Section: Paediatrics

Original Research Article

PLASMA-LYTE VERSUS 0.9% NORMAL SALINE FOR FLUID RESUSCITATION IN CRITICALLY ILL CHILDREN: A RANDOMIZED CONTROLLED TRIAL

Manchinella Srinivas[1], Mundru Venkata Subba Rao[2], Prashanth Reddy Kandi[3]

[1]*Assistant Professor, Department of Paediatrics, Abdul Kalam Institute of Medical Sciences, Indore, Madhya Pradesh, India*
[2]*Professor, Department of General Medicine, MNR Medical College and Hospital, Fasalwadi, Sangareddy, Telangana, India.*
[3]*Assistant Professor, Department of Pediatrics, Pratima relief institute of Medical Sciences, Hanamkonda, Telangana, India.*

Received *: 07/09/2026*
Received in revised form *: 09/10/2026*
Accepted *: 21/10/2026*

Corresponding Author:
Dr. Prashanth Reddy Kandi,
Assistant Professor, Department of Pediatrics, Pratima relief institute of Medical Sciences, Hanamkonda, Telangana, India.
Email: preddy1173@gmail.com

DOI: 10.70034/ijmedph.2026.4.233

Source of Support: Nil,
Conflict of Interest: None declared

Int J Med Pub Health
2026; 16 (4); 1528-1531

ABSTRACT

Background: Fluid resuscitation is a fundamental component of management in critically ill children. Although 0.9% normal saline is widely used, its relatively high chloride content may contribute to hyperchloremia and metabolic disturbances. Balanced crystalloids such as Plasma-Lyte may provide a more physiological alternative.

Materials and Methods: This open-label randomized controlled study included 80 critically ill children requiring fluid resuscitation within the first 6 hours of admission. Participants were randomized equally to receive Plasma-Lyte or 0.9% normal saline. Serum bicarbonate, sodium, chloride, pH, base excess, lactate, and creatinine were assessed at baseline and during 24, 48, and 72 hours. Secondary outcomes included hyperchloremia, non-anion-gap metabolic acidosis, acute kidney injury, renal replacement therapy, inotrope requirement, mechanical ventilation, hospital stay, and mortality.

Results: Changes in serum bicarbonate were comparable between Plasma-Lyte and normal saline groups at 24 hours (2.84±6.48 vs 3.39±4.84 mmol/L), 48 hours (5.98±7.90 vs 5.88 ± 7.21 mmol/L), and 72 hours (9.07±9.43 vs 8.98±8.44 mmol/L). Hyperchloremia, sodium disturbances, non-anion-gap metabolic acidosis, acute kidney injury, ventilation, and mortality did not differ significantly between groups. Inotropic support was required significantly less frequently with Plasma-Lyte (37.5% vs 67.5%; p=0.013). Hospital stay was also shorter in the Plasma-Lyte group (9.28 vs 12.78 days; p=0.042).

Conclusion: Plasma-Lyte and 0.9% normal saline demonstrated comparable effects on bicarbonate and major acid base outcomes. Plasma-Lyte was associated with lower inotrope requirement and shorter hospital stay, supporting further evaluation in larger pediatric trials.

Keywords: Plasma-Lyte; normal saline; fluid resuscitation; critically ill children; balanced crystalloid; hyperchloremia; metabolic acidosis.

INTRODUCTION

Fluid resuscitation is a fundamental component of the initial management of critically ill children presenting with shock, impaired tissue perfusion, dehydration, or evolving organ dysfunction. Although isotonic crystalloids remain the principal fluids used for resuscitation, the optimal crystalloid formulation in critically ill children remains uncertain. 0.9% normal saline (NS) has traditionally been widely used because of its availability, familiarity, and isotonic properties. However, its supraphysiological chloride concentration has raised concerns regarding hyperchloremia, metabolic acidosis, and possible renal consequences following substantial fluid administration.[1,2]

Balanced crystalloids such as Plasma-Lyte were developed with an electrolyte composition closer to plasma and a lower chloride content than NS. Plasma-Lyte also contains acetate and gluconate as metabolizable anions, which may facilitate restoration of bicarbonate and acid–base equilibrium following administration. These characteristics provide a physiological rationale for using balanced

solutions in patients who require repeated or substantial fluid resuscitation, particularly when metabolic derangements are already present.[3,4] The potential clinical importance of limiting chloride exposure has been supported by studies demonstrating associations between chloride-rich fluid strategies and renal outcomes, although causality remains incompletely established.[5]

