

NONINVASIVE HEMODYNAMIC MONITORING

- $BP = \text{cardiac output (CO)} \times \text{systemic vascular resistance (SVR)}$
- $CO = \text{stroke volume (SV)} \times \text{HR}$
- $SVR = \text{MAP} - \text{CVP} / \text{CO}$
- SV is determined by the preload, afterload and contractility
- EaDyn (dynamic arterial elastance) is **an index of arterial load** and is defined as the *ratio between pulse pressure variations (PPV) and stroke volume variations (SVV) in a single respiratory cycle.*
- $dP/dt(\text{max})$ is an index of **myocardial contractility and the loading conditions on the ventricle**
- Systolic shock index (SSI) = $\text{HR} / \text{systolic BP}$
- Diastolic shock index (DSI) = $\text{HR} / \text{diastolic BP}$

Dynamic Tests (PPV, SVV, Eadyn, dP/dt, and fluid responsiveness)

The HemoSphere Monitor is a noninvasive system that estimates the SV and consequently the CO, SVR, PPV, SVV, Eadyn, and estimates the $dP/dt(\text{max})$.

EaDyn estimates the dynamic changes in pressure as flow is varied and reflects ventricular-arterial coupling. It is useful to assess fluid responsiveness and guide fluid and vasoactive drug therapy in hypotensive patients.

- Normal value 0.9 to 1.1

dP/dt (max) is determined by the maximal rate of rise of LV pressure and is estimated by HemoSphere as the maximal upslope of the arterial pressure waveform.

- Normal value determined by direct measurement in the LV is $>1200 \text{ mmHg/s}$. Values between 1000 and 1200 are borderline, and $<1000 \text{ mmHg/s}$ may indicate decreased contractility.
- The dp/dt trend estimated by HemoSphere correlate Better correlation when femoral line is used.

Fluid Challenge

- Performed with 250 ml IVF-crystalloids over 5-10 min or 2-minutes leg raising maneuver
- SVV $>12\%$ indicates fluid responsiveness. 10 to 12% changes is borderline
- *Can only be used if patient is sedated and not breathing over the ventilator*

Treating Hypotension

Preload dependency and arterial load should be identified before starting volume expansion to treat hypotension when we consider it may be beneficial but are unsure volume expansion will be well tolerated.

- Preload dependency can be assessed with SVV via fluid challenge or passive leg raise
- Arterial load can be assessed by Eadyn
 - *Pt must have HemoSphere monitoring*
 - If Eadyn is high >1.1 and the patient is preload dependent, BP will improve along with SV after volume expansion. On the contrary, if Eadyn is low <0.9 , *even if the patient is fluid-responsive*, volume expansion will not increase BP and vasopressors should be considered in order to correct hypotension
 - If hypotension and Eadyn is increased >1.1 , give IVF
 - If hypotension and Eadyn is decrease <0.9 , give vasopressors
 - The clinical scenario of fluid responsiveness and Eadyn <0.9 usually indicate vasoplegia characteristic of vasodilatory shock and will limit the BP increase to fluids if vasopressors are not added *even if volume responsive*. Low diastolic pressure is common during this scenario indicating vasodilation and need of vasopressors.

Systolic shock index (SSI)

- SSI >1 is associated with increased risk of death

Diastolic shock index (DSI)

- DSI >2.5 is associated with increased risk of death. Reflect the importance of diastolic BP in critically ill patients

Weaning Vasopressors

Eadyn can also be used to wean vasopressors in normotensive vasopressor-dependent patients

- Vasopressor-dependent patients with an Eadyn >1 could have their vasopressor decreased without hypotension
- Whereas if Eadyn was <1 vasopressor weaning is associated with hypotension