Middle East Research Journal of Pharmaceutical Sciences
ISSN 2789-7702 (Print) & ISSN 2958-213X (Online)
Frequency: Bi-Monthly
DOI: https://doi.org/10.36348/merjps.2024.v04i04.001

KUWAIT SCHOLARS PUBLISHER
Website: http://www.kspublisher.com/
Email: office@kspublisher.com

Electrolytes Status in Acute Stroke Patient in Rajshahi Medical College Hospital

Md Azizul Haque[1*], Mohammad Mahbubur Rahman Khan[2], Pijush Kundu[3]
[1]Assistant Professor, Department of Medicine, Udayan Dental College, Rajshahi, Bangladesh
[2]Professor and Head, Department of Medicine, Rajshahi Medical College, Rajshahi, Bangladesh
[3]Professor, Department of Neuromedicine, Naogaon Medical College, Naogaon, Bangladesh

Abstract: ***Background:*** Stroke is a major cause of mortality and morbidity worldwide, significantly impacting patients and healthcare systems. Electrolyte imbalances are common in acute stroke patients and can influence clinical outcomes. This study investigates the electrolyte status in acute stroke patients admitted to Rajshahi Medical College Hospital ***Objective:*** To evaluate the electrolyte status (sodium and potassium levels) in acute stroke patients and its association with stroke types (Ischaemic and haemorrhagic) and clinical outcomes. ***Method:*** A cross-sectional study was conducted over two years (July 2017 to June 2019) in the Medicine and Neuromedicine Department of Rajshahi Medical College Hospital. A total of 104 acute stroke patients were included. Serum sodium and potassium levels were measured upon admission. Sociodemographic data, stroke types, and electrolyte levels were analyzed. ***Results:*** Among the 104 stroke patients, 71 (68.27%) had ischaemic stroke, and 33 (31.73%) had haemorrhagic stroke. The age distribution was highest in the 50-60 years group (34.62%). Males comprised 58.65% of the patients. Sodium levels were normal in 61.54% of patients, high in 2.88%, and low in 35.58%. Potassium levels were normal in 68.27% of patients, high in 10.58%, and low in 21.15%. No significant difference was found in sodium ($p>0.05$) and potassium ($p>0.05$) levels between ischaemic and haemorrhagic stroke patients. ***Conclusions:*** Electrolyte imbalances are prevalent in acute stroke patients, but no significant differences were observed between ischaemic and haemorrhagic stroke types. Regular monitoring and correction of electrolytes are crucial in managing stroke patients to improve outcomes.

Keywords: Acute stroke, Electrolytes.

Research Paper

***Corresponding Author:**
Md Azizul Haque
Assistant Professor, Department of Medicine, Udayan Dental College, Rajshahi, Bangladesh

How to cite this paper:
Md Azizul Haque *et al* (2024). Electrolytes Status in Acute Stroke Patient in Rajshahi Medical College Hospital. *Middle East Res J. Pharm. Sci*, *4*(4): 51-58.

Article History:
| Submit: 06.07.2024 |
| Accepted: 05.08.2024 |
| Published: 19.08.2024 |

INTRODUCTION

Stroke is the most common neurological emergency, accounting for a significant proportion of morbidity and mortality worldwide. It ranks as the third most common cause of death in developed countries, following ischemic heart disease and cancer [1]. Globally, stroke impacts millions of lives each year, contributing extensively to long-term disability and imposing substantial economic and social burdens on patients and their families [2].

The incidence of stroke is increasing, particularly in developing countries where the adoption of unhealthy lifestyles and a lack of health awareness exacerbate the problem. In these regions, the growing burden of stroke is evident, with many patients suffering from severe outcomes due to inadequate medical care and delayed interventions. In Bangladesh, for instance, stroke is the third leading cause of death, with a prevalence rate of 370 per 100,000 individuals aged 40 and above [3]. This high prevalence underscores the need for improved healthcare strategies and public health interventions to manage and prevent stroke effectively.

