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Performance of Clinical Signs in the Diagnosis of Dehydration in Children with Acute Gastroenteritis

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ABSTRACT

Background: Acute evaluation and treatment of children presenting with dehydration represent one of the most common situation in the pediatric emergency department. To identify dehydration in infants and children before treatment, a number of symptoms and clinical signs have been evaluated. The aim of the study was to describe the performance of clinical signs in detecting dehydration in children.

Methods: Two hundred children aged 1 month to 5 year were involved in our prospective study. The clinical assessment consisted of the ten clinical signs of dehydration, including those recommended by WHO (World Health Organization), heart rate, and capillary refill time. **Results:** Two hundred patients with diarrhea were enrolled in the study. The mean age was 15.62±9.03 months and 57.5% were male. Of these 121 had a fluid deficit of < 5%, 68 had a deficit of 5 to 9% and 11(5.5%) had a deficit of 10% or more. Patients classified as having no or mild, moderate, and severe dehydration were found to have the following respective gains in percent weight at the end of illness: 2.44±0.3, 6.05± 1.01 and, 10.66± 0.28, respectively. All clinical signs were found more frequently with increasing amounts of dehydration (p<0.001, One-way ANOVA). The median number of findings among subjects with no or mild dehydration (deficit <5%) was 3; among those with moderate dehydration (deficit 5% to 9%) was 6.5 and among those with severe dehydration (deficit >10%) the median was 9 (p<0.0001, Kruskal-Wallis test). Using stepwise linear regression and a p value of <0.05 for entry into the model, a four-variable model including sunken eyes, skin elasticity, week radial pulse, and general appearance was derived. **Conclusion:** None of the 10 findings studied, is sufficiently accurate to be used in isolation. When considered together, sunken eyes, decreased skin turgor, weak pulse and general appearance provide the best explanatory power of the physical signs considered.

Key words: acute gastroenteritis, dehydration, clinical signs of dehydration.

1. BACKGROUND

Dehydration secondary to gastroenteritis remains a major cause of morbidity and mortality (1). Acute evaluation and treatment of children presenting with dehydration represent one of the most common situation in the pediatric emergency department (2). Underestimating fluid deficit and not providing proper rehydration can lead to acidosis, electrolyte disturbances, acute kidney injury, or even death (3). Alternatively, overestimating fluid deficit can lead to unnecessary interventions, longer hospital stays, and increased adverse events in children (4, 5).

In order to apply the most appropriate treatment for dehydration in children with gastroenteritis, healthcare providers must first accurately assess the severity of dehydration (6). Comparing change in body weight from before and after rehydration is the standard method for diagnosing dehydration (1). To identify dehydration in infants and children before treatment, a number of symptoms and clinical signs have been evaluated and compared with this standard method. Physical examination find-

ings during dehydration represent desiccation of tissue, the body's compensatory reaction to maintain perfusion, or both (7). Hence, having accurate dehydration clinical signs is essential to detect dehydration and to manage the patient appropriately (8). A systematic review found that the best individual examination signs for assessment of dehydration were prolonged capillary refill time, abnormal skin turgor and abnormal respiratory pattern (4).

Aim of the study: The goal of the study was to describe the performance of clinical signs in detecting dehydration in children.

2. MATERIAL AND METHODS

Two hundred children aged 1 month to 5 year were involved in our prospective study. A convenience sample of such patients, were seen during year 2012 and 2013 at Pediatric Clinic. The chief complaint was diarrhea with or without vomiting. Because several conditions can alter the clinical signs, patient meeting the following criteria were excluded from the study: diarrhea of more than 7

days duration, children with signs of malnutrition, history of cardiac or renal disease, and those who received treatment prior 24 hours at another health facility. The clinical assessment was performed by one pediatrician in the presence of others two. In the event of disagreement the opinion of the majority (two of three) was accepted. The clinical assessment consisted of the ten clinical signs of dehydration, including those recommended by WHO (World Health Organization), heart rate, and capillary refill time (9). Capillary refill time was performed in a warm ambient temperature, and was measured in sternum of infants and on finger or arm held at level of the heart in older children (it should be less than two seconds) (7). Heart rate and respiratory pattern were compared with age specific normal values. For categorical variables, findings were marked as normal, moderately abnormal, or markedly abnormal unless the signs were recorded in dichotomous fashion as: heart rate, capillary refill time and urine output (none of the children were assigned to markedly abnormal findings). The initial assessment was performed before the any rehydration therapy. After admission children were weighed and they underwent rehydration therapy according to the hospital protocols. Naked body weight was measured by nurses on the same scale daily, until discharge. Post-illness weight was defined as the first weight with less than 1% of differences between two consecutive daily weight measurements, after diarrhea and vomiting had disappeared. Clinically important dehydration was defined as a fluid deficit of 5% or greater. It was calculated as (post-illness weight–admission weight)/(post-illness weight) x 100 for the “gold standard” method (10). Data were analyzed by determining the mean and standard deviation for each result. Non-parametric comparisons (Kruskal-Wallis test) were performed for the median number of findings among subjects with no or mild, moderate and severe dehydration. Comparisons across three categories of findings were performed using One-way ANOVA. Multiple linear regression was used to compare the explanatory ability of different sets of signs of dehydration.

