Is there a relationship between SOFA scores and albumin leak rates as a marker of endothelial dysfunction?

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Introduction

Increased capillary permeability is a hallmark of the systemic inflammatory response syndrome (SIRS) and sepsis. An assessment of organ dysfunction may be obtained using the Sequential Organ Failure Assessment (SOFA) score (Fig 1). (2)

Initial studies showed SOFA scores of greater than 5 on initial presentation had at least 20% mortality while scores > 11 had a mortality of 95%. (6).

When analyzing trends in the daily SOFA score during the first 96 hours, regardless of the initial score, the mortality rate was at least 50% when the score increased, 27% to 35% when it remained unchanged, and less than 27% when it decreased. (3)

The normal physiologic response to localized infection includes the activation of host defense mechanisms that result in the influx of activated neutrophils and monocytes, the release of inflammatory mediators, local vasodilation, increased endothelial permeability (capillary leak), and activation of coagulation pathways. This increased shift of fluid and protein from the intravascular to the interstitial space results in intravascular hypovolemia despite total body fluid overload (4)

The albumin leak rate can be measured using I-131 tagged albumin injected into the patient and measuring serial disappearance of the isotope. The albumin leak rate - a surrogate of capillary permeability - may represent the degree of endothelial dysfunction and severity of illness. Previous observation has shown that persistent elevation of albumin leak rate at day 5-7 has an 8 fold increase in mortality. (1)

SOFA score	1	2	3	4
Respiration PaO_2/FiO_2 mmHg	< 400	< 300	< 200 with respiratory support	< 100 with respiratory support
Coagulation Platelets x 10^3/mm³	< 150	< 100	< 50	< 20
Liver Bilirubin, mg/dL (μmol/L)	1.2–1.9 (20–32)	2.0–5.9 (33–101)	6.0–11.9 (102–204)	> 12.0 (> 204)
Cardiovascular Hypotension*	MAP < 70 mm Hg	Dopamine ≤ 5 or Dobutamine (any dose)	Dopamine < 5 or epinephrine ≤ 0.1 or norepinephrine ≤ 0.1	Dopamine > 1.5 or epinephrine > 0.1 or norepinephrine > 0.1
Central Nervous System Glasgow coma score	13–14	10–12	6–9	< 6
Renal Creatinine, mg/dL (μmol/L) or urine output	1.2–1.9 (110–170)	2.0–3.4 (171–299)	3.5–4.9 (300–440) or < 500 mL/day	> 5.0 (> 440) or < 200 mL/day

* adrenergic agents administered for at least one hour (doses given are in μg/kg · min)

Figure 1. SOFA scoring system

Hypothesis

There may be a relationship between albumin leak rate and SOFA scoring.

Methods

Critically-ill surgical patients requiring resuscitation of severe sepsis, septic shock, cardiovascular collapse, and/or ARDS had blood volume analysis (BVA) performed 12-24 hours after resuscitation and days 2, 3, 5-7. Plasma volume was measured with the BVA-100 (Daxor, NY, NY) using I-131 labeled albumin (1ml) injected into the patient with 5 sequential blood draws at timed intervals to compensate for albumin leak.

As part of the blood volume report, the albumin leak rate is presented as a % per minute, with normal values being 0-0.4% per minute. Albumin leak rate at Day 1, 2, 3, 5-7 after resuscitation was compared with the SOFA scores obtained on the same day. An example of a blood volume analysis is presented in Figure 2.

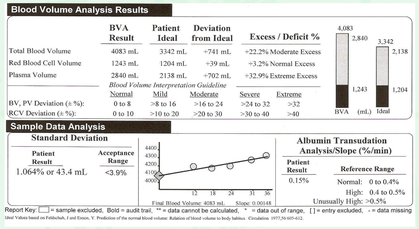

Figure 2. An example of blood volume analysis

Statistical Analysis

A Pearson correlation was obtained to determine any relationship between SOFA scores and albumin leak at 1, 2, 3, 5-7 days after resuscitation.

Results

Of the 46 patients studied, demographics were: age 61 ± 16 years, 15 females: 31 males, 38 septic shock/severe sepsis, 8 cardiovascular collapse, 10 ARDS patients, APACHE II score 24 ± 3 with a mortality rate of 8/46 (17%). The relationship between albumin leak and SOFA scores are presented in table 1.

Pearson correlations are represented in Figure 3. There was no statistically significant correlation between SOFA score and albumin leak on any of the days studied. There was a relationship between SOFA scores and mortality (fig 4). Data analysis shows that there is a statistically significant survival benefit if the patient's SOFA score continued to decrease during the first 3 days.

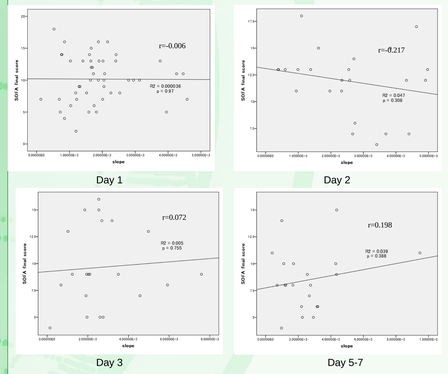

Figure 3 . Correlation of SOFA score vs albumin leak

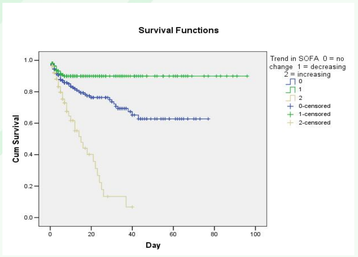

Figure 4: Survivorability based on SOFA score trend

Conclusions

The SOFA score measures the degree of organ failure and has been related to mortality. Our previous observation reported a high albumin leak on Days 5-7 to increased mortality. This study, however, did not demonstrate a relationship between the SOFA score and albumin leak at days 1-7. Our patient population is a highly selective and small group and may explain the lack of relationship between SOFA score and albumin leak. The other possibility is that the albumin leak may be effected by albumin levels and other treatment modality which may also impact survival.

References

1. **Inouye,D et al, Crit Care Med 2009;37:A89**
2. **Bersten & Soni: Oh's Intensive Care Manual, 6th ed.**; Chapter 3 - Severity of illness and likely outcome from critical illness
3. **Ferreira F L, Bota DP, Bross A *et al.*** Serial evaluation of the SOFA score to predict outcome in critically ill patients. *JAMA* 2001;286:1754-58.
4. **Cabre L, Mancebo J, Solsona JF *et al.*** Multicentre study of the multiple organ dysfunction syndrome in intensive care units: the usefulness of the Sequential Organ Failure Assessment scores in decision making. *Intensive Care Med* 2005;31:927-33.
5. **Vincent J L, de Mendonca A, Cantraine F *et al.*** Use of the SOFA score to assess the incidence of organ dysfunction/failure in intensive care units: results of a multicenter prospective study. *Crit Care Med* 1998;26:1793-800.
6. **Arts D, de Keizer N, Vroom M, de Jonge E.** Reliability and accuracy of Sequential Organ Failure Assessment (SOFA) scoring. *Crit Care Med* 2005:33;1988-93.

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