

Research Article

J Ped. Nephrology 2013 July;1(1):23-27.  
http://journals.sbmu.ac.ir/jpn

## Frequency of Hyponatremia in Gastroenteric Patients Treated with Intravenous Hypotonic Fluid

**How to Cite This Article:** Badeli HR, Golshekan K, Shahrkami M, Azizi Asl MR, Hassanzadeh Rad A. Frequency of Hyponatremia in Gastroenteric Patients Treated with Intravenous Hypotonic Fluid. J Ped. Nephrology 2013 July;1(1):23-27.

**Hamidreza Badeli,\***  
**Kioomars Golshekan,**  
**Moslem Shahrkami,**  
**Mohammad Reza Azizi**  
**Asl,**  
**Afagh Hassanzadeh**  
**Rad**

Pediatrics Growth  
Disorders Research  
Center, School of  
Medicine, Guilan  
University of Medical  
Sciences, Rasht, Iran

**\*Corresponding Author**  
Hamidreza Badeli  
17 shahrivar pediatrics  
hospital  
Rasht, Iran.  
Email: [Badeli@gums.ac.ir](mailto:Badeli@gums.ac.ir)

**Introduction:** Acute gastroenteritis (AGE) is one of the most common infectious illnesses of childhood. While no treatment is needed for self-limited virus-induced AGE, dehydration caused by diarrhea and emesis is of great concern and should be treated vigorously. However, there is no consensus on the most appropriate electrolyte composition of intravenous fluids; therefore, according to basic protocols in our hospital which suggest hypotonic fluid therapy for AGE, investigators aimed to assess the frequency of hyponatremia in gastroenteritis patients treated with intravenous hypotonic fluid therapy.

**Materials and Methods:** This descriptive observational study was conducted at 17 Shahrivar Pediatrics Hospital between September 2008 and January 2011. The patients' medical records were assessed and children aged between 1 month and 14 years with a diagnosis of gastroenteritis and dehydration were enrolled in the study. According to sodium concentration at T0, patients were divided into three groups: hyponatremic, hypernatremic and isonatremic. The blood samples were analyzed for the sodium concentration at T0 and during 24 hours. Statistical analyses were performed by T test and chi-square using SPSS18 and statistical significance was defined as a p-value less than 0.05.

**Results:** The mean age of the participants was 16.43±11.1 months; 58 patients were male (67.4%) and 28 were female (32.6%). At T0, 35 patients (40.7%) were hyponatremic, 2 patients (2.3%) were hypernatremic and 49 patients were isonatremic. Sodium concentration in the hyponatremic and isonatremic group were 137.25±1.9 and 138.29±2.04 mEq/L respectively which showed a significant difference (p=0.028).

**Conclusions:** Our study showed that increased sodium intake could decrease acquired hyponatremia. It seems that hyponatremia could be prevented by administering high sodium concentration fluids.

**Keywords:** Hyponatremia; Gastroenteritis; Hypotonic Solution; Intravenous Infusion

**Running Title:** Frequency of Hyponatremia in Gastroenteric Patients

Received : 2-Nov-2012  
Last Revised : 3-Dec-2012  
Accepted : 10-Dec-2012

### Introduction

Acute gastroenteritis (AGE) is one of the most common infectious illnesses of childhood [1]. In the United States, it accounts for up to 10% of hospital admissions of children younger than 5 years [2].

Symptoms of AGE are pathogen-dependent and frequently include vomiting, diarrhea, abdominal pain, and fever [3].

While no treatment is needed for self-limited virus-induced AGE, dehydration caused by diarrhea and emesis is of great concern and

should be treated vigorously [4] because it is the most important complication and a major reason for hospital admission [5]. Also, assessing the dehydration level determines the immediate management of this condition [6].

Hyponatremia is the most common electrolyte abnormality in post-operative pediatric patients. If the plasma sodium concentration ( $p\text{-Na}^+$ ) declines to below 125 mmol/L in < 48 h, transient or permanent brain damage may occur [7]. The clinical manifestations of hyponatremia include headache, dizziness, nausea/vomiting, seizures and death [8]. It is associated with an increasing risk of cognitive dysfunction and falls [9].

A series of pediatric researches support the notion that a hospital acquired hyponatremia in ill children receiving parenteral fluid therapy is the result of administering an hypotonic saline solutions [10,11].

Although most guidelines recommend low osmolar oral rehydration solutions for children with mild to moderate dehydration secondary to non-cholera gastroenteritis [12,13], there is no consensus on the most appropriate electrolyte composition of intravenous fluids and there are some recommendations for using 0.45% to 0.9% saline solutions [14,15].

