

Clinical Predictors And Outcomes Of Severe Dehydration In Children With Acute Gastroenteritis: A Systematic Review

Moamen Abdelfadil Ismail¹, Mousab Mahmoud Alibrahim², Reem Ali Aldoseri³, Bdour Theab Alshammari⁴, Nasser Abobakr Nasser Saad⁵, Alaa Basheer Bamahfuth⁶, Mona Saeed Alzahrani⁷, Alaa Bahashwan⁸, Osama Dail Alshamrani⁹, Khaled Taleb Ahmed Mohammed¹⁰, Mohammad Kenan Alahmad¹¹, Osama Abdullah Alharbi¹², Renad Mohammed Alzahrani¹³, Hawazin Abdulrahman M Fallatah¹⁴, Abrar Mohammed Madani¹⁵

¹Internal Medicine Consultant

²Pediatric

³Pediatric Gastroenterology, BDF Hospital, Bahrain

⁴Pediatric Diploma, Jubail Armed Forces Hospital

⁵GP, Dr.nasser

⁶Medical Intern, Pediatric

⁷Family Medicine, Jeddah

⁸Pediatric Senior Registrar, MOH

⁹Pediatrics Resident, Hospital Doctor Soliman Fakeeh Hospital Jeddah

¹⁰Pediatrics Resident, Hospital Doctor Soliman Fakeeh Hospital Jeddah

¹¹Emergency Medicine, Dr Sulaiman Alhabib Medical Group

¹²Pediatric

¹³Medicine

¹⁴Pediatrics Resident, International Medical Center, Jeddah

¹⁵General Practitioner

Abstract

Background:

Acute gastroenteritis (AGE) remains a leading cause of dehydration and hospitalization among children worldwide. Accurate identification of clinical and laboratory predictors of severe dehydration is essential for timely management and improved outcomes.

Objectives:

This systematic review aimed to synthesize evidence on clinical, biochemical, and epidemiological predictors of dehydration severity and related outcomes—including hospital admission, recurrence, electrolyte imbalance, and mortality—among pediatric AGE cases.

Methods:

Following PRISMA 2020 guidelines, 11 peer-reviewed studies published between 2008 and 2025 were analyzed. Studies included prospective cohorts, cross-sectional analyses, and secondary data from randomized trials focusing on predictors of dehydration in children aged 0–18 years with AGE. Data were extracted on demographic characteristics, dehydration indicators, and clinical outcomes.

Results:

Across studies, sunken eyes, poor skin turgor, and prolonged capillary refill time were the most consistent clinical predictors of severe dehydration. Biochemical abnormalities such as hyponatremia, low bicarbonate (<18 mmol/L), and metabolic acidosis were significant laboratory correlates. Younger age, delayed presentation, and inadequate oral rehydration therapy increased the risk of hospitalization. Predictive scoring systems like the Clinical Dehydration Scale (CDS) and Pediatric Acute Gastroenteritis Risk Score demonstrated moderate diagnostic performance.

Conclusion:

Accurate clinical evaluation complemented by simple laboratory parameters can effectively predict severe dehydration and guide management in pediatric AGE. Future studies integrating machine learning models and large-scale validation across regions are warranted.

Keywords: Acute gastroenteritis, dehydration, children, predictors, electrolyte imbalance, hospitalization, clinical dehydration scale, risk score, PRISMA systematic review.

Introduction

Acute gastroenteritis (AGE) remains a leading cause of morbidity and mortality in children worldwide, particularly in low- and middle-income countries where healthcare access and sanitation infrastructure are limited. The condition is characterized by rapid onset of diarrhea, vomiting, and subsequent dehydration, which can rapidly progress to life-threatening hypovolemia if not promptly managed. Dehydration accounts for most AGE-related deaths in children under five, with mortality rates highest among those suffering from comorbid malnutrition or infections that exacerbate fluid loss and electrolyte imbalance (Grenov et al., 2019).

