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Original Article

Clinical Parameters, Risk Factors, and Serum Sodium Level on Admission in Patients with Spontaneous Intracerebral Hemorrhage

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ABSTRACT

Background: *Spontaneous intracerebral hemorrhage (S-ICH) is a critical neurological emergency with high morbidity and mortality, particularly in low-resource settings. Although clinical parameters, such as hematoma volume and Glasgow Coma Scale, are widely used to predict outcomes, the role of serum sodium levels at admission remains underexplored in the Bangladeshi population.* ***Objectives:*** *This study aimed to evaluate the clinical characteristics, admission serum sodium levels, and their association with early hospital outcomes in patients with spontaneous ICH.* ***Methods & Materials:*** *A hospital-based observational study was conducted at Dhaka Medical College Hospital from January 2015 to December 2016, involving 100 patients with first-ever spontaneous ICH. Clinical presentations, neuroimaging findings, and serum sodium levels were recorded. Outcomes such as in-hospital mortality and functional status at two weeks were analyzed.* ***Results:*** *The majority of patients were aged above 60 years, with hypertension being the most common risk factor (68%). Hyponatremia on admission was observed in 20% of patients. Most hemorrhages occurred in the putamen (48%). At the end of two weeks, 62% of patients exhibited disability, and the in-hospital mortality rate was 18%.* ***Conclusion:*** *Admission hyponatremia is a notable biochemical abnormality in spontaneous ICH and may be linked to poorer early outcomes. Incorporating sodium monitoring into initial assessments could enhance prognostication and care strategies in S-ICH management.*

Keywords: *Intracerebral hemorrhage, Hyponatremia, Serum sodium, Stroke outcomes, Bangladesh*

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INTRODUCTION

Spontaneous intracerebral hemorrhage (S-ICH), a subset of hemorrhagic stroke, represents one of the most devastating neurological emergencies, accounting for approximately 28.8% of all stroke cases and 45.6% of stroke-related deaths worldwide[1]. Despite advances in medical imaging and intensive care management, S-ICH remains responsible for nearly half of all stroke-related disability-adjusted life years (DALYs), with the highest burden observed in Southeast Asia and other low- and middle-income countries (LMICs)[2]. In the context of Bangladesh—a densely populated LMIC with a high prevalence of stroke risk factors—the mortality and morbidity associated with S-ICH are believed to be significantly underestimated due to limited surveillance systems and underreporting. Regional studies have consistently shown that while ischemic stroke is more common, spontaneous ICH carries a disproportionately higher risk of fatality and disability, especially among patients who present late to tertiary care centers or lack access to critical care[3]. Clinically, spontaneous ICH is often more challenging to manage than ischemic stroke, owing to its rapid neurological deterioration, potential for hematoma expansion, and high risk of elevated intracranial pressure (ICP)[4]. The sudden rupture of cerebral vasculature leads to a cascade of destructive processes, including mass effect, inflammation, and disruption of the blood-brain barrier, which further complicate recovery[5]. The prognosis is often determined early, with initial Glasgow Coma Scale (GCS) scores, hematoma volume, and intraventricular hemorrhage being strong predictors of outcome. Alarmingly, case-fatality rates for S-ICH remain high, ranging from 35% to over 50% within the first 30 days, with significant proportions of survivors left with moderate to severe disability[6,7]. This highlights the pressing need for more targeted, evidence-based strategies for early risk stratification and management in resource-limited settings. A growing body of evidence has emphasized the role of modifiable and non-modifiable risk factors in the development of spontaneous ICH. Among these, hypertension stands out as the single most significant contributor, particularly in LMICs like Bangladesh where awareness,

