Original Research

EFFICACY OF 3% HYPERTONIC SALINE VS 20% MANNITOL IN REDUCING CEREBRAL OEDEMA OF NONTRAUMATIC ETIOLOGY IN PICU ADMITTED CHILDREN: A COMPARATIVE OBSERVATIONAL STUDY

Dr. Narendra Mishra[1], Dr. Priyanka Kumari[2], Dr. Madangopal Choudhary[3], Dr. Pawan Kumar Dara[4*], Dr. Vikas Katewa[5], Dr. Rajendra Kumar Soni[6]

[1]M.D. Pediatrics, Senior specialist, department of Pediatrics, S K Medical College and attached hospital, Rajasthan.
[2]M.D. Anaesthesiology, Assistant Professor, department of Anaesthesia, S P Medical College Bikaner.
[3]M.D. Pediatrics, Associate Professor, department of Pediatrics, S P Medical College, Bikaner, India.
[4*]M.D. Pediatrics, Associate Professor, department of Pediatrics, S P Medical College, Bikaner, India.
[5]M.D. Pediatrics, Associate Professor, department of Pediatrics, Dr. S N Medical College Jodhpur.
[6]M.D. Pediatrics, Senior Professor, department of Pediatrics, S P Medical College Bikaner.
Email: [1]drmishra.narendra@gmail.com, [2]drpriyankadara04@gmail.com, [3]dr.madangopal.choudhary@yahoo.com, [4*]drpawandara51@gmail.com, [5]drvikaskatewa@gmail.com, [6]drsonirajendra@gmail.com
Corresponding Author: Dr. Pawan Kumar Dara
M.D. Pediatrics, Associate Professor, Department of Pediatrics, S P Medical College Bikaner, Rajasthan. India Pin-334003.

ABSTRACT

Objective: To compare the efficacy and safety of 3% hypertonic saline and mannitol in children with cerebral edema. **Methods:** This observational study was conducted in the PICU of a tertiary care hospital, including 60 children (3 months-14 years) with non-traumatic cerebral edema, PT INR ≤1.5, and at least one reactive pupil. Exclusion criteria included seizure disorders, hepatic encephalopathy, anoxic spells, cerebral malaria, renal dysfunction, intracranial bleed, and renal failure. Participants were divided into two groups by simple randomization; Group A (n = 30) received mannitol, while Group B (n = 30) was treated with 3% saline. MAP, serum electrolytes, osmolality were monitored and neurological status was assessed using the GCS. **Results:** The mean age was comparable between groups. Fever was the most common symptom and meningoencephalitis was the leading cause of cerebral edema. Group B showed significantly faster improvement in GCS scores at 12, 24, and 48 hours. The duration of coma was significantly shorter in Group B (48.43 ± 18.61 hrs) than Group A (71.50 ± 17.59 hrs; $p = 0.001$). Serum sodium and chloride levels increased in Group B but remained within safe limits. No significant differences were observed in potassium, renal function markers, osmolality, or mortality between the groups. **Conclusion:** 3% hypertonic saline was found to be more effective than mannitol in improving neurological outcomes in children with non-traumatic cerebral edema, without adverse effects. It may be a preferred choice in patients with hypotension.

Keywords: Mannitol, 3% Hypertonic Saline, Children, Cerebral Oedema, Picu, Nontraumatic.

INTRODUCTION

Cerebral edema, defined as swelling of the brain, is a common and potentially life-threatening condition with diverse etiologies including vasogenic, cytotoxic, osmotic, and interstitial mechanisms.[1]

www.ajmrhs.com
eISSN: 2583-7761

Date of Received: 29-12-2025
Date Acceptance: 10-01-2026
Date of Publication: 11-02-2026

It may result from trauma, ischemia, intracranial lesions, or hydrocephalus.[2] According to the Monroe-Kellie doctrine, the cranial vault contains a fixed volume of brain tissue, blood, and cerebrospinal fluid (CSF); an increase in one component must be balanced by a decrease in another. In cerebral edema, brain tissue swells, raising intracranial pressure (ICP), reducing cerebral perfusion, and exacerbating brain injury.[3]

Clinical manifestations of cerebral edema vary from subtle symptoms to coma and death, typically becoming apparent when ICP exceeds 20 cm H_2O.[4] Management strategies include surgical

decompression, head elevation, sedation, hypothermia, and hyperosmolar therapy most commonly mannitol and 3% hypertonic saline. These agents lower ICP by creating an osmotic gradient that draws fluid out of the brain parenchyma.[5]

Mannitol, a sugar alcohol used since the 1960s, promotes diuresis and ICP reduction but may cause hypotension, limiting its use in hemodynamically unstable patients. 3% hypertonic saline, introduced in the late 1980s, lowers ICP through osmotic fluid shifts and may also enhance cardiac output and modulate immune responses.[6]

Given the limited pediatric data, this study aimed to evaluate the efficacy and safety of 3% hypertonic saline in children with non-traumatic cerebral edema and to compare outcomes with those treated with mannitol.

