Clinical Profile:
Adult Respiratory Distress Syndrome (ARDS). A form of restrictive lung disease due to abnormal permeability of either the pulmonary capillaries or the alveolar epithelium. Clinically, there is acute respiratory failure with pulmonary edema, hemorrhage into the lung tissue, hyaline membranes, and pulmonary fibrosis. The death rate is approximately 50%.1

ARDS patients have acute clinical needs for efficient, effective and accurate hemodynamic management due to their potential for increased pulmonary vascular resistance (PVR), right ventricular (RV) afterload, and impaired RV function. Historically, preload assessment using central venous pressure (CVP) and pulmonary artery wedge pressure (PAWP) has been utilized to meet the challenging treatment modalities of ARDS. The Advanced Swan-Ganz catheter provides volumetric measurements of right ventricular ejection fraction (RVEF) and right ventricular end diastolic volume (RVEDV), which will be evaluated herein.

Correlations:
• Correlation #1: between RVEDVI and CI
   The right ventricular end diastolic volume index (RVEDVI) and pulmonary artery occlusion pressure (PAOP) were compared with the cardiac index (CI) in 64 surgical patients with acute respiratory failure requiring treatment with PEEP. The study showed that “at all levels of PEEP, the CI correlated significantly better with the RVEDVI than with PAOP. At levels of PEEP ≥ 15cm H2O, CI was inversely correlated with PAOP, but remained positively correlated with RVEDVI.”2

• Correlation #2: between filling pressures and preload measurements
   Studies by Safcsak, et al. have shown that critical care patients supported by positive-pressure mechanical ventilation can demonstrate a potentially misleading increase in filling pressure originating from increased airway / pleural pressures transmitted to the central vasculature. In this case, “traditional filling pressure measurements may show a disparate relation with a preload measurement by end diastolic volume assessment.”3

• Reliability of RVEDVI as an indicator of preload
   In a study of 64 patients in acute respiratory failure, when PEEP was applied, the PAOP and CVP increased significantly. Many patients achieved PAOP’s > 20 mmHg, with some as high as 50 mmHg. These patients, however, had intravascular volume depletion evidenced by low urinary output, low CI, low RVEDVI, and elevated base deficit and lactate levels that responded appropriately to volume administration. The investigators concluded that in patients supported by application of PEEP, up to 50cm H2O, the RVEDVI was statistically superior and a more reliable predictor of right ventricular preload status and fluid responsiveness than was PAOP.3

• Correlation #3: between preload expansion and pulmonary function
   39 trauma patients with RVEF’s < 40% were randomized to increase preload by fluid administration to maintain RVEDVI > 120 ml/m2 during resuscitation (or 90-100 ml/m2 using inotropes). It was shown that the incidence of ARDS was actually less in the increased preload group than in the group receiving inotropes (p > 0.1). This study by Miller, et al. also showed that “mortality was 37% and 55% in the preload and inotrope groups, respectively (p > 0.1).”6

• Correlation #4: between RVEF, CO, oxygen delivery and ARDS survival
   In a study of patients suffering from sepsis and ARDS, a depressed RVEF was associated with simultaneously reduced cardiac output (CO) and oxygen delivery in ARDS non-survivors.3

   “Hemodynamic monitoring combined with oxygen transport assessment has been used to differentiate the relative magnitude of pulmonary and cardiovascular dysfunction that contributes to hypoxemia.”5

Outcome: Effect of combining SvO2, RVEF, RV, EDV, and CCO
It has been recognized that the Advanced Swan-Ganz catheters, combining continuous venous oximetry (SvO2), continuous cardiac output (CCO), continuous right ventricular end diastolic volume (RVEDV), and continuous right ventricular ejection fraction (RVEF) measurements, will yield not only information regarding oxygen consumption and delivery, but will also allow an even better understanding of hemodynamics. A intermittent indication of pulmonary vascular resistance (PVR) and a continuous systemic vascular resistance (SVR) may be used as an index to left ventricular (LV) and right ventricular (RV) afterload when continuous cardiac output (CCO) is integrated with continuous central and arterial pressure measurements.5
Advanced Technology Swan-Ganz Catheter Algorithm

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References:

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