Original Article
DOI: https://doi.org/10.70749/ijbr.v3i7.2704

INDUS JOURNAL OF BIOSCIENCE RESEARCH
https://ijbr.com.pk
ISSN: 2960-2793/ 2960-2807

Frequency of Electrolyte Imbalance in Ischemic Stroke Patients Presenting to Ayub Teaching Hospital Abbottabad

Atiq Ullah[1], Syed Yasir Hussain Gillani[2], Qasim Shah[3], Nizakat Hussain[4], Nayab Ihsan[5], Zia Ul Haq[6]

[1-6]Department of Medicine, Ayub Teaching Hospital, Abbottabad, KP, Pakistan.

ARTICLE INFO

Keywords: Brain Ischemia, Electrolyte Imbalance, Hypocalcemia, Hypokalemia, Hyponatremia, Stroke.

Correspondence to: Atiq Ullah, Department of Medicine, Ayub Teaching Hospital, Abbottabad, KP, Pakistan.
Email: atiqkhanatd@gmail.com

Declaration
Authors' Contribution
All authors equally contributed to the study and approved the final manuscript

Conflict of Interest: No conflict of interest.

Funding: No funding received by the authors.

Article History
Received: 20-05-2025 Revised: 30-06-2025
Accepted: 04-07-2025 Published: 15-07-2025

ABSTRACT

Background: Ischemic stroke is among the major causes of morbidity and mortality worldwide. Patients with ischemic stroke commonly experience electrolyte disturbance due to ischemic injury, stress response, hormonal changes, and low dietary intake. This condition can contribute to the organ damage, raise the possibility of developing complications, and prolong hospital stay. Information regarding electrolyte disturbance in ischemic stroke patients has remained scarce, especially in the region of Abbottabad. **Objective:** To determine the frequency of electrolyte imbalance in ischemic stroke patients presenting to Ayub Teaching Hospital Abbottabad. **Study Design:** Cross sectional study. **Duration and Place of Study:** This study was conducted from 15 January 2025 to 15 May 2025 in the Department of Neurology, Ayub Teaching Hospital Abbottabad, Pakistan. **Methodology:** A total of 120 patients aged 40 to 70 years of either gender with ischemic stroke within 36 hours of onset were included. Venous blood samples were collected before administration of intravenous fluids to assess serum sodium, potassium and calcium levels. Electrolyte imbalance was labeled when serum sodium was 130 millimoles per liter or less, serum potassium was 3.5 millimoles per liter or less or serum calcium was below 2.20 millimoles per liter. Data were analyzed using Statistical Package for Social Sciences version 26. **Results:** The mean age of patients was 55.05 ± 8.38 years. Hypokalemia was found in 20.00% patients, hyponatremia in 30.00% patients, and hypocalcemia in 50.00% patients. **Conclusion:** Electrolyte imbalance is common in ischemic stroke patients, with hypocalcemia being the most frequent abnormality followed by hyponatremia and hypokalemia.

INTRODUCTION

Ischemic stroke is a common neurological condition caused by the sudden restriction or occlusion of the blood flow to the brain, leading to the inadequacy of oxygen and glucose levels in the brain.[1] The restriction in blood flow leads to neuronal damage and cell death if reperfusion is not done immediately.[1] The common cause of ischemic stroke is primarily associated with thrombosis or embolism of the cerebrovascular arteries and accounts for the overall number of stroke cases.[2] The symptoms shown by the patient primarily depend upon the area affected in the brain, which may include weakness, aphasia or speech disturbances, facial weakness, and poor coordination.[3] The severity of ischemic stroke is dependent upon the duration of ischemia, the size of the blood vessel, and individual risk factors like age, hypertension, diabetes mellitus, and cardiovascular disease.[4]

Electrolytes are very prevalent concerns for patients who are hospitalized because they indicate an imbalance of sodium, potassium, calcium, magnesium, or chloride in the body.[5] Each of these components is very important to maintain signal transmission in nerves, muscle contraction in skeletal muscle, fluid balance in the body, as well as the balance between acids and bases in the body.[6] These six electrolytes are very common concerns that patients with similar symptoms experience, with hyponatremia and hypokalemia topping the list.[7] The complications include patients who are severely ill and experience confusion, seizure disorders, arrhythmias, muscular weakness, or prolongation of hospitalization.[8]

