Does Bicarbonate Concentration Predict Hospitalization among Children with Gastroenteritis?

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ABSTRACT

Objective: To determine the relationship between bicarbonate concentration and hospitalization among children with gastroenteritis.

Methods: This study was conducted at Prince Ali Bin Al-Hussein Hospital over a period of 6 months between August 2008 and February 2009. A total of 84 children aged 6 months to 5 years were included in the study. All patients included in this study were evaluated in our Pediatric Outpatient Clinic and they had acute gastroenteritis with mild to moderate dehydration, associated with vomiting at least 5 times per day for less than 48 hours duration. Blood gases either arterial or venous and serum electrolytes were measured for all patients as ordered by an attended pediatric physician after initial evaluation. Each patient was given 20-30 ml / kg dextrose 5% saline over a period of two hours, followed by the oral administration of small and frequent amount of clear fluids (about 30-50 ml / 30 minutes for two hours). Patients who developed vomiting during or after oral rehydration were hospitalized for prolonged intravenous fluid therapy while patients who tolerated oral fluids were discharged and their caregivers were advised to come back to hospital if vomiting persisted, diarrhea increased or any new complaint was noticed by the family. We extend the period of observation for patients with bicarbonate measurements ≤ 13mmol/l to 4 hours, but bicarbonate measurements didn't contribute to the decision of hospitalization. The patients were divided into three groups according to the bicarbonate measurements: 13 mmol/l or less, between 13 mmol/l and 18 mmol/l, and 18 mmol/l or more.

Results: A total of 84 children aged 6 months to 5 years were included in the study. The mean age was 17.94 months; thirty- seven (44.0%) were males and 47 (56.0%) were female. Twenty- nine (34.5%) patients were hospitalized; thirteen (44.8%) males and 16 (55.2%) females. In group I; sixteen patients (94%) out of 17 were hospitalized. In group II; 11 patients (26.2%) out of 42 were hospitalized, while in group III; 2 patients (8.0%) out of 25 were hospitalized. Twenty-six (36.1%) patients out of 72 with moderate dehydration were hospitalized while; 3 (25.0%) patients out of 12 with mild dehydration were hospitalized. Dehydration was improved in all patients after intravenous rehydration. The frequency of serum bicarbonate concentration of 13 mmol/L or less on presentation was significantly greater (P= 0.001) in patients requiring hospitalization than in those discharged from the Emergency Department to home.

Conclusion: Most children who had bicarbonate measurements less or equal to 13mmol/L didn't tolerate oral fluids after rapid intravenous rehydration and required hospitalization for prolonged intravenous rehydration. Bicarbonate concentrations above 13 mmol/L are associated with less hospitalization for intravenous fluids in acute gastroenteritis.

Key words: Bicarbonate, Concentration, Dehydration, Gastroenteritis.

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Introduction

Acute gastroenteritis is characterized by the acute onset of diarrhea, which may or may not be accompanied by nausea, vomiting, fever, and abdominal pain.[1] It is one of the most common pediatric illnesses that accounts for a significant number of our pediatric outpatient visits as well as hospitalizations.

Diarrhea was associated with ~13% of all hospitalizations among children less than 5 years of age (13.1% in 1997 and 12.6% in 2000) in United State.[2] Rotavirus remains the major etiologic cause of diarrhea among children hospitalized.[2,3] Dehydration remains the most common cause of morbidity or even mortality. Worldwide, 16% of deaths among children less than five years of age are due to diarrhea.[4]

Although many studies support the equal efficacy of oral rehydration therapy and intravenous solutions, oral rehydration solutions are still underused in our society. The advantages of oral rehydration therapy over intravenous therapy are that oral rehydration therapy is less expensive and can be administered in many settings, including at home by family members. Intravenous rehydration therapy is a common practice in our local society especially for those children who were complaining of diarrhea, vomiting and poor oral intake. Their caregivers (often their parents) frequently ask for intravenous fluid therapy. The aim of this study was to determine the relationship between bicarbonate concentration and hospitalization among children with gastroenteritis.

Methods

This study was conducted at Prince Ali Bin Al-Hussein Hospital over a period of 6 months between August 2008 and February 2009. A total of 84 children aged 6 months to 5 years were included in the study. All patients included in this study were evaluated either in our Pediatric Outpatient Clinic or Emergency Department by attending pediatric physician. All patients who had acute gastroenteritis with mild to moderate dehydration, associated with vomiting at least 5 times per day for less than 48 hours duration were enrolled in the study. Severity of dehydration was estimated by attending pediatric specialist based on the weight loss classification of 3-5% (mild), 6-9% (moderate), ≥10% (severe),[1] if an accurate recent weight was available otherwise we depended on the clinical signs of dehydration (Table I). After the initial evaluation, attending pediatric physician ordered blood gases either arterial or venous and serum electrolytes (sodium, potassium, blood urea nitrogen, creatinine, and glucose) for all patients enrolled in the study at the time of intravenous catheter insertion. Acidosis was defined as PH less than 7.35. Bicarbonate concentrations less than 18 mmol/L were considered low. Patients with extra intestinal infection, endocrine anomalies, chronic diarrhea; malnutrition, failure to thrive, and patients with severe dehydration were excluded from the study.

