Original Research Article

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Dehydration as a Poor Prognostic Factor in Acute Ischemic Stroke: An Observational Study in a Tertiary Care Hospital in India

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Abstract

Background: Stroke is a leading cause of mortality among patients presenting to the emergency department with Acute Ischemic Stroke being a significant contributor. Clinical guidelines emphasize the importance of adequate hydration in management of stroke. Dehydration may impair cerebral oxygen delivery and worsen clinical outcome in patients with acute ischemic stroke (AIS). Elevated blood urea nitrogen to creatinine ratio (BUN/Cr) as a marker of dehydration has been associated with poor clinical outcome in emergency department (ED) patients presenting with AIS. Dehydration also attributes to the increased rate of infections and length of hospital stay in patients with AIS. *Objectives:* To study the association of dehydration markers BUN/Creatinine ratio, plasma osmolality, haematocrit and Caval Index with the outcome in patients with Acute Ischemic Stroke in terms of Mortality and Morbidity (Length of Stay in Hospital) and to correlate the hydration status with the disease progression by using NIHSS score and Modifies Rankin score. *Methods and study design:* The study was conducted from January 2017 till January 2018 over a period of 1 year. It was a Prospective observational cohort study. Patient included in the study were followed up at 3 and 30 days as per the questionnaire designed for the study after the approval by scientific and ethics committee of the institute. For the purpose of statistical significance we will recruit 64 patients as per the inclusion & exclusion criteria of the study. Data collection was done as per the approved data collection forms for the purpose of study. Patient's initial, BUN, Creatinine, Urea, Sodium, blood glucose, Caval index (optional) and clinical status was be collected as per NIHSS and Modified rankin scale. The patient was followed up during their duration of stay in the hospital on 1st, 2nd and 3rd day. During the follow up period patients was followed for progression and outcome based on clinical parameters and the mentioned scores. *Results and Conclusion:* In conclusion, though we were able to associate plasma osmolality and BUN/Creatinine ratio with mortality, length of stay and with poorer outcome in terms of early neurological deterioration; hematocrit and Caval Index failed to associate to significant level to prove as a prognostic marker. Initial risk stratification using the plasma osmolality and BUN/Creatinine ratio may assist with prognostication and help prevent deterioration of the patients with Acute Ischemic Stroke.

Keywords: Dehydration; Acute Ischemic Stroke; Dehydration.

Introduction

Stroke is a leading cause of mortality among patients presenting to the emergency department with Acute Ischemic Stroke being a significant contributor. Several predictors of outcome have been studied so far and clinical outcome, survival and residual neurological impairment have been

attributed to a variety of clinical and biochemical parameters [1].

Clinical guidelines emphasize the importance of adequate hydration in management of stroke. Dehydration may impair cerebral oxygen delivery and worsen clinical outcome in patients with acute ischemic stroke (AIS) [3]. Elevated blood urea nitrogen to creatinine ratio (BUN/Cr) as a marker of dehydration has been associated with poor clinical outcome in emergency department (ED) patients presenting with AIS [4]. Dehydration also attributes to the increased rate of infections and length of hospital stay in patients with AIS.

Dehydration can be measured using any of the 4 parameters-

1. Plasma Osmolality
2. BUN/creatinine Ratio
3. Haematocrit
4. Caval Index (optional)

Intensive review of literature shows no direct studies have been conducted on the association of these four parameters with poor prognosis of AIS. All the study parameters form a part of routine initial investigations and have individually been correlated with the outcome of AIS.

The objective of this study is to find the association of dehydration measured using, haematocrit, BUN/Creatinine ratio, plasma osmolality and Caval Index with the clinical outcome in patients in terms of NIHSS scores and Modified Rankin Score, these scores being the standardized measure of monitoring disease progression among stroke patients.

The Modified Rankin Scale (mRS) is used to measure the degree of disability in patients who have had a stroke, as follows [20, 21, 22].

