What are the Endpoints of Resuscitation?

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Objective

• Understand the current debate regarding endpoints of resuscitation in shock.

Nothing to disclose
A Few Things to Think About

• Are proposed “endpoints” appropriate for all types of resuscitation?
  – Are endpoints specific for the type of shock being treated?
  – How does a short term “endpoint” influence long term outcome?

• If an “endpoint” can be achieved via different therapeutic approaches what is more important the therapy or the endpoint?
  – Monitors & Outcomes

• If a specific “endpoint” is believed to be important, what confidence do we have in our ability to reliably measure and trend it?
  – What is the comparator (“Gold Standard”) for assessing new technology

Anesthesiology 2010;5:1180
Shock States And Resuscitation

• Shock – Inadequate Tissue Perfusion
  – Classification: Hypovolemic, Cardiogenic, Distributive, Restrictive
    • Uncompensated
    • Compensated

• Goal of Resuscitation
  – Restore tissue oxygenation and cellular homeostasis
    (achieved through therapeutic fluid administration, vasoactive medications, inotropes)
Proposed Targets

• Hemodynamic Measurements
  – Static
    • Filling pressures
  – Dynamic (Functional) (Fluid Responsiveness)
    • Cardiac Output (SV)
    • SPV, SVV, PPV

• Oxygenation (Enhance O2 Delivery)
  – Global
  – Regional

• Other
Bringing a method to the madness

- Proposed Target
- Physiologic Reasoning/Rationale
- Technique(s) of Measurement
- Limitations
- Clinical Application/Data
  - What Population?
  - Outcome Data?
Hemodynamic Targets

• Physiologic Reasoning
  – Optimization of cardiovascular function is important in assuring adequate oxygen delivery
Static Hemodynamic Targets: CVP

• Physiologic Reasoning
  – CVP reflects intravascular volume and RV preload

• Limitations
  – Static, pressure measurement, fails to account for alterations in venous tone and driving pressure

• Clinical Application
  – Meta-analysis: poor correlation between CVP and blood volume/ ΔCVP and fluid responsiveness
Dynamic Hemodynamic Targets: Multiple Methods

• Physiologic Reasoning
  – Provides measurement of CV performance, allows calculation of oxygen delivery

• Multiple Methods
  – Thermodilution
    • PAC
    • Transpulmonary
  – Arterial Catheter Based
    • Pulse Contour Analysis
  – Esophageal Doppler
  – Bioimpedance/Bioreactance
  – Echocardiography

Curr Opin Crit Care 2009;15:239
Dynamic Hemodynamic Targets: Multiple Methods

• Limitations
  – Accuracy of measurements  Anesth Analg 2010;111:1180
  – Risks associated with technique (e.g. PAC)
  – Technology Dependent e.g. MV, Dysrhythmia, Valvular heart disease
Dynamic Hemodynamic Targets: Multiple Methods

- Clinical Applications
  - Multiple clinical scenarios, limited data to support (problem of therapeutic algorithm)
Dynamic Targets: Arterial Pressure Analysis

• Proposed Target: Fluid Responsiveness via SPV, SVV, PPV

• Physiologic Reasoning
  – Respiratory variation in parameters reflects fluid responsiveness

• Limitations
  – Multiple other variables impact accuracy: MV, Arrhythmia, Pleural Pressure (Open Chest), Cst, Vt, Chest Wall Compliance, Trend Accuracy

• Clinical Application
Oxygenation Targets

• Physiologic Reasoning:
  – In “compensated” shock states hypoperfusion often exists even when vital signs and other hemodynamic parameters have been “normalized”

Oxygenation Targets

• Global Assessment
  – Metabolic Markers of Tissue Hypoxia
    • Lactate
    • Base Deficit
    • Bicarbonate
  – Venous Oximetry
    • SvO2
    • ScvO2
Global Oxygenation Targets: Metabolic Markers - Lactate

• Physiologic Reasoning
  – Under conditions of inadequate oxygen delivery (or uptake) anaerobic metabolism ensues leading to increased lactate production

