ACID AND BASE DISORDERS IN DIARRHOEA AND VOMITING:

STUDY IN 805 INFANTS WITH GASTROENTERITIS

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Abstract — This study was carried out on 1330 infants, from one to 24 months old, suffering from diarrhoea and moderate to severe dehydration who were hospitalized in Bahrami childrens' hospital over a period of eleven months. Fifteen percent of them had signs of shock and 36% had marasmus. Nine percent of treated children required readmission to hospital within 24 hours of discharge and 8% were hospitalized elsewhere. In 805 patients blood electrolytes were studied when hospitalized and after rehydration. Blood bicarbonate during hospitalization ranged between 2 to 24 mmol/L (an average of 13.4 mmol/L). After rehydration, blood bicarbonate value reached to range of 8 to 25 mmol/L, (an average of 20 mmol/L). Blood pH was reported between 6.84 to 7.56 when hospitalized (an average of 7.17). After rehydration this value ranged between 7.05 to 7.45 (an average of 7.27).
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Key words: Acid and base; diarrhoea; vomiting; gastroenteritis; dehydration.

INTRODUCTION

One of the most common disorders in infants is acid and base changes. This can be due to metabolic disease, reduction of plasma volume in various diseases, or kidney problems.

Since vomiting and diarrhoea are widespread diseases among infants, especially in warmer seasons, variations of acid and base in these patients were studied in Bahrami hospital. It was shown that by prescribing bicarbonates, these disorders are easily treated. The advantage of oral rehydration therapy over intravenous therapy in diarrhoea and vomiting (and also the correction of acid and base disorder in patients with moderate to severe dehydration and even shock) has been proven.

MATERIALS AND METHODS

The study population consisted of 1330 infants aged from 1 to 24 months old, who were hospitalized in Bahrami children's hospital and their acid and base variations were studied. They were admitted dur to moderate to severe dehydration, diarrhoea and vomiting, regardless of the duration of illness and state of nutrition. All were initially examined by the hospital house officers and the decision to hospitalize was based on their clinical assessment and severity of dehydration. They had no medical complication other than those directly related to dehydration. Thirty six percent of the patients were below the third percentile of weight for age according to the standards published by the National Center for Health statistics. (1,2). If two or more signs in the severe dehydration category (Table 1) were present, the patient was considered to have severe dehydration, otherwise with two signs corresponding to moderate dehydration, moderate dehydration was diagnosed. (3,4)

In this study shock was considered present if the patient had severe dehydration, rapid, feeble and sometimes impalpable pulse, unrecordable systolic blood pressure, limp, cold and sweaty cyanotic extremities, and impaired sensorium ranging from intense anxiety to frank coma. The volume of fluid administered to each patient and frequency of vomiting were recorded. The patients were weighted on admission after hydration and after recovery when diarrhoea had resolved.

Laboratory Studies

laboratory studies performed on admission included venous blood sampling for serum levels of sodium, potassium, chloride, and for blood gases, stool sampling (via rectal catheter), for parasitological and bacteriological examination for enteric pathogens. Follow-up laboratory studies were performed after hydration and after recovery.

Treatment

The treatment protocol consisted of two phases: rehydration and maintenance therapy. For rehydration therapy a nosogastric tube was introduced for all patients and their gastric contents aspirated. Intragastric drip was started with rehydration solution similar to ORS (sodium 80 mmol/L, potassium 20 mmol/L, chloride 65 mmol/L, bicarbonate 35 mmol/L, dextrose 70 mmol/L, and osmolality 270 mosmol/kg) at a rate of 40 ml/kg/hr (maximally 400 ml/hr) (5,6).

Administration was continued at the same rate until all clinical signs of dehydration disappeared. If within the first two hour of therapy the signs of dehydration had become worse or unchanged, oral therapy was stopped and intravenous treatment started. In this case, oral therapy was difined as having failed.

Following complete hydration the patients were discharged and maintenance therapy was performed at home by mothers, administering maintenance solution (sodium 40 mmol/L, potassium 30 mmol/L, chloride 45 mmol/L, bicarbonate 25 mmol/L, dextrose 140 mmol/L and osmolality 270 mosmol/kg) *adlibitum* (5,6).