3. RESULTS

Two hundred patients were enrolled in the study. The mean age was 15.62±9.03 months and 57.5% were male. Of these 121 (60,5%) had a fluid deficit of <5%, 68 (34%) had a deficit of 5 to 9% and 11(5.5%) had a deficit of 10% or more. Patients classified as having no or mild, moderate, and severe dehydration were found to have the following respective gains in percent weight at the end of illness: 2.44±0.3, 6.05±1.01 and, 10.66±0.28, respectively (p<0.001, One-way ANOVA) (Figure 1).

With respect to the individual signs of dehydration table 1 shows actual percent dehydration in patients with varying degrees of these signs. Comparisons were generally made across three categories of classification (normal, moderately abnormal and markedly abnormal) un-

Sign	Score (n)	Mean percent weight gain(±SD)	p
Eyes	Normal (95)	2.83 (2.00)	0.001
Skin elasticity	Sunken (98)	4.95 (2.44)	0.001
Quality of radial pulse	Very sunken (7)	9.95 (1.95)	0.001
General condition	Pinch retracts immediately (81)	2.71 (1.98)	0.001
Quality of respiration	Pinch retracts slowly (112)	4.79 (2.47)	0.001
Tears	Pinch retracts very slowly (>2 sec) (7)	9.73 (1.98)	0.001
Mucous membranes	Normal (129)	3.21 (2.09)	0.001
Heart rate	Thready or weak (67)	5.47 (2.69)	0.001
Capillary refill	Feeble or impalpable (4)	10.78 (0.26)	0.001
Urine output	Thirsty; alert; restless (76)	3.01 (2.26)	0.018
	Lethargic or drowsy (117)	4.44 (2.35)	
	Limp; may be comatose (7)	10.81 (0.21)	
	Normal (142)	3.45 (2.32)	
	Deep (51)	5.47 (2.33)	
	Deep and rapid (7)	10.74 (0.32)	
	Present (168)	3.60 (2.32)	
	Decreased (28)	6.26 (2.66)	
	Absent (4)	10.90 (0.20)	
	Moist (40)	2.65 (1.97)	
	Dry (152)	4.18 (2.41)	
	Very dry (8)	10.45 (0.90)	
	Normal (132)	3.26 (2.04)	
	Increased (68)	5.79 (3.02)	
	Normal (106)	3.40 (2.27)	
	Delayed capillary refill (>2 sec) (94)	4.93 (2.91)	
	Normal (88)	3.61 (2.71)	
	Reduced (112)	4.52 (2.62)	

Table 1. Individual signs of dehydration and their relationship to percent weight gain*. *One way Anova

less the signs were recorded in dichotomous fashion. All clinical signs were found more frequently with increasing amounts of dehydration (p<0.001, One-way ANOVA, urine output p<0.018). The median number of findings among subjects with no or mild dehydration (deficit <5%) was 3; among those with moderate dehydration (deficit 5% to 9%) was 6.5 and among those with severe dehydration (deficit >10%) the median was 9 (p<0.0001, Kruskal-Wallis test). Multiple linear regression was then used to examine the ability of different subsets of clinical signs to explain the variation in weight gained. Using step wise linear regression and a p value of ≤0.15 for entry into the model, a four-variable model including sunken eyes, skin elasticity, week radial pulse, and general appearance was derived (Table 2).

