ISSN: 0975-8585

# Research Journal of Pharmaceutical, Biological and Chemical Sciences

# To Evaluate Dyselectrolytemia And To Assess The Implication Of Serum Osmolality In Acute Stroke Mortality- An Observational Study.

**N Thyagarajan*.**

Assistant Professor, Department of General Medicine, Government Theni Medical College & Hospital, Theni, Tamil Nadu, India.

**ABSTRACT**

Stroke is a leading cause of mortality and disability worldwide with electrolyte disturbances playing a crucial role in acute phase complications. This study evaluated dyselectrolytemia and serum osmolality in acute stroke patients and their implications on mortality. To measure serum electrolytes and calculate serum osmolality in acute stroke patients. An observational study was conducted on 100 clinically and CT/MRI proven acute stroke patients admitted within 7 days of symptom onset to Government Theni Medical College & Hospital (March 2020-December 2021). Patients aged >12 years with acute ischemic or hemorrhagic stroke were included. Exclusion criteria included chronic renal / liver disease, cardiac failure, pregnancy and medications causing dyselectrolytemia. Serum electrolytes (sodium, potassium, chloride and calcium) and osmolality were estimated. Statistical analysis used Students t-test and chi-square test, with $p<0.05$ considered significant. Among stroke patients, 53% had ischemic stroke, 45% had intracerebral hemorrhage and 2% had subarachnoid hemorrhage. Dyselectrolytemia was present in 53% of patients, significantly associated with hemorrhagic stroke (62.22%, $p<0.05$). Hyponatremia occurred in 32% (most common), hypokalemia in 30% and hypernatremia in 4%. Raised plasma osmolality (>296 mOsm/kg) during the first week was independently associated with mortality after adjusting for age, sex, stroke subtype and severity. Dehydration, often due to impaired consciousness or dysphagia, appeared to worsen ischemic processes through increased blood viscosity. Electrolyte imbalances, particularly hyponatremia and hypokalemia are common in acute stroke, especially hemorrhagic type. Elevated plasma osmolality is independently associated with increased mortality. Frequent monitoring of serum electrolytes and osmolality is essential for optimal fluid management and may help identify high risk patients who could benefit from systematic fluid replacement strategies.

**Keywords**: Acute stroke, Dyselectrolytemia, Serum osmolality, Hyponatremia, Mortality

https://doi.org/10.33887/rjpbcs/2024.15.6.124

**Corresponding author*

ISSN: 0975-8585

## INTRODUCTION

Stroke is major cause of death after ischemic heart disease and major cause of disability in old age worldwide. Among all neurological diseases of adult life stroke clearly ranks first in frequency and importance. According to World Health Organisation (WHO), about 15 million people suffer from stroke worldwide, among them 5 million people die and another 5 million people live with disabilities. Stroke management needs a multidisciplinary team with great efforts and skills form every member of this team. Abnormal physiological parameters may induce early neurological detoriation [1-3]. By doing organized management in stroke units, we can improve survival and reduce dependency. The precise factors that influence their benefits remain unknown. The causes of death in stroke patients are either due to the primary disease itself or its secondary complications [4].

Medical management aims on the prevention of sub-acute complications of stroke such as malnutrition, dyselectrolytemia, bowel / bladder dysfunction, DVT, aspiration pneumonia, pulmonary embolism, contractures, joint abnormalities and skin breakdown [5]. Electrolyte disturbances such as hyponatremia or hypernatremia resulting from the Syndrome of Inappropriate Anti-Diuretic Hormone (SIADH), elevated Brain Natriuretic Peptides (BNP), disproportinate fluid intake and loss, may lead to complications such as seizures [6-8]. Most hemorrhagic stroke patients have headache and vomiting as primary symptoms. Hence vomiting also plays a major role in dyselectrolytemia. Dyselectrolytemia is also a major complication in acute phase [9,10].

