Research Article

Blood Chemical Analysis in Children with Acute Gastroenteritis, When Is It Useful?

Reza Tavakolizadeh[1],
Manelie Sadeghi[2],
Nasim Namiranian[2],
Daryoosh Fahimi[3*],
Mohammad Barkhordari[3]

1 Ziaeeian Hospital, Tehran University of Medical Sciences, Tehran, Iran.
2 Specialist in Community Medicine, Research Development Center, Tehran University of Medical Sciences, Tehran, Iran.
3 Bahrami Children Hospital, Tehran University of Medical Sciences, Tehran, Iran.

* Corresponding author
Daryoosh Fahimi MD,
Bahrami Children Hospital,
Shaheed Kiaee St, Damavand
Ave, Tehran, Iran.
Tel: +98-21-77937557,
+98-9125279195
Fax: +98-21-77551584
Email:
fahimida@sina.tums.ac.ir

Introduction: Acute gastroenteritis (AGE) is one of the most common diseases in children. Intravenous (IV) fluid therapy may be indicated in some of them. The aims of this study were to assess the usefulness of blood chemical analysis (blood glucose, urea, creatinine, sodium, potassium and bicarbonate) and to define any clinical criterion that helps to predict usefulness before starting IV fluid therapy.

Materials and Methods: A cross sectional study was conducted at the Emergency Department of Bahrami Children Hospital from March 2011 to June 2012; all children with AGE who were between 3 months to 10 years without any underlying diseases were enrolled in the study. Demographic variables, medical history and physical examination, laboratory tests results, and dehydration grading (according to the World Health Organization criteria) were noted. The usefulness of laboratory tests was defined as any change in the treatment plan due to laboratory results.

Results: Four hundred and fifty nine children (55.3% boys, 44.7% girls, mean age 25.36 months) were assessed. There were statistically significant associations between the usefulness of tests and patients' age, frequency of passing diarrheal stool in the last 24 hours, and dehydration grade (p<0.001). Only dehydration grade could significantly predict usefulness according to a logistic regression model (p<0.05).

Conclusions: According to these results, routine blood chemical analysis may be useful in patients with moderate to severe dehydration.

Keywords: Gastroenteritis; Child; Blood Chemical Analysis

Running Title: Blood Chemical Analysis and Acute Gastroenteritis.

Introduction

Acute gastroenteritis (AGE) is the second cause of pediatric disease worldwide. It is a major cause of pediatric morbidity and mortality and accounts for 1.5-2.5 million deaths annually throughout the world among children aged <5 years [1-2]. In Iran, about 6% of the mortality of the children less than 5 years old is due to diarrheal diseases [3-4]. Fortunately, if rehydrated properly, most cases of AGE are self-limited [5-6]. Many pediatricians believe that laboratory studies, including Blood Chemical Analysis (BCA), are not usually necessary to assess children with acute diarrhea [7-8]. However, Wathen et al reported that serum electrolyte panels were useful in children receiving intravenous (IV) fluid therapy for their dehydration [9]. On the other hand, other pediatricians express contradictory comments on the aforementioned finding. They believe that many electrolyte abnormalities would resolve if children with AGE are appropriately rehydrated [7-8].

In our center, BCA (consisting of blood sugar (BS), urea, creatinine (Cr), sodium (Na), potassium (K) and bicarbonate) is ordered by the attending pediatrician as a routine part of evaluating AGE in

children who receive IV serum therapy. The main reasons for doing so are to evaluate dehydration severity and to diagnose co- morbid electrolyte abnormalities. This approach may force a heavy burden on hospital financial and human resources.

The aims of this study were to assess the usefulness of BCA and to define any clinical criterion that helps to predict usefulness before starting intravenous fluid therapy.

Materials and Methods

A cross-sectional study was conducted at the Emergency Department (ED) of the hospital from March 2011 to June 2012. All children between 3 months to 10 years old who were diagnosed with AGE and needed IV rehydration therapy by the ED pediatrician (who was unaware of the study) were enrolled (Inclusion criteria).

The exclusion criteria were serious underlying disease (i.e. cardiac, renal, or metabolic conditions or malnutrition), vomiting or diarrhea due to other diseases (i.e. otitis media, urinary tract infection, acute abdomen, meningitis…), history of medication affecting serum electrolytes levels (i.e. aminoglycosides, salbutamol)**,** persistent or chronic diarrhea, and dysentery. The convenient method was used for sampling. All patients who fulfilled the inclusion criteria were included. (Sample size was calculated by estimating a characteristics formula: p=0.1; d=0.03 and calculated n=385).