0	No symptoms at all
1	Significant disability despite symptoms; able to carry out all usual duties/activities
2	Slight disability; unable to carry out all previous activities, but able to look after own affairs without assistance
3	Moderate disability; requiring some help, but able to walk without assistance
4	Moderately severe disability; unable to walk without assistance and unable to attend to own bodily needs without assistance
5	Severe disability; bedridden, incontinent and requiring constant nursing care and attention
6	Dead

The National Institutes of Health Stroke Scale (NIHSS)

1a LOC	0=Alert, 1=Not alert but arouse, 2=Not alert, 3=Unresponsive
1b LOC questions	0=Answers both, 1=Answers one, 2=Answers neither question
1c LOC commends	0=Perform both, 1=Perform one, 2=Perform neither task
2 Best gaze	0=Normal, 1=Partial gaze palsy, 2=Forced deviation
3 Visual fields	0=No visual loss, 1=Partial, 2=Complete, 3=Bilateral hemianopsia
4 Facial weakness	0=Normal, 1=Minor, 2=Partial, 3=Complete paralysis
5a Motor left arm	0= No drift, 1=Drift before 10 seconds, 2= Fall before 10 seconds, 3= No effect against gravity, 4= No movement
5b Motor right arm	0= No drift, 1=Drift before 10 seconds, 2= Fall before 10 seconds, 3= No effect against gravity, 4= No movement
6a Motor left leg	0= No drift, 1=Drift before 5 seconds, 2= Fall before 5 seconds, 3= No effect against gravity, 4= No movement
6b Motor right leg	0= No drift, 1=Drift before 5 seconds, 2= Fall before 5 seconds, 3= No effect against gravity, 4= No movement
7 Ataxia	0=Absent, 1=Present in one limb, 2=Present in two limb
8 Sensory	0=Normal, 1= Mild to moderate loss, 2=Severe to total loss
9 Best language	0=Normal, 1=Mild to moderate aphasia, 2=Severe aphasia, 3=mute, global aphasia
10 Dysarthria	0=Normal, 1=Mild to moderate dysarthria, 2=Severe dysarthria
11 Extinction	0=Normal, 1=Mild, 2=Severe

Literature Review

LOC: Loss of Consciousness

Previous studies have evaluated various factors defining dehydration and correlating it with the progression of disease in patients with Acute Ischemic stroke.

"*Predictors of early clinical deterioration after acute ischemic stroke*" a study by Lin LC et al in Am J Emerg Med. 2011 Jul;29(6):577-81, did a prospective study on 196 patients with Acute Ischemic Stroke and identified risk factors which lead to early deterioration. The patients with early deterioration in National Institutes of Health Stroke Scale scores (increase ≥ 3 points within 3 days) were defined as stroke-in-evolution (SIE). BUN/Creatinine higher than 15 was an independent predictor of Stroke in evolution. These patients were 3.4 folds more likely to have Stroke in evolution (p = 0.08) [5]. This concluded at BUN/creatinine higher than 15 was associated with early clinical deterioration.

"Dehydration is an independent predictor of discharge outcome and admission cost in acute ischaemic stroke" a study by C.H. Liu et al. in Eur J Neurol. 2014 Sep. Studied predictive value of initial hydration status on clinical outcome and admission cost in acute ischaemic stroke and highlights the importance of monitoring BUN/Cr in the acute stage. Discharge outcome were monitored using modified Rankin scale and Barthel Index [7]. Acute ischaemic stroke with admission dehydration had higher infection rates ($p = 0.006$), worse discharge BI ($p < 0.001$), worse mRS ($p < 0.001$) and higher admission costs ($p<0.001$)

"Influence of raised plasma osmolality on clinical outcome after acute stroke" a study by Ajay Bhalla et al. in Stroke. 2000 Sep, concluded that a plasma osmolality of >296 mOsm/kg on admission showed a significant association with stroke mortality at 3 months independent of age, sex, stroke severity, Barthel Index before stroke and stroke subtype [9].

"Predictors of early neurological deterioration in patients with acute ischaemic stroke with special reference to blood urea nitrogen (BUN)/creatinine ratio & urine specific gravity" a study by K. Bhatia et al. in Indian J Med Res. 2015 Mar studied 114 patients of Acute Ischemic Stroke (AIS) in an Emergency Department setting. They defined Early neurological deterioration (END) as worsening of neurological condition as indicated by an increase of three or more points in the NIHSS score or death not attributed to other cause, within the first three days. They concluded that BUN/creatinine >15 was found as an independent factor predictive of END [4].