Electrolyte imbalance is increasingly noted among ischemic stroke patients and can greatly influence the course of the illness and its management and outcomes.[9] The resulting injuries within the central nervous system due to stroke can alter the regulation of hormones in the body and lead to conditions like the syndrome of inappropriate secretion of antidiuretic hormone or cerebral salt-wasting syndrome and hyponatremia as already discussed.[10] In addition, stress response, decreased oral intake, intravenous fluids, as well as the use of particular medications, influence electrolyte imbalances among stroke patients.[11] Findings suggest patients with

stroke and electrolyte imbalances have longer stays and greater chances of complication during hospitalization.[12]

In a study by Hossain M, et al. has shown that frequency of hypokalemia was 18.7% in patients with ischemic stroke.[13] In another study by Khan A, et al. has shown that frequency of hyponatremia was 35% in patients with ischemic stroke.[14] In another study by Ashraf AS, et al. has shown that frequency of hypocalcemia was 53% in patients with ischemic stroke.[15]

There is a lack of local information regarding the occurrence of electrolyte imbalances in ischemic stroke patients in the region of Abbottabad. The current research findings are largely based on studies done in large cities, which may not be applicable to the local population owing to differing lifestyle, dietary habits, and health facilities. Patients suffering from ischemic strokes admitted to the hospitals in Abbottabad often come late to the hospitals, along with the possibility of the existing electrolyte abnormalities not being comprehensively recorded. Via the conduct of the current study, the prevalent abnormalities in the ischemic stroke patients within the local context can be comprehended.

METHODOLOGY

This cross-sectional study was carried out in the Department of Neurology at Ayub Teaching Hospital Abbottabad Pakistan from 15 January 2025 to 15 May 2025 after approval of the synopsis. Ethical clearance was obtained from the hospital ethical committee and CPSP before initiation of the study and all research activities were conducted according to institutional guidelines. The sample size was 120 and was calculated using WHO sample size software by taking a 95% confidence level a 7% margin of error and an expected frequency of hypokalemia of 18.7% in patients with ischemic stroke.[13] Patients aged from 40 to 70 years of either gender who presented with ischemic stroke within 36 hours of onset were included. Ischemic stroke was considered present when computed tomography of the brain demonstrated loss of grey-white matter differentiation with hypoattenuation of deep nuclei or cortical hypodensity associated with parenchymal swelling and gyral effacement, along with clinical features such as abnormal reflexes inability to speak, reduced sensation, imbalance, mental function changes including irritability or behavioral disturbance, visual impairment with visual acuity less than 6/6, difficulty in walking with muscle power less than 5/5 or limb weakness within 36 hours. Patients with history of chronic kidney disease, use of medications such as diuretics or corticosteroids, prior neurological deficit, hematoma on CT scan, history of any major surgery, or pregnancy confirmed on ultrasound were excluded from the study.

Baseline demographic characteristics were recorded including age, gender, body mass index, socioeconomic status, education level, duration of complaints and residential status. A brief clinical history was taken and physical examination was performed to document neurological findings relevant to stroke presentation. Five milliliters of fasting venous blood were drawn from each patient within 36 hours of stroke onset before administration of intravenous fluids. Samples were sent immediately to the hospital laboratory under supervision of qualified laboratory staff for analysis of serum electrolytes. The primary outcome was electrolyte imbalance, which was assessed after laboratory evaluation. Electrolyte imbalance was considered present if any abnormality was detected in serum potassium, sodium or calcium levels. Hypokalemia was taken as serum potassium level of 3.5 mmol/L or less, hyponatremia as serum sodium level of 130 mmol/L or less and hypocalcemia as serum calcium level below 2.20 mmol/L. Patients fulfilling any of these criteria were labeled as having electrolyte imbalance.