Data Collection:

A simple check list including the following information was used: child's gender and age, drug history, duration of the disease, fever (Axillary temperature ≥ 38°C), severity of diarrhea and vomiting (based on character and frequency in the last 24 hours), the results of laboratory tests, dehydration grading, and pediatrician's final plan for the patient. Grading of dehydration was determined by the attending physician according to the World Health Organization's (WHO) criteria [10]. BCA except bicarbonate was performed in all children prior to initiation of IV fluid therapy. The venous bicarbonate level was measured only in those with moderate or severe dehydration. Our limitations included discontinuation of therapy due to parents' decision and recognition of an underlying disease during the study. Usefulness of BCA was defined as achievement of one or more of the following criteria:

1. Change in the treatment plan after receiving the laboratory test results.
2. Transferring the patient to other wards either in order to receive a different treatment regimen or to undergo more diagnostic procedures based on the test results
3. Referral to specialized medical consultation due to laboratory tests abnormality.

Repetition of laboratory tests that produced normal result without any of the above-mentioned criteria was not considered as a criterion of usefulness.

Statistical analysis:

SPSS software version 16 was used for data analysis. Descriptive tests were performed on demographic data. To determine the relationship between independent variables and usefulness of the laboratory tests, independent sample t-test and chi square test were employed (the non-parametric tests like Mann Whitney U were used if the distribution of the variables was not normal). In order to predict usefulness, those variables which had a significant relationship with usefulness of BCA were entered into a logistic regression model (significant level of α was 0.05).

Results

Totally, 459 children were enrolled in the study (55.3% boy and 44.7% girls, mean age 25.36±22.93 months). Half of them were less than 16 months old. Most children attended ED in the first 5 days of the beginning of their symptoms and 162 (35.3%) in the first 24 hours of their disease. Of 286 children with a positive drug history, metoclopramide was prescribed in 138, ORS in 49, and antibiotics other than aminoglycosides in 48 cases. The majority of the children (69%) were afebrile at the time of admission. According to WHO criteria, 298 (64.9%) had mild, 150 (32.7%) had moderate and only 11 (2.4%) children had severe dehydration. Descriptive variables are presented in Table 1.

Overall, 64.1% of the children had at least one abnormal laboratory finding. The most common biochemical abnormality was abnormal serum creatinine, which was reported in 65 (14.2%) cases. In the "moderate" or "severe" dehydration groups, 96.1% had bicarbonate levels lower than normal. Hypo- and hypernatremia were found in 46 and 10 patients, respectively. The frequency of laboratory abnormalities is shown in Table 2. Usefulness criteria were met in 20 (4.4%) children, 12 girls and 8 boys, with a mean age of

12.3±3.38 months. Of these patients, 7 had severe, 12 had moderate, and only one patient had mild dehydration with a serum Na level of 148 mEq/L and intractable vomiting who was transferred from ED and thus had a criterion of usefulness. Low bicarbonate levels were the most common abnormality seen in patients that BCA was considered useful. There were significant relationships between the frequency of diarrhea in the last 24 hours (p<0.001), age (p<0.001), and dehydration grade (p<0.001) with the usefulness of BCA, but there were no statistically significant relationships between the usefulness of BCA and gender (p=0.158), duration of the disease (p=0.47), medication history (p=0.8), times of vomiting in the previous 24 hr (p=0.22) and fever (p=0.07). Finally, by entering those variables that had a significant relationship with the usefulness of BCA into a logistic regression model, clinical grading of dehydration was the sole criterion which predicted usefulness (Table 3).

Table 1-Descriptive and comparative Characteristics of the

Descriptive Characteristics	Total frequency	Usefulness	No usefulness	P-value [2]
Gender				
Boys	254(55.3%)	8(40%)	246(56%)	0.158
Girls	205(44.7%)	12(60%)	193(44%)	
Age (months)	25.36±22.93	12.3±3.38	25.95±23.2	0.00
Duration of disease <24 hours	162(35.3%)	2(10%)	160(36.4%)	
1-5 days	264(57.5%)	17(85%)	247(56.2%)	0.066
>5 days	33(7.2%)	1(5%)	32(7.4%)	
History of medication				
Yes	286(62.3%)	8(40%)	163(37.3%)	0.807
No	173(37.7%)	12(60%)	276(62.3%)	
Dehydration grade				
Mild	298(64.9%)	1(5%)	297(67.7%)	
Moderate	150(32.7%)	12(60%)	138(31.4%)	0.00
Severe	11(2.4%)	7(35%)	4(0.9%)	
Presence of Fever				
Yes	141(30.7%)	10(50%)	131(29.8%)	0.078
No	318(69.3%)	10(50%)	308(70.2%)	
Times of diarrhea in the last 24 hours				
0	88(19.2%)	1(5%)	87(19.8%)	
1-4	163(35.5%)	1(5%)	162(36.9%)	0.00
5-8	127(27.7%)	7(35%)	120(27.3%)	
≥9	81(17.6%)	11(55%)	70(16%)	
Times of vomiting in the last 24 hours				
0	26(5.7%)	3(15%)	24(5.3%)	
1-4	212(46.3%)	10(50%)	202(46.1%)	0.061
5-8	152(33.2%)	7(35%)	145(13.1%)	
≥9	68(14.8%)	0(0%)	68(16.5%)	

Study Population (N=459)

Result of comparing usefulness and no usefulness groups with Mann Whitney U or t-test analysis.

