



## Role of serum osmolarity as an indicator for neurological morbidity in children with acute central nervous illness

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### ABSTRACT

Acute CNS illness comprising of Acute CNS infections along with Traumatic head Injury is an important cause for significant morbidity and mortality in Pediatric Intensive Care units across the world. Osmolar changes in the blood correlate well with CNS status. Acute BM is still a meaningful, host-pathogen interaction responsible for bacterial invasion of the CNS Osmolality in children with CNS illness is a good indicator of assessing neurological Morbidity and Mortality. A complex neuroendocrine system is involved in the maintenance of sodium and water homeostasis. Bacterial Meningitis (BM) is an acute purulent infection of the meninges. It is the most common bacterial infection of the CNS& it's the medical emergency that still has high mortality and morbidity. Blood-Brain Barrier is relatively impermeable to sodium, but water crosses freely. Variety of result in sodium dysregulation such as Traumatic Brain Injury, pyogenic meningitis, viral encephalitis, which is associated with significant Mortality and Morbidity. The objective of our study is to determine the incidence and outcome of Serum Osmolar change in children presenting with acute neurological illness. A prospective observational study was carried out between Jan 6<sup>th</sup> 2020-March 6 th2020 enrolling children between ages of 1 month to 15 years, admitted to the PICU of SMCH with Acute onset neurological illness. Among 40 children, 20 children with hyponatremia have 50% of neurological deficit, Children with hypernatremia 50% had Neurological deficit, which is not statistically significant at P value0.083. Among the 40 children 40% had low Osmolality, 25% have high Osmolality& 35% had normal range, which is not statistically significant at P value 0.199

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### INTRODUCTION

Acute CNS illness comprising of Acute CNS infections along with Traumatic Head Injury is an impor-

tant cause for significant Morbidity and Mortality in Pediatric Intensive Care unit across the world Childhood. Acute BM is still significant, host-pathogen interaction responsible for bacterial invasion of the CNS ([Guenec et al., 2020](#))

Acute Bacterial Meningitis remains a significant cause of morbidity and mortality, especially in developing countries. The pattern of both sporadic and epidemic cases of meningitis has been known to change from place to place even in the same country ([Loic Le Guennec and S Bourdoulous, 2020](#))

The global burden of Acute Bacterial Meningitis (CNS infections) in children remains high. In India, the overall incidence of meningitis is about 2 to 10 cases per 100,000 populations per year, although

the attack rates are very age-specific. Bacterial Meningitis (BM) is an acute purulent infection of the meninges. It is the most common bacterial infection of the CNS & it's the medical emergency that still has high mortality and morbidity. The incidence is most significant in pediatric patients, especially infants, with attack rates in neonates at about 400 per 100,000, and 20 per 100,000 in those less than or equal to 2 years old. (Mado and Aliyu, 2018) In a multicentre survey in India, Acute Bacterial Meningitis constituted 1.5% of admissions in pediatric wards with a mean case fatality rate of 16%. (Mace, 2008)

Traumatic Brain Injury (TBI) is the most common cause of death and acquired disability among children and young adults in developed countries and, even when adequate treatment is provided, TBI commonly causes neuronal loss. (Aneja and Aggarwal, 1998) In a study done in the UK prevalence of head injury was 5.6 per 100,000 populations, It is estimated that nearly 1.5 to 2 million persons are injured, and one million succumbed every year in India. (Bahloul *et al.*, 2011) Road traffic injuries are the leading cause (60%) of TBIs followed by falls (20%-25%) and violence (10%) in children between the age groups of 0-14 years. (Parslow, 2005) From the above scenario meningitis, and traumatic neurological injury may be the primary consequence of CNS illness, but secondary systemic and metabolic complications like a peripheral circulatory failure, dyselectrolytemia, metabolic acidosis, hypoglycemia disseminated intravascular coagulation can also adversely affect the outcome of the primary disease, A complex neuroendocrine system is involved in the maintenance of Sodium and water homeostasis (Gururaj, 2002; Kirkman *et al.*, 2013)

The blood-brain barrier (BBB) physiologically protects the meningeal spaces from blood-borne bacterial pathogens. Some bacteria can cross the BBB in humans and cause meningitis, an acute purulent infection of the meninges (Ferguson-Myrthil, 2017) Blood Brain Barrier is relatively impermeable to sodium, but water crosses freely. Variety of insults may result in Sodium Dysregulation such as traumatic brain injury, pyogenic meningitis, viral encephalitis, which is associated with significant mortality and morbidity. Osmolar changes correlate linearly with CNS status and measuring serum and urine Osmolality will help predict Morbidity and Mortality in children with Acute CNS illness. Our study hopes to bring out the utility of measuring Serum Osmolality as an indicator of neurological morbidity.

## MATERIALS AND METHODS

For the present study, A qualitative approach with experimental research design was used. The study was conducted at Saveetha Medical College and Hospital, Chennai. Which is 1200 bedded hospital; approximately 75 children are attending the Outpatient Department (OPD) every day.