Electrolyte imbalance is a common complication in acute stroke patients, significantly influencing clinical outcomes. Electrolytes such as sodium, potassium, calcium, and magnesium play crucial roles in maintaining cellular function, neuronal excitability, and overall homeostasis. Abnormal levels of these electrolytes can exacerbate neurological deficits, affect prognosis, and complicate the management of stroke patients [4].

Hyponatremia, or low sodium levels, is frequently observed in stroke patients. It can result from the syndrome of inappropriate antidiuretic hormone secretion (SIADH) or cerebral salt-wasting syndrome (CSWS). Hyponatremia can lead to increased intracranial pressure, cerebral edema, and worsened neurological outcomes [5]. Conversely, hypernatremia,

or high sodium levels, can arise from dehydration or excessive sodium intake, potentially causing brain shrinkage and increased mortality.

Potassium levels are critical for maintaining membrane potential and neuromuscular function. Hypokalemia, or low potassium levels, can cause muscle weakness, arrhythmias, and exacerbate ischemic brain injury [6]. Hyperkalemia, although less common, can lead to cardiac arrest and requires immediate management. Calcium plays a pivotal role in neurotransmitter release and neuronal excitability. Hypocalcemia, or low calcium levels, can lead to neuromuscular irritability, seizures, and cardiac dysfunction. On the other hand, hypercalcemia, or high calcium levels, can cause lethargy, confusion, and exacerbate stroke-related brain injury [7].

Magnesium acts as a neuroprotectant by inhibiting excitatory neurotransmission and reducing calcium influx into neurons. Hypomagnesemia, or low magnesium levels, can exacerbate excitotoxicity and worsen stroke outcomes [8]. Correcting magnesium levels has shown potential benefits in improving neurological recovery post-stroke [9].

Given the critical role of electrolyte balance in stroke outcomes, it is essential to understand the electrolyte status of stroke patients comprehensively [10]. This study aims to investigate the electrolyte status of acute stroke patients admitted to Rajshahi Medical College Hospital. By analyzing the levels of key electrolytes (sodium, potassium, calcium, and magnesium), we seek to understand their impact on the clinical outcomes and prognosis of stroke patients in this setting.

OBJECTIVES

General Objective

- To evaluate the electrolyte status (sodium and potassium levels) in acute stroke patients at Rajshahi Medical College Hospital and determine its association with stroke types and clinical outcomes.

Specific Objectives

- Assess the prevalence of sodium and potassium imbalances in acute stroke patients.
- Compare serum sodium levels between ischaemic and haemorrhagic stroke patients.
- Compare serum potassium levels between ischaemic and haemorrhagic stroke patients.
- Analyze the sociodemographic profile of acute stroke patients.
- Determine the relationship between electrolyte imbalances and stroke severity.
- Evaluate the impact of smoking and alcohol history on electrolyte levels.
- Provide management recommendations for electrolyte imbalances in stroke patients.

MATERIAL AND METHODS

Study Design

This cross-sectional study was conducted over two years, from July 2017 to June 2019, in the Medicine and Neuromedicine Departments of Rajshahi Medical College Hospital. A total of 104 acute stroke patients were included in the study. Patients were selected based on clinical diagnosis and imaging results confirming either ischaemic or haemorrhagic stroke. Serum electrolyte levels (sodium and potassium) were measured upon admission. Sociodemographic data, stroke types, and clinical outcomes were also recorded. Data were analyzed to assess the prevalence of electrolyte imbalances and their association with stroke type and severity.

Inclusion Criteria

- Patients aged 18 years and above.
- Patients admitted to Rajshahi Medical College Hospital with a confirmed diagnosis of acute stroke (ischaemic or haemorrhagic) based on clinical assessment and imaging studies.
- Patients who provided informed consent to participate in the study.
- Patients with available serum electrolyte measurements (sodium and potassium) upon admission.