Also, a number of studies which have focused on the relation between hypotonic IV fluid therapy and hyponatremia in gastroenteritis have concluded that hypotonic saline solutions can cause hyponatremia in children with gastroenteritis [16] and concerns regarding hyponatremia have led some authors to recommend isotonic saline as the routine maintenance fluid therapy for hospitalized patients and hypotonic fluids for special situations [17-20]. Although different studies have reported that isotonic saline administration may result in an increase in serum  $[\text{Na}]$  and/or chloride [21-23], they did not show an increase in the risk of hypernatremia [24]. Neville et al recommended that normal saline solution is preferable to hypotonic saline in pediatric gastroenteritis treated with IV fluids, because it protects against hyponatraemia without causing complications like hypernatraemia [23].

Therefore, according to the protocols in our hospital which recommend hypotonic fluid therapy, investigators aimed to assess the frequency of hyponatremia in gastroenteritis patients treated with intravenous hypotonic fluid therapy.

### Materials and Methods

In this cross sectional study conducted between September 2008 and January 2011, 1020 patients' medical records were assessed. The inclusion criteria were age between 1 month to 14 years, diagnosis of gastroenteritis and dehydration, at least two checked serum  $\text{Na}$  levels at the first 24 hours with 4 to 24 hours interval.

Exclusion criteria included a baseline serum  $[\text{Na}]$  of less than 130 or greater than 150 mEq/L, renal disease, cardiac dysfunction, pre-existing hypertension, diuretic use, edema, known adrenal dysfunction, acute or severe chronic neurological illness, meningitis, and sepsis. Hence, 86 patients were included in the study.

The severity of dehydration at T0 was assessed by an attending pediatrician according to standard clinical methods and based on their weight and dehydration level; also, the volume of bolus, deficit, and maintenance serum was determined. Subsequently, the estimated deficit fluid and maintenance fluid were replaced over 24 h. Ringer lactate or normal saline serum was used as bolus serum and 5% dextrose water and Ç normal saline were applied as maintenance and deficit serum.

According to sodium concentration at T0, patients were divided into three groups: hyponatremic (130-134 mEq/L), isonatremic (135-145mEq/L) and hypernatremic (146-150mEq/L). The blood samples were analyzed for sodium concentration at T0 and during 24 hours, BUN and Hb and urine specific gravity (SG) were also assessed. The amount and type of fluids received in hyponatremic and isonatremic patients were compared. The study protocol was approved by the Guilan University of Medical Sciences Ethics Committee and informed consent was obtained from parents of all participants.

Statistical analyses were performed using SPSS 18. Differences between quantitative variables were analyzed by T-tests, and chi-square was used for qualitative variables. P-value <0.05 was considered significant.

**Results**

The medical records of 1020 patients were assessed; however, 86 patients were finally eligible to participate in the study according to exclusion criteria.

The mean age of the participants was 16.43±11.1 months, 58 patients were male (67.4%) and 28 female (32.6%). At T0, 35 patients (40.7%) were hyponatremic, 2 patients (2.3%) were hypernatremic, and 49 patients were isonatremic (Table 1).

**Table 1.** Types of natremia before (T0) and after (T4) intravenous infusion.

Participants	T0	T4
86 patients enrolled	35 hyponatremia (40.7%)	18 hyponatremia (51.4%)
		17 isonatremia (48.6%)
	49 isonatremia (57%)	32 isonatremia (65.4%)
		17 hyponatremia (34.6%)
	2 hypernatremia (2.3%)	1 hypernatremia (50%)
		1 hyponatremia (50%)

After intravenous fluid therapy during the second assessment, 32 patients (65.4%) in the isonatremic group still had isonatremia while 17 patients in this group developed hyponatremia (34.6%). The sodium concentration in the hyponatremic and isonatremic group was 137.25±1.9 and 138.29±2.04 meq/L respectively which showed a significant difference (p=0.028). The comparison between groups in T0 isonatremic group is shown in Table 2.

Also, In T0 hyponatremic group, 18 patients (51.4%) had hyponatremia and 17 (48.6%) became isonatremic. Furthermore, in the

hypernatremic group, 1 patients remained hypernatremic and 1 developed hyponatremia.