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control, and compliance with antihypertensive therapy are suboptimal[8,9]. Other modifiable factors—such as smoking, alcohol consumption, diabetes mellitus, and anticoagulant use—have also been consistently linked to increased S-ICH risk, often acting synergistically with hypertensive vasculopathy[8,10]. Non-modifiable factors, including age, male sex, and genetic predispositions such as ABO blood group and clotting factor variability, may further influence the risk and severity of hemorrhage[11,12]. These findings highlight the potential value of early screening and aggressive risk modification, particularly among high-risk populations. In recent years, increasing attention has been directed toward the prognostic value of serum sodium abnormalities in the context of acute neurological injuries, including S-ICH. Hyponatremia—defined as serum sodium concentration <135 mmol/L—can lead to cerebral edema and raised ICP, thereby compounding the mass effect already present in hemorrhagic stroke[13,14]. Conversely, hypernatremia may contribute to brain tissue dehydration and microvascular damage, further impairing neurological recovery[15]. Emerging studies have confirmed that dysnatremia, even when mild or within the low-normal range, is associated with increased in-hospital mortality, longer ICU stays, and worse functional outcomes in various acute care settings, including traumatic brain injury and subarachnoid hemorrhage[16,17]. Despite these insights, existing literature reveals a critical knowledge gap in understanding how admission serum sodium levels influence clinical trajectories in S-ICH, particularly in LMIC settings like Bangladesh. Most available studies have focused on well-established predictors like GCS, hematoma volume, or location, with relatively few exploring the role of biochemical parameters such as sodium in early triage and management[18]. Furthermore, local factors such as genetic background, high dietary salt consumption, poor hypertension control, and variable access to intensive care may significantly influence both the prevalence and impact of sodium imbalances. Yet, these variables remain underrepresented in global research. Bridging this gap could not only improve clinical outcomes through more personalized fluid and electrolyte management strategies but also aid in developing cost-effective, evidence-based triaging tools tailored to high-burden, resource-constrained settings. In light of these considerations, the present study aims to investigate the clinical parameters, risk factors, and serum sodium levels on admission in patients presenting with spontaneous ICH in a tertiary care hospital in Bangladesh. By correlating sodium levels with key clinical outcomes and severity scores, we hope to identify novel insights that can guide acute management protocols and inform future stroke care strategies in similar settings.

METHODS & MATERIALS

This hospital-based observational study was conducted in the Department of Neurology at Dhaka Medical College Hospital (DMCH), Dhaka, Bangladesh, from January 2015 to December 2016, aiming to assess the impact of admission hyponatremia on short-term hospital outcomes in patients with spontaneous intracerebral hemorrhage (S-ICH). The study included a total of 100 patients presenting with first-ever spontaneous ICH, admitted to the Departments of Neurology, Neurosurgery, and Internal Medicine at DMCH, and selected using purposive sampling techniques. Patients were eligible if they were aged 18 years or older, of either sex, had a confirmed diagnosis of spontaneous ICH based on clinical features and non-contrast computed tomography (CT) scans, were admitted within 24 hours of symptom onset, and provided informed consent through themselves or their attendants. Exclusion criteria were strictly followed, disallowing patients with head trauma, S-ICH secondary to tumors, arteriovenous malformations (AVMs), anticoagulation or thrombolysis use, or coagulopathy determined through clinical assessment and CT imaging. Additionally, patients with serious comorbid conditions such as chronic kidney disease, heart failure, decompensated chronic liver disease, respiratory failure, active infections including aspiration pneumonia, hypernatremia (serum sodium >145 mmol/L) at admission, or those undergoing neurosurgical interventions were excluded from participation. Ethical approval was obtained from the institutional review board of Dhaka Medical College Hospital, and written informed consent was collected from all patients or their legally authorized representatives before data collection. Patient data included demographic characteristics, clinical presentations, laboratory results (especially serum sodium at admission), neuroimaging findings, and hospital outcomes, including in-hospital mortality, duration of hospital stay, and functional status at discharge. The collected data were statistically analyzed to determine the association between admission hyponatremia and clinical outcomes among patients with spontaneous ICH.