Exclusion Criteria

- Patients below 18 years of age.
- Patients with a history of recent trauma, surgery, or other conditions that could influence electrolyte levels.
- Patients with chronic kidney disease, liver disease, or endocrine disorders affecting electrolyte balance.
- Patients on medications known to affect electrolyte levels, such as diuretics or steroids.
- Patients who did not provide informed consent.
- Patients with incomplete clinical or laboratory data necessary for the study analysis.

Data Collection

Data were collected from 104 acute stroke patients admitted to the Medicine and Neuromedicine Departments of Rajshahi Medical College Hospital from July 2017 to June 2019. Sociodemographic information (age, sex, occupation, educational status, and monthly income) and clinical data (stroke type, smoking and alcohol history) were recorded. Serum sodium and potassium levels were measured upon admission using standard laboratory procedures. Patients were diagnosed with either ischaemic or haemorrhagic stroke based on clinical assessments and imaging studies. Data were

systematically documented in structured forms and entered into a database for analysis to assess the prevalence and impact of electrolyte imbalances.

Data Analysis

Data were analyzed using SPSS version 26. Descriptive statistics were used to summarize sociodemographic and clinical characteristics. The prevalence of electrolyte imbalances (sodium and potassium) was calculated, and comparisons between ischaemic and haemorrhagic stroke patients were performed using chi-square tests for categorical variables and t-tests for continuous variables. P-values <0.05 were considered statistically significant. Logistic regression analysis was conducted to determine the association between electrolyte imbalances and stroke severity. Results were presented in the form of tables and figures to illustrate the key findings of the study.

Ethical Considerations

The study was approved by the Ethical Review Committee of Rajshahi Medical College Hospital. Informed consent was obtained from all participants or their legal guardians. Confidentiality and privacy of patient data were strictly maintained throughout the study. Participation was voluntary, and patients were free to withdraw at any time without affecting their medical care. The study adhered to the principles outlined in the Declaration of Helsinki for ethical medical research.

RESULTS

The results of the study on electrolyte status in acute stroke patients at Rajshahi Medical College Hospital are presented below.

Table 1: Sociodemographic Profile of the Case Study (N=104)

Variable	Total n (%)	P Value
Age Distribution		
<30 years	3 (2.88)	>0.05
30-40 years	6 (5.77)	
40-50 years	11 (10.58)	
50-60 years	36 (34.62)	
60-70 years	24 (23.08)	
70-80 years	17 (16.35)	
>80 years	7 (6.73)	
Sex		
Male	61 (58.65)	>0.05
Female	43 (41.35)	
Occupation		
Farmer	41 (39.42)	>0.05
Service	15 (14.42)	
Business	12 (11.54)	
Housewife	32 (30.77)	
Student	2 (1.92)	
Others	2 (1.92)	
Educational Status		
Illiterate	36 (34.62)	>0.05
Primary	38 (36.54)	
SSC	21 (20.19)	
HSC	6 (5.77)	
Graduation	3 (2.88)	
Monthly Income		
Upper	11 (10.58)	>0.05
Middle	45 (43.26)	
Lower	48 (46.15)	
Smoking History		
Present	57 (54.81)	>0.05
Absent	47 (45.19)	
Total	104 (100)	

The sociodemographic profile of stroke patients at Rajshahi Medical College Hospital shows that the majority were aged 50-60 years (34.62%), predominantly male (58.65%), and mostly farmers (39.42%). Education levels were generally low, with 36.54% having only primary education and 34.62%

being illiterate. Most patients belonged to the lower-income group (46.15%). Smoking was prevalent in 54.81% of patients, emphasizing its role as a significant risk factor. These findings align with global trends showing higher stroke risk in older, less educated, and lower socioeconomic individuals. The data highlight the need for targeted public health interventions, including education, lifestyle modifications, and smoking cessation programs, to address these risk factors and improve stroke outcomes in this population.