Data were entered and analyzed using SPSS version 26. Quantitative variables were expressed as mean with standard deviation. Categorical variables including were presented as frequencies and percentages. Stratification of electrolyte imbalance was performed with respect demographics. Post-stratification comparisons were made using chi-square test or Fisher exact test and a p value of 0.05 or less was taken as statistically significant.

RESULTS

The study included total 120 ischemic stroke patients with mean age was 55.05 ± 8.38 years and mean BMI was 25.37 ± 2.75 kg/m^2 (as shown in Table-I). The baseline electrolyte levels shows mean potassium level was 4.08 ± 0.66 mmol/L, mean sodium level was 133.82 ± 7.73 mmol/L, and mean calcium level was 2.15 ± 0.29 mmol/L (as shown in Table-I). Regarding gender distribution, males were predominant with 80 patients (66.7%) compared to females who were 40 patients (33.3%) (as shown in Table-I). Most of patients belongs to poor socioeconomic status with 68 patients (56.7%), followed by middle class with 29 patients (24.2%) and rich class with 23 patients (19.2%) (as shown in Table-I). The residential status shows that 68 patients (56.7%) were from rural areas while 52 patients (43.3%) were from urban areas (as shown in Table-I).

Table I

Patient Demographics and Clinical Characteristics

Demographics	Mean ± SD / n (%)
Age (years)	55.05 ± 8.38
BMI (kg/m^2)	25.37 ± 2.75
Potassium (mmol/L)	4.08 ± 0.66
Sodium (mmol/L)	133.82 ± 7.73
Calcium (mmol/L)	2.15 ± 0.29
Gender	
Male n (%)	80 (66.7%)
Female n (%)	40 (33.3%)
Socioeconomic Status	
Poor n (%)	68 (56.7%)
Middle n (%)	29 (24.2%)
Rich n (%)	23 (19.2%)
Residential Status	
Rural n (%)	68 (56.7%)
Urban n (%)	52 (43.3%)

The frequency of electrolyte imbalances reveals that hypokalemia was present in 24 patients (20.00%) and absent in 96 patients (80.00%) (as shown in Table-II). Hyponatremia was observed in 36 patients (30.00%) while 84 patients (70.00%) did not have hyponatremia (as shown in Table-II). Hypocalcemia shows equal distribution with 60 patients (50.00%) having

hypocalcemia and 60 patients (50.00%) not having hypocalcemia (as shown in Table-II).

Table II

Frequency of Electrolyte Imbalances in Ischemic Stroke Patients

Electrolyte Imbalance	Frequency	%age
Hypokalemia		
Yes	24	20.00%
No	96	80.00%
Total	120	100%
Hyponatremia		
Yes	36	30.00%
No	84	70.00%
Total	120	100%
Hypocalcemia		
Yes	60	50.00%
No	60	50.00%
Total	120	100%

The association of electrolyte imbalances with demographic factors demonstrates that for age groups, patients ≤55 years had hypokalemia in 15 patients (22.4%) compared to 9 patients (17.0%) in >55 years group with p-value of 0.462 which was not significant (as shown in Table-III). For hyponatremia, 21 patients (31.3%) in ≤55 years and 15 patients (28.3%) in >55 years showed p-value of 0.718 which indicates no significant association (as shown in Table-III). Hypocalcemia was present in 34 patients (50.7%) in ≤55 years and 26 patients (49.1%) in >55 years with p-value of 0.854 showing no significance (as shown in Table-III). When BMI was analyzed, patients with BMI ≤25 kg/m^2 had hypokalemia in 16 patients (23.5%) while those with BMI >25 kg/m^2 had 8 patients (15.4%) with p-value of 0.269 (as shown in Table-III). Hyponatremia was seen in 17 patients (25.0%) with BMI ≤25 kg/m^2 and 19 patients (36.5%) with BMI >25 kg/m^2 having p-value of 0.172 (as shown in Table-III). For hypocalcemia, 36 patients (52.9%) with BMI ≤25 kg/m^2 and 24 patients (46.2%) with BMI >25 kg/m^2 showed p-value of 0.461 (as shown in Table-III). Socioeconomic status analysis reveals that among poor patients, hypokalemia was present in 16 patients (23.5%), among middle class in 5 patients (17.2%), and among rich in 3 patients (13.0%) with p-value of 0.522 by Fischer Exact Test (as shown in Table-III). Hyponatremia was observed in 17 poor patients (25.0%), 10 middle class patients (34.5%), and 9 rich patients (39.1%) with p-value of 0.368 (as shown in Table-III). Hypocalcemia shows 36 poor patients (52.9%), 13 middle class patients (44.8%), and 11 rich patients (47.8%) with p-value of 0.745 (as shown in Table-III). The residential status comparison shows that rural patients had hypokalemia in 16 patients (23.5%) compared to urban patients with 8 patients (15.4%) having p-value of 0.269 (as shown in Table-III). For hyponatremia, 17 rural patients (25.0%) and 19 urban patients (36.5%) were observed with p-value of 0.172 (as shown in Table-III). Hypocalcemia was present in 36 rural patients (52.9%) and 24 urban patients (46.2%) with p-value of 0.461 showing no statistical significance (as shown in Table-III).

