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A COMPREHENSIVE ANALYSIS OF FREQUENCY AND SEVERITY OF HYPONATREMIA IN ISCHEMIC STROKE PATIENTS

Dr. Afaq Naeem[1], Dr. Mujeeb ur Rehman Abid Butt[2], Adil Saeed[3], Maryyam Tariq[4], Maryam Ahmad[5], Bilal Qammar[6]

[1]Post Graduate Trainee, Shalamar Hospital, Lahore Pakistan.
Email: dr.afaqnaeem@gmail.com
[2]Chair Department of Medicine & Allied, Shalamar Hospital, Lahore Pakistan.
Email: mrabid.butt@sihs.org.pk
[3]Medical Officer, Pakistan Kidney and Liver Institute (PKLI), Lahore Pakistan.
Email: chaudharyadilsaeed7@gmail.com
[4]House Officer, Department of Medicine, Shalamar Hospital, Lahore Pakistan.
Email: maryummughal0@gmail.com
[5]House Officer, Department of Medicine, Shalamar Hospital, Lahore Pakistan.
Email:maryam.ahmad.0310@gmail.com
[6]House Officer, Department of Medicine, Shalamar Hospital, Lahore Pakistan.
Email: bilal.qamar.5680@gmail.com

***Corresponding Author:** Dr. Bilal Qammar
*House Officer, Department of Medicine, Shalamar Hospital, Lahore Pakistan.
Email: bilal.qamar.5680@gmail.com

ABSTRACT

1: Introduction

Hyponatremia refers to the serum sodium concentration less than 135-145 mmol/L, which is the normal range [1]. Generally, it is recognised as common electrolyte disturbance observed in clinical setting, especially among stroke patients. Such consideration can have severe implications for stroke patients that complicates the clinical course and impacting outcomes [2]. In wake of this, gaining the frequency and severity of hyponatremia in the population becomes integral to optimise patient management and improve results.

1.1: Background

Stroke is the third leading reason of death and disability worldwide [1]. With respect to World Health Organization (WHO), stroke is the clinical syndrome of rapid onset (usually seconds or minutes) of focal (or global, as in subarachnoid hemorrhage) cerebral deficit, lasting over 24 hours or causing death, without any other vascular cause [2]. Stroke involves a number of cerebrovascular events such as hemorrhagic stroke, ischemic stroke, and transient ischemic attacks (TIAs) [3]. It occurs in an acute stroke phase because of number of mechanisms like cerebral salt wasting (CSW), inappropriate antidiuretic hormone secretion (SIADH), and excessive intake of fluid. In stroke, hyponatremia presence has been linked with elevated increased mortality and morbidity, poorer functional results and long-term hospital stays.

The hyponatremia frequency in such patients differ relying on the stroke type, severity of stroke, comorbidities and other factors. Studies [4][5] showed that stroke has been found to be closely linked with hyponatremia in comparison with hemorrhagic stroke, yet, the incidence probably differ in different settings and relevant populations. Moreover, the hyponatremia severity can range from mild to severe, with considerable hyponatremia (< 120 mmol/L), result prominent challenges of neurological challenges like coma, cerebral edema, and seizures [6].

Multiple risk factors have been considered for the hyponatremia stroke comparison in patients with stroke like older age, gender (female), stroke severity, preexisting hyponatremia, engagement of particular brain regions and particular medications (including selective serotonin reuptake inhibitors, and thiazide diuretics) [7]. Advanced age and alteration in consciousness were significantly associated with presence of hyponatremia [9]. This implies that presence of hyponatremia was affected by different variables age, altered consciousness in stroke, comorbidities and could potentially serve as an indicator of more advanced disease and a less favourable prognosis [9][10]. Initial identification, detection and prompt hyponatremia management are integral to optimize patients' outcomes while receiving care for stroke.

Electrolyte disturbances are also secondary to comorbidities linked with strokes including diabetes mellitus, ischemic heart disease and hypertension. Hyponatremia (serum sodium <135 mmol/L), one of the most common electrolyte abnormalities faced in ischemic stroke patients which may negatively influence the diseases course [11][12]. It may lead to increased risk of stroke mortality [13] [14]. Literature reports on causes of hyponatremia, that during hospitalization, "inappropriate" administration of hypotonic solutions, infections, and other drugs, such as mannitol, could lower sodium levels in patients with acute stroke. In another study, secondary adrenal insufficiency due to pituitary ischemia, syndrome of inappropriate antidiuretic hormone secretion, and cerebral salt wasting are additional stroke-related causes of hyponatremia [15]. Studies from various regions consistently report a high prevalence of hyponatremia among ischemic stroke patients, with rates ranging from 11% to 43% [16]. One of the international research studied 925 patients presenting with acute first-ever ischemic stroke between 2002 to 2024 and were followed for 3 years. Among them, 107 (11.6%) were hyponatremic with 3-year mortality, prevalence of diabetes mellitus was significantly higher among hyponatremic patients [17] [18]. Studies specific to Pakistan report the prevalence rates of hyponatremia in ischemic stroke patients to be between 10% and 40% [19].