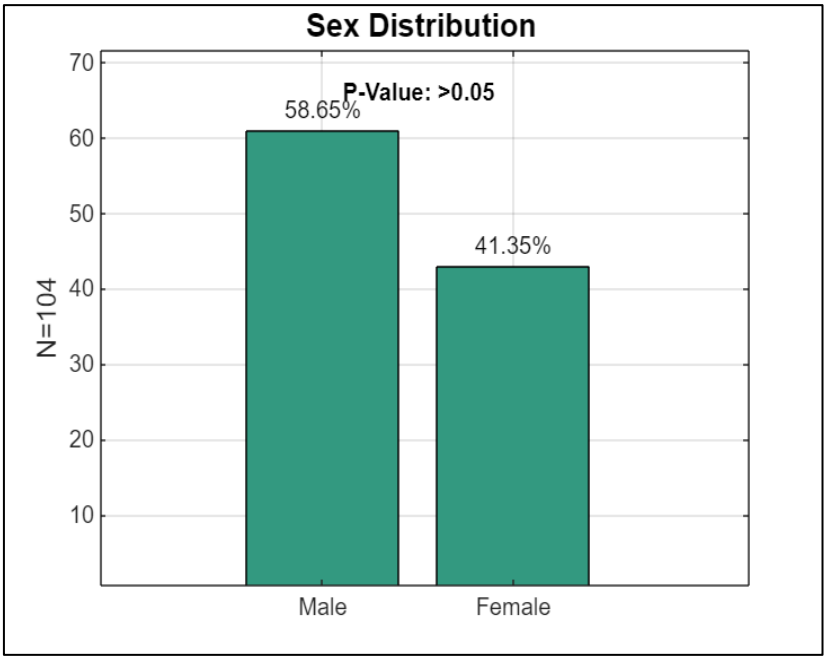

Figure 1: Sex Distribution of Stroke Patients

Showed a higher prevalence in males (61, 58.65%) compared to females (43, 41.35%). The difference was not statistically significant (p>0.05), indicating similar stroke occurrence rates between genders in this study population.

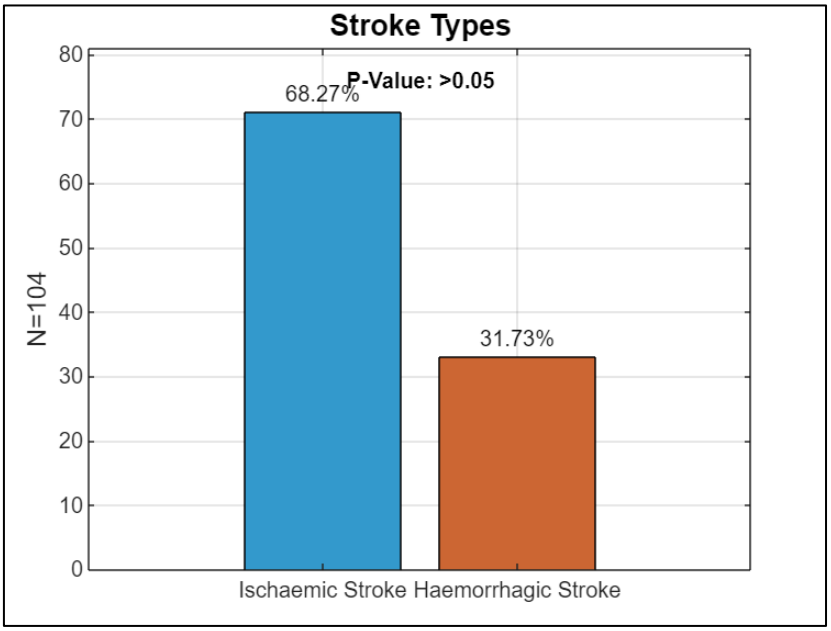

Figure 2: Distribution of Stroke Types Among Patients (N=104)

The distribution of stroke types among patients at Rajshahi Medical College Hospital showed that 71 patients (68.27%) had ischaemic strokes, while 33 patients (31.73%) had haemorrhagic strokes. The difference in the distribution of stroke types was not

statistically significant (p>0.05), indicating a similar pattern of stroke occurrence in this study population.