Maintenance solution was prepared by disolving one prepared package in 250 ml of tap water. Mothers were adequately supplied with these packages, and were advised to report to the hospital 24 hours after discharge (for assessment of the patient's clinical status) and sooner if the patient's condition had worsened, and also to report the hospital when diarrhoea had stopped. Within 24 hours most children were fed with breast milk or formula at about 10-20 Kcal/kg/day. No intravenous solutions or medications were used (5,6,7).

RESULTS

Patients average age was 7.4 month, 53% were boys. and 71% had vomiting when hospitalized. Average diarrhoea duration before being admitted was close to four days. Eighty one percent of patients had used antibiotic before admission. When admitted, the average rectum temperature was 37.9 °C. Seventy seven percent of the patients had moderate dehydration and 23% had severe dehydration.

Shock symptoms were observed in 15% of the children. Plasma electrolytes were measured in 805 cases of the 1330 patients. Eleven percent were hypernatraemic (serum sodium > 150 mmol/L) 16% were hyponatraemic (serum sodium < 130 mmol/L), 6% were hyperkalaemic (serum potaassium > 5.5 mmol/L) and 8% were hypokalaemic (serum potassium < 2.5 mmol/L).

Patients clinical conditions are shown in Table 2, weight increase and body temperature before and after rehydration are shown in Table 3, and stool pathogens which were observed in 480 samples are summarized in Table 4.

Table 1. Clinical assessment of severity of dehydration

Sings and symptoms	Moderate dehydration	Severe dehydration
General appearance and condition	Thirsty, restless of lethargic and drowsy, but irritable to touch	Drowsy, limp, cold, sweaty, cyanotic extremities; may be comatose
Radial pulse	Rapid and weak	Rapid, feeble, sometimes impalpable
Respiration	Deep, may be rapid	Deep and rapid
Anterior fontanelle	Sunken	Very sunken
Systolic blood pressure	Normal or low	Less than 90 mmHg; may be unrecordable
Skin elasticity	Pinch retracts slowly	Pinch retracts very slowly (<2sec)
Eyes	Sunken (detectable)	Grossly sunken
Tears	Absent	Absent
Mucous membranes	Dry	Very dry
Urine flow	Reduced amount and dark	None passed for several hours; empty bladder
Body weight loss (%)	6-9%	10% or more

Modified from WHO (1983)

Table 2. Features of patients on admission

Number	1330
Age (months), mean ± SD	7.4±1.2
Boy/girl (%)	53/47
Number (%) with history or vomiting	994(71)
Days of diarrhoea before admission, mean ± SD	4±2.2
Rectal temperature (°C), mean ± SD	37.9±0.8
Number (%) given antidiarrhoeal drugs before admission	1077(81)
Estimated degree of dehydration, number (%)	
Moderate	1024 (77)
Severe with signs of shock	306 (23)

Table 3. Weight and temperature before and after hydration — Mean±SD

Rectal temperature on admission	37.9±0.8
Rectal temperature (°C) after hydration	37.6±0.4
Body weight (Kg) on admission	5.8±1.9
Body weight (Kg) after hydration	6.3±1.9
Percentage weight gain after hydration	8.1±4.1

Table 4. Type of pathogens identified in stool samples

Pathogens identified in 480 stool samples, number (%)	153	(31.9)
Escherichia coli	71	(14.8)
Salmonella	20	(4.2)
Shigella	18	(3.7)
Campylobacter	24	(5)
Entamoeba histolytica	10	(2.1)
Giardia lamblia	10	(2.1)

Table 5. Concentration of serum electrolytes and blood gases on admission and after hydration in 805 patients.