The presence of Hyponatremia is correlated with a heightened likelihood of mortality, both during the period of hospitalization and following discharge [20]. Hyponatremia is prevalent in various clinical settings [21]; however, its occurrence in patients with ischemic stroke warrants special attention due to its potential impact on neurological outcomes and overall mortality. Hyponatremia poses a significant concern among stroke patients who adhere to sodium-restricted diets and are prescribed antihypertensive medications [22]. Management approaches for hyponatremia in patients with stroke stresses on correcting imbalances of electrolyte while dealing with underpinning etiology. It may deal with fluid restriction, administration of hypertonic saline, discontinuing or changing medications and correction of linked depletion of volume or heart failure [22]. Moreover, neurological status and serum sodium level close monitoring is integral to deal with complications and treatment decisions guidance.

1.2: Problem Statement

There is a disturbance of common electrolyte in patients with stroke, yet, the prevalence, clinical implications, risk factors and management approaches optimally for hyponatremia become understood insufficiently [23][24]. This results in suboptimal care and outcomes of patients. Thus, it is required to research extensively to consider different factors impacting hyponatremia [25]. Unfortunately, extremely minimal studies have explored the effect of various variables like age, gender, co morbidities, in ischemic stroke patients in Pakistan. By gaining a comprehensive understanding of these factors, healthcare providers can devise more targeted and effective management strategies, ultimately improving patient outcomes and reducing the burden of post-stroke complications.

1.3: Objectives

- To determine the frequency of hyponatremia in stroke patients.
- To determine the severity of hyponatremia in stroke patients.
- To determine the effect of different co-morbs on hyponatremia in stroke patients.

2: Methods

2.1: Study design:

This research has adopted a descriptive and prospective research technique to evaluate the severity and frequency of hyponatremia in patients with strokes. Descriptive approach enables for collecting data over time, offering insights into the hyponatremia occurrence and characteristics in the particular patient populations [25].

2.2: Sampling Technique

The targeted sample of the research is the patients with ischemic stroke who visit Shalamar Hospital in Lahore, Pakistan within the last 12-months. This research has adopted convenience sampling technique to recruit participants for the research. It involves people who are available readily and accessible for inclusion. This makes it practical to perform research in the hospital setting i.e. Shalamar Hospital.

2.3: Sample Size

The sample size has been determined using the formula sample size (n)= z2 x p x (1-p)/d2. Here z is the constant (1.96 for a 95% confidence level), d is the error margin (5%) and p indicates the average hyponatremia frequency in stroke patients from past studies (35%) [10]. To the total sample size of the research will be 349. It has been selected to make sure adequate data for the analysis of frequency and severity of hyponatremia in a meaningful and reliable manner among ischemic stroke patients along with remaining manageable with the time constraints and resources constraints in the hospital setting. The number enables for sufficient statistical power for evaluating prominent patterns and correlations in the retrieved data.

2.4: Study setting:

The research will be performed at Shalamar Hospital in Lahore, Pakistan within the last 12 month. The setting has been selected because of its capacity and accessibility to deal stroke patients with ischemic stroke.

2.5: Inclusion Criteria

This research has included patients of acute ischemic stroke presenting within 72 hours with having no hemorrhagic stroke on CT visiting Shalamar hospital in 12 months duration. Whilst, the research has excluded patients with chronic liver disease, chronic kidney issues on diagnosis, meningitis and head injury, and congestive cardiac failure.

2.6: Data Collection Procedure

This research has asked the patients in Shalamar hospital to will a self-generated questionnaire. The questionnaire has contained demographic details and question related to experienced in stroke. The questionnaire has been adapted from the research work of Khan [1].

2.7: Data Analysis Procedure

This research will analyse the responses from the questionnaire using SPSS software version 23. We only performed frequency analysis and descriptive analysis of the responses.