Table 2: Distribution of Sex Among Patients with Ischaemic and Haemorrhagic Stroke (N=104)

Sex	Ischaemic Stroke N (%)	Haemorrhagic Stroke N (%)	Total N (%)	P Value
Male	47 (45.19)	14 (13.46)	61 (58.65)	0.136
Female	24 (23.08)	19 (18.27)	43 (41.35)	
Total	**71 (68.27)**	**33 (31.73)**	**104 (100)**	

Out of the total 104 stroke patients, 71 (68.27%) had ischaemic stroke and 33 (31.73%) had haemorrhagic stroke. Among the ischaemic stroke patients, 47 (45.19%) were male and 24 (23.08%) were female. Among the haemorrhagic stroke patients, 14 (13.46%) were male and 19 (18.27%) were female. No significant sex difference was found among acute stroke patients (p>0.05).

Table 3: Frequency of Abnormal Serum Sodium in Patients with Ischaemic and Haemorrhagic Stroke (N=104)

Serum Sodium	Ischaemic Stroke (n=71) N (%)	Haemorrhagic Stroke (n=33) N (%)	Total N (%)	P Value (χ^2)
Normal	43 (60.56)	21 (63.64)	64 (61.54)	>0.05
High	3 (4.23)	0 (0.00)	3 (2.88)	
Low	25 (35.21)	12 (36.36)	37 (35.58)	
Total	**71 (100)**	**33 (100)**	**104**	

In this study, high sodium levels were observed in 0% of haemorrhagic stroke patients and 4.23% of ischaemic stroke patients. The mean (±SD) serum sodium level was 136.57 (±5.72) mmol/l in ischaemic stroke patients and 134.98 (±7.37) mmol/l in haemorrhagic stroke patients. Statistically, there was no significant difference in serum sodium levels between ischaemic and haemorrhagic stroke patients (p>0.05).

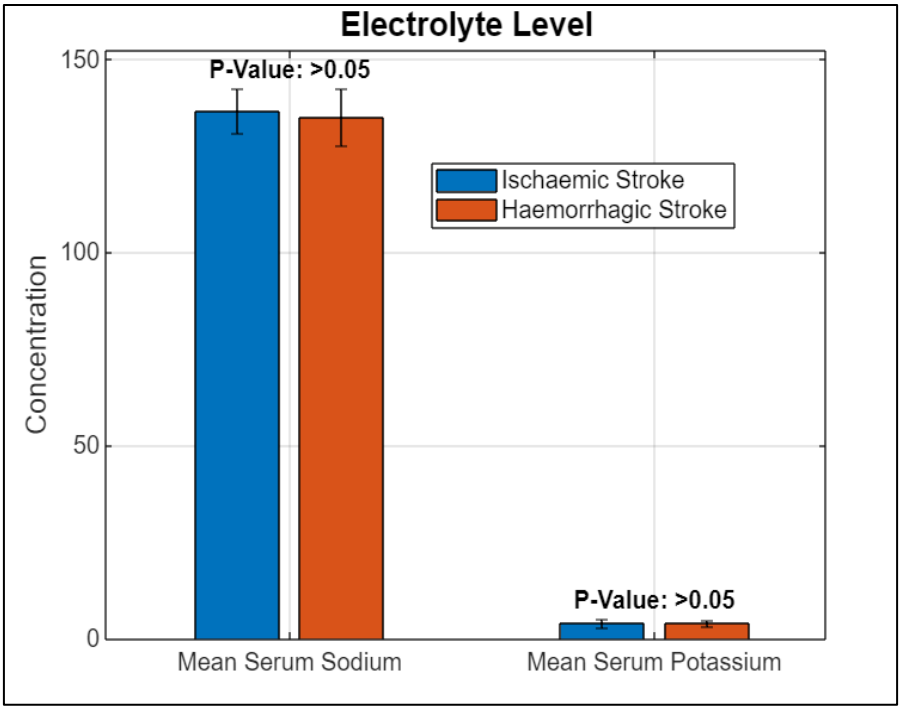

Figure 3: Comparison of Serum Sodium and Potassium Levels Between Stroke Types (N=104)

The comparison of serum sodium and potassium levels between ischaemic and haemorrhagic stroke patients revealed no significant differences. The mean serum sodium level was 136.57 (±5.72) mmol/L in ischaemic stroke patients and 134.98 (±7.37) mmol/L in haemorrhagic stroke patients. The mean serum potassium level was 4.06 (±1.12) mmol/L in ischaemic stroke patients and 4.07 (±0.85) mmol/L in haemorrhagic stroke patients, with p-values greater than 0.05 for both electrolytes.