"Elevated blood urea nitrogen/creatinine ratio is associated with poor outcome in patients with ischemic stroke" a study by Schrock JW et al. in ClinNeurolNeurosurg. 2012 Sep studied 324 patients with AIS and concluded an elevated BUN/Cr ratio of ≥ 15 OR 2.2 (1.2-4.0) is associated with poor outcome at 30 days [14].

Ultrasound has become an important tool for evaluating a variety of acute conditions in ED, because it is not invasive and relatively easy to perform with adequate training, portable and with good effectiveness. An observational study Identification of the hydration state in emergency patients: correlation between caval index and BUN/creatinine ratio done by A. Riccardi et al. in Eur Rev Med Pharmacol Sci. 2013 Jul; found a good correlation between Caval index and BUN/Cr Ratio (Pearson Index 0.76, $p < 0.001$, with significant t-Student test ($p < 0.01$, IC 99%) [8].

Inspiratory inferior vena cava and expiratory inferior vena cava diameters were measured, 2 cm from the right atrial border in a long-axis/subxiphoid view with a 3.5 MHZ curvilinear probe. Measurements were taken during a normal respiratory cycle, and the CIn was recorded (CIn is the difference between end-expiratory and end-inspiratory IVC diameter divided by the end-expiratory diameter). Bedside ultrasonographic measurement of caval index greater than or equal to 50% is strongly associated with a low central venous pressure.

Elevated hematocrit (Hct) contributes to blood viscosity and has an adverse effect in acute stroke. *"Elevated hematocrit is associated with reduced reperfusion and tissue survival in acute stroke"* Allport LE et al. in Neurology November 08, 2005 studied 64 patients and found that an increasing Hct was a significant predictor of infarct growth (OR = 1.26, 95% CI = 1.00 to 1.59) [16].

"Use of the Barthel index and modified Rankin scale in acute stroke trials" study by Sulter G et al. in Stroke journal 1999 Aug investigated the commonly used scales BI and mRS that measure disability or dependence in activities of daily living in stroke victims. Favorable outcome on the MRS was defined as either </=1 or </=2.

Study Questions

1. How are the markers of dehydration correlating with the outcome in patients with Acute Ischemic stroke?
2. What is the impact of the hydration status on the progression of Acute Ischemic stroke?

Study Objective

1. Primary Objective

To study the association of dehydration markers BUN/Creatinine ratio, plasma osmolality, haematocrit and Caval Index with the outcome in patients with Acute Ischemic Stroke in terms of Mortality and Morbidity (Length of Stay in Hospital).

2. Secondary Objective

To correlate the hydration status with the disease progression by using NIHSS score and Modifies Rankin score.

Study Endpoint/ Outcome

The results of the study would indicate the trends of dehydration with early neurological deterioration and poor prognosis in patients with Acute Ischemic Stroke.

An association of the clinical parameters, BUN/ Creatinine ratio, plasma osmolality, hematocrit and Caval Index with the prognosis of patients with Acute Ischemic Stroke.

Study Design:	Prospective observational study.
Study Duration:	12 Months.
Data Selection:	Based on Inclusion and Exclusion Criteria.

Study Duration and Timeline

Data would be collected from the site of study from January 2017 to January 2018.

Materials and Methods

Study Area

The study was conducted in the Emergency Department of Max Hospital, Shalimar Bagh, New Delhi.

Inclusion criteria

1. Patients both males and females with age more than 18 years old and above.
2. All diagnosed cases of acute ischemic stroke diagnosed by the clinical presentations and brain imaging.
3. Venous strokes.
4. Has a measurable neurologic deficit according to the National Institutes of Health Stroke Scale (NIHSS) or Modified Rankin Scale (mRS).
5. Patients presenting at the ED with a history of onset of neurological symptoms within the last 24 hours.

