

Research Article

Predictors of length of hospital stay in children with acute gastroenteritis in a tertiary referral center in Egypt



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Abstract

background: Diarrhea is the second leading cause of death in children under-fives worldwide. It accounted for 21% of all deaths in the developing countries with several factors described to affect the outcome. **Objective:** To evaluate the anthropometric, clinical and laboratory parameters and the effect of gender as predictors of length of stay (LOS). in children with acute gastroenteritis. **Patients and methods:** An observational cross-sectional study was carried out at Cairo University Children's Hospital, including 200 patients admitted with acute gastroenteritis, aged 3-50 months. Anthropometry, serum sodium, potassium and albumin were done for all patients. Statistical analysis included grouping of patients according to age and mid-upper arm circumference (MUAC) categories. **Results:** The length of hospital stay was significantly longer among infancy group (89% of the enrolled patients) and low MUAC group (<12.5 cm). Low MUAC group had significantly lower anthropometric measurements and higher frequency of hypokalemia, hypernatremia and hypoalbuminemia. Prolonged LOS was significantly predicted by low MUAC (Odd's ratio: 5.221, 95% CI: 1.703 to 16.008, p= 0.004) and hypernatremia (Odd's ratio: 5.779, 95% CI: 2.208 to 15.123, p< 0.001). On the other hand, LOS was significantly shorter in males (Odds ratio: 0.393, 95% CI: 0.156 to 0.991, p= 0.048), older children (Odds ratio: 0.278, 95% CI: 0.093 to 0.832, p= 0.022) and those with higher MUAC z-scores: 0.531, 95% CI: 0.369 to 0.764, p= 0.001). **Conclusion:** MUAC, serum Na, gender and age were significant predictors of length of stay for children hospitalized with acute gastroenteritis.

Keywords: Acute gastroenteritis; length of stay; mid-upper arm circumference; age; predictors.

Introduction

Diarrheal disease is the second leading cause of death in children under five years old worldwide, causing annually around 525,000 deaths in children under five. A significant proportion of diarrheal disease can be prevented through safe drinking water and adequate sanitation and hygiene. Globally, there are nearly 1.7 billion episodes of childhood diarrheal disease every year. It is a leading cause of malnutrition in children under five ⁽¹⁾.

In developing countries, diarrhea accounts for 21% of all deaths, 42% of which

occurred in the African region ⁽²⁾. The annual mortality rate associated with diarrhea is 30 deaths per 100,000 among Egyptian children under 5 years old, according to recent statistics by the World Health Organization (WHO) ⁽³⁾.

The literature reviews highlight the inter-professional teams' role in evaluating and treating this condition, being a preventable and treatable condition. Several factors were described in the literature to affect the outcome of those children. Epidemiological characteristics, nutritional status and electrolyte profile of hospitalized under-

five children with acute gastroenteritis were points of interest for many researchers (4; 5; 6).

The current study aims to evaluate the anthropometric clinical and laboratory parameters in acute gastroenteritis as predictors of length of stay.

Methods

Ethical Considerations

The study protocol was approved by Cairo University's ethical committee (approval code: MS-119-2019).

Study Design

An observational cross-sectional study including a total of 200 eligible children admitted to the Gastroenterology Inpatient Department, at Cairo University Children's Hospitals. Patient recruitment was done between August 2019 and April 2020.

Sample size calculation was performed using Power and Sample size calculator program version 3.0.43. It was based on the following inputs: power of 80%, significance level 0.05. Sample size will be 200 using the results (7,8)

Inclusion criteria:

Infant and toddlers and children of both sexes, aged 3-60 months, with acute gastroenteritis necessitating hospitalization due to persistence and/or deterioration of symptoms after 8-hour daycare management:

- 1- Persistent vomiting despite antiemetics
- 2- Severe dehydration with unusual irritability or drowsiness
- 3- Failure of oral rehydration treatment, including worsening diarrhea or dehydration despite adequate volumes
- 4- Persistent electrolyte and/or acid-base disturbance
- 5- Febrile gastroenteritis with poor oral intake

Exclusion criteria:

- 1- Hemodynamic instability
- 2- Chronic diarrhea more than one month and exclude also any diarrhea lasting more than 7 days

- 3- Children with known food allergies or chronic bowel conditions (e.g. inflammatory bowel disease)
- 4- Children with vomiting/diarrhea with a focus on another infectious disease (e.g., otitis media, urinary tract infection).
- 5- Chronically ill children with known medical conditions.