**Table 2.** The comparison between groups in T0 isonatremic group.

	Hyponatremic Group	Isonatremic Group	p-value
Age (Mean±SD)	18.11±2.28	15.27±1.22	P=0.24
Gender			
Male	12	21	P=0.492
Female	5	11	
serum intake (Mean±SD)	13.52±86.24	1339.51±60.18	P=0.9
Hb (Mean±SD)	10.67±0.22	10.75±0.17	P=0.76
BUN (Mean±SD)	14.39±1.47	14.9±1.7	P=0.83
SG (Mean±SD)	1018.13±1.81	1014.41±2.19	P=0.22
sodium intake (Mean±SD)	52.26±4.51	50.9±3.34	P=0.88
T0 sodium concentration (Mean±SD)	137.25±1.9	138.29±2.04	0.028

The serum sodium concentration in all the participants who received bolus serum and those who did not was 136.97±4.42 and 135.26±3.44 meq/L, respectively (p=0.49). In the isonatremic group, 28 patients received bolus serum and 21 did not; logistic regression analysis showed that patients who received bolus serum had less hyponatremia (p=0.029).

The mean sodium intake in the hyponatremic and isonatremic groups was 52.26±4.51 and 50.9±3.34 meq/L, respectively (p=0.88).

The mean sodium intake in the hyponatremic and isonatremic groups was compared according to less than 50 meq/L, 50-80 meq/L and more than 80 meq/L which showed no significant difference (p=0.676).

**Discussion**

Gastroenteritis is one of the most common disorders seen by pediatricians. The standard approach to IV fluid therapy for these patients has been to administer a 0.9% sodium chloride (NaCl) bolus followed by a hypotonic solution ranging from 0.2-0.45% NaCl to replace the deficit plus maintenance [25].

Fluid therapy restores circulation by expanding extracellular fluid. However, there has been dispute regarding the nature of intravenous therapy for acutely ill children following the development of acute hyponatraemia from overuse of hypotonic saline. Some propose changing the definition of "maintenance therapy" and recommend that isotonic saline be used as maintenance [26].

In this retrospective study which focused on acquired hyponatremia in acute gastroenteritis, administering hypotonic fluids made 34.6% of isonatremic patients hyponatremic. According to our results, patients receiving bolus serum were significantly less hyponatremic ( $p=0.029$ ); in contrast, patients with hyponatremia at T0 were more hyponatremic ( $p=0.028$ ). Sodium intake was compared between isonatremic and hyponatremic groups but showed no significant difference ( $p=0.88$ ).

Similar to a report made by hanna et al, there was no significant correlation between Hb, BUN, SG, and serum intake in patients who became hyponatremic. They demonstrated that the single significant variable was age and hyponatremic patients were older than isonatremic groups ( $p<0.05$ ). They also reported that hypotonic intravenous fluids could increase acquired hyponatremia ( $p<0.05$ ). They concluded that administration of 0.9% NaCl in a continuous infusion following bolus therapy was as a safer and more effective approach. NaCl 0.9% not only serves as prophylaxis against hyponatremia, it is superior to hypotonic fluids as an extracellular volume expander and corrects the volume deficit more rapidly [16].

In addition, in a clinical trial by Nevllie et al, the frequency of hyponatremia in patients who received sodium concentrations similar to normal saline were obviously less than those receiving  $\bar{E}$  sodium concentration ( $p<0.001$ ), and they concluded that in gastroenteritis treated with intravenous fluids, normal saline is preferable to hypotonic saline because it protects against hyponatraemia without causing hypernatraemia [23].

### Conclusions

Our study showed that increased sodium intake more than  $\bar{C}$  normal saline could decrease acquired hyponatremia. It seems that hyponatremia could be prevented by administering serum with high sodium concentrations. In addition, because it was a

retrospective study and a limited number of participants were enrolled, we recommend a prospective clinical trial with more samples.

### Acknowledgement

This study was supported by pediatric infectious research center and authors wish to thank the staff of PIRC.