RESULTS

A total of 100 patients with spontaneous intracerebral hemorrhage (S-ICH) were included in the analysis. The majority of the participants were aged between 61 and 70 years (36%), followed by 71–80 years (26%) and over 80 years (13%). Participants aged 51–60 years represented 17%, while younger age groups (≤50 years) collectively accounted for only 8% of the sample. More than half of the study population was male (57%), and a majority of patients resided in rural areas (66%). Regarding marital status, most participants were married (93%) (Table 1). In terms of risk factors and comorbidities, hypertension was the most prevalent condition, observed in 68% of the participants. Smoking was also common, reported by 39% of patients. Diabetes mellitus was present in 19%, while a family history of stroke and ischemic heart disease were found in 16% and 13%, respectively. Alcohol consumption was the least common risk factor, identified in only 5% of participants (Table 2). The most common presenting symptoms at admission were headache (82%), followed by hemiplegia or hemiparesis (73%), and vomiting (60%). Deterioration of consciousness was noted in 30% of the patients, while dysphasia or aphasia and dysphagia were observed in 18% and 15%, respectively. Other symptoms included dysarthria (13%), behavioral abnormalities (12%), vertigo (11%), convulsion (9%), mono paresis (4%), and hemisensory loss

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(3%) (Table 3). Regarding the types of spontaneous intracerebral hemorrhage (S-ICH), hypertensive ICH was the predominant type, observed in 68% of the patients, while the remaining 32% presented with non-hypertensive ICH (Figure 1). The most common location of S-ICH was the putamen, which accounted for nearly half of the cases (48%). Other frequent sites included the frontal lobe (17%) and temporal lobe (15%). Hemorrhages located in the parieto-occipital lobe were identified in 8% of patients, while cerebellar hemorrhages were noted in 6%. The thalamus and brainstem were the least common locations, each representing only 3% of cases (Table 4). At admission, serum sodium levels were found to be within the normal range (135–145 mmol/L) in the majority of patients (80%). Hyponatremia, defined as serum sodium levels below 135 mmol/L, was present in 20% of the study participants (Figure 2). Regarding short-term hospital outcomes, at the end of the second week after admission, significant disability was recorded in 62% of patients, while 38% did not experience significant disability (Figure 3). The mortality rate within the first two weeks following admission was 18%, with 82% of the participants remaining alive (Figure 4).

Table – I: Baseline characteristics distribution among the participants (*n*=100)

Baseline Characteristics	n	%
Age		
≤ 30	2	2%
31 – 40	2	2%
41 – 50	4	4%
51 – 60	17	17%
61 – 70	36	36%
71 – 80	26	26%
>80	13	13%
Gender		
Male	57	57%
Female	43	43%
Residence		
Rural	66	66%
Urban	34	34%
Marital status		
Married	93	93%
Unmarried	7	7%

Table – II: Distribution of risk factors and co-morbidities among the participants (*n*=100)

Variable	n	%
Hypertension	68	68%
Smoking	39	39%
Family history of stroke	16	16%
History of DM	19	19%
History of IHD	13	13%
Alcoholism	5	5%

Table – III: Presenting features among the participants at admission (*n*=100)

Presenting Features	n	%
Headache	82	82%
Hemiplegia/paresis	73	73%
Vomiting	60	60%
Deterioration of consciousness	30	30%
Dysphasia/ aphasia	18	18%
Dysphagia	15	15%
Dysarthria	13	13%
Behavioral abnormalities	12	12%
Vertigo	11	11%
Convulsion	9	9%
Monoparesis	4	4%
Hemisensory loss	3	3%

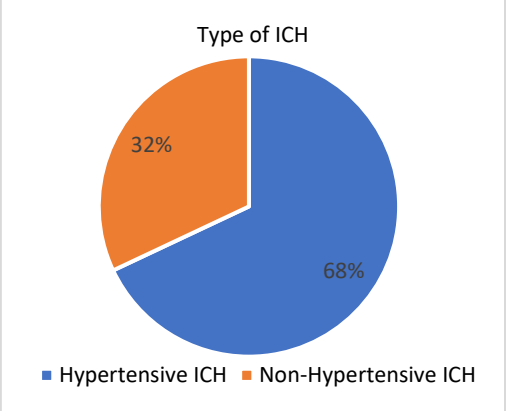

Figure – 1: Distribution of participants by type of spontaneous intracerebral hemorrhage (S-ICH)

Table – IV: Distribution of participants by location of S-ICH (*n*=100)