Pediatric evidence comparing balanced crystalloids with NS has expanded considerably but remains heterogeneous. In children with acute gastroenteritis, Plasma-Lyte was associated with more rapid improvement in serum bicarbonate compared with NS, although both solutions demonstrated acceptable safety profiles.[6] A randomized pediatric septic-shock trial subsequently demonstrated lower rates of new or progressive acute kidney injury and hyperchloremia with balanced multiple-electrolyte solution compared with saline, without a significant difference in mortality.[7] Conversely, other randomized investigations have reported comparable clinical outcomes between different crystalloid preparations, emphasizing that the benefits of balanced fluids may vary according to clinical setting and patient population.[8]

Recent evidence further illustrates this uncertainty. A systematic review and meta-analysis of randomized trials found that balanced solutions were associated with lower risks of acute kidney injury, renal replacement therapy, and hyperchloremia in pediatric septic shock, but did not demonstrate a significant mortality reduction.[9] More recent large-scale pediatric evidence has similarly shown substantially lower hyperchloremia with balanced fluids while finding no significant difference in major adverse kidney events.[10] Thus, biochemical effects and clinically important outcomes should be evaluated together. The present study therefore compares Plasma-Lyte with NS as resuscitation fluids in critically ill children, primarily assessing changes in serum bicarbonate at 24, 48, and 72 hours, with secondary evaluation of metabolic acidosis, electrolyte disturbances, AKI, vasoactive support, ventilation, mortality, and hospital outcomes.

MATERIALS AND METHODS

A prospective, open labelled randomized controlled study was conducted in the Department of Pediatrics at Pratima Relief Institute of Medical Sciences, Hanamkonda, Telangana. A total of 116 children presenting to the pediatric emergency department who required intravenous fluid resuscitation were screened for eligibility. Children between 1 month and 18 years who required at least 10 mL/kg of intravenous fluid bolus within the first 6 hours of hospital admission were included. Patients with established chronic kidney disease, chronic liver disease, disorders associated with significant electrolyte abnormalities, inborn errors of metabolism were excluded. Children whose parents or legal guardians declined informed consent were also excluded.

All the study participants were randomly allocated to two study groups (n=58 each) and medicated with Plasma-Lyte (Group 1) and 0.9% normal saline (Group 2). The assigned crystalloid was administered according to the treating physician's assessment of shock severity, hemodynamic status, and clinical response. The minimum qualifying resuscitation volume was 10 mL/kg.

Baseline demographic and clinical information was recorded before administration of the study fluid. Relevant pre-admission fluid intake, vomiting, diarrhoea, urine output, and previous intravenous fluid exposure were documented. Severity of illness was assessed using the Pediatric Risk of Mortality III (PRISM III) score. All administered fluids and potentially confounding electrolyte-containing medications were recorded. Blood samples were obtained at baseline and at 24, 48, and 72 hours. Serum bicarbonate, sodium, chloride, pH, base excess, lactate, and creatinine were assessed using standardized laboratory methods.

The primary outcome was the change in serum bicarbonate concentration from baseline at 24, 48, and 72 hours. Secondary outcomes included changes in sodium, chloride, pH and other acid base parameters, incidence of normal anion gap metabolic acidosis, new onset or progressive acute kidney injury according to KDIGO criteria, requirement for vasoactive medications, maximum vasoactive-inotropic score (VIS), mechanical ventilation, renal replacement therapy, blood product administration, length of hospital, PICU stay, and in hospital mortality.

Statistical analysis: The collected data was extracted into Microsoft Excel sheet and analysed using SPSS v.26.0. Data were summarized using mean and standard deviation for continuous variables and frequencies with percentages for categorical variables. Continuous variables were compared using the independent samples-t test, as appropriate, while categorical variables were analyzed using the chi-square test. A p value <0.05 was considered statistically significant.

RESULTS

Table 1: Demographic and baseline clinical characteristics of study participants.

Variable	Group 1 (n=58)	Group 2 (n=58)	p-value
Age (In years)	7.2 (3-12)	6.4 (2-11.8)	0.52
Gender			
Male	35 (60.3%)	32 (55.2)	0.58
Female	23 (39.6%)	26 (44.8%)	

Weight (In kgs)	20.5 (12.0-35.8)	22.5 (10.0-43.3)	0.69
PRISM III score	11 (7-16)	12 (6-21)	0.81
Bicarbonate (mmol/L)	18.7 (9.2-23.8)	18.4 (10.5-23.0)	0.9
Lactate (mmol/L)	2.6 (1.7-4.9)	3.1 (1.8-5.3)	0.49
Sodium (mmol/L)	139 (134-143)	136 (131-140)	0.07
Chloride (mmol/L)	104 (101-108)	101 (97-110)	0.24
Creatinine (mg/dL)	0.61 (0.37-0.94)	0.65 (0.40-0.97)	0.59
pH	7.32 (7.13-7.42)	7.34 (7.19-7.42)	0.41

Table 2: Changes in Serum bicarbonate, Serum Sodium, Serum chloride and change in pH among study groups.

