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| **Title** | Arterial Pulse Pressure Variation with Mechanical Ventilation |
| **Introduction** | Pulmonary Artery Catherter (PAC) use is declining. Studies show confounding or no effects of PAC. Hence, development of less-invasive methods are being researched.  Predicting fluid responsiveness (FR) for individualizing hemodynamic therapy has a major place in resuscitation of ICU patients. Research has shown that that only 50% of fluid administered patients in the ICU were FR.  Estimating FR from preload measures such as central venous pressure (CVP) is not feasible. FR can be deduced from preload based on the Frank-Starling Curve (FSC).    The FSC has a high inter-individual variability. Estimating the slope of the FSC through short-term stroke volume (SV) changes in response to preload changes is possible.  Historically, these tests are conducted through fluid administration. However, since this can harm patients, dynamic tests are gaining popularity.  Mechanical Ventilation (MV) changes preload- and afterload conditions in both ventricles. Inspiration reduces right ventricular (RV) preload, and increases RV afterload. Hence, RV SV is minimal at end-inspiration.  Reduction in RV SV, leads to reduced left ventricular (LV) preload. For LV preload responsive patients, the reduced preload leads to reduced LV SV, reaching a minimum at expiration.  Based on the aforementioned mechanisms, it is hypothesized that LV SV changes if both ventricles are preload responsive, with no changes occurring if one ventricle is preload unresponsive.  Research has confirmed that the magnitude of RV and LV SV changes are good predictors of FR in MV patients.  **PPV for predicting FR:**  Pulse pressure variation (PPV) is clinically applied as a measure of FR.  Aortic pulse pressure I proportional to LV SV and inversely related to aortic compliance.  PPV is advantageous over systolic pressure, since it is less affected cyclic intrathoracic pressure changes  Manual PPV calculations used to be the clinical standard. Today, most hemodynamic monitors show PPV in real time.  Some algorithms estimate SV based on arterial pressure waveform analysis. These algorithms require an arterial cather for data collection.  None-invasive devices such as finger blood pressure devices were as reliable as invasive methods, except in norepinephrine administered patients.  **Limitations of PPV**  In acute respiratory distress syndrome (ARDS), low VT and low CL interfere with PPV usage. ARDS patients are adviced to be treated with low VT, and the AUROC of PPV decreased at VT <8ml/kg, which limits its usage. However, even during low VT, high PPV still indicated fluid responsiveness.  Limitations at low VT can be overcome by dividing PPV by respiratory changes in PEso.  Low CL and CRS also confound PPV interpretations.  Spontaneous breathing efforts also confound the PPV readings, since intrathoracic pressure becomes irregular in rate or amplitude.  PPV is unreliable when heart rate/respiratory ratio < 3.6  Prone positioning of ARDS patients can negatively influence predictive value of PPV  Predictive power is unaffected by PEEP  *PPV and RV dysfunction*  RV dysfunction may increase false-positive PPV rates.  The mechanism for this would be the increased pulmonary vascular resistance as a result of increased intrathoracic pressure, in effect increasing RV afterload.  *PPV and and Intraabodimnal Hypertension*  PPV may still be a good predictor for FR in patients with intraabdominal hypertension, but the threshold value may be higher than for normal conditions.  **PPV in General Population of ICU Patients**  In a study, 2,213 patients data was examined to see if FR indices were applied. Of these patients, CVP was used in 576 cases, PPV or SSV in 176 cases, and passive leg raising in 248 cases.  In ICU patients without ARDS, Low VT is commonly used. In these patients, PPV is not reliable in predicting FR.  PPV is limited in quite a number of ICU patients.  **PPV and Impact on Outcome**  Both insufficient and excessive fluid administration is associated with increased postoperative complications.  Using PPV in guiding fluid management is associated with a decrease in postoperative morbidity.  **Practical use of PPV**  PPV for FR prediction is only recommended when no spontaneous breathing activity is present and the patient has a sinus rhythm.  In ARDS patients, interpretating PPV is problematic, due to low VT or low CRS.  A PPV “gray zone” is postulated, between 9% and 13% PPV, where conclusions regarding fluid responsiveness can’t be drawn. In this gray zone, and increase of VT from 8ml/kg to 12ml/kg is thought to restore PPV prediction validity.  PPV is unreliable in cases of cardiac arrythmias and spontaneous breathing activity (SBA), as seen in figure 4    The SBA condition is present in patients 1) who are intubated and ventilated with persistent respiratory efforts, 2) non-invasively ventilated patients and 3) patients not administered mechanical ventilation. |
| **Hypothesis** | Postulate:  PPV reflects respiratory SV changes, and thus FR. Assuming arterial compliance is isometric during the respiratory cycle. |
| **Methods** | **Study population:**  X patients with septic shock  Comparative studies tested on patients with VT >=8ml/kg, assumed no spontaneous breathing or cardiac arrythmias are present. |
| **Results** | PPV outperforms systolic pressure variation and cardiac filling pressures for predicting FR. |
| **Discussion** |  |
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