Discussion

Among 459 patients, only 11 (2.3%) had severe dehydration. At first, it may seem that IV hydration was not indicated in most children because majority of them had mild to moderate dehydration. However, in our study, the pediatrician's decision may be attributed to intolerance to oral rehydration because of repeated episodes of vomiting: only 5% of the children had no vomiting during the past 24 hours. The most accurate criterion of the dehydration severity is weight change. Since the pre-illness weight is not known in most cases, the WHO criteria are used for assessing the degree of dehydration. Although some studies consider tissue perfusion, skin turgor or pattern of breathing as the main criteria of dehydration grading [8, 9], systematic reviews have shown that a constellation of signs and symptoms is more valid for predicting the dehydration severity [11].

The prevalence of BCA abnormalities was 64.1%. The data reported by del Barrio and Shah were 80% and 79%, respectively [12,13]. The difference can be explained by different normal ranges of values for laboratory tests in different studies. In the present study, the most common laboratory abnormality was abnormal serum creatinine. In studies by studies Del Barrio and Shah, metabolic acidosis and hyponatremia were the most common abnormalities [12,13]. Ukarapol also reported metabolic acidosis as the main laboratory abnormality [14]. This finding is in accordance with our study which showed that low bicarbonate levels were the most common abnormality seen in patients that BCA was considered useful. It should be emphasized that in addition to different normal ranges of laboratory tests, demographic characteristics of our patients may differ from aforementioned studies. For example, Ukarapol included children with an age range of 1 month to 5 years [14], but infants younger than 3 months were excluded from our study. As all children received IV rehydration (a commercially available solution containing 3.33 gr/dl glucose and 51 mEq/L NaCl), plus 20 mEq/L KCl after establishing urine output, and most improved clinically, the treatment plan changes only in those cases whose signs or symptoms did not change after rehydration and/or in those who had significant electrolyte disturbance(s);

therefore, children whose laboratory results showed minimal abnormality but clinical assessment by the attending pediatrician showed marked improvements were discharged from ED.

Of 459 children, 20(4.4%) had at least one usefulness criterion. In studies by Del Barrio and Wathen, routine laboratory tests were considered useful in 12.3% and 10.4% of the children, respectively [9,12]. The difference can be attributed to inclusion and exclusion criteria for enrolling patients and usefulness criteria used by each author. The IV rehydration formula also plays an important role in the patients' outcomes. The treatment regimen used in this study contained Na, glucose, and K, and could probably reverse some mild abnormalities. This IV solution is commercially available in Iran and its formula differs from solutions used in other studies.

As our study showed, only the dehydration grade could significantly predict the usefulness of routine BCA. So, it seems unnecessary to order routine BCA in all children undergoing IV rehydration. Although Wathen et.al [9] recommended BCA in every child undergoing IV fluid therapy, American Pediatrics Association and many other sources recommend that the serum electrolyte panel should be assessed in children with moderate or severe dehydration [15-20]. Some other studies also have shown that routine laboratory tests do not change the therapeutic or diagnostic approach in most cases [21, 22].

Conclusions

According to the above-mentioned results, it is not recommended to order routine BCA in all children with AGE undergoing IV rehydration. According to our findings, the only variable proved to significantly predict usefulness of routine BCA is clinical grading of dehydration.

Table 2- Laboratory test results in children undergoing intravenous hydration as a result of acute gastroenteritis.

Laboratory test	Normal range*	Mean± SD	Prevalence of abnormality
Bicarbonate (mmol/L)	20-25	13.41±3.12	155(96.1%)**
Urea (mg/dl)	8-40	27.35±12.22	36(7.8%)
Cr(mg/dl)	0.1-0.6	0.54±0.14	65(14.2%)***
Na(mmol/L)	135-145	140.32±4.39	Hyponatremia: 46(10%) Hypernatremia: 10(2.2%)
Blood Sugar (mg/dl)	60-140	96.85±30.36	Hypoglycemia: 16(3.5%) Hyperglycemia: 34(7.4%)

*Normal range for our study Age group
**Performed in 161 patients
***In each patient serum creatinine was compared with age-matched normal .

Table 3-Logistic regression analysis of associated variables in predicting the usefulness of Blood Chemical Analysis.

Associated variables	Wald -test	P-value	Odds ratio	CI*
Age	19.37	0.12	3.12	0.81-11.5
Times of diarrhea in the last 24h	5.55	0.443	0.417	0.53-4.34
Dehydration grading	42.59	0.046	2.57	9.53-65.7

*Confidence interval for odds ratio (95%)

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