



Original Research

## Prevalence and Impact of Hyponatremia on Hospital Stay in Subarachnoid Hemorrhage Patients

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### ABSTRACT

**Introduction:** This research study was designed to ascertain the prevalence of hyponatremia and its impact on the duration of hospital stay in patients with subarachnoid hemorrhage (SAH) in our local population.

**Materials & Methods:** We carried out this study at the Department of Neurology, Lady Reading Hospital Peshawar for 1 year, which started in March 2022. The total sample size was 90 and a consecutive sampling method was used for sampling the study population. Patients aged between 20 to 70 years and who had a diagnosis of SAH were involved in included in the study, while those with confounding conditions were put in the exclusion criteria.

**Results:** Our study showed a high prevalence of hyponatremia (42%) in patients with SAH, and it was associated with a prolonged duration of hospital stays of 8.2 days ( $SD \pm 3.5$ ). There was a statistical difference in the mean hospital stay between the patients with hyponatremia and those without hyponatremia ( $t=3.2$ ,  $p < 0.002$ ).

**Conclusion:** Our study reported a high prevalence of hyponatremia in SAH patients and has established an association with longer hospital stays. Thus, identifying and managing patients of hyponatremia with SAH promptly should be emphasized for better results and to lessen the financial burden on families and the hospital.

**Keywords:** Hyponatremia, Subarachnoid Hemorrhage, Duration of Hospital Stay.

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### INTRODUCTION

Subarachnoid hemorrhage (SAH) is a form of hemorrhagic stroke characterized by bleeding in the subarachnoid space, situated between the arachnoid and pia mater layers.<sup>1</sup> The rate of SAH varies across different regions, starting from 2 to 22 cases per 100,000 individuals yearly, which makes up approximately 5% of all stroke cases.<sup>2</sup> Although hypertension, smoking, and a family

history of intracranial rupture are the main risk factors associated with SAH,<sup>3</sup> intracranial aneurysm rupture remains the leading cause of SAH in patients with typical ages that range between 50 to 55 years.

SAH is a life-threatening neurological emergency and causes a high rate of morbidity and mortality. The importance of identifying potential predictors that enhance the chances of better survival and functional outcomes is advocated in the settings of SAH. One of the main aspects is the role of electrolyte imbalances, particularly hyponatremia. In approximately 40-50% of the patients affected with SAH, the electrolyte imbalances are particularly manifested during the initial acute phase of SAH.<sup>4,5</sup>

Sodium plays a pivotal role in maintaining fluid balance within our bodies. Sodium imbalances can cause severe neurological complications and if not dealt with promptly can lead to adverse outcomes. Hyponatremia is primarily caused by two conditions: Cerebral Salt Wasting Syndrome (CSWS) and Syndrome of inappropriate Antidiuretic hormone secretion (SIADH).<sup>6</sup> Differentiating between these two conditions is onerous because assessing the patient's volume status precisely poses difficulties.

Hyponatremia and hypovolemia can negatively affect the prognosis of sub-arachnoid hemorrhage as it worsens the vasospasm which is caused by SAH. Prompt managing the condition by preventing vasospasm and delaying cerebral ischemia is far better than dealing with the complications later on.<sup>7</sup>

In one systematic review, the prevalence of hyponatremia in SAH was reported at 36%, and co-occurrence of SAH with hyponatremia led to prolonged hospital stays that cost an additional financial and psychosocial burden on patients and their families.<sup>8</sup> In another study, the reported prevalence ranged from 30% to more than 50%.<sup>9</sup>

The motive of this study is to investigate the prevalence of hyponatremia in patients with subarachnoid hemorrhage (SAH) in our local

population and its impact on hospital stay. The study aims to provide new local statistics on sodium imbalance in SAH, as there is a lack of current data available. The motive behind conducting this research was the observation of a high prevalence of hyponatremia in our clinical setting and the need to compare it with existing data. This study will bring about significant statistical data that can help in identifying and addressing hyponatremia early, which is commonly overlooked in SAH cases. If left untreated, hyponatremia can lead to worse outcomes in already compromised SAH patients and delayed diagnosis and treatment can prolong hospital stay.

## **MATERIAL AND METHODS**

### **Study Design & Setting**

The research was conducted at the Department of Neurology, Lady Reading Hospital, Peshawar. Ethical approval was acquired from the institutional research board (IRB) of Lady Reading Hospital (Ref: No. 339.2/LRH/MTI) before the initiation of this study. A cross-sectional study design was employed. The study was carried out over one year, starting from March 2022.

### **Sample Size and Sampling Technique**

WHO calculator 1.1 was used to compute the sample size, considering an anticipated population proportion of hyponatremia in patients with SAH to be 36%.<sup>8</sup> The sample size was determined to be 90. Consecutive sampling (non-probability) was utilized to select the study participants.

### **Inclusion Criteria**

Patients aged between 20 and 70 years diagnosed with subarachnoid hemorrhage, both male and female gender, were included in the study.