Timeline	Group 1	Group 2	p-value
	Mean±SD	Mean±SD	
Serum bicarbonate			
24 h	2.84±6.48	3.39±4.84	0.9
48 h	5.98±7.9	5.88±7.21	0.97
72 h	9.07±9.43	8.98±8.44	0.82
Serum sodium			
24 h	2.08±5.9	6.35±8.29	0.033
48 h	2.74±7.1	7.47±9.6	0.049
72 h	2.57±7.61	6.71±10.81	0.128
Serum chloride			
24 h	5.75±7.89	9.19±9.18	0.143
48 h	5.03±8.62	8.84±9.58	0.161
72 h	3.37±8.84	5.86±11.63	0.441
Change in pH			
24 h	0.09±0.17	0.39±0.01	0.272
48 h	0.14±0.2	0.41±0.02	0.121
72 h	0.18±0.24	0.45±0.07	0.46

Table 3: NAGMA and renal outcome among study groups.

Clinical outcome	Group 1		Group 2		p-value
	Frequency	Percentage	Frequency	Percentage	
NAGMA					
At 24 h	31	53.44%	33	56.89%	0.70
At 48 h	30	51.72%	39	67.24%	0.08
At 72 h	32	55.17%	38	65.51%	0.25
Renal outcome					
New or progressive AKI	04	6.89%	03	5.172%	0.69
RRT	03	5.17%	01	1.72%	0.30
Need for inotropes	22	37.93%	39	67.24%	0.001
Need for ventilation	29	50%	32	55.17%	0.57
Mortality	11	18.96%	08	13.79%	0.45
DAMA	07	12.06%	06	10.34%	0.76

DISCUSSION

These findings should be interpreted in the context of the proposed physiological differences between the two fluids. Normal saline contains a chloride concentration higher than that of plasma and, when administered in substantial quantities, may produce hyperchloremia and a reduction in strong-ion difference, thereby contributing to metabolic acidosis. Plasma Lyte contains lower chloride concentrations together with metabolizable anions, including acetate and gluconate, which theoretically support maintenance of acid base balance. However, the clinical effect of fluid composition is influenced by the quantity administered, the underlying disease process and concurrent therapies. In the present study, the overall resuscitation volumes were relatively modest, with mean cumulative bolus volumes of approximately 30.5 ml/kg in the PL group and 32.4 ml/kg in the NS group. This limited exposure may partly explain the absence of a significant between-group difference.

The findings are consistent with some pediatric trials but differ from studies demonstrating more pronounced biochemical benefits with balanced solutions. Allen et al. reported faster correction of bicarbonate and improved clinical dehydration scores with PL in children with acute gastroenteritis, whereas Arya et al. demonstrated improved acid base parameters and a smaller chloride increase after PL administration in children with shock. Differences in patient populations, disease severity, fluid exposure and timing of biochemical assessment may explain these discrepancies. In contrast, the present study included heterogeneous critically ill children and evaluated outcomes over 72 hours, making the influence of the underlying illness and subsequent treatment greater than in studies focused on a specific clinical condition.

An important observation was the significantly lower proportion of children requiring inotropic support in the PL group (37.5% versus 67.5%; p=0.013). The maximum vasoactive-inotropic score, however, was not significantly different. This finding is clinically interesting but should be interpreted cautiously

because vasoactive requirement is influenced by disease severity, myocardial function, vascular tone, timing of treatment and clinician practice, rather than fluid composition alone. Nevertheless, the observation is directionally consistent with findings from previous pediatric research suggesting a possible reduction in vasoactive support with balanced crystalloids.

Renal outcomes were comparable. New-onset or progressive AKI occurred in 7.5% of PL-treated children and 5% of those receiving NS, while RRT was uncommon. These results differ from the large multicentre trial by Sankar et al., in which Plasma-Lyte was associated with a substantially lower risk of new or progressive AKI and lower hyperchloremia than saline.[7] However, the present study was considerably smaller and AKI was a secondary outcome, limiting statistical power. Contemporary evidence remains mixed: a 2026 meta-analysis of randomized pediatric trials found lower AKI, RRT and hyperchloremia with balanced solutions but no significant mortality benefit.[8,9] Conversely, the recent large PRoMPT BOLUS trial found no significant difference in major adverse kidney events between balanced fluids and saline, despite substantially less hyperchloremia with balanced fluids.[10]

Similarly, no significant differences were observed in hyperchloremia, hypernatremia, normal-anion-gap metabolic acidosis or mortality. Hospital stay was numerically shorter with PL, although the study was not sufficiently powered to establish a definitive clinical benefit. These observations reinforce the concept that biochemical effects of crystalloid composition do not necessarily translate directly into patient centred outcomes.

