Clinical audit on pediatric hypovolemic shock

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Though often considered a benign disease, acute gastroenteritis remains a major cause of pediatric morbidity and mortality around the world and the main cause of pediatric hypovolemic shock. Fifty patients with hypovolemic shock due to gastroenteritis were included. Clinical management of these cases was compared with the guidelines. Weight was monitored only at the time of admission for most of cases, but according to the guidelines weight should be monitored daily during fluid intake. We need to stick with the international guidelines as the reference standard to avoid the use of unnecessary lines of management and to decrease mortality rate from pediatric hypovolemic shock due to gastroenteritis

Keywords:
deficit, gastroenteritis, hypovolemic shock, maintenance, shock therapy

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Introduction

Though often considered a benign disease, acute gastroenteritis remains a major cause of pediatric morbidity and mortality around the world, accounting for 1.34 million deaths annually in children younger than 5 years, or roughly 15% of all child deaths [1]. Management of hypovolemic shock due to gastroenteritis include the following: Before the start of administration of intravenous fluids, the child should be weighed.

Phase I

Rapid fluid resuscitation with isotonic fluid (normal saline or lactated Ringer's solution) if the patient is in shock. This resuscitation phase requires rapid restoration of the circulating intravascular volume and treatment of shock with intravenous isotonic fluid boluses 20 ml/kg over ~20 min.

In children with severe volume depletion, fluid boluses should be repeated (≤60 ml/kg) until vital signs, perfusion, and capillary refill have normalized; otherwise inotropes should be used.

Fluid and electrolytes given during resuscitation should be subtracted from the total deficits to be calculated for the patient.

Phase II

Deficit repletion, maintenance, and ongoing losses according to the guidelines used for the study. Before calculating deficit requirements, the degree of dehydration should be calculated:

$$\text{Degree of dehydration} = \frac{\text{Preillness weight} - \text{illness weight}}{\text{Preillness weight}} \times 100$$

Each 1% dehydration corresponds to 10 ml/kg fluid deficit. Dehydration may be estimated clinically: Before calculating deficit requirements the degree of dehydration should be calculated [2] (first 8 h include replacement of the fluid loss with: 1/2 deficit + 1/3 maintenance).

Phase III

Stabilization phase is carried out over the next 16 h and includes 2/3 maintenance + 1/2 deficit [3].

The aim of the study is:
(1) To properly calculate the amount of fluid needed in hypovolemic shock due to gastroenteritis
(2) To decrease the rate of mortality from hypovolemic shock due to gastroenteritis.

Patients and methods

The study included 50 patients in the Assiut Children's University Hospital; all of them have the criteria of hypovolemic shock due to gastroenteritis.

Inclusion criteria

Patients with hypovolemic shock due to gastroenteritis with the following criteria (general signs of dehydration):
(1) diarrhea or vomiting or both,
(2) dry mucous membrane,
(3) delayed capillary refill,
(4) delayed skin turgor,

(5) impaired vital signs, and
(6) impaired mental status.

Exclusion criteria

Other causes of hypovolemic shock and patients who fulfill the inclusion criteria matching the data with the guidelines used regarding:

(1) Steps of treatment of hypovolemic shock.
    (a) Shock therapy.
    (b) Treatment of dehydration.
    (c) Maintenance fluid administration.

Results

This study conducted in Assuit Children University Hospital, in gastroenterology and emergency units. It included 50 children aged from 1 month to 2.6 years. All of them have manifestations of pediatric hypovolemic shock due to gastroenteritis.

According to Table 1: the study included 20 (40%) cases who were men, 30 (60%) cases who were women, 33 cases (66%) cases from the rural area, and 17 (34%) cases from the urban area.

According to Table 2: 50 (100%) cases have diarrhea, 46 (92%) cases have vomiting, 50 (100%) cases have cold extremities, 40 (80%) cases have dry mucous membrane, 11 (22%) cases eager to drink, 39 (100%) cases tachycardic, 40 (80%) cases have low blood pressure, 47 (94%) cases have delayed capillary refill, 48 (96%) cases have delayed skin turgor, 10 (20%) cases were conscious, 33 (66%) cases were lethargic, and seven (14%) cases were irritable.

According to Tables 3–5: blood picture was done for 44 (44%) cases, renal function was done for 40 (80%) cases, serum electrolytes were done for 48 (96%) cases, and arterial blood gases were done for 35 (70%) cases (Fig. 1).

According to Tables 6 and 7: all were properly calculated except the rate and time of correction of hypernatremia.

According to Table 8: 50 (100%) cases have been observed clinically; in 41 (82%) cases clinical signs have been monitored; in 33 (66%) cases serum electrolytes have been monitored every 24 h; 13 (26%) cases of patients have been weighed after intravenous fluids were given; urine output was not monitored for any case.