Exclusion criteria

1. Uncontrolled Hyperglycemia (> 400 mg/dl)
2. Active Infections.
3. Initial NIHSS of > 22.
4. Pre-existing Chronic Kidney Disease or Liver Disease.

Study design

It was a Prospective observational cohort study. Patient included in the study were followed up at 3 and 30 days as per the questionnaire designed for the study after the approval by scientific and ethics committee of the institute.

For the purpose of statistical significance we will recruit 64 patients as per the inclusion & exclusion criteria of the study.

Data collection method

- Patient's history was taken from the patient and his/her attendants.
- CPRS (Computerized Patient Record System) and investigations reports were be used for collection of following data:

Data Collection

The study was conducted in the Emergency department (ED) of Max Super Specialty Hospital, Shalimar Bagh, which is a tertiary care referral hospital with an average of 9000 visits per annum.

Study subjects was followed prospectively from the time of presentation to the ED. Data collection was collected from patient reports and case files with no intervention on behalf of the investigator. Patient safety and care was in no way be compromised as the study is based on data which is yielded by routinely monitored parameters.

Data collection was done as per the approved data collection forms for the purpose of study. Patient's initial, BUN, Creatinine, Urea, Sodium, blood glucose, Caval index (optional) and clinical status was be collected as per NIHSS and Modified rankin scale. The patient was followed up during their duration of stay in the hospital on 1st, 2nd and 3rd day. During the follow up period patients was followed for progression and outcome based on clinical parameters and the mentioned scores.

Early neurological deterioration (END) is defined as worsening of neurological condition as indicated by an increase of three or more points in the NIHSS score or death not attributed to other cause, within the first three days. An increase of three or more points in the NIHSS score was used to diagnose END. Patients were divided into two groups. The first group included patients with END and the second group included those without END. Patients were followed up on day 30th for mRS scoring. AnmRS Scoring of 3 or more was taken as an unfavorable outcome.

Dehydration was defined by any one of the following:

1. Plasma Osmolality > 295, or
2. BUN/creatinine Ratio ≥ 15, or

3. Hematocrit > 43%, or
4. Caval Index > 50%

At the end of the study period the data collection was utilized to derive an association of dehydration and progression of AIS in terms of END and mRS.

All data mentioned above and required for the study was entered into a data collection form. (Annexure 1)

Sample Size and Statistical Analysis

Based on the results of previous studies to derive a statistically significant co relation we recruited a sample size of 64 patients. Correlation between intravascular volume depletion markers such as BUN/ Creatinine ratio, Plasma osmolality, Hematocrit, Caval Index, NIHSS score, Modified rankin score and, outcome and survival was obtained by pearson correlation coefficient and its statistical significance was tested by Z test after fisher transformation. The same procedure was also be used to compare the correlation between two groups under study. For comparing average in two groups student t test was used assuming Gaussian distribution. In case the distribution was far from Gaussian wilcoxon-Mann whitney test was used.

Statistical Plan

Statistical Analysis

Summarized data was presented using Tables and Graphs. Data was normally distributed as tested using the Shaperio-Wilk W test (p-value was less than 0.05). Level of statistical significance was set at p-value less than 0.05. Spearmans and pearson correlation coefficient was used to calculate correlation. Chi square test was used to find association between categorical variables and Mann Whitney U test to compare mean between two independent groups.

Results

Demographic details

Table 1: Distribution of study population according to age group

Age (years)	Frequency	Percent
30-40	6	9.4
41-50	4	6.3
51-60	12	18.8
61-70	18	28.1
71-80	18	28.1
81-90	6	9.4
Total	64	100.0

Table 2: Distribution of study population according to Plasma Osmolality levels

Plasma Osmolality	Frequency	Percent
Greater than 295	25	39.1
Less than or equal to 295	39	60.9
Total	64	100.

