

Vol 45 (1) March , 2021

Print: ISSN 0304 4904
Online: ISSN 2305-820X



PAKISTAN PEDIATRIC JOURNAL



A JOURNAL OF PAKISTAN PEDIATRIC ASSOCIATION

Indexed in EMBASE/Excerpta Medica, Index Medicus WHO
IMEMR & Global Health/CAB Abstracts and UDL-EDGE Products and Services

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ORIGINAL ARTICLE

Comparison of the Efficacy of Isotonic Vs Hypotonic Maintenance IV Fluids in Maintaining Normal Na Level in Hospitalized Children

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Pak Pediatr J 2021; 45(1): 92-96

ABSTRACT

Objective: To compare the efficacy of isotonic vs hypotonic maintenance IV fluids for maintaining normal sodium level in hospitalized children.

Study Design: Randomized Control Trial

Place and Duration of Study: Department of Pediatrics, Khyber Teaching Hospital, Peshawar from January to July 2016.

Material and Methods: By non-probability consecutive sampling and using inclusion criteria, 156 patients were placed equally into 2 groups. Efficacy was assessed by maintaining normal sodium level and data analyzed using SPSS20.

Results: In Group A mean age was 2 ± 1.76 years and 2 ± 1.93 years in Group B. Male to female ratio was 55:45 in Group A and 58:42 in Group B. Isotonic maintenance IV fluids were effective in maintaining normal serum sodium levels in 66(85%) children whereas hypotonic fluids were effective in 30(38%) children.

Conclusion: Isotonic fluids were found to be more effective than hypotonic fluids in maintaining normal sodium levels in hospitalized children requiring maintenance fluid therapy.

Key Words: *Isotonic, Hypotonic, maintenance IV fluids, Hyponatremia, Sodium level*

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Received 11th February 2020

Accepted for publication

15th February 2021

INTRODUCTION

Intravenous (IV) fluids are used for homeostasis maintenance in patients who are unable to fulfill their water, electrolytes & caloric requirements by oral route. Holliday and Segar devised 0.2% NaCl 5% dextrose as maintenance IV fluid in 1957.¹ The recommendation though appropriate for healthy children but not suitable for children in hospital settings, who are often under stress and has excess anti diuretic hormone (ADH) secretion, causing retention of water.²⁻⁴ Hypotonic fluids with

78% electrolyte free water (0% with normal saline), along with excess ADH increases the risk of developing acute hyponatremia.⁵⁻⁷

Recent studies suggest the development of iatrogenic hyponatremia when using hypotonic fluids in contrast to isotonic fluids as maintenance therapy.⁸ Guidelines and standard textbooks continue recommending hypotonic fluids though prescriptions among physicians differ widely.⁹ For prophylaxis against iatrogenic hyponatremia, 0.9% NaCl/ 5% dextrose has been recommended

for maintenance IV prescription, with 154 mmol/L of Sodium and being isotonic with respect to body fluids.^{3,6,7,1}

Clinical manifestations of acute hyponatremia are caused by cerebral edema & include headache, lethargy, convulsions and rarely cardio respiratory arrest due to brainstem herniation in severe cases. These manifestations occur more frequently with acute hyponatremia and in children as compared to adults.^{5,6}

In recent studies serious morbidity and mortality has been reported among children while receiving IV fluids due to resultant iatrogenic hyponatremia.^{5,10,11} A case control study showed 9% (40/432) of hospitalized children with normal initial serum sodium had a subsequent Na <136 mmol/L while on hypotonic fluids.⁵ Another study reported 24% admitted children (21/86) with hyponatremia, with majority receiving hypotonic fluids.¹¹ A study in Spain randomized 122 ICU patients and showed that frequency of hyponatremia was 20.6% among those getting hypotonic fluids as compared to 5.1% in the group receiving isotonic fluids.¹² Similar study from Australia, randomized 50 ICU patients and reported that type of fluid and not the rate was strongly associated with hyponatremia.⁸ Another Spanish study showed a decrease of 3.2 mmol/L in Na concentration and 5.8 times increased risk of hyponatremia with hypotonic fluids.¹³

The rationale for this study was the observation that a great proportion of children were receiving maintenance IV fluids in our unit as commercially available 0.45% Saline 5% Dextrose with 60 mEq/L sodium concentration (Plabolyte M). Since iatrogenic hyponatremia has been observed in a significant number of admitted cases, we believe there is justification to reconsider the choice of maintenance IV fluid.