Location of S-ICH	n	%
Putamen	48	48%
Frontal Lobe	17	17%
Temporal Lobe	15	15%
Parieto-occipital Lobe	8	8%
Thalamus	3	3%
Cerebellum	6	6%
Brain stem	3	3%

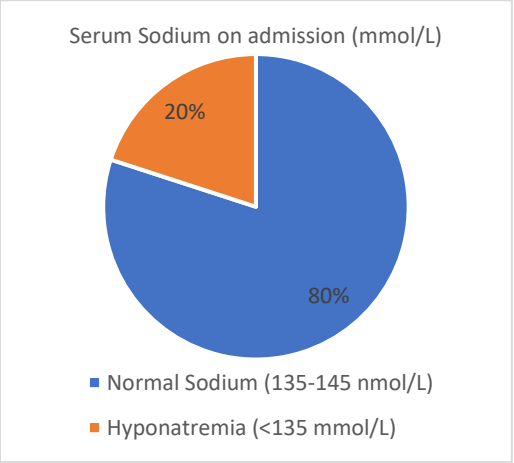

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Figure – 2: Distribution of serum Sodium on admission (mmol/L) (*n*=100)

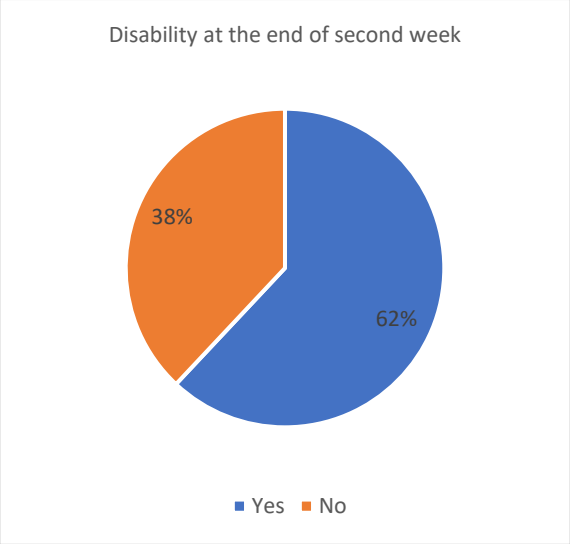

Figure – 3: Distribution of disability at the end of the second week (*n*=100)

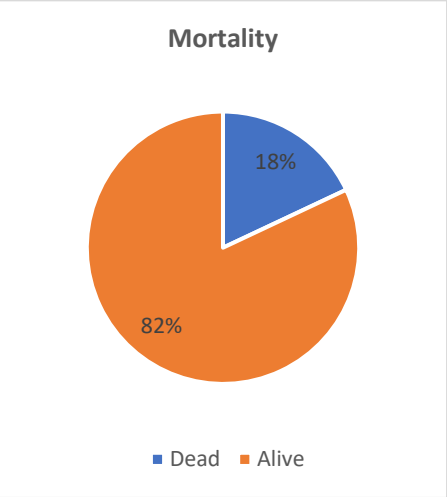

Figure – 4: Distribution of mortality during the first two weeks (*n*=100)