Table 3: Distribution of study population according to BUN/ Creatnine ratio

BUN/Creatnine ratio	Frequency	Percent
Greater than or equal 15	44	68.8
Less than 15	20	31.3
Total	64	100.0

Table 4: Distribution of study population according to Hematocrit

Hematocrit	Frequency	Percent
Greater than 43%	15	23.4
Less than or equal to 43%	49	76.6
Total	64	100.0

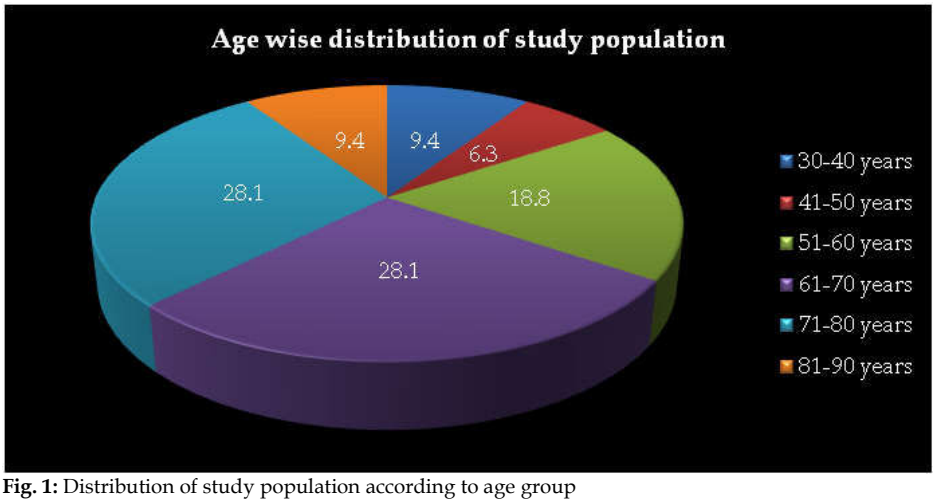

Fig. 1: Distribution of study population according to age group

Table 5: Distribution of a sub group among the study population in whom the caval index was calculated

Plasma Osmolality	Frequency	Percent
Less than 50%	14	70.0
More than or equal to 50%	6	30.0
Total	20	100.0

Table 6: Comparison of early neurological deterioration and dehydrated patients among the study population

		Early neurological deterioration		Total
		Present	Absent	
Dehydrated	N	18	33	51
	%	35.3%	64.7%	100.0%
Non Dehydrated	N	2	11	13
	%	15.4%	84.6%	100.0%
Total	N	20	44	64
	%	31.3%	68.8%	100.0%
Chi Square Value			1.911	
p Value			0.147	

Table 7: Comparison of modified Rankin Score and dehydrated patients among the study population

		Modified Rankin Score (mRS score)			Total
		2	3-5	6	
Dehydrated	N	20	25	6	51
	%	39.2%	49.0%	11.8%	100.0%
Non Dehydrated	N	8	5	0	13
	%	61.5%	38.5%	0.0%	100.0%
Total	N	28	30	6	64
	%	43.8%	46.9%	9.4%	100.0%
Chi Square Value			2.956		
p Value			0.228		

Table 8: Mean ± SD of Length of stay among study population based on dehydration

Length of stay	Mean	Std. Deviation
Dehydrated	7.49	6.76
Non Dehydrated	10.6	11.1
Mann whitney u test. Level of significance set at 0.05	Z value: -101, p value: 0.919	

Table 9: Distribution of NIHSS among the study population

NIHSS	Frequency	Percent
Minor Stroke (1-4)	14	21.9
Moderate Stroke (5-15)	36	56.3
Moderate to Severe Stroke (16-20)	14	21.9
Severe Stroke (21-42)	0	0
Total	64	100.0

Table 10: Comparison of plasma osmolality with NIHSS

Minor Stroke		NIHSS			Total
		Moderate Stroke	Moderate to Severe Stroke		
Greater than 295	N	11	6	8	25
	%	44.0%	24.0%	32.0%	100.0%
Less than or equal to 295	N	3	30	6	39
	%	7.7%	76.9%	15.4%	100.0%
Total	N	14	36	14	64
	%	21.9%	56.3%	21.9%	100.0%
Chi Square Value			18.6889		
P Value			0.001*		