MATERIALS AND METHODS

This comparative observational study was conducted from September 2019 to August 2020 in the Pediatric Intensive Care Unit (PICU) of a tertiary care hospital in Western Rajasthan. The study included children aged 3 months to 14 years with non-traumatic cerebral edema and PT INR ≤1.5, with at least one reactive pupil. Exclusion criteria included seizure disorders, hepatic encephalopathy, anoxic spells, cerebral malaria, renal dysfunction, intracranial bleeding, and renal failure.

Ethical approval from the Institutional Ethical Committee was taken from start of study and informed written consent were obtained from parents. Participants were divided into two groups at the time of admission in PICU by simple randomization. Group A (n = 30) children were received 20% mannitol, while Group B (n = 30) children were treated with 3% hypertonic saline. Both groups received a loading dose of 5 mL/kg followed by 2 mL/kg every 6 hours for 48 hours.[7] The osmolarity of both treatments was similar.

Monitoring included blood pressure (NIBP), mean arterial pressure (MAP), serum sodium, potassium, chloride levels and osmolality. ICP was assessed indirectly by measuring MAP. Data on demographics, clinical profiles, and biochemical parameters were collected and entered into Microsoft Excel for analysis. Data were analyzed with SPSS 22.0. All categorical values were presented as mean and SD. For quantitative variables, paired t-test for effect of hypersomolar therapy on ICP and Student's t-test for both groups with a significance level set at $p < 0.05$.

RESULTS

A total of 93 patients were enrolled, 60 cases meeting criteria were included and were divided into two groups:Group A (Mannitol, n = 30) Group B (3% HS, n = 30). Thirty three patients were excluded excluded due to hepatic encephalopathy (20), renal failure (5), intracranial bleeding (5), and seizure disorder (3). Mean age in group A was 8.17±3.95 years and 7.45±2.65 years in group B and comparable. Majority of cases were from rural areas: 83.33% in and 76.67% in Group A & B (Table 1).

Fever was most common symptoms in both group-60.00% in group A and 73.33% in group B followed by vomiting (50% each group) , convulsions and alterted sensorium. Meningoencephalitis was found the most common cause (43.33% in group A and 53.33% in group B) followed by pyomeningitis (26.67% and 10.00% in groups respectively) (Table 2).

The improvement in GCS score was much faster in group B as compared to group A at 12, 24 and 48 hours and the duration of coma significantly lower in patients who received 3% Saline (48.43 $\pm$ 18.61 vs 71.50 $\pm$ 17.59 hours; $p = 0.001$) (Table 3). The MAP in both groups was reduced every time as compared to previous one measured 6 hourly (Table 4).. In Group B, serum sodium and chloride increased significantly higher in the 3% NS group at 24, 36, and 48 hours ($p = 0.001$) but remained within acceptable limits. There was no difference in serum potassium, blood urea nitrogen, serum creatinine levels, osmolality ($p > 0.05$). Both groups had an equal mortality rate of 6.67%.mortality.

DISCUSSION

Cerebral edema is commonly managed using osmotherapy to create an osmotic gradient that reduces brain water content. This study aimed to compare the effectiveness of 3% hypertonic saline and mannitol in pediatric patients with cerebral edema. A total of 93 patients were enrolled, with 60 meeting the inclusion criteria. They were divided into two groups based on blood pressure at admission: Group A (mannitol) for high blood pressure and Group B (3% HS) for hypotension. Thirty-three patients were excluded due to conditions like hepatic encephalopathy, renal failure, intracranial bleeding, and seizure disorders.

The mean age of patients was comparable between both groups (Mannitol: 8.17 ± 3.95 years, 3% NS: 7.45 ± 2.65 years). Gender distribution also showed no significant differences between the two groups (Mannitol: 63.33% male, 3% NS: 46.67% male), consistent with findings from previous studies by Yildizdas D et al.[8] and Kumaraguru D et al.[9] Most patients were from rural areas (Mannitol: 83.33%, 3% NS: 76.67%).