Table III

Association of Electrolyte Imbalances with Demographic Factors

Demographic Factors		Hypokalemia		p-value	Hyponatremia		p-value	Hypocalcemia		p-value
		Yes n(%)	No n(%)		Yes n(%)	No n(%)		Yes n(%)	No n(%)	
Age (years)	≤55	15 (22.4%)	52 (77.6%)	0.462	21 (31.3%)	46 (68.7%)	0.718	34 (50.7%)	33 (49.3%)	0.854
	>55	9 (17.0%)	44 (83.0%)		15 (28.3%)	38 (71.7%)		26 (49.1%)	27 (50.9%)	
BMI (Kg/m^2)	≤25	16 (23.5%)	52 (76.5%)	0.269	17 (25.0%)	51 (75.0%)	0.172	36 (52.9%)	32 (47.1%)	0.461
	>25	8 (15.4%)	44 (84.6%)		19 (36.5%)	33 (63.5%)		24 (46.2%)	28 (53.8%)	
Socioeconomic Status	Poor	16 (23.5%)	52 (76.5%)	0.522*	17 (25.0%)	51 (75.0%)	0.368	36 (52.9%)	32 (47.1%)	0.745
	Middle	5 (17.2%)	24 (82.8%)		10 (34.5%)	19 (65.5%)		13 (44.8%)	16 (55.2%)	
	Rich	3 (13.0%)	20 (87.0%)		9 (39.1%)	14 (60.9%)		11 (47.8%)	12 (52.2%)	
Residential Status	Rural	16 (23.5%)	52 (76.5%)	0.269	17 (25.0%)	51 (75.0%)	0.172	36 (52.9%)	32 (47.1%)	0.461
	Urban	8 (15.4%)	44 (84.6%)		19 (36.5%)	33 (63.5%)		24 (46.2%)	28 (53.8%)	

*Fischer Exact Test

DISCUSSION

In this study, hypokalemia was recorded among 24 patients (20.00%), showing its high prevalence. This can be accounted for by the high degree of sympathetic stimulation in stroke patients, as well as its propensity for intracellular potassium movement, and probably their poor diet during the stroke phase. The stress response associated with stroke triggers the released catecholamines, facilitating the movement of potassium ions into cells and hence lowering the serum potassium levels. Hyponatremia recorded the second highest prevalence among the electrolyte disorders and was noted among 36 patients (30.00%). This could be associated with the high prevalence of the Syndrome of Inappropriate ADH secretion, which is very common among stroke patients. Damage associated with the hypothalamic-pituitary axis due to stroke brings an increase in ADH secretion and water retention in the body, hence lowering the concentration of sodium in the blood. Additionally, the increase in sodium excretion due to the Cerebral Salt Wasting Syndrome is also probable among stroke patients as the kidneys increase sodium excretion due to the associated brain injury due to stroke. Hypocalcemia recorded the highest prevalence among the disorders and was revealed among 60 patients (50.00%) of the study population. This could be attributed by the stress of illness and inflammation associated with stroke, which might render the parathyroid glands less responsive and affect Vitamin D metabolism and also increase urinary calcium excretion due to stress-associated hormones and possible movement of calcium ions into the damaged areas within the brain due to stroke. The low levels associated with stroke also influence the decrease in calcium levels as measured in the blood tests as it is largely bound by albumins within the blood.

