

## Research Article

# Assessment of Dehydration in Children with Acute Gastroenteritis: A Narrative Review of International Guidelines

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### Abstract

**Background:** Acute Gastroenteritis (AGE) is a major cause of presentation to hospital in children. Detection and classification of the degree of dehydration are vital for proper treatment.

**Methods:** The authors reviewed six international guidelines on AGE in children. The aim was to equip clinicians working in a hospital setting with practical and readily applicable clinical handles to assist them in detecting and classifying dehydration.

**Results:** Published international guidelines on AGE vary in their recommendations on the assessment of dehydration as well as their classification of dehydration severity. Nevertheless, a practical scheme utilizing a combination of these guidelines could be devised.

**Conclusion:** In addition to the World Health Organization classification of dehydration in children, several clinical handles were suggested.

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## 1. Introduction

Acute gastroenteritis (AGE) and its complications remain one of the leading causes of mortality in children worldwide [1]. In underdeveloped countries, the disease poses a particular burden on the resource-limited healthcare systems; enormously higher mortality rates from the disease in sub-Saharan Africa, for example, is not unexpected [2]. In some regions of Africa, diarrheal diseases remain the leading cause of hospital presentation and the second most common cause of death in children under five years of age (excluding the neonatal period) [3]. In places with underdeveloped, under-resourced, and overburdened community and primary care services, a considerable percentage of patients with AGE present to the emergency departments (EDs) of large hospitals without passing through primary healthcare services. This necessitates an easy and reliable tactic to quickly and efficiently detect and classify dehydration in children in a busy and understaffed ED. The aim of this article is to equip clinicians

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working in a hospital setting with practical and readily applicable clinical handles to assist them in detecting and classifying dehydration. The article may be useful mainly for physicians working at moderately to markedly under-resourced pediatric EDs.

Clinical practice guidelines have been defined as “statements that include recommendations intended to optimize patient care, and that are informed by a systematic review of evidence and an assessment of the benefits and harms of alternative care options” [4]. It has been demonstrated that adherence to robust clinical practice recommendations and guidelines improves the outcomes, lowers the rate of hospital admissions, reduces the duration of hospital stay, and lowers the financial costs attributable to diarrheal diseases in children [5, 6]. However, when individual guidelines cannot provide satisfactory answers to all practice ambiguities across all settings, poor adherence to these guidelines is an expected outcome [7]. Inconsistencies in recommendations among different guidelines further complicate things for practicing physicians.

Classifying dehydration into subgroups is an “essential basis” for appropriate rehydration [8]. This review of the international guidelines aims at providing practical answers to the following clinical questions relevant to the management of AGE in children.

- What is the utility of individual clinical signs and symptoms in detecting and categorizing dehydration?
- What is the most convenient and practical way of classifying the degree of dehydration in an ED?

This has been done after reviewing, utilizing, and combining practical recommendations from international guidelines, taking into consideration the peculiarities of the organization of services, processes, and setting of a typical resource-limited yet busy hospital's ED.

## 2. Materials and Methods

### 2.1. Selecting, retrieving, and reviewing the guidelines

In addition to the existing World Health Organization (WHO) guidelines for treating diarrhea in children, five international guideline documents addressing acute diarrhea/gastroenteritis and dehydration were retrieved from the websites of the relevant professional organizations and institutions. The guidelines are:

- The WHO guidelines on the treatment of diarrhea in children [9–11].
- National Institute for Health and Care Excellence (NICE) guidelines [12, 13].

- Cincinnati Children's Hospital (CCH) Medical Center's guidelines on AGE In children aged 2 months through 5 years [14].
- Guidelines for the management of acute gastroenteritis in children in Europe (ESP) [15].
- Canadian Pediatric Society (CPS) position statement on "Oral rehydration therapy and early refeeding in the management of childhood gastroenteritis" [16].
- "Managing Acute Gastroenteritis Among Children" from the Centers for Disease Control and Prevention (CDC) [17].

These guidelines were chosen based on their international reputability in addition to their quality being critically appraised previously by Van Den Berg and Berger [18]. No further critical appraisal of data has been done in this article.

