Comparing Venous To Arterial Base Excess During Hemorrhage And Resuscitation

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Introduction

The base deficit of arterial blood is an accepted indicator of the systemic metabolic insult (extent and duration) caused by trauma.\(^1\) Arterial base deficit is also used to indicate mortality risk and to monitor patient responses to resuscitation.\(^2\)

Relevant Effects of Hemorrhage

- Cardiac output (total blood flow from heart)
- Blood pressure & heart rate
- \(\text{O}_2\) delivery to cells
- ATP & \(\text{Pi}\)
- Arterial base deficit (indicator of systemic metabolic insult)

Venous blood samples are easier and less painful to obtain than are arterial samples.

Arterial blood becomes venous blood after passing through the capillaries.

Hypothesis: The base deficit value from venous blood can be substituted for the base deficit value from arterial blood.

Methods

8 anesthetized (thiopental infusion, cephalic vein, ventilated (end-tidal \(\text{PCO}_2\) 30-35 mmHg for arterial \(\text{PCO}_2\), 35-40 mmHg at baseline), instrumented, purpose bred dog subjects subjected to a pressure titrated severe hemorrhage, low-pressure stabilization, and resuscitation protocol.

Arterial and venous blood samples were simultaneously obtained at 30 minute intervals. Base deficits of the paired samples were determined twice using 2 different blood gas analyzers (the 1620 pH/Blood Gas Analyzer\(^a\) and the i-STAT\(^a\)). Only values from complete arterial/venous sample pairs were used for analysis. Pearson correlation coefficients were calculated for arterial versus venous values and for values from one analyzer versus the other (±SD).

Hemorrhage Protocol:

- MAP decreased during hemorrhage, remained constant during stabilization, then increased during resuscitation
- Heart rate increases during hemorrhage and declines during stabilization and resuscitation
- Blood flow (cardiac index and carotid flow) decreased during hemorrhage, remained constant during stabilization, then increased during resuscitation

Methods (continued)

Hemorrhage Protocol:

90 min Hemorrhage

- 120 min Cardiopulmonary stabilization: 0.05 mg/kg/hr etomidate plus one of two fluids: 1) hemoglobin based oxygen carrier (HBOC) for MAP 45-55mmHg, n=5 or 2) 3L 3% hypertonic saline dextran (HSD) for MAP 45-50mmHg, n=3

60 min Traditional resuscitation: lactated Ring's (LRS) for MAP 75-90mmHg

60 min Monitoring: no fluids administered at minute 330

Results (continued)

Average Base Deficit Values

- Arterial and venous values trended together for each analyzer:
  - 1620 pH/Blood Gas Analyzer\(^a\) arterial vs venous \(r = 0.77 \pm 0.20\)
  - i-STAT\(^a\) arterial vs venous \(r = 0.80 \pm 0.19\)

- Values from the different analyzers trended together:
  - 1620 pH/Blood Gas Analyzer\(^a\) vs i-STAT\(^a\) \(r = 0.98 \pm 0.02\)

- Almost all arterial base deficit values were worse (higher) than matched venous values (90 arterial higher, 10 arterial lower, 3 no difference).

- The arterial to venous base deficit differences varied over time in each dog. The smallest differences were observed during the periods of highest blood flow (greater than baseline cardiac index and carotid flow).

Discussion

- When systemic blood flow is high, venous base deficit can be used in lieu of arterial base deficit.

- When systemic blood flow is low, venous base deficit values do not reflect arterial base deficit values.

- Use of base deficit values in trauma patient assessment and monitoring typically does not occur during periods of high systemic blood flow.

- Substitution of venous blood samples for arterial samples for base deficit analysis in trauma patients, therefore, cannot be recommended.

- But, this does not mean that base deficit trends cannot be monitored using venous blood samples.

- It also does not mean that the base deficit values obtained from venous samples are not potentially useful; however, reference values for the venous base deficit relationship to mortality risk do not exist.

References


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