DISCUSSION

In the present study, the clinical characteristics, serum sodium levels, and short-term outcomes of 100 patients with spontaneous intracerebral hemorrhage (S-ICH) admitted to a tertiary hospital in Bangladesh were evaluated. The demographic profile revealed that the majority of patients were aged between 61 and 70 years, with over one-third falling within this age group. This aligns closely with findings from Wang et al., who reported that S-ICH primarily affects older populations, particularly those above 60 years of age, across multiple Chinese hospitals[19]. Similarly, Rashid et al. observed that in Bangladeshi settings, the average age of S-ICH onset skews toward older adults, with males more frequently affected, as also reflected in our study with a male predominance of 57%[20]. The higher rural representation (66%) in our cohort may reflect disparities in healthcare access, consistent with socioeconomic patterns influencing stroke incidence described in the U.S. inpatient study by Javalkar et al[21]. Risk factor analysis revealed that hypertension was present in 68% of cases, followed by smoking (39%) and diabetes (19%). These findings reinforce hypertension as the dominant contributor to spontaneous ICH, as demonstrated by Talha et al. in a case-control study in Bangladesh, which identified hypertension as the most significant non-genetic factor[9]. Brott et al. also confirmed hypertension's role as a leading modifiable risk, increasing S-ICH risk nearly five-fold[22]. Our data on smoking and diabetes prevalence parallels that of Cho et al. and Jolink et al., who reported similar associations between smoking and diabetes with increased risk and poor prognosis in S-ICH patients[23,24]. Clinical presentations in our cohort were dominated by headache (82%), hemiplegia or hemiparesis (73%), and vomiting (60%). These findings are consistent with those of Rashid et al., whose hospital-based analysis in Dhaka also identified headache and hemiparesis as the most common initial complaints among S-ICH patients[20]. Similarly, Danovska et al. highlighted that neurological symptoms at admission, such as motor deficits and consciousness deterioration, serve as early prognostic indicators[25]. Etiologically, hypertensive S-ICH accounted for 68% of our sample. This figure aligns with previous reports that estimate hypertensive arteriopathy as responsible for up to 70–90% of spontaneous ICH cases globally[26]. The higher incidence of hypertensive S-ICH in our study is also consistent with findings from Yakushiji et al., who reported that East Asian populations have significantly higher rates of hypertensive S-ICH compared to Western populations[27]. Anatomically, the putamen was the most frequent site of hemorrhage (48%), which aligns with both Kase's findings and more recent regional data from Sharkar et al., who confirmed deep cerebral hemorrhages, especially in the basal ganglia, as dominant sites in Bangladeshi ICH cohorts[26,28]. A key biochemical focus of our study was admission serum sodium levels. Hyponatremia (serum sodium <135 mmol/L) was found in 20% of patients, while the rest had normal sodium levels. This is comparable to findings by Gray et al., who reported a 24% incidence of hyponatremia in hospitalized ICH patients and highlighted its association with increased complications and longer hospital stays[29]. Our findings are further supported by Mailuhu et al., who demonstrated a significant correlation between low serum sodium and greater S-ICH severity[30]. Regarding short-term outcomes, our study recorded an in-hospital mortality rate of 18% and a disability rate of 62% at the end of the second week. These outcomes, while notable, are lower than the 30–40% mortality rates reported in studies by Nzwalo et al. in Portugal and Troberg et al. in Sweden, possibly due to variations in patient selection, hospital resources, and stroke unit care availability[31,32]. Nonetheless, the high disability burden aligns with data from Alexandrova & Danovska, who found that poor discharge outcomes were strongly associated with biochemical and clinical markers of S-ICH severity[33]. Overall, the findings from our study are consistent with regional and international

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evidence, particularly regarding risk factors, anatomical distribution, biochemical disturbances, and short-term outcomes in spontaneous ICH. The inclusion of serum sodium levels as a prognostic marker in this cohort adds to the growing evidence supporting its clinical relevance. This emphasizes the need for early identification of modifiable risks and physiological imbalances to optimize management and improve patient outcomes in low-resource settings like Bangladesh.

Limitations of The Study

The study was conducted in a single hospital with a small sample size. So, the results may not represent the whole community.

CONCLUSION

This study highlights the clinical relevance of serum sodium levels in patients with spontaneous intracerebral hemorrhage (ICH) and their association with early hospital outcomes. The findings reaffirm hypertension as the most prevalent risk factor, with the putamen being the most common site of hemorrhage. Hyponatremia on admission was observed in a notable proportion of patients and may serve as a valuable marker for identifying individuals at greater risk for poor neurological outcomes. A considerable proportion of patients developed disability during hospitalization, and in-hospital mortality remained significant despite prompt care. These observations highlight the importance of early risk stratification using both clinical and biochemical parameters—such as serum sodium—to guide management in resource-constrained settings. Further large-scale, prospective studies are needed to validate these findings and develop standardized protocols for incorporating serum sodium monitoring into acute stroke care in low- and middle-income countries like Bangladesh.

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Ethical approval: The study was approved by the Institutional Ethics Committee

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