Methods

The following data were collected upon recruitment:

- 1- **Anthropometric measurements:** weight, height, and mid-upper arm circumference (MUAC) were obtained and standard deviation score (z-scores) were calculated using **WHO Anthro software** based on recommendations for data collection, analysis and reporting on anthropometric indicators in children under 5 years old reported by WHO and UNICEF (9). Z-scores were used instead of absolute numbers of anthropometric measurements to exclude age as a confounder in data interpretation. Trained nurses took weight including one layer of clothes and length without shoes. The MUAC was measured at a midpoint between the acromion and olecranon with the left arm flexed at a 90° angle and with the tape measure perpendicular to the long axis of the arm.
- 2- **Biochemical analysis:** serum sodium, potassium and albumin were analyzed using Roller Mixer, RMX-TR-S, RMX-TR-SR.
- 3- **Tracking the hospital course:** checking if PICU admission was indicated, LOS (in the current study we used 5 days as cut-off for prolonged hospital stay) and the outcome (10,11).

Statistical analysis:

Data were collected, revised, coded and entered into the Statistical Package for Social Science (IBM SPSS) version 28. The quantitative data were presented as mean, standard deviations and ranges when parametric and median and inter-quartile

range (IQR) when data found non-parametric. The comparison between 2 groups with qualitative data was done using the Chi-square test and/or Fisher exact test, and quantitative data were compared using the t-test or Mann-Whitney test. Spearman correlation coefficients were used to assess the correlation between two quantitative parameters. Multivariate logistic regression was done for detection of independent predictors of prolonged stay and pediatric intensive care (PICU) admission⁽¹²⁾. The independent factors entered were age, gender, mid-upper arm circumference, serum sodium, potassium and albumin. The confidence interval was set to 95% and the margin of error accepted was set to 5%. The p-value was considered significant when P-value was <0.05.

Results

We enrolled 200 patients with acute gastroenteritis, admitted for inpatient care fulfilling the inclusion criteria. The median age was 9 months (IQR: 6-16.75 months). They were 107 (53.5%) males and 93 (46.5%) females. On asking about the type of feeding, we found that (32%) were breastfed, (43.5%) were formula-fed while predominantly breastfed (12%), predominantly formula feeding (2%) mixed feeding (10.5%). Regarding anthropometric parameters, weight was normal in 169 (84.5%) participants, while 14 (7%) were moderately underweight and 17 (8.5%) were severely underweight. The length was normal in 180 (90%) participants, while 11 (5.5%) were moderately stunted and 9 (4.5%) were severely stunted. Looking at weight for length, it was normal in 172 (86%) participants and decreased in 28 (14%) participants. MUAC was more than 12.5 cm in 127 (63.5%) participants and less than 12.5 cm in 73 (36.5%).

Patients spent a median of 4 days (IQR: 4-6 days, range 3-15 days) in hospital, and 11 (5%) patients were admitted to PICU during the hospital course. All participants were discharged upon improvement with no mortality.

Due to the large age scale of the enrolled subjects that might affect the length of hospital stay (LOS), we divided the patients into two groups; infant and toddler 3-24 months and children 24-60 months. Infancy incorporated the majority of patients; 168 (84%) and the remaining were older as shown in Table (1). Comparing the two age groups, we observed statistically significant lower MUAC measurement (less than 12.5 cm) and lower weight for length z-scores among the infant and toddler group with significantly longer lengths of hospital stay compared to the children group ($p < 0.001$). No significant differences were noted regarding gender, weight for age and length/height for age z-scores or the biochemical profile as shown in Table (2).

Using the MUAC 12.5 cm cutoff value, patients were categorized into two groups; the normal MUAC group and the low MUAC group. When both groups are compared, the low MUAC group had lower weight for age, length for age and weight for length z-scores, had a significantly higher frequency of hypernatremia (56.2% vs. 37.8%), hypokalemia (58.9% vs. 37.8%) and hypoalbuminemia (75.3% vs. 36.2%) ($p < 0.001$ for all parameters) as shown in Table (2).

All patients who were admitted to PICU were among the low MUAC group. LOS was significantly longer among the low MUAC group compared to the normal MUAC group. Also, gender was significantly different between groups with female predominance among the low MUAC group ($p < 0.001$) as shown in Table (2).