Table 1 Demographic characteristics of children included in the study

Age (months)		Sex [*n* (%)]		Residence [*n* (%)]	
Mean	Range	Male	Female	Rural	Urban
8.9	1-30	20 (40)	30 (60)	33 (66)	17 (34)

Table 2 Data of the studied cases compared with the standard sheets

Item	*n* (%)
Diarrhea	50 (100)
Vomiting	46 (92)
Cold extremities	50 (100)
Dry mucous membranes	40 (80)
Eager to drink	11 (22)
Tachycardia	50 (100)
Low blood pressure	40 (80)
Delayed capillary refill	47 (94)
Delayed skin turgor	48 (96)
Patient conscious level	
Conscious	10 (20)
Lethargic	33 (66)
Irritable	7 (14)
Patient breathing	
Rapid deep breathing	28 (56)
Normal breathing	2 (4)
Not monitored	20 (40)

Table 3 Laboratory data of children included in the study

Item	*n* (%) (*n*=50)
Complete blood picture	44 (88)
Renal function	40 (80)
Serum electrolytes	48 (96)
Arterial blood gases (*n*=35)	
Acidosis	28 (80)
Alkalosis	7 (20)

Table 4 Serum electrolytes in studied cases

Serum electrolytes	Mean±SD	Range
Normal sodium	138.9±4.3	135-144
Hypernatremia	163.2±9.1	158-174
Hyponatremia	112±4.5	110-118
Normal potassium	3.32±0.2	3.5-3.9
Hyperkalemia	5.7±0.14	5.6-6
Hypokalemia	2.3±0.33	2-2.4

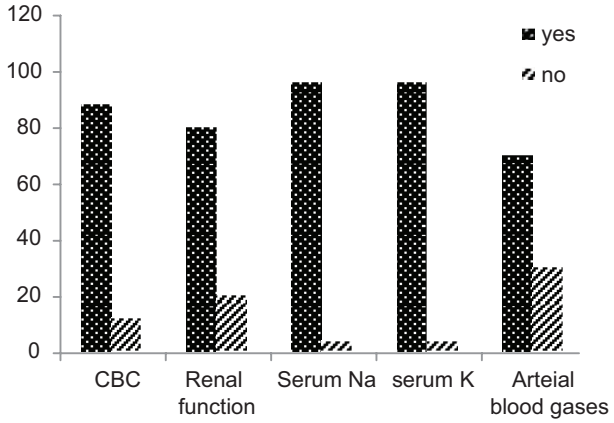
Table 5 Clinical data for patients who have received shock therapy (isotonic fluids)

	n (%)
Type of isotonic bolus administered	
Normal saline	48 (96)
Ringer's lactate	2 (4)
Period and repetition of shock therapy	
Given over 20 min	35 (70)
The bolus repeated	13 (26)
Twice	5
Thrice	8

Discussion

The study was done on 50 patients. All of them had hypovolemic shock due to gastroenteritis. The weight was monitored for only 26% of patients before fluid intake according to the guidelines used for the treatment of hypovolemic shock; weight should be

Figure 1



Laboratory data of children included in the study.

monitored daily during intravenous fluid intake [4]. According to the guidelines, there was no role of antibiotics in the treatment of pediatric hypovolemic shock, while in the present study antibiotics have been used empirically in all cases with no effect as antibiotics may prolong the carrier state (*Salmonella* infection) or may increase the risk of developing hemolytic-uremic syndrome (enterohemorrhagic *Escherichia coli* infection) [5]. As regards the guidelines, there is no role of antidiarrheal drugs in the treatment of diarrhea [6], while in the present study antidiarrheal drugs have been used for all cases with no benefit. Urine output should be monitored frequently according to the guidelines. In this present study the urine output is not monitored in all cases. According to the guidelines, slow correction of hypernatremia should be done in order to avoid cerebral edema caused by rapid correction. The recommended rate for sodium correction is 0.5 mEq/h or as much as 10–12 mEq/l in 24 h. Dehydration should be corrected over 48–72 h. Steiner *et al.* (2007), but in the study there was defect in the correction of hypernatremia; rate and time of correction of hypernatremia were falsely done in 50% of cases [7].

Recommendations

(1) Improvement of physician skills regarding documentation of data and management of cases.
(2) All children on intravenous fluids should be monitored for serum electrolytes and blood glucose checked before starting the infusion, and again within 24 h while intravenous therapy continues or sooner if clinically indicated preferably after 6–8 h.
(3) Pay particular attention if weight changes by more than 5%, if serum sodium is less than 135 mmol/l or greater than 150 mmol/l, or if serum sodium is rising or falling quickly.

Table 6 Management of studied cases according to the type of dehydration

	n (%)
Isonatremic dehydration (*n*=15)	
The first 8 h include replacement of the fluid loss with: 1/2 deficit+1/3 maintenance	15 (100)
Did the next 16 h include 1/2 deficit+1/2 maintenance	15 (100)
Hyponatremic dehydration (*n*=5)	
Na+ requirements properly calculated (not exceeding 12 mEq/l over 24 h)	4 (80)
Hypernatremic dehydration (*n*=28)	
Rate of Na+ correction 10-12 m Eq/l/24 h	14 (50)
Dehydration corrected over 48-72 h	14 (50)

Na, sodium.

Table 7 Administration of maintenance fluid

Step of treatment (*n*=50)	*n* (%)
Total fluid requirements properly calculated	50 (100)
Na+ requirements properly calculated	50 (100)
K+ requirements properly calculated	50 (100)
Glucose requirement properly calculated	50 (100)
Rate properly calculated	48 (96)

Na, sodium; P, potassium.

Table 8 Monitoring of the patient during receiving intravenous fluids

Item monitored	*n* (%) (*n*=50)
Clinical signs	50 (100)
Vital signs	41 (82)
Serum electrolytes every 24 h	33 (66)
Weight	13 (26)

Conclusion

We need to stick with the international guidelines as the reference standard to avoid the use of unnecessary lines of management and to decrease the mortality rate from pediatric hypovolemic shock due to gastroenteritis.

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Conflicts of interest

There are no conflicts of interest.

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