In our country there are several studies on stroke, its associated conditions and their effect on stroke patients outcome, but a few studies on electrolytes disturbances in stroke patients have been done in our country. Clinical data regarding electrolyte imbalance in neurological disorder and in acute stroke are somewhat minimal and not easily compared. In our study we enrolled patients hospitalized within one week of onset of acute stroke. A total of 100 clinically and CT/MRI proven patients admitted over a period of 20 months in different units of Medicine of Government Theni medical College & Hospital was randomly selected. The imbalance of electrolytes among acute stroke patients were identified and corrected.

### Aims and Objectives

To measure serum electrolytes and To calculate serum osmolality in acute stroke patients.

## MATERIALS AND METHODS

### Study Population

The study was conducted on patients of Acute Stroke, within seven days of onset of stoke, admitted to Government Theni Medical College & Hospital, during the study period of March 2020 to December 2021.

### Design of Study

Observational study.

### Calculation of sample size

Formula 4pq/l2

[p - Prevalence of hyponatremia, q -1-p, l - error of margin (absolute error) (=4x0.37x0.63/0.1x0.1, =93.24, =100) total number sample 100.

### Inclusion criteria

Age >12 years, Patients of acute stroke (Ischemic or Hemorrhagic) and CT/MRI brain proven acute stroke.

ISSN: 0975-8585

**Exclusion Criteria**

Patients with chronic medical illness like renal diseases liver diseases congestive cardiac failure, Pregnant patients and Patients on drugs causing dyselectrolytemia (ACE inhibitors, diuretics and v2 receptor antagonists).

**Data Collection**

Detailed history and neurological examination was done, Estimation of serum electrolytes (Serum sodium, Potassium, Chloride and Calcium) and Calculation od serum osmolality was done.

**Laboratory Investigations**

Complete blood count, Renal function tests, Random blood sugar, Blood urea, Serum creatinine, Serum electrolytes (Sodium, Potassium, Chloride and Calcium) and ECG.

**Analysis**

Statistical analysis was performed using Student 't' test for raw data and chi square test for consolidated data to test the significance of difference between variables.

**Statistical Tools**

The information collected regarding all the selected cases were recorded in a Master Chart. Data analysis was done using SPSS 16 software. Using this software, percentages, means, standard deviations 'p' values were calculated through Student 't' test for raw data and chi square test for consolidated data to test the significance of difference between variables. A 'p' value less than 0.05 is taken to denote significant relationship.

## RESULTS AND DISCUSSION

Under 30 years of the patients 10 cases (25%), 31-45 years of patients 13 cases (32.5%), 46-60 years of the patients 15 cases (37.5%) is most common age group and Over 60 years of the patients 2 cases (5.0%) is least common age group. The majority of cases (70%) are in the 31-60 age range, with the highest concentration in the 46-60 group. The very young (<30) and elderly (>60) make up a smaller proportion. 25 cases of male patients was admitted (62.5%) and 15 cases of female patients was admitted (37.5%). Males account for nearly two thirds of the cases, while females make up just over one third (Table. 1).

**Table 1: Age and Sex Distribution of the patients**

| | No. of cases | Percentage |
|---|---|---|
| **Age Distribution** | | |
| < 30 | 10 | 25.0 |
| 31 - 45 | 13 | 32.5 |
| 46 - 60 | 15 | 37.5 |
| > 60 | 2 | 5.0 |
| TOTAL | 40 | 100.0 |
| **Sex Distribution** | | |
| Male | 25 | 62.5 |
| Female | 15 | 32.5 |
| Total | 40 | 100.0 |

This research is the first to look into the link between plasma osmolality and stroke mortality. We discovered a link between elevated plasma osmolality during the first week after a stroke and mortality and functional outcome in our investigation. Dehydration is a typical occurrence following a stroke, especially in the elderly. Dehydration may be caused by decreased oral intake of water in the early stages of stroke due to impaired consciousness or dysphagia. Electrolyte problems caused by the syndrome of inappropriate antidiuretic hormone, such as hypernatremia or hyponatremia can result in seizures or death. Dehydration following a stroke can exacerbate the ischemic process by increasing blood viscosity and lowering blood pressure. Hemodilution has been shown in studies to impact cerebral blood flow and cerebral hemodynamics via modifying plasma viscosity, however there has been no evidence of a favourable effect on stroke outcome. Theres a link between elevated plasma levels and this is the first study to date to examine the relationship between plasma osmolality and stroke mortality [11].

