**UTILITY**
Arterial lines permit continuous invasive blood pressure measurement, frequent arterial blood sampling, and analysis of the waveform. They can be used to estimate cardiac output, predict volume responsiveness, and identify specific pathologies.

**OVERdamped** = falsely LOW BP
<1.5 oscillations
Fix: Remove extra tubing & any air bubbles.

**UNDERdamped** = falsely HIGH BP
>2 oscillations
Additional artifactual spikes
Fix: Adjust filter settings on monitor.

**SQUARE WAVE TEST**
The arterial line can measure BP inaccurately unless properly calibrated. Rapidly flushing the line (by pulling the release on the flush device) generates a square wave. Counting oscillations after the square wave indicates if the arterial line is working properly.

Normal = accurate BP
1.5 - 2 oscillations

Low PPV
High PPV
Pulse pressure is proportional to stroke volume. Pulse Pressure Variation (PPV) represents an interaction between lungs and heart. Ventilation (either spontaneous or mechanical) alters the intrathoracic pressure and causes stroke volume to vary. Greater variability in stroke volume (increased PPV) may suggest fluid responsiveness.

**PPV** = \( \frac{PP_{max} - PP_{min}}{PP_{mean}} \)

Specifically, a **PPV > 12%** is suggestive that there will be an increase in stroke volume with fluid challenge. However, in order to interpret PPV 3 conditions must be met:

1. Sinus rhythm (consistent filling time)
2. Mechanically ventilated w/o spontaneous respirations; TV = 8 cc/kg (consistent effect of ventilator)
3. Must not have an open chest (heart/lungs interacting)

In contrast to an increase in BP with respiration causing high PPV, **pulsus paradoxus** is the decrease in SBP > 10 mmHg with respiration, associated with tamponade & other conditions.

**CARDIAC ARREST**
During cardiac arrest, an arterial line can be used to gauge adequacy of CPR (e.g. DBP > 25mmg on waveform), to identify ROSC, and to differentiate PEA from pseudo-PEA. See Cardiac Arrest OnePager for more.

**PRINCIPLE**
A continuous column of fluid between indwelling catheter and a pressure transducer allows arterial pressure measurement. For patients on pressors, **femoral MAP may be slightly higher** than radial MAP measurements.

**SPECIFIC ARTERIAL WAVEFORM PATTERNS**

- **Pulsus alternans** - alternating strong and weak pulses; seen in low cardiac output shock states
- **Pulsus bisfires** - double peaked pulse in severe AR ± AS
- **Pulsus tardus** - late peaking pulse; seen in severe AS

**CARDIAC OUTPUT ESTIMATION**
Several techniques can be used to estimate cardiac output using an algorithm to analyze the waveform. There are two types: uncalibrated and calibrated. None is proven superior.

**IV fluid in pressure bag at 300 mmHg**

**Zero** defined by the phlebostatic axis (mid-axillary line at the 4th IC approximating the aortic root)

**Low PPV**
**High PPV**

**Pressure transducer**

**Flush device**

**Arterial line**

**Closed blood sampling system**

**Sampling port**