Chi Square Test, Level of Significance at $p < 0.05$

Table 11: Comparison of BUN/Creatinine ratio with NIHSS

Minor Stroke		NIHSS			Total
		Moderate Stroke	Moderate to Severe Stroke		
Greater than or equal 15	N	7	24	13	44
	%	15.9%	54.5%	29.5%	100.0%
Less than 15	N	7	12	1	20
	%	35.0%	60.0%	5.0%	100.0%
Total	N	14	36	14	64
	%	21.9%	56.3%	21.9%	100.0%
Chi Square Value			6.151		
P Value			0.046*		

Chi Square Test, Level of Significance at p< 0.05

Table 12: Comparison of hematocrit with NIHSS

Minor Stroke		NIHSS			Total
		Moderate Stroke	Moderate to Severe Stroke		
Greater than 43%	N	4	6	5	15
	%	26.7%	40.0%	33.3%	100.0%
Less than or equal to 43%	N	10	30	9	49
	%	20.4%	61.2%	18.4%	100.0%
Total	N	14	36	14	64
	%	21.9%	56.3%	21.9%	100.0%
Chi Square Value			2.301		
P Value			0.316		

Chi Square Test, Level of Significance at p < 0.05

Table 13: Comparison of Caval Index with NIHSS

Minor Stroke		NIHSS			Total
		Moderate Stroke	Moderate to Severe Stroke		
Less than 50%	N	5	6	3	14
	%	35.7%	42.9%	21.4%	100.0%
Greater than or equal to 50%	N	2	2	2	6
	%	33.3%	33.3%	33.3%	100.0%
Total	N	7	8	5	20
	%	35.0%	40.0%	25.0%	100.0%
Chi Square Value			0.844		
p Value			0.340		

Chi Square Test, Level of Significance at p< 0.05

Table 14: Comparison of plasma osmolality with mortality

		Mortality		Total
		Died	Survived	
Greater than 295	N	6	19	25
	%	24.0%	76.0%	100.0%
Less than or equal to 295	N	0	39	39
	%	0.0%	100.0%	100.0%
Total	N	6	58	64
	%	9.4%	90.6%	100.0%
Chi Square Value			10.382	
p value			0.002*	

Chi Square Test, Level of Significance at p< 0.05

Table 15: Comparison of BUN/Creatinine ratio with mortality

		Mortality		Total
		Died	Survived	
Greater than or equal 15	N	6	38	44
	%	13.6%	86.4%	100.0%
Less than 15	N	0	20	20
	%	0.0%	100.0%	100.0%
Total	N	6	58	64
	%	9.4%	90.6%	100.0%
Chi Square Value			3.009	
p Value			0.094	

Chi Square Test, Level of Significance at $p < 0.05$

Table 16: Comparison of hematocrit with mortality

		Mortality		Total
		Died	Survived	
Greater than 43%	N	2	13	15
	%	13.3%	86.7%	100.0%
Less than or equal to 43%	N	4	45	49
	%	8.2%	91.8%	100.0%
Total	N	6	58	64
	%	9.4%	90.6%	100.0%
Chi Square Value			0.361	
p Value			0.432	

Chi Square Test, Level of Significance at $p < 0.05$

The comparison of hematocrit with mortality among the study population was done using chi square test. It failed to reach the level of significance.

Table 17: Comparison of caval index with mortality

		Mortality		Total
		Died	Survived	
Less than 50%	N	1	13	14
	%	7.1%	92.9%	100.0%
Greater than or equal to 50%	N	1	5	6
	%	16.7%	83.3%	100.0%
Total	N	2	18	20
	%	10.0%	90.0%	100.0%
Chi Square Value			0.521	
P Value			0.423	

Chi Square Test, Level of Significance at $p < 0.05$

The caval index was dichotomized in two groups based on median value 50% to calculate association.

Discussion

Acute Ischemic stroke has been one of the significantly known contributors of mortality among the patient present to the emergency room with stroke. As an emergency physician, apart from the duty of diagnosing, resuscitating and managing Acute Ischemic Stroke patients there also lies a role of recognizing dehydration and correcting it to prevent further deterioration of these patients. In this study, we had aimed to associate the parameters i.e Plasma Osmolality, BUN/Creatinine ratio, Hematocrit and Caval Index (optional) with the mortality and morbidity of these patients and also with the progression of the disease.