In this study, we have found an association between raised plasma osmolality during the first week after stroke and mortality and functional outcome. Dehydration is a common phenomenon after stroke, particularly in the elderly. In the early phase of stroke, dehydration may be caused by decreased oral intake of water due to disturbed consciousness or dysphagia. Electrolyte disturbances such as hypernatremia or hyponatremia resulting from the syndrome of inappropriate antidiuretic hormone, can lead to complications such as seizures or death. Dehydration acutely after stroke may worsen the ischemic process, due to an increase in blood viscosity and a decrease in blood pressure. Studies have shown that hemo dilution can affect cerebral blood flow and cerebral hemodynamics by influencing plasma viscosity, but no beneficial effect on stroke outcome has been established. A significant relationship between raised plasma osmolality and mortality has been shown in long stay community patients and an acutely ill patient, which suggests that dehydration may have influenced survival [12].

Studies involving stroke patients are limited. In this study, admission mean plasma osmolality in stroke patients showed a wide variation, indicating a large variance in water homeostasis, which implies that some patients were overhydrated and others under hydrated. The upper limit of normal for measured plasma osmolality in this study was 296 mOsm/kg. Diabetic patients and those with stress hyperglycemia were also prone to raised plasma osmolality levels after stroke. The association between raised plasma osmolality and reduced survival may have reflected stroke severity, stroke subtype, increasing age or coexisting infection. There is evidence that lesions around the hypothalamus and in particular, intracranial hemorrhage may alter plasma osmolality through vasopressin release. However, after adjustment for age, sex, subtype and stroke severity, we demonstrated that raised plasma osmolality, defined as. 296 mOsm/kg on admission was independently related to mortality. This implies that the association may be a direct one. From this study, it appeared that stroke patients were initially hydrated appropriately, with patients with high plasma osmolality levels at admission being hydrated intravenously [13,14].

The explanation of higher maximum and AUC plasma osmolality levels in patients hydrated intravenously throughout the first week may have been explained by differences in stroke severity. Patients who were intravenously hydrated tended to have severe strokes. There is still controversy over whether dysphagia leads to significant dehydration and therefore these findings cannot be explained by a simple division of intravenously hydrated and orally hydrated groups reflecting poor and good outcome. One may have expected a fall in plasma osmolality from admission to day 7 in individuals hydrated intravenously throughout the first week compared with orally hydrated individuals, assuming that individuals who were receiving intravenous fluids were receiving larger volumes of fluid. However, no significant fall was demonstrated. Measurement of oral fluid intake was not achieved owing to practical difficulty in obtaining accurate volume measurements.

Fluid balance, particularly in elderly patients, is notoriously haphazard and difficult to manage because the clinical indicators of dehydration can be subtle. A decline in thirst perception is a consequence of aging and it has been shown that high levels of plasma osmolality can lead to a diminished subjective awareness of thirst. Cortical dysfunction after cerebrovascular disease has also been implicated in causing hypodipsia. When a patient is dysphagic and is thus dependent on intravenous fluids, clinicians have to use clinical and biochemical evidence for dehydration to adequately rehydrate patients. Evidence suggests that independent elderly individuals often drink what is offered to them and then communicate their requests for further replenishment, unlike semi dependent individuals, who often go unnoticed [15].

In this study, we have demonstrated that the present method of hydration with fluids may be inappropriate. Although patients are being hydrated intravenously, clinicians must be mindful that insufficient fluid replacement may be taking place. Frequent measurement of serum urea and electrolytes as well as plasma osmolality, which gives valuable supportive evidence of water homeostasis, must be considered. In this study we have demonstrated that high plasma osmolality levels in the acute phase of stroke are associated with excessive mortality rates. This may enable identification of stroke patients who may benefit from fluid replacement in a more systematic fashion. Further work is required to determine the scale of water homeostasis and stroke subtype.