Fever was the most common symptom in both groups, though statistically insignificant. Headache was less frequently reported, possibly due to difficulty in diagnosing in young children. The most common diagnoses were meningoencephalitis (Mannitol: 43.33%, 3% NS: 53.33%) and pyomeningitis (Mannitol: 26.67%, 3% NS: 10%).

Regarding GCS improvement, the 3% NS group showed faster recovery than the mannitol group at 12, 24, and 48 hours. This aligns with studies by Upadhyay P et al.[7] and Yildizdas D et al.[8], where a statistically significant decrease in coma duration was noted in patients treated with 3% NS. In contrast, Kumaraguru D et al[9] study reported comparable coma durations across both groups.

Mean arterial pressure (MAP) reduced in both groups over time, with statistically significant differences between the groups, as seen in the study by Upadhyay P et al.[7,] The BUN and creatinine levels remained similar between groups at 0 and 48 hours, consistent with findings from Yildizdas D et al.[8] and Upadhyay P et al.[7] However, Kumaraguru D et al.[9] noted a higher incidence of renal failure in the 3% NS group, though not statistically significant.

The sodium levels in the 3% HS group were significantly higher at 24, 36, and 48 hours, a finding that was expected due to the saline's hypertonic nature. Chloride levels also showed similar trends. These results are consistent with studies by Upadhyay P et al., Yildizdas D et al., and Kumaraguru D et al.[7,8,9] However, hypernatremia was not a concern in this study, which mirrors findings from earlier studies. Potassium levels were within normal limits and showed no significant difference between the groups, aligning with Upadhyay P et al.'s observations.[7]

Serum osmolality in both groups was comparable, with no significant difference (p = 0.808), consistent with Upadhyay P et al. and Yildizdas D et al.[7,8]

Mortality rates were equal in both groups at 6.67%, showing no statistically significant difference, which agrees with findings by Upadhyay P et al.[7] However, in the study by Yildizdas D et al.[8], mortality was significantly lower in patients treated with 3% NS.

Limitations of the Study: this was observational study only and ICP was measured indirectly by vitals including MAP, GCS and duration of coma.

CONCLUSION

Our study suggests that 3% hypertonic saline (HS) is a safe and effective treatment for cerebral edema of non-traumatic etiology in children, offering advantages over mannitol, especially in conditions like shock. 3% HS was more effective in reducing the duration of coma compared to mannitol. However, careful monitoring of serum sodium levels is crucial to prevent hypernatremia during treatment with 3% HS. To establish more definitive evidence further research specially RCT is required in pediatric population.

REFERENCES

1. Lawrence SE, Cummings EA, Gaboury I, Daneman D. Population-based study of incidence and risk factors for cerebral edema in pediatric diabetic ketoacidosis. J Pediatr. 2005 May;146(5):688-92. doi: 10.1016/j.jpeds.2004.12.041.
2. Yang Y, Rosenberg GA. Blood-brain barrier breakdown in acute and chronic cerebrovascular disease. Stroke. 2011 Nov;42(11):3323-8. doi: 10.1161. https://pubmed.ncbi.nlm.nih.gov/21940972/
3. Jha SK. Cerebral Edema and its Management. Med J Armed Forces India. 2003 Oct;59(4):326-31. doi: 10.1016/S0377-1237(03)80147-8. Epub 2011 Jul 21.
4. Senger DR, Van de Water L, Brown LF, Nagy JA, Yeo KT, Yeo TK, Berse B, Jackman RW, Dvorak AM, Dvorak HF. Vascular permeability factor (VPF, VEGF) in tumor biology. Cancer Metastasis Rev. 1993 Sep;12(3-4):303-24. doi: 10.1007. https://pubmed.ncbi.nlm.nih.gov/8281615/
5. Sorby-Adams AJ, Marcoionni AM, Dempsey ER, Woenig JA, Turner RJ. The Role of Neurogenic Inflammation in Blood-Brain Barrier Disruption and Development of Cerebral Oedema Following Acute Central Nervous System (CNS) Injury. Int J Mol Sci. 2017 Aug 17;18(8):1788. doi: 10.3390. https://pubmed.ncbi.nlm.nih.gov/28817088/
6. Hinson HE, Stein D, Sheth KN. Hypertonic saline and mannitol therapy in critical care neurology. J Intensive Care Med. 2013 Jan-Feb;28(1):3-11. doi: 10.1177
7. Upadhyay P, Tripathi VN, Singh RP, Sachan D. Role of hypertonic saline and mannitol in the management of raised intracranial pressure in children: A randomized comparative study. J Pediatr Neurosci. 2010 Jan;5(1):18-21. doi: 10.4103. https://pubmed.ncbi.nlm.nih.gov/21436162/
8. Yildizdas D, Altunbasak S, Celik U, Herguner O. Hypertonic saline treatment in children with cerebral edema. Indian Pediatr. 2006 Sep;43(9):771-9.
9. Kumaraguru D, Poovazhagi V, Sangareddi S, Padmanabhan R, Jeyachndran P. Effectiveness of 3% saline versus mannitol in children with cerebral oedema of non traumatic etiology. Journal of Pediatric Sciences. 2012;4(3):e143.