Table 4: Frequency of Abnormal Serum Potassium in Patients with Ischaemic and Haemorrhagic Stroke (N=104)

Serum Potassium	Ischaemic Stroke (n=71) N (%)	Haemorrhagic Stroke (n=33) N (%)	Total N (%)	P Value (χ^2)
Normal	48 (67.61)	23 (69.70)	71 (68.27)	>0.05
High	7 (9.85)	4 (12.12)	11 (10.58)	
Low	16 (22.54)	6 (18.18)	22 (21.15)	
Total	**71 (100)**	**33 (100)**	**104**	

The analysis of serum potassium levels between ischaemic and haemorrhagic stroke patients showed that 67.61% of ischaemic stroke patients and 69.70% of haemorrhagic stroke patients had normal potassium levels. High potassium levels were observed in 9.85% of ischaemic stroke patients and 12.12% of haemorrhagic stroke patients. Low potassium levels were found in 22.54% of ischaemic stroke patients and 18.18% of haemorrhagic stroke patients. The differences in serum potassium levels between the two groups were not statistically significant ($p>0.05$).

DISCUSSION

This study provides valuable insights into the electrolyte status of acute stroke patients at Rajshahi Medical College Hospital [11,12]. By analyzing the prevalence and impact of sodium and potassium imbalances, we aimed to understand their association with different stroke types (ischaemic and haemorrhagic) and their implications for clinical outcomes. The findings underscore the critical need for routine electrolyte monitoring and management in acute stroke patients to mitigate complications and improve outcomes.

Electrolyte imbalances, particularly hyponatremia and hypokalemia, were found to be prevalent among the stroke patients in our study. Specifically, 35.58% of patients exhibited low sodium levels, while 21.15% had low potassium levels. These findings align with existing literature, which suggests that electrolyte disturbances are common in acute stroke patients and can exacerbate neurological deficits and complicate patient management [13]. For instance, noted that hyponatremia can lead to increased intracranial pressure, cerebral edema, and worsened neurological outcomes.

Comparison with Existing Literature

The prevalence of hyponatremia observed in our study (35.58%) is consistent with previous research. Reported a hyponatremia prevalence of 34.2% in a similar cohort, indicating that our findings are in line with broader trends [14]. Similarly, the hypokalemia prevalence (21.15%) is comparable to the 23.5% reported by [15]. These consistencies across studies suggest that electrolyte imbalances are a widespread issue in acute stroke patients, regardless of geographic or demographic differences.

However, our study did not find significant differences in serum sodium and potassium levels between ischaemic and haemorrhagic stroke patients. This contrasts with some studies, such as, which reported higher rates of hyponatremia in haemorrhagic stroke patients [16]. The lack of significant differences in our study could be attributed to several factors, including the relatively small sample size and potential regional differences in patient management practices. Additionally, the demographic and socioeconomic characteristics of our patient population might differ from those in other studies, potentially influencing the prevalence and impact of electrolyte imbalances.

Implications of Research Findings

The high prevalence of electrolyte imbalances in our study highlights the necessity for routine monitoring of electrolytes in acute stroke patients. Prompt identification and correction of these imbalances can prevent further neurological deterioration and improve clinical outcomes. This is particularly important for hyponatremia, which has been associated with poorer prognosis and increased mortality in stroke patients [17]. Our results suggest that all stroke patients, regardless of stroke type, should be closely monitored for electrolyte imbalances. This finding supports the recommendations by the American Heart Association (AHA) for comprehensive management of stroke patients, including regular assessment of electrolyte levels [18].