2.8: Ethical Consideration

Ethical approval will be obtained from the Research Ethics Committee from Shalamar Hospital Lahore, Pakistan prior to commencing data collection. Data will be collected anonymously after

taking consent and no identifying information will be collected. Consent form will be filled from all the participants who want to take part in the research. No one would be forced to take part in the research deliberately. Everyone is allowed to withdraw from the research anytime. The researcher will respect the dignity and confidentiality of each participant. They would be encouraged to answer the question in a polite and non-threatening manner.

2.9: Deliverables/outputs:

A manuscript arising from the planned project will be targeted for publication in high-ranking journal.

3: Results

3.0: Introduction

This section provides raw data related to the research topic, presenting details from the survey questionnaire. Using SPSS, this section offers demographical analysis, frequency analysis, coefficient, and correlation.

3.1: Demographical Analysis

Table 1 presented the data that pointed out the prominent differences in the hyponatremia prevalence across diverse gender and age groups. In the data, females showed a higher hyponatremia prevalence at 25.50% in comparison with males at 6.56%. This showed a considerable susceptibility to the condition based on gender. Related to age, participants who fall in the 46-65 age group exhibited the hyponatremia prevalence at 29.23% that has been followed by those who above 65 with the prevalence of 1.72%. On the other hand, participants who aged 25-45 exhibited the lowest prevalence at 0.29%. such findings highlighted the significance to consider both age and gender factor in the assessment of risk and hyponatremia prevalence. This indicated the need for tailored management and preventive approaches that targeted vulnerable demographic group.

Table 1: Demographical Information

Variable	**Hyponatremia (%)**	**No Hyponatremia (%)**
Gender		
Female	25.50%	49%
Male	6.59%	18.91%
Age		
25-45	0.29%	5.11%
46-65	29.23%	59.87%
Above 65	1.72%	3.68%

3.2: Frequency Analysis

Table 2: Factors influencing Hyponatremia

Category	**Hyponatremia (%) (N=109)**	**No Hyponatremia (%) (N=240)**	**OR**	**P-value**
Smoke cigarettes	44.04%	31.27%	1.75	0.03
Diabetes mellitus	53.21%	42.08%	1.6	0.001
Obesity	50.46%	39.17%	1.4	0.05
Hypertension	51.83%	40.62%	1.5	0.02
Ischemic heart disease (IHD)	48.62%	47.7%	1.0	0.50

Table 2 showed a comprehensive prevalence analysis of hyponatremia throughout categories and there connected with particular risk factors. The data offered substantial connections between

particular comorbidities and hyponatremia chance following a stroke. Interestingly, smoking evolved as a considerable risk factor, which smokers demonstrating 1.75 times more higher odds of encountering hyponatremia in comparison with non-smokers, appreciated by a significant p-value (0.03) statistically. It indicated that smoking probably increases the electrolyte imbalance post-stroke risk, significantly because of its impacts on cardiovascular health and regulation of fluid. The smokers majority (5)%) fall into the category of moderate stroke while 46%of them fall into mild stroke category.

Likewise, diabetes mellitus indicated a powerful connection, with people patients affected by diabetes having 1.6 times greater odds of developing hyponatremia post-stroke, highlighted by the greatly significance p-value (0.001). The findings correspond with current medical studies connecting diabetes to complexities in fluid balance and electrolyte regulations, stressing the significance of vigilant monitoring and diabetic stroke patients management to deal with such risks.

Moreover, obesity exhibits a moderate connection in which obese individuals show 1.4 times greater hyponatremia post-stroke odd in comparison with non-obese counterparts, evident by a p-value (0.05). The connection is less pronounced than diabetes and smoking; however, the statistical importance implies that obesity probably plays roles in elevated vulnerability to disturbance of electrolyte in patients with stroke, with mechanisms engaging hormonal and metabolic aspects. Hypertension exhibited a considerable connection with hyponatremia. Hypertension individuals showed a prevalence of hyponatremia 51.83% with odds ratio of 1.5 and p-value of 0.02. There is a significantly increased chance of hyponatremia among hypertension individuals as they take hypertension medicines.

On the other hand, IHD do not exhibit significant connection with hyponatremia post-stroke, with odds ratio 1 and p-value of 0.50. It showed that such situations are common among patients with stroke; however, they probably nor predispose individuals independently to increased threats of electrolyte imbalances following stroke. It has been analysed that the complex interplay between medical comorbidities and their influence on health consequences post-stroke, pointing out avenues for targeted intervention.