As previously mentioned, LOS increased significantly with the younger age and lower MUAC (Tables 1 and 2). There was also a statistically significant negative correlation between LOS and a) MUAC ($r = -0.448$, $p = 0.000$), b) age ($r = -0.25$, $p = 0.000$), c) potassium ($r = -0.198$, $p = 0.005$) and d) albumin ($r = -0.196$, $p = 0.006$), while there was a statistically significant positive

correlation between LOS and serum sodium ($r= 0.241$, $p=0.001$), (Figs. 1 and 2)

Multivariate logistic regression analysis was used to predict prolonged LOS and the need for PICU admission. Children with hypernatremia, had a 5.78 times increased risk of prolonged hospital stay (95% CI: 2.208-15.123, $P<0.001$). While children with low MUAC (less than 12.5 cm) had a 5.22 risk of prolonged hospital stay (95% CI: 1.703 to 16.008, $p= 0.004$). On the other hand, male gender, older age and higher MUAC z-scores were significantly

protective against prolonged LOS: Odds ratio 0.393 (95% CI: 0.156-0.991, $p= 0.048$) for male gender, Odds ratio 0.278 (95% CI: 0.093-0.832, $p= 0.022$) for older age and Odds ratio 0.531 (95% CI: 0.369-0.764, $p= 0.001$) for MUAC z-scores. Female gender was not a significant predictor and was excluded from the regression model ($p=0.71$). Multivariate logistic regression model for need of PICU admission was only significant for hypoalbuminemia (less than 3.5 g/dl) with Odds ratio: 8.657 (95% CI: 1.05-71.356, $p= 0.045$) as shown in table (3).

Table (1): Comparison of characteristics and outcomes of the studied patients according to age

Characteristics	Infancy Group (3-24 months)	Children Group (24-60 months)	p
Number (%)	168 (84%)	32 (16%)	
Gender, N (%)			
Females	83 (49.4%)	10 (31.3%)	0.06
Males	85 (58.6%)	22 (68.7%)	
MUAC classification, n (%)			0.023
Less than 12.5 cm	67 (49.5%)	6 (18.7%)	
Equals or more than 12.5 cm	101 (50.5%)	26 (81.3%)	
Anthropometry z-score, median (IQR)			
MUAC for age	-0.60 (-2.30 - 0.00)	-1.35 (-2.13- -0.75)	0.09
Weight for age	-0.85 (-1.68- -0.10)	-0.52 (-1.15- 0.22)	0.12
Length/height for age	-.070 (-1.31- 0.00)	-0.82 (-1.28- -0.20)	0.43
Weight for length/height	-0.56 (-1.42- 0.43)	-0.05 (-0.87- 0.77)	0.049
Biochemical profile			
Serum sodium			
Mean+/- SD	145.39+/- 9.18	145.65+/- 10.74	0.88
Normal (135-145 mmol/L)	93 (55.4%)	18 (56.3%)	0.93
High (>145 mmol/L)	75 (44.6%)	14 (43.7%)	
Serum potassium			
Mean+/- SD	3.73+/- 0.64	3.74+/- 0.52	0.94
Low (≤ 3.5 mmol/L)	78 (46.4%)	13 (40.6%)	0.35
Normal (>3.5 mmol/L)	90 (53.6%)	19 (59.4%)	
Serum albumin			
Mean+/- SD	3.50+/- 0.50	3.68+/- 0.31	0.56
Low (≤ 3.5 g%)	87 (52.1%)	14 (43.7%)	0.38
Normal (>3.5 g%)	80 (47.9%)	18 (56.3%)	
Length of hospital stay, days median (IQR)	4 (4-6)	4 (3-5)	0.005
Admission to PICU, n (%)			
Yes	11 (6.5%)	0 (0%)	0.13
No	157 (93.5%)	32 (100%)	

Note: IQR: interquartile range, MUAC: mid-upper arm circumference, PICU: pediatric intensive care unit, SD: standard deviation

Table (2): Comparison of characteristics and outcomes of the studied patients according to mid-upper arm circumference