## Exclusion Criteria

Those patients were excluded who were with space-occupying lesions on CT, a history of head injury, meningitis, bronchogenic carcinoma, congestive cardiac failure, liver cirrhosis, or chronic kidney disease, as these conditions were considered potential confounders that could introduce bias in the study results.

## Data Collection Procedure

Patients meeting the inclusion criteria were consecutively recruited from the Neurology unit of the hospital. Informed consent was acquired from all the participants or their relatives after providing detailed explanations of the study protocols. A pre-designed proforma was used to record relevant information, such as name, age, gender, residence, smoking history, and address. Baseline investigations, including serum electrolytes, were conducted for all patients to detect hyponatremia. The diagnosis of SAH was established through clinical suspicion and confirmed through radiologic evidence from non-contrast CT brain scans showing hypersensitization in subarachnoid areas. Hyponatremia was considered when serum sodium concentration was below 135 mEq/L and was further classified into acute hyponatremia which developed in less than 48 hours and chronic hyponatremia which presented for more than 48 hours or of uncertain duration.

## Data Analysis Procedure

The analysis of data was carried out using the Statistical Package for Social Sciences (SPSS) version 22. Descriptive statistics were utilized for data analysis, including calculating the mean and standard deviation for numerical variables such as age, hospital stay, and serum sodium levels. Frequency and percentages were reported for categorical variables, including gender, hypertension, and presence or absence of hyponatremia. Stratification of hyponatremia was

performed based on age, gender, and hypertension status. Associations between hyponatremia and hospital stay were examined using an independent sample t-test, and relationships within categorical variables were evaluated using the Chi-square test and Fischer Exact test with statistical significance marked at a P-value of less than 0.05.

## RESULTS

### Demographic & Patient Characteristics

Ninety patients diagnosed with subarachnoid hemorrhage were included in the study with a mean age was 44.51 years (SD±12.6). The majority were female (n = 53, 58.9%) and had hypertension (n = 65, 72.2%). Among the patients, 24 (26.7%) were smokers, and the average duration of hospitalization was 7 days (SD=3.08) [Table 1].

**Table 1:** Summary of Patient Characteristics.

Characteristic	Count/Value
<b>Total Patients</b>	90
<b>Mean Age</b>	44.51 ± 12.6 years
<b>Male Population</b>	37 (41.1%)
<b>Female Population</b>	53 (58.9%)
<b>Hypertension (Yes)</b>	65 (72.2%)
<b>Mean Sodium Level</b>	133.6 ± 6.13mEq/L
<b>Hyponatremia</b>	38 (42.2%)
<b>Acute Hyponatremia</b>	26 (68.42% of hyponatremia cases)
<b>Chronic Hyponatremia</b>	12 (31.57% of hyponatremia cases)
<b>Smokers</b>	24 (26.7%)
<b>Mean Hospital Stay</b>	7 days ± 3.08

### Serum Sodium Levels & Hyponatremia

The mean serum sodium level was 133.6 mEq/L (SD=6.13), and 38 (42.2%) patients had hyponatremia. Of the 38 patients with hyponatremia, 26 (68.42%) had acute hyponatremia, and 12 (31.57%) had chronic hyponatremia. the mean serum sodium level for

patients with hyponatremia was 128 mEq/L (SD = 5.1) with a range of 108-134 mEq/L [Table 1].

### Comparison of Hospital Stay and Hyponatremia

The mean hospital stay of patients without hyponatremia was 6.1 days (SD=2.4), while the mean hospital stay of patients with hyponatremia was 8.2 days (SD=3.5). The difference in mean hospital stay between patients with and without hyponatremia was statistically significant ( $t=3.2$ ,  $p<0.002$ ).

### Comparison of Age Gender and Hypertension with Hyponatremia

The mean age for those with hyponatremia did not differ significantly from those without hyponatremia (44.82 years vs. 44.29 years), with a P-value of 0.8.

Patients were compared to male patients (43.4% vs. 40.5%), although this difference was not statistically significant ( $\chi^2 = 0.073$ ,  $p = 0.78$ ).

Patients with hypertension had a higher prevalence of hyponatremia compared to those without hypertension (43.1% vs. 40%), although again this difference was not statistically significant ( $\chi^2 = 0.7$ ,  $p = 0.79$ ).

Overall, patients with hyponatremia had a considerably longer hospital stay in comparison to those without hyponatremia (mean = 8.2 vs. 6.1 days, ( $t=3.2$ ,  $p<0.002$ ). This suggests that hyponatremia may be an important factor contributing to longer hospital stays among patients with SAH.