### Conflict of Interest

None declared

### Financial Support

None declared

### References

1. Jin Y, Cheng WX, Xu ZQ, et al. High prevalence of human bocavirus 2 and its role in childhood acute gastroenteritis in China. *J Clin Virol* 2011;52(3):251-3.
2. Strange GR, Ahrens WR, Lelyveld S, Schafermeyer RW. *Pediatric emergency medicine: a comprehensive study guide*. 2nd ed. Toronto, Ont: McGraw-Hill; 2002. pp. 347-352.
3. Goldman RD.C Zinc supplementation for acute gastroenteritis. *Can Fam Physician* 2013;59(4):363-4.
4. Burkhart DM. Management of acute gastroenteritis in children. *Am Fam Physician* 1999;60(9):2555-2563.
5. Dunkelmann, L, Bucher BS, Tschumi, S, Duppenhaler A, Simonetti GD. Estimation of dehydration using bioelectric impedance in children with gastroenteritis. *Acta Paediatrica* 2012; 101:479-481.
6. Elliott E J. Acute gastroenteritis in children. *BMJ* 2007 6; 334(7583): 35-40.
7. Flöring U, Lünqvist PA, Frenckner B, Svensson JF, Ingolfsson I, Wallenstein L. The efficacy of hypotonic and near-isotonic saline for parenteral fluid therapy given at low maintenance rate in preventing significant change in plasma sodium in post-operative pediatric patients: protocol for a prospective randomized non-blinded study. *BMC Pediatr* 2011 Jul 5; 11: 61.
8. Zenberg RD, Carluccio AL, Merlin MA. Hyponatremia: evaluation and management. *Hosp Pract (Minneap)* 2010 Feb;38(1):89-96.
9. Renneboog B, Musch W, Vandemergel X, Manto MU, Decaux G: Mild chronic hyponatremia is associated with falls, unsteadiness, and attention deficits. *Am J Med* 119: 71.e1- 71.e8, 2006.

10. Yung M, Keeley S. Randomised controlled trial of intravenous maintenance fluids. *J Paediatr Child Health* 2009;45(1-2):9-14.
11. Montanana PA, Alapont VMI, Ocon AP, Lopez PO, Lopez Prats JL, Toledo Parreno JD. The use of isotonic fluid as maintenance therapy prevents iatrogenic hyponatremia in pediatrics: a randomized, controlled open study. *Pediatr Crit Care Med* 2008;9(6):589-597.
12. Armon K, Stephenson T, MacFaul R. et al An evidence and consensus based guideline for acute diarrhoea management. *Arch Dis Child* 2001. 85:132-142.
13. Atia A, Buchman AL. Oral rehydration solutions in non-cholera diarrhea: a review *Am J Gastroenterol* 2009;104(10):2596-604.
14. Sandhu B K. European Society of Pediatric Gastroenterology. Practical guidelines for the management of gastroenteritis in children. *J Pediatr Gastroenterol Nutr* 2001. 33 (suppl 9).
15. Phin S J, McCaskill M E, Browne G J. et al Clinical pathway using rapid rehydration for children with gastroenteritis. *J Paediatr Child Health* 2003. 39:343-348.
16. Hanna M, Saberi MS. Incidence of hyponatremia in children with gastroenteritis treated with hypotonic intravenous fluids. *Pediatr Nephrol* 2010 Aug;25(8):1471-5.
17. Moritz ML, Ayus JC. Prevention of hospital-acquired hyponatremia: a case for using isotonic saline. *Pediatrics* 2003;111(2):227-230.
18. Moritz ML, Ayus JC. Preventing neurological complications from dysnatremias in children. *Pediatr Nephrol* 2005;20(12):1687-1700.
19. Moritz ML, Ayus JC. Hospital-acquired hyponatremia: why are there still deaths? *Pediatrics* 2004;113(5):1395-1396.
20. Moritz ML, Ayus JC. 0.9% saline solution for the prevention of hospital-acquired hyponatremia: why is there still doubt? *J Pediatr* 2008;153(3):444.
21. Wilkes NJ, Woolf R, Mutch M, et al. The effects of balanced versus saline-based hetastarch and crystalloid solutions on acid-base and electrolyte status and gastric mucosal perfusion in elderly surgical patients. *Anesth Analg* 2001;93(4):811-816.
22. Waters JH, Gottlieb A, Schoenwald P, Popovich MJ, Sprung J, Nelson DR. Normal saline versus lactated Ringer's solution for intraoperative fluid management in patients undergoing abdominal aortic aneurysm repair: an outcome study. *Anesth Analg* 2001;93(4):817-822.
23. Neville KA, Verge CF, Rosenberg AR, O'Meara MW, Walker JL. Isotonic is better than hypotonic saline for intravenous rehydration of children with gastroenteritis: a prospective randomised study. *Arch Dis Child* 2006;91(3):226-232.
24. Moritz ML. Urine sodium composition in ambulatory healthy children: hypotonic or isotonic? *Pediatric Nephrology* 2008;23(6):955-957.
25. Moritz ML, Ayus JC. Improving intravenous fluid therapy in children with gastroenteritis. *Pediatr Nephrol* 2010;25(8):1383-4.
26. Holliday MA, Ray PE, Friedman AL. *Arch Dis Child* 2007;92(6):546-50.