Advance Hemodynamic Monitoring

CARDIAC INDEX

- Cardiac Index : $\frac{Cardiac\ Output}{BSA}$
- Cardiac Output = Stroke Volume * HR
- Multiple methods exist to estimate stroke volume

SVR

- V = IR (equation for voltage, current, and resistance)
- Pressure difference = cardiac output * SVR
- SVR = $\frac{80*(MAP-RA\ presure)}{Cardiac\ Output}$
- To Measure SVR → we need stroke volume & pressure differentials (MAP and CVP)
  - Most methods stop at measuring stroke volume since patient may only have central line.
  - But MAP is needed either via arterial line or manual pressure to have the pressure differential.

Swan-less monitoring

- **A-line alone**
  - variation → gross measurement. if peaks don't line up, may be dehydrate and benefit from fluids.
  - the waveform → estimates stroke volume or cardiac output. Lots of assumptions like pressure differential.
- **Arterial line + Central Venous Pressure**
  - more reliable monitoring.
  - Measure cardiac output and pressure difference. Can calculate SVR. Often used as **Flow-Track**
  - New advanced technique. This does know what's going on in left side via arterial line (vs using only pulmonary catheter). May be even better than Fick?

PULMONARY CATHETER ("Swan-Ganz")

- **Thermodilution**
  - non-continuous. Cannot use with Tricuspid or pulmonary regurgitation. Measure PA temperature. Inject cold fluid bolus in RV. Record temperature curve in PA. Estimates Cardiac Output.
- **The FICK principle**
  - Needs 3 things: O2 consumption, arterial O2 concentration, mixed venous O2 saturation
  - O2 consumption is very difficult to measure. Need spirometry and exercise. This is NOT done. Just assumed.
  - **gold-standard** for cardiac output measurements.
  - Common systems (e.g. Vigilance) don't technically use the FICK principle. But uses "Assumed Fick determination". We just assume the oxygen consumption.
  - So at the of the day, in addition to height, weight, hemoglobin and other non-invasive metrics, we just need an ABG & mixed venous O2 saturation from pulmonary artery
  - This does not rely on arterial waveform. Good choice for patients with intra aortic devices (LVAD, balloon pumps).

NON-INVASIVE monitoring

- Clinical - blood pressure. Pulses. Temperature of extremities. Mental status.
- Echocardiogram - can assess gross cardiac integrity. Advance methods can even estimate stroke volume.