Clinical Finding	Coefficient	r partial	P
Sunken eyes	1.3864	0.318	<0.0001
Decreased skin elasticity	1.1426	0.258	0.0002
Week radial pulse	1.2153	0.262	0.0002
General appearance	0.6781	0.157	0.0275

Table 2. Different subsets of clinical signs and variation in percent weight gain* *Stepwise regression analysis; for entry p<0.15

4. DISCUSSION

Accurate assessment of hydration status is very important in the management of diarrhea in children. According to Colletti et al. clinical assessment of the degree of dehydration done quickly and accurately in infants and young children with gastroenteritis often determines patient treatment and disposition (11). Several studies (3, 12-16) mostly from developed countries have tried to evaluate the validity of clinical signs in diagnosis of dehydration while such a study was never conducted in a developing country of Kosovo. Our study shows that three commonly used categories of dehydration were associated with the following mean percentage weight gain: mild dehydration 2.44%, moderate dehydration 6.05%, and severe dehydra-

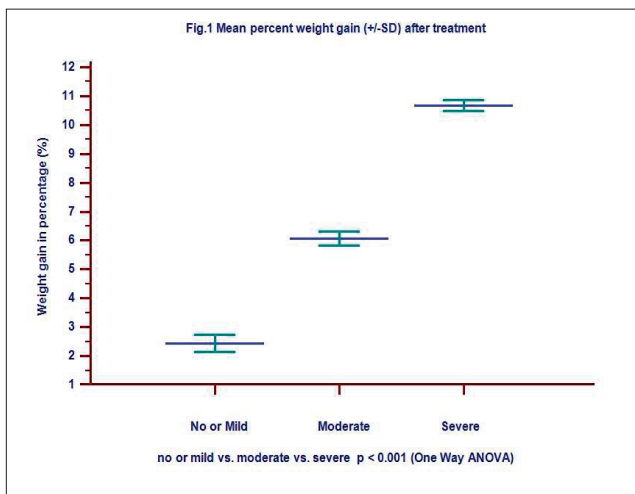


Figure 1. Mean percent weight gain (+/-SD) after treatment

tion 10.66%. The median number of findings in subjects with mild dehydration was 3 while in those with moderate and severe dehydration were 6.5 and 9 respectively. Evaluation of the individual signs of dehydration revealed the presence of sunken eyes to be the most significantly correlated with degree of dehydration, followed by decreased skin turgor, weak radial pulse, general appearance, dry mucous membranes, absent tears, increased heart rate, altered breathing, capillary refill time more than 2 seconds and decreased urine output. Sunken eyes, decreased skin elasticity, weak radial pulse and general appearance are an optimal four variable model. Of these four findings, the presence of any two indicates a deficit of 5% or more, and three or more findings indicates a deficit of at least 10%. In general our results agree very well with those of Duggan et al., who found that fluid deficit of mildly, moderately and severely dehydrated children was closer to 3%, 5% and 9% respectively. They evaluated two different dehydration assessment scales that classified children as mild, moderate, or severe based on the number of dehydration examination signs present (14). Mackenzie et al. who studied 102 Australian children with diarrhea and dehydration, found that signs of dehydration became evident at a 3% weight deficit, and that deep breathing, decreased skin turgor, and decreased peripheral perfusion were present more often in those children with more than 4% dehydration than among those with less dehydration (2). Gorelick et al. explored the accuracy of clinical signs of dehydration individually. All 10 findings they studied had a significant association with the presence of dehydration. Their study showed that the median number of findings among subjects with no or mild dehydration was 1, while among those with moderate and severe dehydration were 5 and 8 respectively. Authors concluded that capillary refill time, dry mucous membranes, absence of tears, and abnormal overall appearance contained most of the predictive power (12). Like Gorelick et al. but in contrast to WHO (9) and American Academy of Pediatrics (AAP) (17) recommendations, we found that clinical signs were already apparent with a deficit of <5%; in our study, children with <5% dehydration had a median of three findings. In a systematic review Steiner et al. (4) concluded that no individ-

ual clinical signs have adequate sensitivity and specificity for the prediction of dehydration. It showed that the most useful individual signs for predicting 5% dehydration in children are an abnormal capillary refill time, abnormal skin turgor and abnormal respiratory pattern. Combinations of examination signs perform markedly better than any individual sign in predicting dehydration.

5. CONCLUSION

Clinical signs of dehydration among children with acute diarrhea differ in their ability to distinguish among mild, moderate, and severe dehydration. Of the 10 findings studied, none is sufficiently accurate to be used in isolation. When considered together, sunken eyes, decreased skin turgor, weak pulse and general appearance provide the best explanatory power of the physical signs considered.

CONFLICT OF INTEREST: NONE DECLARED.

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