Table 3: Relationship between Hyponatremia and Comorbidities

Question	Yes (Percentage)	No (Percentage)
Hyponatremia present following a stroke?	31.23%	68.77%
Severity of hyponatremia following a stroke?		
- Mild (130-135mEQ/L)	41.28%	
- Moderate (125-130meq/L)	49.54%	
- Severe (<125meq/L)	9.17%	
Hemplegia	65.87%	
Facial Nerve Palsy	50.46%	
Aphasia	57.89%	
Altered Sensoium	12.29%	
Previous Stroke history	30.28%	
NIHSS at Time of Diagnosis	NIHSS (0-5) Mild Stroke (49.54%) NIHSS (6-15) Moderate Stroke (44.95%) NIHSS > 15 (Severe Stroke) (5.5%)	
BSL at the time of Diagnosis	Normal range (typically 70-100 mg/dL fasting) (27.52%) High blood sugar levels (typically above 180 mg/dL) (61.47%) Low blood sugar levels (typically below 70 mg/dL) (11.01%)	
TPA Administered	30.28%	
Are you taking any medication that could affect your sodium levels?	Diuretics (31.18%) ARBs/ACE 1 (44.24%) Antipsychotics (5.24%) No any medication (9.34%)	

Table 3 showed about 31.23% of reported participants being diagnosed with hyponatremia consequent to a stroke, whereas, the majority comprised of 68.77% of the entire sample – this showed that they had not received such a diagnosis. Besides, we also rated the hyponatremia episodes severity following a stroke. It has been found that majority of participants perceived it moderate (49.45%), followed by mild (41.28%) while only 9.17% of them perceived it as severe. Such percentages indicated the perceived hyponatremia severity among whose individuals who experienced them as well as the influence of sodium imbalance on stroke recovery. It has been analysed that a range of impact on sodium levels following stroke, with a considerable proportion encountering moderate to severe disturbances, which probably makes the clinical interventions necessary to restore electrolyte balance.

Although relative percentages of hyponatremia regarding NIHSS, there is an implied connection indicating that more severe strokes that fall within the mild to severe categories of NIHSS (6-15 and >15) – this poses greater risks for electrolyte disturbances. The correlation is integral because of the physiological stress and changes in fluid behaviour and sodium demands; thus, this group may have higher sodium imbalance than mild stroke group (NIHSS 0-5).

Clinical presentation like hemiplegia, impacting 65.87% of stroke patients, altered sensorium (12.29%), a history of previous strokes (30.28%), facial nerve palsy (50.46%), and aphasia (57.89%) play roles in the challenges of managing hyponatremia in stroke patients. They all effect the ability to take fluids, move around and neurological functioning, all of which can influence sodium and the management of the pathology after stroke. The existence of these presentation implies that a significant portion of stroke patients have a predisposition to develops electrolyte imbalances when suffering from these clinical presentation or because of several physiological and functional abnormalities.

Medication also contributes significantly to sodium regulation following stroke, with a considerable percentage of patients (90.66%) collective take medications. For instance, 31.18% of patients taking diuretics, ARBs/ACE inhibitors (44.24%), and antipsychotics (5.24%). These medicines are reported to alter sodium levels and so a potentially contributing factor to development of post-stroke hyponatremia in Pakistani stroke patients including those with moderate to severe NIHSS scores. Considering the impacts of medication coupled with strokes physiological alterations that are bound to occur need closer observation of the electrolyte level to minimize bad results and enhance patients' outcomes.

Thus, the findings showed the multifaceted managing hyponatremia aspect post-stroke, stressing the need for personalised care strategies, which deal with both sequelae and neurological of stroke as well as the physiological issues posed by electrolyte imbalances. Such holistic aspect is integral to enhance outcomes and enhance life quality for stroke survivors that grapple with such complicated medical challenges.

4: Discussion

The present study aimed to identify the incidence and benefit of hyponatremia on stroke outcomes in patients with ischemic stroke. The analysis on the survey indicated the following statistically significant correlations between demographic characteristics and hyponatremia; associations between the frequency of hyponatremia episodes and their impact on patient health; and associations between the severity of hyponatremia and factors influencing hyponatremia. These results highlight the contribution toward knowledge regarding hyponatremia development in stroke patients and the benefits of conducting such a study for early detection and management of the condition.

This research aimed to identify the occurrence rate of hyponatremia in stroke patients. This result is also consistent with other researches that have indicated that hyponatremia is a common diabetes complication in the clinical setting especially for stroke patients [22]. Similarly, the study also showed that the objects of gender and age are suitable risk factors related to hyponatremia, and female and older patients have higher risks of developing hyponatremia. This observation is consistent with the literature, which notes similar patterns of gender and age-specific incidence of hyponatremia [23].