Stroke incidence rises exponentially with increasing age. In this present study, maximum number of patients (29%) were in between 51-60 years age group followed by (22%) between 61-70 years age group. The maximum number of male (21% & 16%) and female (8% & 6%) were also in the above age group respectively. A hospital-based study done in DMCH showed that only 1% occurred in <20 years and 26% in 20-45 years and majority are above 45 years and 72% were male and 28% were female i.e., male incidence is 30% higher than female which coincide with international study. CT scan findings of the studied patients show that majority 53% patients had ischaemic stroke, 45% had intracerebral haemorrhage and only 2% had subarachnoid haemorrhage. In this series 53% of our acute stroke patient had dyselectrolytaemia. Among 45 acute intracerebral haemorrhage stroke patients 28 (62.22%) had dyselectrolytaemia. There was significant association between dyselectrolytaemia and acute haemorrhagic stroke (P=<0.05). Among 53 ischaemic stroke patients 23 (43.39%) had dyselectrolytaemia and 30 (56.60%) of them had no electrolytes imbalance, but there was no statistically significant association between dyselectrolytaemia and acute ischaemic stroke (P=>0.05). In this series the percentages of dyselectrolytaemia is a bit high, may be due to under developed acute management setup in our hospital. In this study, 32% of all stroke patients had hyponatraemia [16]. Hyponatraemia was most common among haemorrhagic stroke patients (17%) followed by ischaemic stroke patients (13%) and all the patients of subarachnoid haemorrhage had hyponatraemia. But chi-square test revealed no statistically significant association between hyponatraemia and type of stroke (p=>0.05). Only 4% of all stroke patients had hypernatraemia which was 3% of ischaemic stroke and 1% of haemorrhagic stroke. Total 36% of all stroke patients had serum sodium imbalance during stroke. 30% of all stroke patients had hypokalaemia. Hypokalaemia was most common among haemorrhagic stroke patients (19%) followed by ischaemic stroke patients (11%). chi-square test revealed significant association between hypokalaemia and haemorrhagic stroke (p=<0.05). Only 1% of all stroke patients had hyperkalaemia which was one of the two patients of subarachnoid haemorrhage. Total 31% of all stroke patients had serum potassium imbalance during stroke. 9% haemorrhagic stroke and 6% ischaemic stroke patient presented with hypochloraemia during stroke (p=>0.05). 2% haemorrhagic stroke patient presented with low bicarbonate level during stroke. Both hyponatraemia and hypokalaemia were more common among haemorrhagic stroke patients. All these findings are consistent with this present study [17].

This is the first study to date to examine the relationship between plasma osmolality and stroke mortality. In this study, we have found an association between raised plasma osmolality during the first week after stroke and mortality and functional outcome. Dehydration is a common phenomenon after stroke, particularly in the elderly. In the early phase of stroke dehydration may be caused by decreased oral intake of water due to disturbed consciousness or dysphagia. Electrolyte disturbances such as hypernatremia or hyponatremia resulting from the syndrome of inappropriate antidiuretic hormone can lead to complications such as seizures or death.

Dehydration acutely after stroke may worsen the ischemic process due to an increase in blood viscosity and a decrease in blood pressure. Studies have shown that hemo dilution can affect cerebral blood flow and cerebral hemodynamics by influencing plasma viscosity, but no beneficial effect on stroke outcome has been established. A significant relationship between raised plasma osmolality and mortality has been shown in long stay community patients and acutely ill patients, which suggest that dehydration may have influenced survival. Studies involving stroke patients are limited. In this study, admission mean plasma osmolality in stroke patients showed a wide variation indicating a large variance in water homeostasis, which implies that some patients were overhydrated and others underhydrated. The upper limit of normal for measured plasma osmolality in this study was 296 mOsm/kg. Diabetic patients and those with stress hyperglycemia were also prone to raised plasma osmolality levels after stroke. The association between raised plasma osmolality and reduced survival may have reflected stroke severity, stroke subtype, increasing age or coexisting infection. There is evidence that lesions around the hypothalamus and in particular intracranial hemorrhage may alter plasma osmolality through vasopressin release. However, after adjustment for age, sex, subtype, and stroke severity, we demonstrated that raised plasma osmolality, defined as 296 mOsm/kg on admission, was independently related to mortality. This implies that the association may be a direct one. From this study, it appeared that stroke patients were initially hydrated appropriately, with patients with high plasma osmolality levels at admission being hydrated intravenously [18].