Characteristics	Low MUAC group (MUAC < 12.5 cm)	Normal MUAC group (MUAC ≥ 12.5 cm)	P
Number (%)	73 (36.5%)	127 (63.5%)	
Gender, N (%)			
Females	46 (63%)	47 (37%)	0.000
Males	27 (37%)	80 (63%)	
Anthropometry z-score, median (IQR)			
MUAC for age	-2.91 (-4.17- -1.89)	-0.43 (-0.93- 0.05)	0.000
Weight for age	-1.44 (-2.89- -0.82)	-0.43 (-1.06- 0.32)	0.000
Length/height for age	-1.02 (-1.89- -0.26)	-0.53 (-1.07- 0.09)	0.000
Weight for length/height	-1.12 (-2.27- -0.16)	-0.13 (-0.96- 0.7)	0.000
Biochemical profile			
Serum sodium			
Mean+/- SD	147.07+/- 9.89	144.49+/- 9.03	0.06
Normal (135-145 mmol/L)	32 (43.8%)	79 (62.2%)	0.021
High (>145 mmol/L)	41 (56.2%)	48 (37.8%)	
Serum potassium			
Mean+/- SD	3.57+/- 0.66	3.82 +/- 0.58	0.006
Low (≤ 3.5 mmol/L)	43 (58.9%)	48 (37.8%)	0.004
Normal (>3.5 mmol/L)	30 (41.1%)	79 (62.2%)	
Serum albumin			
Mean+/- SD	3.30 +/- 0.60	3.67 +/- 0.31	0.000
Low (≤ 3.5 g%)	55 (75.3%)	46 (36.2%)	0.000
Normal (>3.5 g%)	18 (24.3%)	81 (63.8%)	
Length of hospital stay, days median (IQR)	7 (4-9)	4 (3-5)	0.000
Admission to PICU, n (%)			
Yes	11 (15.1%)	0 (0%)	0.000
No	62 (84.9%)	127 (100%)	

Note: IQR: interquartile range, MUAC: mid-upper arm circumference, PICU: pediatric intensive care unit, SD: standard deviation.

Table 3: Multivariate logistic regression for detection of prolonged LOS

		P value	OR	95% C.I.	
				Lower	Upper
prolonged LOS	Gender (male)	0.048	0.393	0.156	0.991
	Na_classification (high)	<0.001	5.779	2.208	15.123
	MUAC_age_z	0.001	0.531	0.369	0.764
	MUAC_classification<12.5mm	0.004	5.221	1.703	16.008

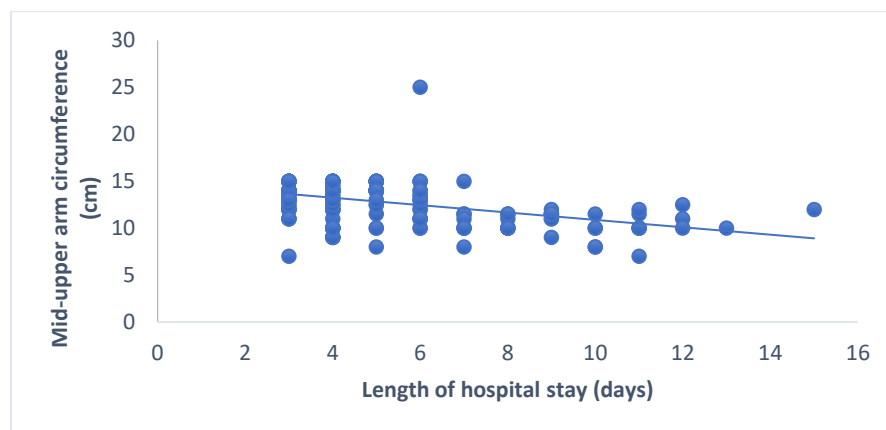


Figure (1): Correlation of length of hospital stay to mid-upper arm circumference values.

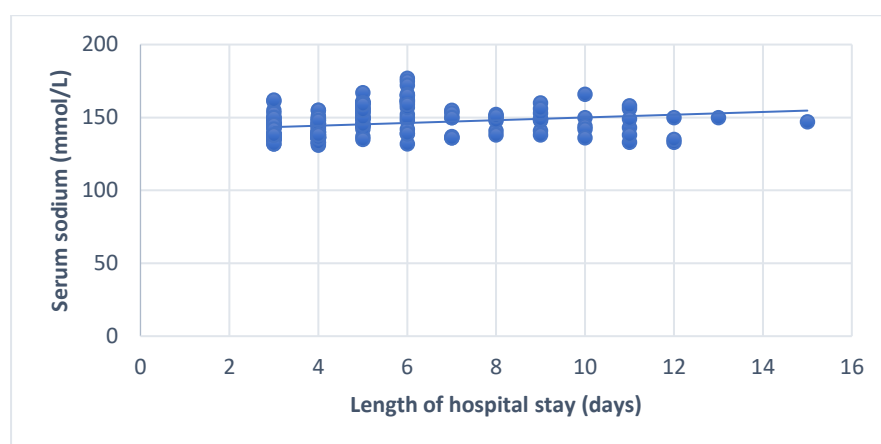


Figure (2): Correlation of length of hospital stay to serum sodium.