## DISCUSSION

Hyponatremia is a frequent occurrence during the early phase following SAH.<sup>10</sup> The findings of this investigation demonstrated that 42.2% of the patients experienced hyponatremia, with an

**Table 2:** Associations with Hyponatremia.

Variable	Hyponatremia Present	Hyponatremia Absent	P-value
<b>Hospital stay (mean)</b>	8.24 days	6.19 days	<0.002
<b>Age (mean)</b>	44.82 years	44.29 years	0.8
<b>Sodium levels (mean)</b>	128.00 mmol/L	137.75 mmol/L	0.0001
<b>Male</b>	40.5%	59.5%	0.78
<b>Female</b>	43.4%	56.6%	0.78
<b>Hypertension (Yes)</b>	43.1%	56.9%	0.79
<b>Smoking (Yes)</b>	41.7%	58.3%	0.9

average serum sodium level of 128 mEq/L, which corresponds with the previously reported rates.<sup>9,11-13</sup> However, unlike our study, Kao et al, documented an increased incidence of hyponatremia (59.2% with a cutoff of 135 mEq/L).<sup>14</sup> Additionally, among the patients with hyponatremia, 68.4% had acute hyponatremia, while 31.57% had chronic hyponatremia. In a study by Ridwan S et al, hyponatremia was detected in 32.7% at any given time with the highest frequency observed on day 1 and subsequently between days 7-10.<sup>15</sup>

Although the prevalence of hyponatremia was slightly higher in female patients compared to male patients (43.4% vs. 40.5%), this difference did not reach statistical significance. Similarly, patients with hypertension had a slightly higher prevalence of hyponatremia compared to those without hypertension (43.1% vs. 40%) but was not significant statistically.

The study suggested a statistically considerable association between hyponatremia and prolonged hospital stay. On average, patients diagnosed with hyponatremia stayed in the hospital for 8.2 days, while those without hyponatremia had a mean hospitalization period of 6.1 days. This difference was statistically significant ( $t=3.2$ ,  $p<0.002$ ). Prolonged hospital stays observed in patients with hyponatremia may be attributed to complications of hyponatremia, such as cerebral vasospasm.<sup>9</sup> The results of our

study are in line with previous studies that have shown that hyponatremia is associated with longer hospital stays in different demographic settings.<sup>8,14,16</sup>

Our study did not ascertain any significant difference in the mean age of patients with and without hyponatremia which suggests that hyponatremia is not linked with the age of patients with SAH. This is inconsistent with previous studies that have shown a significant association between age and hyponatremia among SAH patients.<sup>17</sup>

In the current study, most patients received treatment through fluid restriction, with only a small number receiving 3% hypertonic saline, which is in line with the recommended management of hyponatremia in SAH.<sup>18</sup> Prior research has recognized SIADH as a predominant cause of severe hyponatremia in SAH patients.<sup>14,16</sup> However; the limitation of this study is that it did not investigate the etiology of hyponatremia.

Several studies have shown an association between SAH due to an aneurysm in the anterior vasculature of the brain and a higher occurrence of hyponatremia.<sup>19,20</sup> Additionally, studies have also described a greater frequency of hyponatremia in individuals with severe SAH and those with higher Fisher classification.<sup>21</sup> However, our study did not explore the relationship between aneurysms and the severity of hyponatremia, indicating a limitation of our study. Future studies may need to investigate the causes of hyponatremia in this population and its potential impact on patient outcomes. Another limitation is the small sample size, which may limit the generalizability of the study findings.

## CONCLUSION

In conclusion, this study demonstrated a high prevalence of hyponatremia (42%) in patients with subarachnoid hemorrhage, and it revealed a significant association between hyponatremia and hospital stays. The burden of hyponatremia on

both patients' families and the hospital emphasizes the importance for clinicians to be vigilant in monitoring and managing electrolyte imbalances, including hyponatremia, to potentially improve outcomes and reduce the impact of this common complication in patients with SAH. Future research with larger sample sizes and investigation into the etiology of hyponatremia are needed to validate these findings and enhance our understanding of this condition for more targeted interventions and improved patient care.

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### Additional Information

**Disclosures:** Authors report no conflict of interest.

**Ethical Review Board Approval:** The study was approved by the ethical review board.

**Human Subjects:** Consent was taken from all patients/participants in this study.

**Conflicts of Interest:**

In compliance with the ICMJE uniform disclosure form, all authors declare the following:

**Financial Relationships:** All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work.

**Other Relationships:** All authors have declared that there are no other contacts or activities that could appear to have influenced the submitted work.

**Data Availability Statement:** The authors confirm that the data supporting the findings of this study are available within the article. Raw data used in this study are available upon request from the corresponding author.

### AUTHORS CONTRIBUTIONS

Sr.#	Author's Full Name	Intellectual Contribution to Paper in Terms of:
1.	Zeeshan Ullah	1. Study design, methodology, manuscript writing and data collection and analysis.
2.	Ihtisham Ullah	2. Data collection, and editing.
3.	Imad Majeed	3. Data collection, calculations, editing and writing.
4.	Muhammad Fawad Khan	4. Data Collection.
5.	Saad Ali	5. Literature Review, supervision, quality insurance and editing.
6.	Asim Ali & Hina Nawaz	6. Data Collection.