In a general perspective, any patient fulfilling the criteria for dehydration as per even one of the variable was considered dehydrated. The

comparison of mRS score and dehydration among the study population, the group with dehydration had about 11% subjects with a mRS of 6 i.e death, while majority of dehydrated patients i.e 49% reported to have a mRS score between 3-5 i.e they had unfavorable outcome. Most patients with early neurological deterioration were found to be dehydrated i.e 18 patients in comparison to the non dehydrated i.e 2 patients Surprisingly, the length of stay in the hospital among the survivors was found to be higher in the mean of 10.6 (standard deviation 11.1) days against 7.49 (standard deviation of 6.76).

On considering the individual markers of dehydration; plasma osmolality of more than 295 in comparison with NIHSS, 32% had moderate to severe stroke as per NIHSS ($p = 0.001$). In comparison with mortality, subjects who died showed an plasma osmolality more than 295 while none of the subjects with normal osmolality had died ($p = 0.002$). In terms of length of stay in the hospital, about 75% of patients with plasma osmolality stayed in the hospital for at least more than 6 days.

With BUN/Creatinine ratio, among those with a ratio of more than 15, about 30% were found to have moderate to severe stroke as per the NIHSS. In terms of mortality, the patients who died (mRS score of 6) showed a BUN/Creatinine ratio of 15 or more.

Hematocrit on the other hand, showed no correlation with mortality, length of stay, early neurological deterioration to reach a statistical level of significance.

Caval Index using IVC diameters were assessed in a small sub group of the patient of the study population. Its comparison with NIHSS, mRS, length of stay failed to form any sort of association. In terms of Early neurological deterioration, in about 90% of those with Caval index of more than 50% had been seen to have early neurological deterioration ($p = 0.09$). But this could not be considered significant statistically as the sub group consisted of only 20 patients.

Our study had several limitations.

- It was a single-center study with relatively small numbers of patients. Hence the results cannot be applied to all centers across the India.
- Our sample size was inadequate to provide results which were statistically significant.
- Although we had taken into consideration the degree of hydration and its association with mortality during the time of admission; once admitted in the ICUs, the course of treatment and interventions done based on the treating physician's preferences could have independently varied the outcome within the study population, which could not be accounted for.

Conclusion

In conclusion, though we were able to associate plasma osmolality and BUN/Creatinine ratio with mortality, length of stay and with poorer outcome in terms of early neurological deterioration; hematocrit and Caval Index failed to associate to significant level to prove as a prognostic marker.

Initial risk stratification using the plasma osmolality and BUN/Creatinine ratio may assist with prognostication and help prevent deterioration of the patients with Acute Ischemic Stroke.

Future directions for consideration include a multicentric trial with a larger sample to validate the predictive value of these markers of dehydration in prognosticating Acute Ischemic Stroke.

Annexures I

Protocol no- IVD Stroke 01/2016

Data Collection Form

SSN No. Age : Sex : ☐ M ☐ F

Date : Time of Arrival : Onset of Symptoms:

Diagnosis –

Vitals on arrival : SBP- DBP- PR- Temp- SpO_2 -

Radiological imaging impression-

TOAST Classification:

Large Artery Atherosclerosis-

Small Artery Occlusion-

Cardioembolism-

Caval Index-

Inspiratory IVC Diameter

Expiratory IVC Diameter-

LABS	Day 1	Day 2	Day 3
Hb.			
HCt			
TLC			
S.Urea			
S.Creat			
BUN			
BUN/Creat			
S.Na			
S.K			
Blood Glucose			
Plasma Osmolarity			

Severity	Day 1	Day 2	Day 3	Day 30 mRS
GCS NIHSS mRS				

Length of stay in Hospital :

Complications during stay :