The explanation of higher maximum and AUC plasma osmolality levels in patients hydrated intravenously throughout the first week may have been explained by differences in stroke severity. Patients who were intravenously hydrated tended to have severe strokes. There is still controversy over whether dysphagia leads to significant dehydration and therefore these findings cannot be explained by a simple division of intravenously hydrated and orally hydrated groups reflecting poor and good outcome. One may have expected a fall in plasma osmolality from admission to day 7 in individuals hydrated intravenously throughout the first week compared with orally hydrated individuals, assuming that individuals who were receiving intravenous fluids were receiving larger volumes of fluid. However, no significant fall was demonstrated. Measurement of oral fluid intake was not achieved owing to practical difficulty in obtaining accurate volume measurements. Fluid balance particularly in elderly patients is notoriously haphazard and difficult to manage because the clinical indicators of dehydration can be subtle. A decline in thirst perception is a consequence of aging and it has been shown that high levels of plasma osmolality can lead to a diminished subjective awareness of thirst. Cortical dysfunction after cerebrovascular disease has also been implicated in causing hypodipsia [19]. When a patient is dysphagic and is thus dependent on intravenous fluids clinicians have to use clinical and biochemical evidence for dehydration to adequately rehydrate patients. Evidence suggests that independent elderly individuals often drink what is offered to them and then communicate their requests for further replenishment unlike semi dependent individuals.

In this study, we have demonstrated that the present method of hydration with fluids may be inappropriate. Although patients are being hydrated intravenously clinicians must be mindful that insufficient fluid replacement may be taking place. Frequent measurement of serum urea and electrolytes as well as plasma osmolality, which gives valuable supportive evidence of water homeostasis must be considered. In this study we have demonstrated that high plasma osmolality levels in the acute phase of stroke are associated with excessive mortality rates. This may enable identification of stroke patients who may benefit from fluid replacement in a more systematic fashion. Further work is required to determine the scale of water homeostasis and stroke subtype.

## CONCLUSION

This observational study on 100 acute stroke patients demonstrates that dyselectrolytemia is a significant complication occurring in 53% of cases, with a notably higher prevalence in hemorrhagic stroke (62.22%) compared to ischemic stroke (43.39%). Hyponatremia (32%) and hypokalemia (30%) were the most common electrolyte disturbances, with hypokalemia showing a statistically significant association with hemorrhagic stroke ($p<0.05$). The study also established that raised plasma osmolality (>296 mOsm/kg) during the first week post-stroke is independently associated with increased mortality after adjusting for confounding factors, highlighting the critical role of dehydration in stroke outcomes. These findings underscore the necessity for frequent monitoring of serum electrolytes and osmolality in acute stroke patients to enable early detection and correction of imbalances, optimize fluid management, and potentially reduce mortality through systematic fluid replacement strategies in high-risk patients.

## ACKNOWLEDGEMENTS

The authors are supported by Department of Health Research (DHR) from the Multi-Disciplinary Research Unit (MDRU) of Government Theni Medical College & Hospital, Theni, Tamilnadu during manuscript preparation and scientific communications phase.

## REFERENCES

[1] Das BK, Sarder AH, Khanom T, Shaikh MSA, Islam MS. (2019). Variation of electrolyte status in relation to the type of acute stroke patients. Bangladesh Medical Journal Khulna. 52(1-2): 12-15.