• Limitations
  – Not all elevations result from hypoperfusion
    • Type B LA
    • NRTI rx
    • Seizures
    • Beta Agonists
Global Oxygenation Targets: Metabolic Markers - Lactate

• Clinical Application
  – Level on presentation predictive of survival
    • Trauma/Hemorrhage, Burn, AMI, Sepsis
  – Rate of clearance during resuscitation also predictive
  – No obvious cut off or target to guide therapeutic intervention is available
    • Value as a marker vs. “endpoint”
Global Oxygenation Targets: Metabolic Markers – Base Deficit

• Physiologic Reasoning
  – Similar to Lactate. Often thought of as a surrogate for lactate.

• Limitations
  – Affected by other causes of acidosis
    • Hypercholoremia
    • Ketoacidosis
    • Renal Failure
  – Affected by administration of buffers
Global Oxygenation Targets: Metabolic Markers – Base Deficit

• Clinical Application
  – May be more useful than pH
    J Trauma 1998;44:114
  – Initial values predictive of survival
    • Trauma/Hemorrhage, Burn
      J Burn Care Res 2006;27:289
Global Oxygenation Targets: Metabolic Markers – Venous Oximetry

• Rationale
  – Low values of SvO2 and ScvO2 reflect a mismatch between oxygen delivery and demand
  – Early identification and treatment directed at correcting the relationship should lead to improved outcome

• Limitations
  – Differences between SvO2 and ScvO2 based on sampling site
  – Differences in response to pathological states
Global Oxygenation Targets: Metabolic Markers – Venous Oximetry

• Clinical Application
  – Sepsis (as part of EGDT), CV Surgery, Trauma, General Surgery
  – Continuous monitoring best studied (Efficacy of intermittent sampling)
  – While responses in shock states differ, trend between SvO2 and ScvO2 is usually preserved but may be misleading in sepsis

Oxygenation Targets

• Regional Assessment
  – Mucosal Carbon Dioxide Production
    • Gastric Tonometry
    • Sublingual Tonometry
  – Tissue Oxygenation
    • Near Infrared Spectroscopy
Regional Oxygenation Targets: Tonometry

• Rationale
  – Tissue PCO2 increases with ischemia
  – Likely the result of decreased flow rather than dysoxia per se

• Limitations
  – Gastric mucosal pH variable, influenced by acid suppression therapy, enteral feeds, technically difficult to measure
Regional Oxygenation Targets: Tonometry

- Clinical Application
  - Trials in Trauma, Transplant, Cardiac Surgery, Sepsis
  - Most studies suggest correlation with other markers of hypoperfusion
  - No convincing outcome data

Am Surg 2005;71:252
Regional Oxygenation Targets: NIRS

• Rationale
  – Use of differences in absorption in NIR region enables measurement of pO2, pCO2, pH, occlusion methods can be used to estimate VO2

• Limitations
  – Measurements are averages (arterioles, venules, capillaries)
  – Does not measure microcirculation
  – Affected by adipose tissue
  – Lack of standard for measurement values

Curr Opin Crit Care 2008;3:361
Regional Oxygenation Targets: NIRS

• Clinical Application
  – Correlates with organ dysfunction in Trauma
    J Trauma 2007;62:44
  – Inconsistent values in Sepsis
  – Dynamic values with occlusion testing may estimate hypoperfusion

Am J Physiol Heart Circ Physiol 2007; 293:H1065
Novel Targets

• Coagulation
  – Damage control Resuscitation in Massive Transfusion

J Trauma 2007;62:307
Concluding Thoughts

• An ideal “endpoint” does not exist
• No single endpoint is applicable in all clinical situations
• Best approach is likely use of multiple data points (Targets)
• Current data does not conclusively support that use of therapeutic endpoints improves outcome
• Strategies must consider therapeutic approach as well as the target “endpoint”
• Further work is needed to validate “endpoints” and methods of measurement
Thank You