A study was conducted after obtaining Ethical Clearance from the Institutional Ethical Committee (IEC) of Saveetha Institute of Medical and Technical Science (SIMATS). Formal permission was obtained from the Medical Dean at Saveetha Medical College and Hospital. The data was collected from 40 children who met the inclusion criteria by using a Random sampling technique.

The Informed & Written Consent was obtained from each parent before doing the procedure, and the process was explained to them. Serum osmolality (Serum sodium and serum urine) was collected. In our study serum and urine osmolality was measured by OSMOMAT030 (Automated Cryoscopic Osmometer) the data was analyzed using descriptive and inferential statistics. (Chi-Square Test & Fisher Exact Test).

## RESULTS AND DISCUSSION

Acute CNS infections and traumatic head injury in children are associated with significant mortality and morbidity. Total of 40 patients the children classified according to the diagnosis were 20%, and head injury was 80%. According to (U. Maggiore, E Picetti, E Antonucci critical care 2009) The occurrence of hyponatremia increases the risk of death in patients with severe Traumatic Brain Injury. (Maggiore *et al.*, 2009) In this study, 50% of the children have hypernatremia, and the remaining 50% have hyponatremia. Hyponatremia is the most commonly encountered electrolyte abnormality. If uncorrected, it can lead to seizure, coma, or death.

Among the 40 patients studied, 20 had Serum Sodium below 135 meq/l. Out of the 7 (50%) patients had neurological deficits. 6 patients had Serum Sodium level above 145 meq/l. Out of them 7 (50%) patients had neurological deficits. P-value 0.083, which is not statistically significant.

Among the 40 children, 15 had Serum Osmolality below 280 mosm/kg. Out of the 4 (28.6%) had neurological deficits, 15 children had Serum Osmolality between 280-300 mosm/kg. Out of the 4 (28.6%) of them had neurological deficits. 10 Children had Serum Osmolality above 300, out of the 6 (42.9%) of these patients had neurological deficits, P-value 0.199, which is statistically not Significant.

**Table 1: Classification of Children According to Diagnosis**

Diagnosis	Number of patients (n=40)	%
Head Injury	8	20%
Acute CNS infection	32	80%

**Table 2: Serum Sodium level of Children**

Serum Sodium me Eq/l	N=40	%	Acute CNS Infection (n=32)	Head Injury (n=8)
<135	27	67.5	24	4
>145	13	32.5	9	4

**Table 3: Serum Osmolality level of Children**

Serum osmolality mosm/kg	N=40	%	Acute CNS Infection (n=32)	Head Injury (n=8)
<280	16	40.0	14	2
280-300	14	35.0	12	2
>300	10	25.0	6	4

**Table 4: Correlation of Serum Sodium with Neurological Deficits**

Blood parameters	Absence of Neurological deficit (n=26)		Presence of Neurological deficit (n=14)		P value
	No	%	No	%	
Serum Sodium meq					
< 135	20	76.9	7	50.0	0.083+
<145	6	23.1	7	50.0	

**Table 5: Correlation of serum Osmolality with neurological deficits**

Blood parameters	Absence of Neurological deficit (n=26)		Presence of Neurological deficit (n=14)		P value
	No	%	No	%	
Serum Osmolality- mosm/kg					
<280	15	42.3	4	28.6	0.199
280-300	15	42.3	4	28.6	
>300	10	15.4	6	42.9	

In this study, the classification of the children under the head injury was 8 (20%), children having Acute CNS Infection were 32 (80%). (Table 1)

Among the 40 children studied majority 27(67.5%) were found to have hyponatremia and remaining 13(32.5%) have Hypernatremia. (Table 2)

In this study among the 40 children, 16(40%) had Serum Osmolality below 280, 14(35%) Children had Serum Osmolality between(280-300) and 10(25%) children had Osmolality above 300

mosm/kg. (Table 3)

Among the 40 patients studied, 20 had Serum Sodium below 135meq/l. Out of the 7(50%) patients had neurological deficits.6 patients had Serum Sodium level above145meq/l Outofthem 7(50%) patients had neurological deficits. P-value 0.083 which is not statistically significant (Table 4)

Among the 40 children, 15 had Serum Osmolality below 280mosm/kg. Out of them, 4 (28.6%) had neurological deficits, 15 children had Serum

Osmolality between 280-300 mosm/kg. Out of the 4(28.6%) of them had neurological deficits. 10 Children had Serum Osmolality above 300, out of the 6(42.9%) of these patients had neurological deficits, P-value 0.199, which is statistically not Significant. (Table 5)

## CONCLUSION

Measurement of Serum Osmolality along with Serum Sodium helps in early diagnosis of the above condition, which could in turn help in better management of fluid therapy in such children, thereby averting future morbidity and mortality. Acute Neurological Illnesses are usually associated with an imbalance of sodium and water. These disorders if not recognized early, can lead to seizures, motor deficits and coma. Early Measurement of Serum Osmolality and Serum Sodium first helps in predicting this complications hence we have evaluated the role of Serum Osmolality as a predictor of Morbidity and Mortality in Acute CNS illness.

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Nil

## Conflicts of Interest

The authors declare no conflicts of interest.

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