From a practical standpoint, the study emphasizes the need for healthcare providers to incorporate routine electrolyte assessments into the standard care protocols for stroke patients. Implementing such practices can help identify at-risk patients early and initiate timely interventions, potentially reducing the incidence of complications associated with electrolyte imbalances. Given the resource constraints in settings like Bangladesh, training healthcare professionals to manage these imbalances effectively is crucial. This includes ensuring that medical staff are equipped with the necessary tools and knowledge to conduct regular electrolyte monitoring and intervention.

Future Research Directions

Future research should focus on larger, multi-center studies to validate our findings and explore potential regional differences in the prevalence and impact of electrolyte imbalances. Additionally, longitudinal studies are needed to establish causality and

examine the long-term effects of electrolyte management on stroke recovery. Investigating the underlying mechanisms of electrolyte disturbances in different stroke types could also provide valuable insights into targeted interventions. Given the global burden of stroke, understanding how various factors such as genetics, lifestyle, and healthcare practices influence electrolyte imbalances can inform better prevention and management strategies.

Limitations

Several limitations should be acknowledged in interpreting the results of this study. The relatively small sample size may limit the generalizability of the findings. The cross-sectional design precludes the determination of causal relationships between electrolyte imbalances and stroke outcomes. Moreover, potential confounding factors such as the use of medications that affect electrolyte levels were not fully controlled. Longitudinal studies with larger sample sizes are needed to confirm our findings and elucidate the causal pathways linking electrolyte imbalances to stroke outcomes. While no significant differences were found between ischaemic and haemorrhagic stroke types regarding sodium and potassium levels, the findings underscore the critical importance of routine electrolyte monitoring and management in all stroke patients. These practices are essential to mitigate the adverse effects of electrolyte disturbances and improve patient outcomes. Future research should aim to validate these findings in larger cohorts and explore targeted interventions to address electrolyte imbalances in stroke patients.

CONCLUSION

This study highlights the high prevalence of electrolyte imbalances among acute stroke patients at Rajshahi Medical College Hospital, with no significant differences between ischaemic and haemorrhagic stroke types. Routine monitoring and management of electrolytes, particularly sodium and potassium, are crucial to prevent complications and improve outcomes. These findings underscore the need for comprehensive care protocols and further research to optimize stroke patient management and enhance recovery.

RECOMMENDATIONS

- Regularly check sodium and potassium levels in all acute stroke patients.
- Equip medical staff with training and resources to manage electrolyte imbalances.
- Include electrolyte management in standard stroke care protocols to improve outcomes.

ACKNOWLEDGMENT

We extend our gratitude to the staff of the Medicine and Neuromedicine Departments at Rajshahi Medical College Hospital for their support and assistance. We also thank the patients and their families for their participation and cooperation in this study.

Funding: No funding sources.

Conflict of Interest: None declared.