The present study found hypokalemia in 24 patients (20.00%) which is comparable to findings of Bandyopadhyay *et al.* [16] who reported hypokalaemia in

31% of stroke patients and Setyawati *et al.* [17] who found it in 31.2% of ischaemic cases. However these rates are higher than current study which may be due to their inclusion of both ischaemic and haemorrhagic stroke cases where haemorrhagic stroke shows more potassium disturbances. The lower frequency in present study could be explained by better nutritional status of patients or early presentation before significant electrolyte shifts occurs. Hyponatremia was observed in 36 patients (30.00%) in current study which shows close similarity with multiple previous studies. Bandyopadhyay *et al.* [16] reported hyponatraemia in 33% of stroke patients, Zafar *et al.* [18] found it in 30.1% of ischaemic stroke patients, and Saleem *et al.* [19] reported 30% prevalence. This remarkable consistency across different populations and settings suggests that hyponatraemia is universal complication of stroke regardless of geographical location. The systematic review by Hossain *et al.* [13] also confirms this finding with prevalence ranging from 6.3% to 39.2%. The similar rates indicates that pathophysiological mechanisms like SIADH and cerebral salt wasting occurs with similar frequency across populations. However Mansoor *et al.* [20] reported lower mean sodium in ischaemic stroke (129.41 ± 3.12 mmol/L) compared to present study (133.82 ± 7.73 mmol/L) which may reflect difference in stroke severity or timing of blood sampling.

The current study found hypocalcemia in 60 patients (50.00%) which is considerably higher than reported in literature. Hossain *et al.* [13] systematic review mentioned hypocalcaemia in only 11.8% of stroke patients. This marked difference could be attributed to different diagnostic cutoff values used for defining hypocalcemia or different laboratory methods. Also present study population may have baseline vitamin D deficiency which is common in South Asian region and this predisposes to lower calcium levels. The high prevalence might also reflect inclusion of patients with more severe stroke or longer duration of symptoms before presentation.

The present study found no significant association between electrolyte imbalances and demographic factors including age, BMI, socioeconomic status and residential status (all p-values >0.05). This finding is consistent with Saleem *et al.* [19] who also reported no statistically significant differences in hyponatraemia when stratified by age, gender, stroke type and duration (all $p > 0.05$). These results suggests that electrolyte disturbances develops independent of patient characteristics and are primarily driven by stroke pathophysiology itself rather than demographic variables. However this contradicts findings of Bandyopadhyay *et al.* [16] who found higher hypokalaemia in haemorrhagic stroke (20% vs 11% in ischaemic, $p = 0.0287$) and Hossain *et al.* [21] who reported more electrolyte disturbances in haemorrhagic cases. The difference may be because present study included only ischaemic stroke patients while these studies included mixed stroke types. The clinical importance of electrolyte monitoring is emphasized by Bandyopadhyay *et al.* [16] who found that 52.73% of dyselectrolytaemic patients had poor outcome versus 17.78% of normo-electrolyte patients ($p = 0.0004$) and mortality was significantly higher in hyponatraemic (45.5%) and hypokalaemic (41.9%) patients. Similarly Zafar *et al.* [18] reported 87.5% mortality in severe hyponatraemia and Naidu *et al.* [22] found 35% mortality in hyponatraemic group. These findings indicates that although demographic factors may not predict electrolyte disturbances but the presence of these imbalances significantly affects clinical outcomes. The high prevalence of electrolyte abnormalities found in present study ranging from 20% to 50% therefore warrants routine monitoring in all ischaemic stroke patients regardless of their demographic profile to prevent adverse outcomes and guide appropriate management.

There are some limitations in this study which deserve mention. This study is conducted in one center, which reduces its ability to generalize in terms of population. The sample size is also relatively smaller as it included 120 patients, and its validation would be better in bigger studies. The study also did not measure the severity of stroke in terms of NIH Stroke Scale (NIHSS), which would also have given an understanding about the association of stroke and its severity with electrolyte imbalance. The study has also not followed up patients in terms of its long-term outcomes and association with mortality and recovery due to imbalance in electrolytes. The association of abnormal electrolytes and stroke is also not causal in nature due to its cross-sectional nature.