MATERIAL AND METHODS

The study was conducted at Department of Pediatrics, Khyber Teaching Hospital, Peshawar from Jan-July 2016. It was a randomized control trial. Sample size was 156 with half in each group recruited through non-probability consecutive sampling. Children from 1 month to 5 years of either gender who were kept NPO and needed maintenance IV fluids were enrolled in the study.

Children who were critically ill at admission, had any electrolyte imbalance on arrival, known renal or cardiac disease, with DKA or severe burns and who had any underlying conditions significantly affecting electrolyte concentration/regulation were excluded from the study.

After approval from hospital's ethical and research board, the children were enrolled in the study. Inclusion & exclusion criteria were strictly followed to avoid confounders and bias in the results. A pre-designed proforma was used for data collection. Participants were divided equally into 2 groups by lottery method. Group A received isotonic maintenance IV fluid (Ringer Lactate) and group B received conventional hypotonic maintenance IV fluid (Plabolyte M). Both fluids were given according to the total fluid requirement for weight and age for 24 hours. The participants were followed and the repeat electrolytes sample was taken after 24 hours therapy. Any symptoms of hyponatremia like lethargy, drowsiness and fits if any were noted.

Data was analyzed using SPSS version 20. Descriptive statistics (numerical data) was estimated in terms of mean and standard deviation (age and serum Na concentration). The efficacy between acute hyponatremia with isotonic and hypotonic fluids was compared by using chi square test, with p value kept ≤0.05. The results obtained were displayed in the form of graphs, tables and charts.

RESULTS

Age distribution in the two groups showed that Group A had 41 (52%) children with age range < 1 year, 23 (30%) in 1-3 years and 14 (18%) in 4-5 years. Mean age was 2 years SD ± 1.76. Whereas in group B, 43 (55%) children were in age range <1 year, 23 (30%) in 1-3 years and 12 (15%) in 4-5 years age group. Mean age was 2 years with SD ± 1.93 (table 1).

TABLE 1: Age distribution (n=156)

Age Years)	Group A (%)	Group B (%)
< 1	41 (52.0)	43 (55.0)
1-3	23 (30.0)	23 (30.0)
4-5	14 (18.0)	12 (15.0)
Total	78(100.0)	78(100.0)
Mean and SD	2 years ± 1.76	2 years ± 1.93

Group A: Isotonic maintenance IV

Group B: Hypotonic maintenance IV
t-test was applied in which p value was 1.0000

Male: Female distribution among two groups showed group A as 55:35, and 58:42% in group B (table 2).

TABLE 2: Gender distribution (n=156)

Gender	Group A (%)	Group B (%)
Male	43 (55.0)	45 (58.0)
Female	35 (45.0)	33 (42.0)
Total	78 (100.0)	78 (100.0)

Group A: Isotonic maintenance IV
Group B: Hypotonic maintenance IV
Chi Square test was applied in which p value was 0.7468

Status of serum Na concentration among the two groups was analyzed as Group A with 12(15%) children had serum Na concentration <136 mEq/L, while 66(85%) with 136-145 mEq/L; and mean concentration of 137 mEq/L \pm 111. In Group B 48(62%) children had serum Na concentration <136 mEq/L, while 30(38%) children had serum Na 136-145 mEq/L; with mean serum Na concentration of 133 mEq/L \pm 101.09 (table 3).

TABLE 3: Serum Na concentration (n=156)

Serum Na concentration	Group A	Group B
< 136 mEq/L	12(15%)	48(62%)
136-145 mEq/L	66(85%)	30(38%)
Total	78(100%)	78(100%)
Mean and SD	137 mEq/L \pm 111.34	133 mEq/L \pm 101.09

Group A: Isotonic maintenance IV
Group B: Hypotonic maintenance IV
Chi Square test was applied in which p value was 0.0001

Regarding the incidence of acute hyponatremia in group A, 12(15%) children had acute hyponatremia, while 66(85%) had none, whereas in group B, 48(62%) children had acute hyponatremia, and 30 (38%) had none (table 4).