Bicarbonate measurements, age, severity of dehydration, and admission or discharge were recorded for all patients. After admission the patients were divided into three groups according to the bicarbonate measurements: group I; included patients with bicarbonate measurements 13 mmol/l or less, group II; bicarbonate measurements between 13 mmol/l and 18 mmol/l, and group III; bicarbonate measurements 18 mmol/l or more.

Each patient was given 20-30 ml / kg 5% dextrose saline over a period of two hours, followed by the oral administration of small and frequent amount of clear fluids (about 30-50 ml / 30 minutes for two hours). Patients who developed vomiting during or after oral rehydration were hospitalized for prolonged intravenous fluid therapy while patients who tolerated oral fluids were discharged and their caregivers were advised to come back if vomiting recurred, diarrhea increased or any new complaint noticed by the family. We extend the period of observation for patients with bicarbonate measurements ≤ 13mmol/l to four hours, but bicarbonate measurements didn't contribute to the decision of hospitalization for those patients.

Results

A total of 84 children aged 6 months to 5 years were included in the study. The mean age was 17.94 months; thirty- seven (44.0%) were males and 47 (56.0%) were female.

In group I; sixteen patients (94%) out of 17 were hospitalized. Most of them did not tolerate oral fluids after intravenous rehydration. The mean bicarbonate measurements were 12.59mmol/l. The mean ages were 13.29 months. Fifteen patients

Table I. Assessment of Dehydration*

Variable	Mild, (3%-5%)	Moderate, (6%-9%)	Severe (≥10%)
Blood pressure	Normal	Normal	Normal to reduced
Quality of pulses	Normal	Normal or slightly decreased	Moderately decreased
Heart rate	Normal	Increased	Increased ŦŦ
Skin turgor	Normal	Decreased	Decreased
Fontanelle	Normal	Sunken	Sunken
Mucous membranes	Slightly dry	Dry	Dry
Eyes	Normal	Sunken orbits	Deeply sunken orbits
Extremities	Warm, normal capillary refill	capillary refill Delayed	Cool, mottled
Mental status	Normal	Normal to listless	Normal to lethargic or comatose
Urine output	Slightly decreased	<1 mL/kg/h	<<1 mL/kg/h
Thirst	Slightly increased	Moderately increased	Very thirsty or too lethargic to indicate

* Adapted from Duggan et al. ŦŦ Bradycardia may appear in severe cases.

Table II. Comparison between admitted and discharged patients

		Admission	Discharge
Number of patients		29	55
Sex	Male	13	24
	Female	16	31
Mean age (month)		13.59	20.24
Dehydration	Mild	3	9
	Moderate	26	46
Mean bicarbonate measurements (mmol/l)		13.86	17.73
Electrolyte disturbances		5	4

Table III. Summery of the laboratory findings.

	Age	BUN	Creatinine	Na	K	Glucose	PH	HCO3
Mean	17.94	11.20	0.52	138.76	4.21	94.85	7.27	16.39
Standard Deviation	11.36	5.19	0.17	4.40	0.74	22.14	0.44	3.00

(88.23%) had moderate dehydration and 2 (11.77%) had mild dehydration. In group II; eleven patients (26.2%) out of 42 were hospitalized. The mean bicarbonate measurements were 15.84mmol/l. The mean age was 17.54 months. Thirty-four patients (80.95%) had moderate dehydration and 8 (19.05%) had mild dehydration.

In group III; two patients (8.0%) out of 25 who had bicarbonate measurements 18 mmol/l or more were hospitalized. The mean bicarbonate measurements were 19.9mmol/l. The mean age was 21.7 months. Eighteen patients (72.0%) had moderate dehydration and 7 (28.0%) had mild dehydration.

Twenty- nine (34.5%) patients were hospitalized; 13 (44.8%) males and 16 (55.2%) females (Table II). The mean age for hospitalized children was 6.65 months (95% CI 2.54-10.76) less than the mean age for children discharged. In our study, there is a association between age and bicarbonate levels (P=.006). Patients with bicarbonate measurements ≤13mmol/l were more likely to be younger children and to have higher degree of dehydration. Furthermore, the mean bicarbonate level for children below the age of one year was 15.82mmol/l in comparison to 16.84mmol/l for children above the age of one year.

Twenty- six (36.1%) patients out of 72 with moderate dehydration were hospitalized. Of the 26; twenty- one patients, vomiting persisted during the period of intravenous or oral rehydration and the other 5 patients, vomiting recurred and dehydration developed (moderate) after discharge to home. Three (25.0%) patients out of 12 with mild dehydration were hospitalized during the period of intravenous or oral rehydration. Dehydration was improved in all patients after intravenous rehydration.