CONCLUSION

The conclusion drawn from the study is that electrolyte imbalance is very common in stroke patients and that the highest prevalence is that of hypocalcemia, followed by hyponatremia and hypokalemia. It is seen that the imbalance occurs regardless of age, body mass index, socioeconomic class, and living area, and this shows that the underlying pathological process of stroke itself is the key determinant in this case.

Acknowledgments

The authors would also like to thank the medical staff of the department for their hard work. The meticulous records they kept and effective patient data management were a key determinant in completing this study.

Ethical Approval

Permission for this research was taken from the Ethical Committee. All procedures of the study were carried out by following committee guidelines and the Helsinki Declaration.

Patients' Consent

Informed written consent was obtained from all the participants before being enrolled in this research. Each participant was informed that their personal information would remain confidential, that participation in this research is optional, and that they could withdraw from the research at any time.

REFERENCES

1. Ghozy, S., Reda, A., Varney, J., Elhawary, A. S., Shah, J., Murry, K., Sobeeh, M. G., Nayak, S. S., Azzam, A. Y., Brinjikji, W., Kadirvel, R., & Kallmes, D. F. (2022). Neuroprotection in acute ischemic stroke: A battle against the biology of nature. *Frontiers in Neurology*, *13*. https://doi.org/10.3389/fneur.2022.870141