REFERENCES

1. Rahman, M. L., Uddin, A. H., Rahman, M. M., Islam, M. T., Alim, M. A., & Khan, M. M. H. (2022). Shams-El-Arefin, Kamrun Nahar, Md. *Mahbub Hossain. Correlation of Clinical Findings with Radiological Imaging of Brain in Acute Stroke Patients. SAS J Med*, *12*, 888-894.
2. Lereis, V. A. P., Melcon, M. O., Hawkes, M. A., Schneider, M. M. G., Dossi, D. E., Alet, M. J., ... & Ameriso, S. F. (2019). Stroke epidemiology in Argentina. Design of a population-based study in General Villegas (EstEPA). *Journal of Stroke and Cerebrovascular Diseases*, *28*(1), 56-62.
3. Fatema, K., & Sheikh, S. P. (2023). Awareness Regarding Stroke among the Caregivers of Stroke Survivors at a Tertiary Level Hospital in Bangladesh. *Open Access Library Journal*, *10*(6), 1-17.
4. Datta, A., Saha, C., Godse, P., Sharma, M., Sarmah, D., & Bhattacharya, P. (2023). Neuroendocrine regulation in stroke. *Trends in Endocrinology & Metabolism*, *34*(5), 260-277.
5. Liamis, G., Barkas, F., Megapanou, E., Christopoulou, E., Makri, A., Makaritsis, K., ... & Milionis, H. (2020). Hyponatremia in acute stroke patients: pathophysiology, clinical significance, and management options. *European Neurology*, *82*(1-3), 32-40.
6. Alfano, G., Ferrari, A., Fontana, F., Perrone, R., Mori, G., Ascione, E., ... & Guaraldi, G. (2021). Hypokalemia in patients with COVID-19. *Clinical and experimental nephrology*, *25*, 401-409.
7. Axelsson, K. F., Wallander, M., Johansson, H., Harvey, N. C., Vandenput, L., McCloskey, E., ... & Lorentzon, M. (2022). Analysis of comorbidities, clinical outcomes, and parathyroidectomy in adults with primary hyperparathyroidism. *JAMA network open*, *5*(6), e2215396-e2215396.
8. Dominguez, L. J., Veronese, N., & Barbagallo, M. (2020). Magnesium and hypertension in old age. *Nutrients*, *13*(1), 139.
9. Jiao, Y., Li, W., Wang, L., Jiang, H., Wang, S., Jia, X., ... & Ding, G. (2022). Relationship between dietary magnesium intake and metabolic syndrome. *Nutrients*, *14*(10), 2013.
10. Saravanakumar, R., Maniraj, S. P., Barshan, A. D., Das, S., Hasan, H., & Alazzam, M. B. (2023, November). Clustering big data for novel health care system. In *AIP Conference Proceedings* (Vol. 2587, No. 1). AIP Publishing.
11. Khan, I., Sarkar, N. C., Sarker, M. K., Jahan, S. M. S., Rani, M., & Mondal, R. N. (2020). Clinical

Features, Risk Factors and Hospital Mortality of Acute Stroke Patients. *mortality*, *15*, 18.

12. Shrestha, M. S., Pant, S., Rayamajhi, B. B., Khadka, M., Khadka, R., & Lamsal, S. (2023). Comparative Analysis of Preoperative Ultrasonography Reports with Intraoperative Findings in Cholelithiasis. *Medical Journal of Shree Birendra Hospital*, *22*(2), 7-11.
13. Aktar, S., Akter, K., Akther, K., Begum, S., Islam, T., & Hasan, H. (2022). Knowledge Regarding the Prevention of Cervical Cancer of Adolescent Girls at Rajshahi Division.
14. Wang, J., Li, Y., Qi, L., Mamtilahun, M., Liu, C., Liu, Z., ... & Yang, G. Y. (2023). Advanced rehabilitation in ischaemic stroke research. *Stroke and Vascular Neurology*, svn-2022.
15. Jahns, F. P., Miroz, J. P., Messerer, M., Daniel, R. T., Taccone, F. S., Eckert, P., & Oddo, M. (2019). Quantitative pupillometry for the monitoring of intracranial hypertension in patients with severe traumatic brain injury. *Critical care*, *23*, 1-9.
16. Ayus, J. C., Krothapalli, R. K., & Arieff, A. I. (2017). Treatment of symptomatic hyponatremia and its relation to brain damage. The New England Journal of Medicine, 317(19), 1190-1195.
17. Kallwitz, E. R., Schwartz, E. I., & Adams, H. P. (2012). The relationship between hyponatremia and outcomes in patients with intracerebral hemorrhage. *Neurocritical Care*, 17(2), 140-144.
18. Powers, W. J., Rabinstein, A. A., Ackerson, T., Adeoye, O. M., Bambakidis, N. C., Becker, K., ... & Tirschwell, D. L. (2018). 2018 guidelines for the early management of patients with acute ischemic stroke: a guideline for healthcare professionals from the American Heart Association/American Stroke Association. *stroke*, *49*(3), e46-e99.