Table 1: Demographic Profile

Profile	Group A (30)	Group B (30)	p-value
Age in years (Mean± SD)	8.17± 3.95	7.45±2.65	0.089
Sex	n (%)	n (%)	0.305

Male	19(63.33)	1446.67	
Female	11(36.67)	1653.33	
Rural	25 (83.33)	23 (76.67)	0.624
Urban	5 (16.67)	7 (23.33)	

Table 2: Clinical Profile of Patients and Etiologies of Cerebral Oedema

Clinical profile	**Group A n (%)**	**Group B n (%)**	**Total n (%)**
Fever	18 (60.00)	22 (73.33)	40 (66.7)
Vomiting	15 (50.00)	15(50.00)	30 (50.0)
Convulsion	11 (36.67)	18 (60.00)	29 (48.3)
Altered sensorium	16 (53.33)	11(36.67)	27 (45.0)
Headache	6(20.00)	12 (40.00)	18(30.0)
Etiology			
Meningoencephaltis	13 (43.33)	16 (53.33)	29 (48.3)
Pyomeningitis	8 (26.67)	3 (10.00)	11 (18.3)
Encephalitis	4 (13.33)	7 (23.33)	11 (18.3)
TB meninigitis	4 (13.33)	3 (10.00)	7 (1.1)
ICSOL	1 (3.33)	1 (3.33)	2 (3.3)

Table 3. Comparison between Both Groups in Level of Glass Gow Coma Scale Progression and Duration of Coma

GCS at (Hours)	**Group A (30)**			**Group B (30)**			**p- value**
	<8	≥8	MEAN±SD	<8	≥8	MEAN±SD	
0	29	1	5.70±1.26	26	4	6.40±0.96	0.019
12	26	4	6.33±1.12	18	12	7.10±0.92	0.004
24	16	14	7.17±0.98	8	22	8.10±1.29	0.02
48	9	21	7.87±1.04	4	26	9.20±1.73	0.02
Duration of coma (hrs)	-	-	71.50±17.59	-	-	48.43±18.61	0.001

Table 4. MAP Wise Distribution of Study Subjects

Mean Arterial Pressure (MAP)	**Group A (30)**	**Group B (30)**	**p-value**
	Mean±SD	Mean±SD	
At 0 hour	93.00±8.12	83.00±7.19	0.001
At 6 hours	92.00±8.10	82.00±7.24	0.001
At 12 hours	89.60±7.58	80.63±7.12	0.001
At 18 hours	87.96±7.45	79.20±7.08	0.001
At 24 hours	84.67±7.25	77.06±7.63	0.001
At 30 hours	82.67±6.32	75.30±6.35	0.001
At 36 hours	79.23±6.32	72.73±5.98	0.001
At 42hours	79.60±6.98	71.76±6.39	0.001
At 48 hours	74.76±5.39	70.40±5.36	0.019

How to cite this article: Dr. Narendra Mishra, Dr. Priyanka Kumari, Dr. Madangopal Choudhary, Dr. Pawan Kumar Dara, Dr. Vikas Katewa, Dr. Rajendra Kumar Soni, EFFICACY OF 3% HYPERTONIC SALINE VS 20% MANNITOL IN REDUCING CEREBRAL OEDEMA OF NONTRAUMATIC ETIOLOGY IN PICU ADMITTED CHILDREN: A COMPARATIVE OBSERVATIONAL STUDY, Asian J. Med. Res. Health Sci., 2026; 4 (1):113-116.
Source of Support: Nil, Conflicts of Interest: None declared.