2. Majumder, D. (2024). Ischemic stroke: Pathophysiology and evolving treatment approaches. *Neuroscience Insights*, *19*. https://doi.org/10.1177/26331055241292600
3. Ramadan, S. M., Rayessa, R., & Esisi, B. (2024). Diagnostic challenges of focal neurological deficits during an acute take—Is this vascular? *Clinical Medicine*, *24*(2), 100037. https://doi.org/10.1016/j.clinme.2024.100037
4. Venketasubramanian, N. (2023). Ischemic stroke: New insights from risk factors, mechanisms and outcomes. *Journal of Cardiovascular Development and Disease*, *10*(12), 472. https://doi.org/10.3390/jcdd10120472
5. Iqbal, I. M., Obaid, M., Haider, A. S., Asif, A., Haq, Z. U., Salman, M., & Rehman, I. (2025). Prevalence of electrolyte imbalances in critically ill medical intensive care unit patients and their association with clinical outcomes. *Cureus*. https://doi.org/10.7759/cureus.94698
6. Shaw, I., & Gregory, K. (2022). Acid–base balance: A review of normal physiology. *BJA Education*, *22*(10), 396-401. https://doi.org/10.1016/j.bjae.2022.06.003
7. Luo, Y., Hao, J., Su, Z., Huang, Y., Ye, F., Qiu, Y., Liu, Z., Chen, Y., Sun, R., & Qiu, Y. (2024). Prevalence and related factors of Hypokalemia in patients with acute ischemic stroke. *International Journal of General Medicine*, *17*, 5697-5705. https://doi.org/10.2147/ijgm.s492025
8. Freiman, S., Hauser, W. A., Rider, F., Yaroslavskaya, S., Sazina, O., Vladimirova, E., Kaimovsky, I., Shpak, A., Gulyaeva, N., & Guekht, A. (2023). Post-stroke seizures, epilepsy, and mortality in a prospective hospital-based study. *Frontiers in Neurology*, *14*. https://doi.org/10.3389/fneur.2023.1273270
9. Wang, A., Tian, X., Gu, H., Zuo, Y., Meng, X., Chen, P., Li, H., & Wang, Y. (2021). Electrolytes and clinical outcomes in patients with acute ischemic stroke or transient ischemic attack. *Annals of Translational Medicine*, *9*(13), 1069-1069. https://doi.org/10.21037/atm-21-741
10. Palmer, B. F., & Clegg, D. J. (2022). Cerebral salt wasting is a real cause of hyponatremia: Commentary. *Kidney360*, *4*(4), e445-e447. https://doi.org/10.34067/kid.0001452022
11. Esmealy, B., Esmealy, L., Gholizadeh, L., Nikookheslat, S., & Sari-Sarraf, V. (2024). Optimizing serum electrolyte levels in stroke patients: A multimodal approach with soymilk supplementation. Annals of Medicine & Surgery, 86(9), 5230-5237. https://doi.org/10.1097/ms9.0000000000002390
12. Pelouto, A., Reimer, J., Hoorn, E. J., Zandbergen, A. A., & Den Hertog, H. M. (2023). Hyponatremia is associated with unfavorable outcomes after reperfusion treatment in acute ischemic stroke. *European Journal of Neurology*, *31*(3). https://doi.org/10.1111/ene.16156
13. Hossain, M. F., Kharel, M., Husna, A. U., Khan, M. A., Aziz, S. N., & Taznin, T. (2023). Prevalence of electrolyte imbalance in patients with acute stroke: A systematic review. *Cureus*. https://doi.org/10.7759/cureus.43149
14. Khan, A., Khan, Z., Khan, S., Ullah, A., Ayub, G., & Tariq, M. N. (2023). Frequency of hyponatremia and its impact on prognosis in ischemic stroke. *Cureus*. https://doi.org/10.7759/cureus.40317
15. Ashraf, A. S., Hassan, A., Saeed, M. H., Shamim, A., Hammad, H., & Salim, Y. (2023). Prevalence of Hypocalcemia in patients with acute ischemic stroke at a tertiary care hospital. *Pakistan Journal of Medical and Health Sciences*, *17*(4), 683-685. https://doi.org/10.53350/pjmhs2023174683
16. Bandyopadhyay, M., Jatua, S. K., Adhikari, M., & Bhandari, A. (2017). Study of electrolyte abnormality in acute stroke. *Annals of International medical and Dental Research*, *2*(5). https://doi.org/10.21276/aimdr.2017.3.5.me2
17. Setyawati, Y. D., & Mastura, R. R. (2020). Electrolyte disturbances and lipid profiles in ischaemic and hemorrhagic stroke patients in Aisyiyah Bojonegoro hospital, Indonesia. *International Journal of Research in Medical Sciences*, *8*(6), 2028. https://doi.org/10.18203/2320-6012.ijrms20202238
18. Zafar, M., Jalil, A., Ghaffer, A., Yousaf, M., & Batool, S. (2024). Hyponatremia in ischemic stroke patients and its relationship to clinical outcomes in such patients. *Journal of Rawalpindi Medical College*, *28*(4). https://doi.org/10.37939/jrmc.v28i4.2560
19. Saleem, M., Khattak, A. L., Ayaz, S. B., Raza, Q., Anjum, N., & Raza, S. A. (2020). FREQUENCY OF HYPONATREMIA IN PATIENTS WITH ACUTE CEREBROVASCULAR ACCIDENTS PRESENTING AT COMBINED MILITARY HOSPITAL PESHAWAR. *Pakistan Armed Forces Medical Journal*, *70*(2).
20. Mansoor, F., Kumar, J., Kaur, N., Sultan, S., Tahir, H., Dilip, A., Khan, F., Kumar, N., Khalid, H., & Talpur, A. S. (2021). Frequency of electrolyte imbalance in patients presenting with acute stroke. *Cureus*. https://doi.org/10.7759/cureus.18307
21. Hossain, M. Z., Hossain, M. S., Sutradhar, S. R., Basak, P., & Islam, M. (2018). "A study of electrolyte imbalance in stroke patients". *TAJ: Journal of Teachers Association*, *29*(1), 39-42. https://doi.org/10.3329/taj.v29i1.39092
22. Naidu, M., A., & Kumari, K. A. (2025). Electrolyte imbalances in patients with acute stroke and effect of serum sodium levels on outcome of CVA: a retrospective study. *Int J Acad Med Pharm*. 7(4), 988-991. https://academicmed.org/Uploads/Volume7Issue4/187.%205649.%20JAMP_TRS_ROUZE%202ND_981-983.pdf