™+ software option
for the 840™ ventilator

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Profile

In patients who failed wean criteria, our original standard of ventilator management utilized either assist control/pressure control (AC/PC) or volume control ventilation* (VCV) mode. However, it is well-known that positive pressure ventilation can profoundly alter cardiovascular function, especially in patients with significant cardiovascular pathology.¹

Admitted to our ICU was an 85 year-old male with an extensive cardiac history significant for sick sinus syn-

drome, paroxysmal atrial fibrillation and atherosclerotic coronary artery disease, with an estimated left ventricular ejection fraction of 25%. The patient's surgical history was significant for pacemaker placement and percutaneous coronary intervention. On ventilator day three, with approval from the practicing physician, the patient's ventilator mode was changed from VCV to PAV+ in an effort to increase cardiac output/index as well as explore the hemodynamic differences between said VCV and PAV+ modalities.

Clinical Course

The patient was initially placed on invasive mechanical ventilation due to hypoxic ventilatory failure, secondary to decompensated congestive heart failure. Immediately following the application of mechanical ventilation, the hypoxemia was reversed, yet the cardiac instability persisted and prevented the patient from attempting spontaneous breathing trials. Study design included alternating the ventilator between VCV and PAV+ modes. Ventilator settings were as follows:

VCV: 450 ml, RR 14, 30% FiO₂ and 5 cm H₂O PEEP

PAV+: 80% Support, 30% FiO₂ and 5 cm H₂O PEEP

The patient was allowed one hour to stabilize after mode changes before obtaining respiratory and hemodynamic measurements. Pharmacological agents included a *Dobutamine* infusion @ 4 mcg/minute and a *Propofol* infusion @ 5 cc/hour for patient comfort. No pharmacological changes were completed during data collection or alternating between ventilator modes.

Our patient's initial cardiac output on VCV was 3.06 L/min with a cardiac index of 1.56 L/min/M². Upon conversion to PAV+, the patient's cardiac output and index increased by ~27% while the PaO₂ increased by ~17% (Table 1). After observing hemodynamic improvement with PAV+, the patient was maintained on the preset PAV+ settings. Sedation was rapidly discontinued after the decision to continue employing PAV+, due to improved patient comfort. On ventilator day six, the *Dobutamine* infusion was discontinued and the patient was extubated without complication.

Table 1: Hemodynamic and Respiratory Measurements

Observation Order	1st	2nd (1 hour after Δ)
Ventilation Mode	VCV*	PAV+
Cardiac Output	3.06	4.19
Heart Rate	78	77
Stroke Volume	40.8	54.4
Cardiac Index	1.56	2.14
pH	7.52	7.47
PaCO ₂	31.2	34
PaO ₂	67	80
HCO ₃	25.8	24.3
BE	3	1

Discussion

Researchers have documented a statistically higher cardiac index when utilizing PAV+ compared to pressure support ventilation.² PAV+ permits unhindered spontaneous breathing, thus lowering right atrial pressure while compressing abdominal viscera propelling blood (pre-load) into the inferior vena cava, increasing venous return (stroke volume), therefore amplifying cardiac output.¹ The Puritan Bennett® 840™ ventilator, with its PAV+ software option, provided our clinicians with an instrument for effectively ventilating this patient with significant cardiac etiologies.

* The volume control ventilation (VCV) mode referred to in this case study is Puritan Bennett's *Volume Ventilation Plus™* (VV+®) software option for the 840 ventilator. VV+ is an enhancement to volume ventilation for spontaneous breathing coupled with volume targeted ventilation.

References

1. Pinsky, M. Cardiovascular Issues in Respiratory Care. *Chest*. 2005;128:592s-597s.
2. Kondili, E. et al. Short-term Cardio-Respiratory Effects of Proportional Assist and Pressure-Support Ventilation in Patients with Acute Lung Injury/Acute Respiratory Distress Syndrome. *Anesthesiology*. 2006;105:703-708.

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