The author initially formulated the clinical practice questions mentioned previously (in the Introduction section). Each guideline document was then thoroughly reviewed with a focus on fetching recommendations that answer the research questions. These recommendations were first assessed on whether they were based on evidence of an acceptable level or were graded as strong recommendations. This was partly based on the information extracted from [18] in addition to the guidelines themselves where available. Next, a decision about each recommendation applicability to the practice area of concern (i.e., a large hospital ED) was made based on the author's judgment and experience in working in the same setting for around six years in Sudan. Finally, practical conclusions were suggested building on one or more corresponding recommendations from the international guidelines.

## 2.2. Target patients

AGE has been defined as a diarrheal disease of acute onset "with or without accompanying nausea, vomiting, fever, or abdominal pain" [14]. Diarrhea is the passage of unusually loose or liquid stool, typically  $\geq 3$  times per 24 hr. However, "a change in stool consistency versus previous stool consistency" is more indicative of diarrhea than the frequency of defecation [9, 15].

This review is intended primarily for use in children aged one week to five years with clinically confirmed AGE. It is important to note that the review does *not* apply to the following categories:

- AGE in a **severely** malnourished child (see the WHO definition of severe acute malnutrition [19]).

- Acute diarrhea with or without vomiting as a result of non-gastrointestinal illness, for example, sepsis, urinary tract infection, and meningitis.
- Iso-, hypo-, or hypernatremic dehydration resulting from causes other than AGE, for example, acute adrenal crisis and vomiting with no diarrhea.

### 2.3. Audience

This review will be helpful primarily to practicing pediatricians, pediatric, and pediatric emergency medicine (PEM) trainees working in an ED setting. Although it is more directed to a resource-limited hospital, clinicians in all ranges of EDs may find it useful.

## 3. Results and Discussion

Almost all reviewed guidelines agreed on using a three-category classification of no (< 5%) dehydration, some (mild to moderate) (5 to 9%) dehydration, and severe ( $\geq$  10%) dehydration (the quoted percentages of loss are the ones used by the WHO). The four-category classification has mostly been avoided [20] because of poor interobserver reliability. The guidelines, however, vary in the use of clinical symptoms and signs to assess dehydration. Measuring the child's weight and comparing it to a recent measurement to calculate the percentage fluid loss was not used by any guideline to classify dehydration because of impracticality and accuracy issues.

The WHO and NICE guidelines emphasized on hypovolemic shock as a clinical entity with a greater percentage of body fluid loss and higher fluid requirement than "severe dehydration" [11, 21]. Both guidelines stressed the crucial importance of early recognition and emergency treatment of hypovolemic shock. The WHO characterizes shock diagnosis as based on the clinical signs of cold hands, prolonged capillary refill time of > 3 sec, and weak pulses on top of signs of severe dehydration. NICE guidelines pointed out that a child with shock might have a more profound depressed level of consciousness and more pronounced tachycardia than dehydration. They restated that the manifestations of advanced shock would be unequivocal, however, milder degrees of shock might be challenging to distinguish from severe dehydration, concluding that "when there was uncertainty, the safe approach would be to treat as though shock was present." Importantly also, NICE suggested that, in some cases, when an infant develops rapid fluid losses, shock may ensue before the signs of severe dehydration (e.g., slow skin pinch and dry tongue) are manifested. Other guidelines did not define

the “shock” category. Hypotension was agreed on to be a late sign of severe shock. The presence of normal blood pressure does not rule out shock [22].

Some individual signs have increased the likelihood in detecting  $\geq 5\%$  dehydration, that is, “some dehydration” and worse. The best “individual” signs to indicate dehydration were abnormal skin turgor, absent tears, abnormal (deep/rapid/acidotic) respiratory pattern, and prolonged capillary refill (ESP, CCH, and NICE citing the study of Steiner *et al.* [23]). These were the highest in specificity (and likelihood ratio (LR)) for detecting  $\geq 5\%$  (some or severe) dehydration. This means that the finding of **any one** of these signs is likely indicative that the child is dehydrated, but without taking the degree of dehydration into account (see page 9 in [14] and Table 4.1 in [18]). An altered mental status of any degree (irritability, restlessness, lethargy, coma), sunken eyes, and dry mucous membranes (except for mouth breather) were also consistent individual signs of dehydration across all guidelines, except the WHO that did not assess for mucus membranes. However, their individual LRs for detecting dehydration were less than those for the signs mentioned previously [23]. Poor general appearance, dry mucous membranes, and sunken eyes also had the highest individual sensitivity for detecting  $\geq 5\%$  dehydration [21]. More importantly, the absence of these signs individually had the lowest LR (negative LR = 0.46, 0.41, 0.49, respectively [23]). This implies that children with AGE are likely **not** dehydrated if they appear well, do not have sunken eyes, or have moist mucous membranes (when no recent drinking).