Discussion

Among the 200 enrolled subjects, infant and toddlers showed a significantly longer LOS than older children with lower MUAC values, and weight for length z-scores, with no significant differences regarding the biochemical analysis between both age groups. Both genders were equally distributed among age groups, however, the female gender was more frequent among the low MUAC group. All anthropometric, biochemical and outcome parameters were significantly worse among the low MUAC group. It was found that infancy, female gender, hypernatremia and low MUAC were independent factors that significantly predicted longer hospital stay than 5 days.

Similar to the current study report about the high frequency of infant and toddlers

affected with acute gastroenteritis, another study reported that 89% of their studied cases were infant and toddlers younger than 2 years old with reduced prevalence when shifting to older age groups⁽¹³⁾.

Looking at the nutritional status of the studied patients, infant and toddlers were significantly wasted than older children as evidenced by lower MUAC values and weight for length z-scores. As reported before, MUAC and MUAC z-scores were the most accurate predictors of undernutrition in children with diarrhea. Weight for age and weight for length z-scores were significantly affected by dehydration status, leading to the misdiagnosis of many patients on arrival with severe underweight and severe acute malnutrition⁽⁴⁾.

Acute moderate and severe malnutrition in terms of MUAC value were found in 36.5% of our studied patients, compared to 48.7% in the study conducted in India on under 5 children hospitalized mainly with acute gastroenteritis and pneumonia ⁽⁶⁾.

Regarding gender differences in acute diarrheal illness in other study reported that females were more significantly malnourished than males ⁽¹⁴⁾. This comes in agreement with the current study which found a higher frequency of female gender among the low MUAC group with significant differences in all anthropometric parameters and significantly longer hospital stay.

LOS may be a bit longer in the current study (median [IQR]: 4 [4-6] days), an average of 2.6 days of hospitalization. This longer course of hospitalization in our study might be attributed to infancy representing the larger portion of our enrolled patients with more severe form of the illness than older children ⁽¹⁵⁾.

Coming to biochemical markers, we found that the wasted infant and toddlers and children (low MUAC group) had a higher frequency of electrolyte disturbance and hypoalbuminemia and this both directly and indirectly led to the prolongation of LOS (burden of electrolyte disturbance added to malnutrition). This also could explain why all the patients who were indicated for PICU admission fell in this category. Low albumin may provide clues to the clinician when interpreted in the whole context of nutritional assessment including nutritional intake and anthropometric measurements. we used it in the current study due to being readily available in the hospital setting. May be it is not the perfect marker, but it was significantly lower in the acute malnutrition group (low MUAC group) compared to the normal MUAC group. Prealbumin is a more accurate marker but it was not measured in the current study.

The large sample size is a point of strength of the present study in addition to using a

reliable easy marker like MUAC for assessing acute malnutrition in acute diarrhea. The results highlighted the importance of diagnosing acute malnutrition early in the illness course, therefore, all pediatricians can immediately apply the WHO recommendations for managing acute malnutrition complicated with acute diarrhea and reach the aim of decreasing mortality. Reducing LOS with its subsequent financial burden will be another great achievement. Increasing awareness of the service providers in primary health care units to screen those children using MUAC allows for early referral of the indicated cases to the tertiary care centers.

The absence of follow-up was a major limitation of this study. Since the study design was a cross-sectional one. Many factors during the admission period that could have significantly affected the outcome and LOS were beyond the scope of the current study.

Conclusion:

MUAC, serum Na, gender and age were significant predictors of length of stay for children hospitalized with acute gastroenteritis.

List of abbreviations:

length of stay (LOS)

mid-upper arm circumference (MUAC)

world health organization WHO

pediatric intensive care PICU

interquartile range IQR

the Statistical Package for Social Science (IBM SPSS)

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