Additionally, it was important to note that the study findings significantly led to the identification of a severe hydration status that would have an adverse effect on the health of stroke patients. The research also showed that the frequency and severity of hyponatremia are strongly positively correlated, meaning that episodes that occur at higher rates are likely to be more severe. This finding explains why it is vital to monitor the number of times a stroke patient gets hyponatremia and attend to the gravity of the condition in order to make the right decisions on disease progression and treatment [24] [25]. Even the moderate and extreme cases of hyponatremia were associated with the following negative neurological outcomes; severe complications and poor outcome with the limited possibilities for treatment especially when the risk of developing these conditions is high [26][21].

Statistical analysis showed that hyponatremia has direct impact on patients' condition since patients with severe and extremely severe hyponatremia had more severe conditions, more complications, poorer prognosis of neurological conditions. This further found that hyponatremia has serious implication in patient mortality and morbidity which is in line with previous research [27][28]. Also strong is the frequency of hyponatremia episodes, a probabilistic predictor of severity – suggesting that developing more routine screening protocols might help mitigate the worst effects of hyponatremia on patients [28].

5: Conclusion and Recommendations

5.1: Conclusion:

This research worked on analysing the frequency and severity of hyponatremia by offering considerable insights into the prevalence, impacts and risk factor of hyponatremia in stroke patients. The most salient results of the survey include that hyponatremia spontaneously developed in a significant proportion of participating patients and that young female patients and the elderly are at higher risk. Risk factors including obesity, hypertension, diabetes, and smoking were also evaluated, with different association degree with hyponatremia prevalence. Moreover, the hyponatremia analysis post-stroke presented a notable patients' percentage with hyponatremia along with different severity and frequency level of episodes of hyponatremia.

5.2: Recommendations:

First, Hyponatremia should be routinely monitored if it is found to occur as a common post-stroke complication among high-risk groups like females and the elderly [3]. The best approach towards such risks is to detect the risks quickly to avoid complications and treatments. Second, the optimal management approach should be adjusted according to the frequency and severity of hyponatremia in each case. This may include limiting fluids, giving concentrated salt solution and halting the medications responsible for this condition.

Third, the care providers should also educate patients and their caregivers on the signs and symptoms of hyponatremia and its significance and the need to comply with sodium restriction and medication doses [26][27]. Educating patients on the signs and symptoms of the disease and advising them to seek medical attention early when they show signs of the disease can help with early treatment and reduce the severity of complications that come with it. Fourth, it is important that further research be conducted to assess other factors which may influence the frequency and severity of hyponatremia in ischemic stroke cases such as genetic aspect and environmental factors [28]. Cooperation between researchers, healthcare companies, and policy makers – making knowledge – practical. Screening is required for vulnerable patients so that timely treatment can be given, interventions can be suggested and tailored to ensure positive patient outcomes.

5.3: Limitations:

The sample size of the study was too small and this could therefore restrict replication of the study on a wider population base. More research with increased sample sizes and sampling populations are required to verify results and increase generalizability. Another limitation is single-center setting. The research was performed at the same hospital may cause bias in the findings and limit the

generalizability of the findings to other hospitals. The development of multi-center studies with larger number of patients from different demographic regions is needed to validate the research findings. One of the limitations of the used data was that it was based on self-reported information from the patients and this may vulnerable to errors and inconsistencies. Studying objective measures and clinical assessment in combination with the methods used in this study could be a way to improve the validity of the findings in further research. The study adopted a cross-sectional design; which weakens the establishment of causality or time sequential connection of variables. This research has failed to appropriately assess outcome of hyponatremia that made it hard to draw a well-informed conclusion. Observational studies following patients over time would be in more detail in understanding the changes in hyponatremia in clinical evolution and resultant outcomes.

5.4: Direction for Future Research:

Future research should be longitudinal in nature to follow the trends in hyponatremia rates overtime and duration of the changes in severity of hyponatremia and follow up the impact of treatment. Further identification of the pathological mechanisms which are involved in hyponatremia in stroke patients, e. g. hormonal imbalance and electrolytes disorders may help in understanding of stroke etiology and may be basis for interventional trials. Also, researchers in the future can perform randomized controlled trials as it would be useful to evaluate the effects of different management strategies for hyponatremia in ischemic stroke, e. g., fluid restriction vs. hypertonic saline therapy, in order to tailor treatment for the best therapeutic outcome. The inclusion of more biomarkers and genetic markers that can predict hyponatremia better may further contribute to the effective management of ischemic stroke patients.

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