	On admission		After hydration	
	Means±SD	Range	Mean±SD	Range
Sodium (mmol/L)	137.4±11	(106-184)	138.7±8	(118-176)
Potassium (mmol/L)	4.4±1.2	(1.4-7.7)	4.7±0.8	(2.1-6.7)
Chloride (mmol/L)	113.9±12	(83-161)	107.7±7.8	(88±146)
Bicarbonate (mmol/L)	13.4±5.1	(2-24)	20.1±2.8	(8-26)
Blood pH	7.17±0.16	(6.84-7.56)	7.27±0.11	(7.0-7.45)
Blood PCO2 (mmHg)	30.7±7.2	(10-46)	35.2±5.5	(17-46)
Blood base deficit (mmol/L)	11.7±5.2	(2-26)	4.9±1.9	(1-18)
Blood haemoglobin (g/dl)	11.4±2.7	(5-18)	10.5±2.7	(4.5-16)

DISCUSSION

It was observed that the change of acid and base condition was such that the blood pH of hospitalized patient varied between severe acidosis (pH=6.84) to mild alkalosis (pH=7.76). Alkalose was observed in patients whose disorder was initiated by severe vomiting.

The average blood pH of 805 patients after analysis was 7.17 ± 0.16. Patient's bicarbonate analysis on admission ranged between 2 to 24 mmol/L, an average of 13.4 mmol/L, with a standard deviation of 5.1. Patients blood base dificit on admission ranged between 2 to 26 mmol/L, an average of 11.7 mmol/L with a standard deviation of 5.2 mmol/L.

Patient's PCO2 on admission ranged between 10 to 26 mmHg an average of 30.7 mmHg with a standard deviation of 7.2. Patient's blood chloride on admission varied between a range of 83 to 161 mmol/L with a standard deviation of 12. According to the following data after rehydration, the acid and base disorders were significantly improved to blood pH ranged between 7.05 and 7.45; an average of 7.27 with a standard deviation of 0.11. Blood bicarbonate after rehydration varied between 8 to 26 mmol/L, an average of 20.1 with a standard deviation of 2.8. This indicated a 76.7 mmol/L increase in blood bicarbonates after rehydration.

Patients blood base deficit ranged between 1 to 18 mmol/L, an average of 4.9 mmol/L with a standard deviation of 1.9. This indicates a 6.8 mmol/L improvement. Blood PCO2 after rehydration ranged between 17 to 46 mmHg, an average of 35.2 mmHg with a standard deviation of 5.5. This indicates a 4.5 mmHg increase. Blood chloride after rehydration ranged between 88 to 146 mmol/L, an average of 107.7 mmol/L, with a standard deviation of 7.8. This means patients blood chloride has decreased 6.2 mmol/L. (8,9). Acid and base variation is summarized in Table 5.

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REFERENCES

1. NCHS Growth curves for children birth 18 years, United States, Hyattsville Md. National Centre for Health statistics (DHEW Publcation N (PHS) (1997) 78-1950.

2. Adelman R.D.; Salbung Mj pathophysology of body fluids and fluid Therapy. In: Nelson Textbook of Pediatrics London, 1996, 206-219.

3. WHO Oral rehydration therapy An annotated bibliography. second edition, world health organization, 1983.

4. Johns Hopkins University population Information Program Oral rehydration therapy (ORT) for Childhood diarrhoea. Population reports. Baltimore, Md, USA, 1980, 8 (6).

5. Sharifi J. and Ghavami F Oral rehydration theraphy of severe diarrheal dehydration. clinical Pediatrics 23, 87; 1984.

6. Sharifi J., Ghavami F., Nowrouzi Z., et al. Oral versus Intravenous rehydration therapay in severe gastroenteritis. Archieves of Disease in childhood 60, 856; 1985.

7. J. Sharifi, F. Ghavami and Z. Nowrouzi . Treatment of severe diarrhoeal dehydration in hospital and home by oral fluids. Journal of Tropical Medicine and Hygiene. 90, 19-24; 1987.

8. Rase B.D. metabolic acidosis in clinical physiology of acid-base and electrolyte disorders Mc Graw Hill London, 4th edition, 1994, 540-603 .

9. Segar E.w. and Friedman A.L. water and electrolyte physiology in Rudolph's pediatrics Appleton and lange, California, 19th edition 1991, 225-233.