Nurse Driven Fluid Optimization Using Dynamic Assessments

2016
WHAT WE BELIEVE

- We believe that clinicians make vital fluid and drug decisions every day with limited and inconclusive information.

- Cheetah believes that with a complete hemodynamic profile, clinicians are empowered to make decisions better...leading to improved outcomes.

- We believe Cheetah’s accurate, precise and non-invasive technology can help you optimize your patients fluid and perfusion status.

Decisions Made Better
Careful management of intraoperative fluids can greatly enhance patient outcomes.

Volume overload in septic patients is associated with an increased risk of mortality.

Careful management of intraoperative fluids can greatly enhance patient outcomes.

WHY VOLUME MATTERS

FLUID IMBALANCE CAN LEAD TO SERIOUS CONSEQUENCES

- Every patient has unique and constantly changing hemodynamic needs
- Understanding a patient’s volume status throughout their care is a challenge clinicians face every day
- Serious complications are associated with both under- and over-resuscitation of a patient, including organ failure and death

Too Little Fluid

[Hypovolemia]
- Tissue Hypoperfusion
- Tissue Hypoxia
- Organ Failure
- Insufficient Perfusion

Too Much Fluid

[Hypervolemia]
- Tissue Edema
- Organ Failure
- Increased ICU/Ventilator Days
- Increased Mortality

References:
HEMODYNAMICS – THE SCIENCE OF BLOOD FLOW

HEMO → Blood
DYNAMICS → Flow

#1 Driver

Perfusion is critical for life – delivery of oxygen, nutrients, and toxin removal at tissue level

Optimized Hemodynamics Enables Perfusion
HOW DO WE CURRENTLY MEASURE PERFUSION?

**Blood Pressure**
- MAP > 65
- SBP > 90

**BioMarkers**
- Lactate
- SvO2

**Physiology**
- Urine Output

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Critical Care Is About Optimizing Hemodynamics
DRAWBACKS TO USING PRESSURE TO ASSESS VOLUME

\[ \Delta \text{Pressure} \times \text{Compliance} = \Delta \text{Volume} \]

*For pressure to accurately reflect volume ... 
... compliance must remain constant*
Adequate Perfusion

- IV Fluid
  - Preload
- Vasopressors
  - Vasodilators
- Inotropes
  - Contractility

Volume

Peripheral Resistance

Cardiac Function
4 non-invasive sensor pads are applied to the thorax, creating a ‘box’ around the heart

A small electric current of known frequency (75kHz) is applied across the thorax between the outer pair of sensors

A voltage signal is recorded between the inner pair of sensors

The flow of blood in the thorax introduces a time delay or phase shift in our signal

We have correlated these signal changes to known thermodilution cardiac output

- 65,000 patient samples in multiple clinical settings (ICU/OR/Cath Lab)
DYNAMIC ASSESSMENTS

**WHAT ARE THEY?**

- Directly challenging the heart with volume to see the response
- Ideal for assessing fluid responsiveness
- Provides continuous feedback of volume response after an intervention
- May answer the following key questions regarding your patient:
  - “Will additional IV fluid increase cardiac output?”
  - “Will additional IV fluid optimize perfusion?”
ASSESSING FLUID RESPONSIVENESS

METHODS OF FLUID BOLUS

- Passive Leg Raise
- Bolus Challenge
- Trending Therapy

Before Therapy

During Therapy

FRANK-STARLING LAW

SVI ≤ 10%: Fluid Non-Responsive
SVI ≥ 10%: Fluid Responsive

Once preload approaches the flat part of the Starling Curve, additional fluid does not increase Stroke Volume
METHODS TO ASSESS VOLUME – DYNAMIC ASSESSMENT

Passive Leg Raise

- Reversible challenge
- ~ 300cc of acute volume
- High sensitivity & specificity
- Positive change in SVI of $\geq 10\%$ is predictive of an increase in Cardiac Output
- Pro: Reversible
- Con: Contraindicated in certain patient populations

Will Fluid Increase Stroke Volume?
Bolus Challenge

- Reliable
- Rapid infusion of 250cc over 3-5 minutes
- High sensitivity /specificity
- Positive change in SVI of 10% or greater is predictive of an increase in CO and therefore flow
- Pro: Reliable
- Con: Irreversible

Will Fluid Increase Stroke Volume?
Methods to Assess Volume

Trending Therapy

- Minute-to-minute Information
- Assess Therapeutic Response
- Identify Early Trends
- Pro: Real Time / Continuous
- Con: None!

Will Fluid Increase Stroke Volume?
WHO IS A CHEETAH PATIENT?

**Shock States:**
- Severe Sepsis/Septic Shock
- Hypovolemic
- Cardiogenic
- Neurogenic

**Other Conditions characterized by hemodynamic instability**
- Congestive Heart Failure (CHF)
- Acute Respiratory Distress Syndrome (ARDS)
- Acute Kidney Injury/Renal Insufficiency (AKI)
- Subarachnoid Hemorrhage (SAH)

**Care Pathways and Protocols**
- ERAS & Perioperative Goal Directed Fluid Therapy
- CMS Severe Sepsis and Septic Shock Bundle (NQF #0500, SEP-1)
- Surviving Sepsis Campaign
- Emergency/Trauma
CHEETAH SCENARIO – SEPTIC PATIENT

- 42 year old male, paraplegic with large wound to coccyx, admitted with septic shock
- Pt had already received 6L fluid over night, however remained on low-dose Levophed that was unable to be weaned down further
- CVP reading 8-10, UOP >30mL/hr, MAP 55-60
- Cheetah monitor placed on patient to assess if more volume is needed as they were unable to wean the Levophed
STROKE VOLUME INDEX CHANGE

SVI (ml/m²/beat)

Start of PLR

Patient placed back in semi-recumbent position
PLR indicated patient was likely fluid responsive. 1 Liter LR was ordered to be given and PLR to be repeated after infusion complete.
REPEAT PASSIVE LEG RAISE

Patient placed back in semi-recumbent position

Start of PLR
Results and Outcome

PLR indicated patient was unlikely fluid responsive. Pt was able to be weaned off of Levophed following the 1 Liter LR infusion.

Minimal change in CI compared to previous test (11.3%)

< 10% change in SVI, patient unlikely to be fluid responsive
SUMMARY

- Volume matters

- Perform *guided* fluid resuscitation to optimize organ perfusion, oxygenation and prevention of organ failure

- Determine fluid responsiveness by means of simple, nurse-driven dynamic assessments

- Use of hemodynamics at the bedside by nurses can help to drive differential diagnosis and treatment of shock states