TABLE 4: Acute hyponatremia (n=156)

Acute hyponatremia	Group A (%)	Group B (%)
Yes	12 (15.0)	48 (62.0)
No	66 (85.0)	30 (38.0)
Total	78 (100.0)	78 (100.0)

Group A: Isotonic maintenance IV

Group B: Hypotonic maintenance IV
Chi Square test was applied in which p value was 0.0001

On analyzing the findings in two groups, Isotonic maintenance IV fluids were effective in 66 (85%) children in Group A and not effective in 12 (15%) children. In group B hypotonic maintenance IV fluids were effective in 30 (38%) and not effective in 48 (62%) children (table 5).

TABLE 5: Comparison of Efficacy of two types of maintenance fluids in maintaining iso-natremia (n=156)

Efficacy	Group A (%)	Group B (%)
Effective	66(85%)	30(38%)
Non-Effective	12(15%)	48(62%)
Total	78(100%)	78(100%)

Group A: Isotonic maintenance IV
Group B: Hypotonic maintenance IV
Chi Square test was applied in which p value was 0.0001

DISCUSSION

Intravenous (IV) fluids are used for homeostasis maintenance in patients who are unable to fulfill their water, electrolytes & caloric requirements. Holliday and Segar devised using 0.2% NaCl/dextrose 5% as maintenance IV fluid in 1957.¹ The recommendation though appropriate for healthy children but not suitable for children in hospital settings, who are often in a state of stress and has excess antidiuretic hormone (ADH) secretion, causing retention of water.^{2,3,4}

Our study shows that in group A (Isotonic maintenance IV) mean age was 2 years with SD \pm 1.76, while 2 years with SD \pm 1.93 in group B. In group A 43 (55%) children were male and 35 (45%) children were female. Where as in group B 45 (58%) children were male and 33 (42%) children were female. In group A mean serum Na concentration was 137 mEq/L \pm 111.34, while group B mean serum Na concentration was 133 mEq/L \pm 101.09. In group A 12 (15%) children had acute hyponatremia while 66 (85%) children didn't have acute hyponatremia. Where as in group B 48 (62%) children had acute hyponatremia while 30 (38%) children didn't have acute hyponatremia. Hence Isotonic maintenance IV fluid were effective in 66 (85%) children whereas hypotonic maintenance IV fluid were effective in 30 (38%) children.

Lately many studies have been published comparing the tonicity of IV fluids. In a Spanish study by Rey et al¹⁴ 122 ICU were randomized. After 24 hours, 20.6% cases in group receiving hypotonic fluids compared to 5.1% in the group receiving Isotonic fluids were found to be hyponatremic (p=0.02).

Australian study performed by Yung et al¹⁵, with 50 ICU patients, reported that the type of fluid (p=0.006) was more strongly associated with severity of hyponatremia as compared to rate of fluid (p=0.12).

In Spain, Holliday MA et al¹⁶ included 125 children from three PICU settings and reported a decline of 3.2 mmol/L in Na concentration along with nearly 6 times higher risk of hyponatremia with hypotonic fluids. To exclude patients who were hyponatremic at the outset, meta-analysis by Garcia et al¹⁷ included those who were isonatremic at baseline. This sensitivity analysis also supported the finding that isotonic fluids offer protection against hyponatremia when compared with hypotonic fluid as maintenance IV solutions. (RR 0.49; 95% CI 0.34 to 0.71). These results were similar to our study which also found out that hypotonic fluids when used as maintenance IV fluid cause more frequent hyponatremia, and that tonicity of fluid was more important for prevention of hyponatremia compared to rate of fluid administration.

The limitations with this study were the relatively small sample size and second electrolyte sample taken only once at 24 hours interval. Had it been possible to include more patients or take repeat electrolyte samples at different time intervals (at 36 or 48 hours), the effect could have been studied in more depth. There is need for more studies at different in-patient setups and with larger sample size enrolled to have stronger evidence.

CONCLUSION

Isotonic fluids were more effective than hypotonic fluids in hospitalized children for maintenance IV fluid therapy in terms of maintaining normal serum Na concentration.

Grant support and financial disclosure: It is stated that during the study, no financial support was taken from any person or company.

Conflict of interest: There was no conflict of interest among the contributors during the study.

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