# Systemic Inflammatory Response Syndrome and Anemia in Aneurysmal Subarachnoid Hemorrhage: An Exploratory Analysis

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## Introduction

We investigated the relationship between the systemic inflammatory response and anemia after aneurysmal subarachnoid hemorrhage. We studied the impact of the systemic inflammatory response and anemia on discharge disposition and cerebrovascular events, such as delayed neurologic deficit and refractory cerebral vasospasm requiring intra-arterial therapy.

## Methods

We performed a retrospective analysis of 194 consecutive patients admitted with aneurysmal subarachnoid hemorrhage. SIRS was characterized by two or more of the following criteria on any given day during the first week of hospitalization: (1) temperature >38°C or <36°C; (2) white blood cell count >12,000 or <4,000; (3) heart rate >90 beats per minute (tachycardia); (4) respiratory rate >20 breaths per minute (tachypnea). Anemia was defined as a hemoglobin level <10 g/dl. Univariate and multivariate analyses were conducted to determine the associations between clinical variables and outcome measures of interest.

## Learning Objectives

The purpose of this exploratory analysis is to further investigate the relationship between SIRS and anemia following aneurysmal subarachnoid hemorrhage. Secondly, we investigate the relationship between SIRS, hemoglobin parameters, and various outcome measures, such as delayed neurologic deficit (DND), cerebral vasospasm, refractory vasospasm requiring intra-arterial rescue therapy, cerebral infarct, and discharge disposition.

## Results

Sixty seven percent of patients developed anemia during their hospital stay. An increase in the number of days with SIRS during the first week of hospital-stay was associated with a successive decrease in hemoglobin level during hospitalization (p=0.016). Admission WFNS grade =4 (OR 3.14, p=0.014) and admission hemoglobin level (OR 0.53, p<0.001) were independent predictors of anemia. Higher WFNS grade was also associated with the need for intra-arterial therapy (OR 3.1, p=0.006). A poor discharge disposition was predicted by age (OR 1.1, p<0.001), WFNS grade =4 (OR 3.94, p=0.010), admission hemoglobin level (OR 1.37, p=0.028), anemia (OR 3.03, p=0.043) and cerebral infarct (OR 5.05, p=0.010).

## Conclusions

Admission WFNS grade =4 and admission hemoglobin level were independently associated with anemia after aneurysmal subarachnoid hemorrhage. A greater reduction in hemoglobin level during hospitalization was observed in patients with more frequent SIRS during the first week of hospitalization. Admission hemoglobin level and anemia were independent predictors of discharge disposition.

### Table1: Univariate and Multivariate Analysis

| Variable | Anemia (n = 130) | No Anemia (n = 64) | p-value | Multivariate Odds Ratio (95% CI) | p-value[5] |
|---|---|---|---|---|---|
| Age, mean (SD) | 55.33 (1.12) | 52.80 (1.60) | 0.191 | | |
| Female, n (%) | 98 (75%) | 35 (55%) | 0.004 | 1.82 (0.83-3.98) | 0.136 |
| History of HTN, n (%) | 76 (58%) | 39 (60%) | 0.741 | | |
| History of smoking, n (%) | 53 (41%) | 33 (25%) | 0.155 | | |
| History of diabetes, n (%) | 6 (5%) | 3 (2%) | 0.982 | | |
| WFNS grade (admission), n (%)[1] | | | 0.002 | | |
| 1 | 35 (27%) | 34 (53%) | | | |
| 2 | 34 (26%) | 16 (25%) | | | |
| 3 | 6 (5%) | 3 (5%) | | Reference | |
| 4 | 39 (30%) | 9 (14%) | | 3.14 (1.26-7.86) | 0.014 |
| 5 | 16 (12%) | 2 (3%) | | - | |
| MFS (admission), n (%)[2] | | | 0.008 | | |
| 0 | 1 (0.8%) | 3 (5%) | | | |
| 1 | 18 (14%) | 15 (23%) | | | |
| 2 | 0 (0%) | 1 (1.6%) | | Reference | |
| 3 | 76 (58%) | 39 (60%) | | 1.92 (0.71-5.20) | 0.202 |
| 4 | 35 (27%) | 6 (9%) | | - | |
| Aneurysm location[3], n (%) | | | 0.567 | | |
| Anterior cerebral artery | 54 (42%) | 22 (34%) | | | |
| Internal carotid artery | 42 (32%) | 21 (33%) | | | |
| Middle cerebral artery | 17 (13%) | 8 (13%) | | | |
| Posterior circulation | 17 (13%) | 13 (20%) | | | |
| Treatment modality, n (%) | | | 0.458 | | |
| None | 2 (1.5%) | 2 (3%) | | | |
| Surgical clipping | 74 (57%) | 31 (48%) | | | |
| Endovascular | 54 (42%) | 31 (48%) | | | |
| ≤24 h to treatment, n (%) | 105 (8%) | 50 (78%) | 0.666 | | |
| Vasospasm, n (%) | 86 (66%) | 44 (68%) | <0.001 | | |
| DND, n (%) | 38 (29%) | 7 (11%) | 0.005 | | |
| Required IA therapy, n (%) | 34 (26%) | 4 (6%) | 0.001 | | |
| Hydrocephalus, n (%) | 100 (77%) | 35 (55%) | 0.002 | 2.34 (0.95-5.76) | 0.063 |
| SIRS (admission), n (%) | 79 (61%) | 31 (48%) | 0.103 | 1.42 (0.67-3.01) | 0.366 |
| Total SIRS (score) burden[4], mean (SD) | 15.02 (4.93) | 12.47 (4.39) | <0.001 | | |
| Hemoglobin (admission), mean (SD) | 12.62 (1.88) | 14.30 (1.56) | <0.001 | 0.53 (0.42-0.67) | <0.001 |
| Transfusion, n (%) | 21 (16%) | 0 (0%) | 0.001 | | |
| Length of stay, mean (SD) | 26.28 (1.19) | 16.16 (0.88) | <0.001 | | |
| Discharge Disposition, n (%) | | | <0.001 | | |
| Home | 48 (37%) | 44 (69%) | | | |
| Other | 82 (63%) | 20 (31%) | | | |