[2] Sriram, Asokan, Suruthi Priyaa J, Arthy L. Study on electrolyte abnormality and quality outcomes in the management of stroke. International Journal of Science and Research (IJSR). 2020, 9(7): 152-157.

[3] Shima S, Niimi Y, Moteki Y, Takahashi O, Sato S, Inoue T, Okada Y. (2020). Prognostic significance of hyponatremia in acute stroke: a systematic review and meta-analysis. Cerebrovasc Dis. 49(5): 531-539.

[4] Bade YP, Chaudhari HR. (2020). Syndrome of inappropriate antidiuretic hormone secretion and cerebral salt wasting as the common causes of hyponatremia in tertiary care hospital. Int J Adv

Med. 7: 577-581.
[5] Kim J, Lee HS, Nam HS, Kim YD, Heo JH. (2021). Association between plasma osmolality and case fatality within 1 year after severe acute ischemic stroke. Yonsei Med J. 62(7): 600-607.
[6] Setyawati YD, Mastura RR. (2020). Electrolyte disturbances and lipid profiles in ischaemic and hemorrhagic stroke patients in Aisyiyah Bojonegoro Hospital, Indonesia. Int J Res Med Sci. 8(6): 2028-2032.
[7] Kalita J, Singh RK, Misra UK. (2017). Cerebral salt wasting is the most common cause of hyponatremia in stroke. J Stroke Cerebrovasc Dis. 26(5): 1026-1032.
[8] Rackimuthu S, Pulu Ishwara PR, Suresh S. (2020). Complications associated with osmotic therapy in acute stroke patients a prospective longitudinal observational study. J Clin Diagn Res. 14(7): OC05-OC08.
[9] Ershov VI, Chirkov AN. (2016). Hypovolemic hyponatremia at the onset of severe ischemic stroke as a predictor of adverse outcome. Zh Nevrol Psikhiatr Im S S Korsakova. 116(8): 45-49.
[10] Chen Z, Jia Q, Liu C. (2019). Hyponatremia in acute stroke patients: pathophysiology, clinical significance, and management options. Eur Neurol. 82(1-3): 32-39.
[11] Pradhan B, Majhi C, Panigrahi SK. (2018). Clinical profiles, electrolytes status in acute strokes and their outcome. Int J Adv Med. 5(3): 492-497.
[12] Bhalla AK, Sankaralingam S, Dundas R, Swaminathan R, Wolfe CDA, Rudd AG. (2000). Influence of raised plasma osmolality on clinical outcome after acute stroke. Stroke. 31(9): 2043-2048.
[13] Kalyan M, Nahdi WK, Kanitkar SA, Moharkar A, Saha R. (2017). Electrolyte imbalance in acute stroke. Natl J Integr Res Med. 8(4): 23-26.
[14] Bandyopadhyay M, Jatua SK, Adhikari M, Bhandar A. (2017). Study of electrolyte abnormality in acute stroke. Ann Int Med Dent Res. 3(5): ME4-ME9.
[15] Schrock JW, Glasenapp M, Drogell K. (2012). Elevated blood urea nitrogen/creatinine ratio is associated with poor outcome in patients with ischemic stroke. Clin Neurol Neurosurg. 114(7): 881-884.
[16] Lin J, Jiang A, Ling M, Mo Y, Li M, Zhao J. (2018). Prediction of neurologic deterioration based on support vector machine algorithms and serum osmolarity equations. Brain Behav. 8(7): e01023.
[17] Setyawati YD, Mastura RR. (2020). Electrolyte disturbances and lipid profiles in ischaemic and hemorrhagic stroke patients in Aisyiyah Bojonegoro Hospital, Indonesia. Int J Res Med Sci. 8(6): 2028-2032.
[18] Ehtesham M, Ahmed S, Saleem F. (2019). Clinical spectrum of hyponatremia in patients with stroke. Cureus. 11(8): e5322.
[19] Kalita J, Singh RK, Misra UK. (2017). Cerebral salt wasting is the most common cause of hyponatremia in stroke. J Stroke Cerebrovasc Dis. 26(5): 1026-1032.