The frequency of serum bicarbonate concentration of 13mmol/L or less on presentation was significantly greater (P=.001) in patients requiring

hospitalization than in those discharged from the emergency department to home. Twenty- eight (41.2%) out of 68 patients who had PH less than 7.35 were hospitalized. Thirteen (44.8%) patients who were admitted had PH less than 7.30 and bicarbonate concentrations equal or less than 13mmol/L. Metabolic acidosis (PH < 7.35) is often equated to a reduction in serum bicarbonate (HCO_3 <18 mmol/l), a correlation was correct in only 72% of our patients.

Serum electrolytes measurements were also evaluated. Eight (9.5%) patients had hypokalemia, 5 of them were hospitalized. One patient had hyponatremia (Table III).

Discussion

Metabolic acidosis is often encountered in hospitalized children with acute gastroenteritis. All children included in the study had mild to moderate dehydration and persistent vomiting due to acute gastroenteritis. The mainstay in treatment of acute gastroenteritis is replacement of fluid and electrolyte losses.

Intravenous 5% dextrose saline was used in this study to decrease the number of admissions.[1] Sixteen patients out of 17 with bicarbonate measurements equal or less than 13mmol/L were admitted. Reid and Bonadio[6] studied the efficacy of outpatient rapid IV rehydration in correcting dehydration and resolving vomiting in 58 children with mild to moderate dehydration resulting from acute gastroenteritis. Similar to our finding, this group found an increase in rate of admission in children with bicarbonate concentrations less than 13mmol/L.

Narchi,[1] studied the relation of bicarbonate measurements in serum samples from 106 children with gastroenteritis and dehydration and he found that there was no difference in serum bicarbonate concentrations between patients with and without vomiting. Also the concentration less than 22 mmol/l was more common in children with severe dehydration, but the magnitude of bicarbonate reduction was not different with increasing degrees of dehydration. They concluded that doctors should not rely on the serum bicarbonate concentration when assessing fluid deficit. In our study we did not find a relationship between bicarbonate measurements and severity of dehydration and because all our patients had vomiting we did not evaluate the difference in bicarbonate measurements in children with or without vomiting.

At the time of initial evaluation, it is difficult to predict which children would have clinically abnormal electrolyte measurements.[8,9] In this study, abnormal serum biochemistries were encountered in 9 (10.7%) patients (hyponatremia and hypokalemia), 50% of them were admitted.

Bicarbonate loss in diarrheal stools,[10] is most likely the cause of acidosis, yet was not measured in this study. Our study excluded infants with acidosis and an increase anion gap that is found more often in infants with prolonged diarrhea and underlying malnutrition.[11]

Conclusion

Most children who had bicarbonate measurements less or equal to 13mmol/L did not tolerate oral fluids after rapid intravenous rehydration and required hospitalization for prolonged intravenous rehydration. Bicarbonate concentrations above 13mmol/L are associated with less hospitalization for intravenous fluids in acute gastroenteritis.

References

1. **American Academy of Pediatrics:** Provisional committee on quality improvement, subcommittee on acute gastroenteritis, Practice parameter: the management of acute gastroenteritis in young children. *Pediatrics* 1996; 97:424-35.
2. **Malek M, Curns A, Holman R, *et al.*** Diarrhea and rotavirus-associated hospitalizations among children less than 5 years of age: United States, 1997 and 2000. *Pediatrics* 2006; 117:1887-92.
3. **Bon F, Fascia P, Dauvergne M, *et al.*** Prevalence of group a rotavirus, human calicivirus, astrovirus, and adenovirus type 40 and 41 infections among children with acute gastroenteritis in dijon, France. *J Of Clinical Microbiology.* 1999; 37:3055–58.
4. **World Health Organization** (Child and Adolescent Health and Development): Child Health Epidemiology. [http:/ / www.who.int/ child-adolescent-health/ overview/ child_health/ child_epidemiology.htm] webcite
5. **Levy J, Bachur R.** Intravenous Dextrose During Outpatient Rehydration in Pediatric Gastroenteritis. *Acadimic Emergency Medicine.* 2007; 14:324–331.
6. **Reid SR, Bonadio WA.** Outpatient rapid intravenous rehydration to correct dehydration and resolve vomiting in children with acute gastroenteritis. *Annals of Emergency Medicine* 1996; 28:318-323.
7. **Narchi H.** Serum bicarbonate and dehydration

severity in gastroenteritis. *Archives of Disease in Childhood* 1998; 78:70-71.

8. **Yilmaz K, Karabocuoglu M, Citak A, *et al.*** Evaluation of laboratory tests in dehydrated children with acute gastroenteritis. *Journal of Paediatrics & Child Health* June 2002; 38(3):226-22
9. **Ks IP, Ym MA, Chan J, *et al.*** Use of intravenous therapy in the management of acute gastroenteritis in young children: a retrospective analysis. *HK J Paediatrics* (new series) 2005; 10:10-14.
10. **Teree TM, Font EM, Ortiz A, *et al.*** Stool loss and acidosis in diarrheal disease of infancy. *Pediatrics* 1965; 36: 704-713.
11. **Weizman Z, Houri S, Ben-Ezer G**. Type of acidosis and clinical outcome in infantile gastroenteritis. *J Pediatr Gastroenterol Nutr* 1992; 14:187-191.