Co-Morbidities- ☐ DM ☐ HTN ☐ CKD ☐ CLD ☐ AF

Signature of ER Resident

Signature of ER Consultant

Referrences

1. Leng C. Lin et al. Predictors of early clinical deterioration after acute ischemic stroke. The American Journal of Emergency Medicine. 2011, Article/S0735-6757(09)00643-3.
2. Lin, L.C. et al., Bun/creatinine ratio-based hydration for preventing stroke-in-evolution after acute ischemic stroke. Am J Emerg Med. 2014;32:709–12.
3. Lin WC et al. Preliminary Prospective Study to Assess the Effect of Early Blood Urea Nitrogen/ Creatinine Ratio-Based Hydration Therapy on Poststroke Infection Rate and Length of Stay in Acute Ischemic Stroke. J Stroke Cerebrovascular Dis. 2015 Dec;24(12):2720-7.
4. Bhatia K et al. Predictors of early neurological deterioration in patients with acute ischaemic stroke with special reference to blood urea nitrogen (BUN)/creatinine ratio & urine specific gravity. Indian J Med Res. 2015 Mar;141:299-307.
5. Lin LC et al. Predictors of clinical deterioration during hospitalization following acute ischemic stroke. Eur Neurol. 2012;67(3):186-92.
6. Miyamoto N. et al. Demographic, clinical, and radiologic predictors of neurologic deterioration in patients with acute ischemic stroke. J Stroke Cerebrovasc Dis. 2013 Apr;22(3):205-10.
7. Liu CH et al. Dehydration is an independent predictor of discharge outcome and admission cost in acute ischaemic stroke. Eur J Neurol. 2014 Sep;21(9):1184-91.
8. RiccardiA et al. Identification of the hydration state in emergency patients: correlation between caval index and BUN/creatinine ratio. Eur Rev Med PharmacolSci. 2013;17(13):1800-03.
9. Bhalla A et al. Influence of Raised Plasma Osmolality on Clinical Outcome after Acute Stroke.Stroke. 2000 Sep;31(9):2043-8.
10. Angela M et al. Predictive Variables for Mortality after Acute Ischemic Stroke. Stroke. 2007;38: 1873-80.
11. Lee Hooper et al. Diagnostic accuracy of calculated serum osmolarity to predict dehydration in older people: adding value to pathology laboratory reports. BMJ Open. 2015;5:e008846.
12. Rowat A et al. Dehydration in Hospital-Admitted Stroke Patients. Stroke. 2012;43:857-859.

13. Kellert L et al. Cerebral Oxygen Transport Failure?: Decreasing Hemoglobin and Hematocrit Levels After Ischemic Stroke Predict Poor Outcome and Mortality. Stroke. 2011;42:2832-2837.
14. Schrock JW et al. Elevated blood urea nitrogen/ creatinine ratio is associated with poor outcome in patients with ischemic stroke. ClinNeurolNeurosurg. 2012 Sep;114(7):881-4.
15. Sulter G et al. Use of the Barthel Index and Modified Rankin Scale in Acute Stroke Trials. Stroke. 1999;30: 1538-41.
16. Allport LE et al. Elevated hematocrit is associated with reduced reperfusion and tissue survival in acute stroke. Neurology. 2005 Nov 8;65(9):1382-87.
17. Schrock JW et al. Elevated blood urea nitrogen/ creatinine ratio is associated with poor outcome in patients with ischemic stroke. Clin Neurol Neurosurg. 2012 Sep;114(7):881-4.
18. Cheuvront SN et al. Dehydration: Physiology, Assessment, and Performance Effects American Physiological Society. Compr Physiol. 2014;4:257-285.
19. Nagdev AD et al. Emergency department bedside ultrasonographic measurement of the caval index for noninvasive determination of low central venous pressure.AnnEmerg Med. 2010 Mar;55(3):290.
20. Wilson JT et al. improving the assessment of outcomes in stroke: use of a structured interview to assign grades on the modified Rankin Scale. Stroke. 2002 Sep;33(9):2243-6.
21. Wilson JT, et al. Reliability of the modified Rankin Scale across multiple raters: benefits of a structured interview. Stroke. 2005 Apr;36(4):777-81.
22. Quinn TJ et al. Initial experience of a digital training resource for modified Rankin scale assessment in clinical trials. Stroke. 2007 Aug;38(8):2257-61.