Tachycardia, although a consistently mentioned sign of dehydration in all reviewed guidelines, may also occur in a well-hydrated child with coexisting fever, abdominal pain, or anxiety [24]. This markedly lowers its utility in detecting dehydration (positive LR of 1.3 [23]). However, this consistency in guidelines might make the absence of tachycardia a reasonable indicator that a child is not severely dehydrated. The heart rate in some children with no or some dehydration may be normal (CDC, CPS, CCH, NICE). CCH and CDC guidelines also drew attention to the fact that bradycardia can occur in the most severe cases (of dehydration or shock).

Assessment of tears was not part of the evaluation of dehydration in three out of six guidelines (WHO, CPS, NICE). However, the presence of normal tears would argue against **severe** ( $\geq 10\%$ ) dehydration. Assessment of the anterior fontanelle was used only by CCH and CPS guidelines, and its use was deemed “unreliable and misleading” by the CDC. Parental reports of symptoms/signs of dehydration were not part of the assessment in all but one (NICE) guidelines. Parental reporting was stated as being not clinically useful by ESP guidelines. The latter, however, strongly recommends that “parental report of normal urine output decreases the likelihood of dehydration” [15].

At the same time, NICE guidelines stated that “some reassurance could be taken if the urine output was said to be normal” [13] (see Table 1).

TABLE 1: Assessment and classification of dehydration.<sup>A</sup>

Parameter	No dehydration (< 5%)	Some dehydration (5– 9%) <sup>B</sup>	Severe dehydration (≥ 10%) <sup>B</sup>	Hypovolemic shock (>> 10%)	Comment
<b>Mental status and general condition</b>	Well, alert <sup>C</sup>	Restless, irritable	Lethargic or unconscious <sup>D</sup>	Lethargic or unconscious <sup>D</sup>	A well-appearing alert child <b>decreases</b> the likelihood of dehydration. (Sensitivity of abnormal general appearance = 0.80) <sup>E</sup>
<b>Eyes</b>	Normal <sup>C</sup>	Sunken eyes**	Sunken eyes**	Sunken eyes**	Normal eye (not sunken) <b>decreases</b> the likelihood of dehydration. (Sensitivity of sunken eyes = 0.75) <sup>E</sup>
<b>Skin pinch</b>	Goes back quickly	Goes back slowly <sup>F</sup>	Goes back very slowly (≥ 2 sec) <sup>F</sup>	Goes back very slowly (≥ 2 sec) <sup>F</sup>	Abnormal skin pinch alone <b>increases</b> the likelihood of ≥ 5% dehydration ( <b>not in the severely malnourished</b> child)
<b>Thirst</b>	Drinks normally, no excessive thirst	Thirsty, drinks eagerly	Drinks poorly or is unable to drink	Drinks poorly or is unable to drink	
<b>Hands/extremi</b>	– <sup>G</sup>	–	–	Cold ± pale and mottled	If hands are warm, the child probably does <b>not</b> have <b>hypovolemic</b> shock (distributive types of shock may cause warm hands).
<b>Breathing<sup>F</sup></b>	Acidotic breathing alone in the context of AGE increases the likelihood of >> 5% dehydration. <sup>H</sup>				
<b>Capillary refill time (CRT)</b>	–	–	–	Delayed > 3 sec <sup>F</sup>	A delayed CRT alone in the context of AGE <b>increases</b> the likelihood of >> 5% dehydration.