Overall, the findings suggest that PL and NS produced broadly comparable short-term biochemical and renal outcomes when used predominantly for initial resuscitation in critically ill children, while PL was associated with a lower requirement for inotropic support. The results should not be interpreted as evidence that the two fluids are universally equivalent. Rather, they highlight the importance of fluid volume, underlying disease, duration of exposure and illness severity when evaluating crystalloid effects. Recent systematic reviews similarly demonstrate persistent uncertainty regarding mortality and other major clinical outcomes despite more consistent reductions in hyperchloremia with balanced solutions.[9,11,12] Larger, adequately powered pediatric randomized trials with standardized fluid exposure and clinically meaningful renal and survival endpoints are therefore required to define the optimal resuscitation fluid.

CONCLUSION

In critically ill children requiring fluid resuscitation, Plasma Lyte and 0.9% normal saline produced comparable changes in serum bicarbonate and acid base status during the first 72 hours. Although Plasma-Lyte demonstrated favourable trends in chloride balance, electrolyte disturbances, acute kidney injury, duration of ventilation, and hospital stay, these differences were not consistently statistically significant. A significantly lower requirement for inotropic support was observed among children receiving Plasma-Lyte. Overall, both fluids were effective for resuscitation, while the potential clinical advantages of balanced crystalloids warrant further evaluation in larger, adequately powered pediatric randomized controlled trials.

REFERENCES

1. Semler MW, Self WH, Wanderer JP, et al. Balanced Crystalloids versus Saline in Critically Ill Adults. N Engl J Med. 2018;378(9):829-839.
2. Honore PM, Mugisha A, Kugener L, Redant S, Attou R, Gallerani A, et al. The causal link between hyperchloremia and acute kidney injury is yet to be conclusively established: we are not sure. Crit Care. 2020;24:1-2.
3. Verma B, Luethi N, Cioccari L, et al. A multicentre randomised controlled pilot study of fluid resuscitation with saline or Plasma-Lyte 148 in critically ill patients. Crit Care Resusc. 2016;18(3):205-212.
4. Allen CH, Goldman RD, Bhatt S, et al. A randomized trial of Plasma-Lyte A and 0.9 % sodium chloride in acute pediatric gastroenteritis. BMC Pediatr. 2016;16:117.
5. Self WH, Semler MW, Wanderer JP, et al. Balanced Crystalloids versus Saline in Noncritically Ill Adults. N Engl J Med. 2018;378(9):819-828.
6. Allen CH, Goldman RD, Bhatt S, et al. A randomized trial of Plasma-Lyte A and 0.9 % sodium chloride in acute pediatric gastroenteritis. BMC Pediatr. 2016;16:117.
7. Sankar J, Muralidharan J, Lalitha AV, et al. Multiple Electrolytes Solution Versus Saline as Bolus Fluid for Resuscitation in Pediatric Septic Shock: A Multicenter Randomized Clinical Trial. Crit Care Med. 2023;51(11):1449-1460.
8. Trepatchayakorn S, Sakunpunphuk M, Samransamruajkit R. Balanced Salt Solution Versus Normal Saline in Resuscitation of Pediatric Sepsis: A Randomized, Controlled Trial. Indian J Pediatr. 2021;88(9):921-924.
9. Chandelia S, Angurana SK, Prasad S, et al. Balanced Salt Solution Versus Normal Saline as Resuscitation Fluid in Pediatric Septic Shock: A Systematic Review and Meta-Analysis of Randomized Controlled Trials. J Intensive Care Med. 2026;41(4):274-283.
10. Balamuth F, Weiss SL, Long E, et al. Balanced Fluid or 0.9% Saline in Children Treated for Septic Shock. N Engl J Med. 2026;395(9):870-881.
11. Vijendra B, Bertol AB, de Almeida MMG, de Freitas PHAG, Simão ÁMS, de Faria BL. Balanced crystalloid versus saline for resuscitation in pediatric septic shock: a systematic review and meta-analysis. BMC Pediatr. 2025;25(1):81.
12. Williams V, Jayashree M, Nallasamy K, Dayal D, Rawat A. 0.9% saline versus Plasma-Lyte as initial fluid in children with diabetic ketoacidosis (SPinK trial): a double-blind randomized controlled trial. Crit Care. 2020;24(1):1.