Parameter	No dehydration (< 5%)	Some dehydration (5– 9%) <sup>B</sup>	Severe dehydration (≥ 10%) <sup>B</sup>	Hypovolemic shock (>> 10%)	Comment
Pulse rate	–	–	–	Increased (decreased in most severe cases)	Poor discriminatory sign for dehydration as coexisting fever, pain, anxiety may also cause tachycardia. A normal pulse rate <b>decreases</b> the likelihood of <b>severe</b> dehydration.
Pulse volume	–	–	–	Weak	If the pulse is <b>strong and not fast</b> , the child is <b>not</b> in shock [11].
Mucous membranes	Moist (not after a drink) <sup>C</sup>	–	–	–	Moist tongue <b>decreases</b> the likelihood of ≥ 5% dehydration. (Sensitivity of dry mucous memb. = 0.86) <sup>E</sup>
Tears	Normal	–	Absent <sup>F</sup>	Absent	<b>Absent</b> tears alone increases the likelihood of ≥ 5% dehydration ( <b>not</b> in <b>severely</b> malnourished children). Normal tears <b>decreases</b> the likelihood of <b>severe</b> dehydration. (Sensitivity of absent tears = 0.63) <sup>E</sup>

<sup>A</sup>This table is a modification and expansion of the WHO classification of dehydration in children. The shaded cells represent the WHO classification of dehydration. Use these first to classify dehydration. If in doubt, supplement clinical judgment by using unshaded cells.

<sup>B</sup>Two or more signs classify children in this category.

<sup>C</sup>Any one negative (normal) sign makes ≥ 5% dehydration **unlikely**.

<sup>D</sup>Lethargy here means dull mental status, and the child cannot be fully awakened.

<sup>E</sup>Data from [23].

<sup>F</sup>Any one positive sign indicates a high likelihood of ≥ 5% dehydration.

<sup>G</sup>A dash (–) means the presence or absence of the sign is not very useful in detecting or classifying this category of dehydration.

<sup>H</sup>Acidotic = deep ± rapid breathing

\*\*\*“In some infants and children, the eyes normally appear somewhat sunken. It is helpful to ask the mother if the child’s eyes are normal or more sunken than usual.” [9]

### 3.1. Practice bottom line

- It is recommended to use the WHO guidelines for the assessment and classification of dehydration in a pediatric ED setting, particularly a resource-limited one.
- Hypovolemic shock represents a higher fluid deficit than severe dehydration.
  - Hypovolemic shock should be strongly considered if a child has features of severe dehydration and, in addition, has decreased level of consciousness, cold hands, prolonged capillary refill time, and weak and markedly fast pulses.
  - If the pulse is strong and not fast, the child is **not** in shock.
  - If in doubt, the child should be treated as if shock was present.

- In addition to the WHO classification of dehydration, the following general guides may provide clinical handles to supplement the assessment process and remove potential uncertainty.
  - The presence of any **one** of the following signs increases the likelihood of **at least** some ( $\geq 5\%$ ) dehydration (note that these signs do not indicate the degree of dehydration [some versus severe] when used individually).
    - \* Prolonged capillary refill time
    - \* Slow return of skin pinch (except in severe malnutrition)
    - \* Acidotic (deep  $\pm$  rapid) breathing
    - \* Absent tears (except in severe malnutrition)
  - A child with **any one** of the following signs is likely **not** dehydrated.
    - \* Well appearing and alert
    - \* Eyes not sunken
    - \* Moist mucus membranes (except after a drink)
  - A child with **any one** of the following signs is likely **not severely** dehydrated.
    - \* **Normal** tears
    - \* Normal pulse rate (bradycardia can occur in most severe cases of shock)
- The examination of anterior fontanel is not reliable in the assessment of dehydration.
- Parental reporting of normal urine output decreases the likelihood of  $\geq 5\%$  dehydration.

## 4. Conclusion

The WHO classification of dehydration in children with AGE seems simple yet practical. With a supplement of clinical handles from other international guidelines, as suggested in this article, a clinician may find himself better equipped for a more accurate and quicker clinical assessment in a busy hospital ED setting.

## Conflict of Interest

The author declares that there is no conflict of interest.



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