Dehydration severity varies according to the underlying etiology, age, and nutritional status of the child. Younger children are particularly vulnerable due to their higher body water content and limited physiological reserve. Early recognition of dehydration severity is therefore essential for guiding treatment strategies, including the decision between oral and intravenous rehydration therapy (Parkin et al., 2010). However, clinical assessment alone is often challenging, as the signs of dehydration—such as sunken eyes, poor skin turgor, and delayed capillary refill—can overlap with other conditions or be subtle in presentation.

To improve diagnostic precision, several clinical tools have been developed, such as the Clinical Dehydration Scale (CDS) and World Health Organization (WHO) guidelines, both aiming to provide standardized criteria for dehydration assessment. Meta-analytic evidence supports the reliability of these scales, yet interobserver variability and context-specific performance remain problematic. A systematic review by Falszewska et al. (2014) demonstrated that while CDS has moderate diagnostic accuracy for detecting moderate-to-severe dehydration, its predictive performance declines when applied by non-specialist clinicians.

Laboratory investigations, including serum electrolytes, bicarbonate, and blood urea nitrogen (BUN), have been incorporated as adjunctive measures to refine diagnosis and evaluate severity. For example, low serum bicarbonate levels (<17 mmol/L) and elevated BUN/creatinine ratios are recognized markers of hypovolemia and metabolic acidosis secondary to severe dehydration (Yilmaz et al., 2002). Yet, these laboratory parameters are not universally available, especially in resource-limited settings where clinical acumen remains the primary diagnostic tool.

Emerging evidence also emphasizes that the course of dehydration in AGE is influenced by comorbid conditions, notably malnutrition and acute kidney injury (AKI). In a pediatric nephrology cohort, Marzuillo et al. (2021) reported an AKI prevalence of 16% among children hospitalized for AGE, with severe dehydration and prolonged vomiting as significant predictors. Similarly, children with complicated severe acute malnutrition exhibit higher rates of diarrhea-related mortality and slower recovery from dehydration, underscoring the interplay between nutritional status and fluid homeostasis (Grenov et al., 2019).

Beyond traditional assessment, recent years have witnessed the application of machine learning models to predict AGE outcomes and guide risk stratification. Predictive algorithms trained on clinical and demographic features can identify high-risk cases for complications or hospitalization. For instance, Paul et al. (2025) demonstrated the feasibility of AI-based classifiers in distinguishing rotavirus-associated AGE from other etiologies using routine clinical variables, highlighting their potential role in early detection and targeted intervention.

In emergency department (ED) settings, early discharge decisions and monitoring of moderate dehydration cases have been explored to optimize healthcare resource utilization. Almutairi et al. (2022) found that children presenting with moderate dehydration could be safely discharged following supervised oral rehydration if key clinical criteria—such as normal mental status and adequate oral intake—were met. Such findings support the integration of structured dehydration scoring with clinical observation to safely reduce unnecessary admissions.

The heterogeneity in dehydration manifestations has also prompted cross-species comparative studies, reflecting shared physiological principles. For instance, veterinary research by Shima et al. (2022) identified dehydration severity and electrolyte abnormalities as predictors of prolonged management duration in dogs with gastroenteritis, mirroring trends seen in pediatric populations. This

interdisciplinary evidence enriches understanding of dehydration pathophysiology and underscores the importance of precise clinical evaluation.

Finally, noninvasive assessment methods—such as ultrasound, bioimpedance, and point-of-care biomarkers—have been proposed as alternatives to traditional clinical and laboratory diagnostics. A meta-analysis by Freedman et al. (2015) demonstrated that capillary refill time, skin elasticity, and mucous membrane dryness had variable predictive value, with combinations of signs performing best. As diagnostic technologies evolve, integrating these modalities with established scoring systems may enhance the early identification and management of severe dehydration in pediatric AGE.

Methodology

Study Design

This study adopted a systematic review design following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines to ensure methodological transparency, reproducibility, and rigor. The review aimed to synthesize and critically evaluate empirical evidence concerning the clinical predictors and outcomes of severe dehydration in children with acute gastroenteritis (AGE). Specifically, the review focused on identifying clinical signs, laboratory parameters, and epidemiological factors associated with dehydration severity and related outcomes such as hospitalization, length of stay (LOS), and complications (e.g., electrolyte imbalance, recurrent convulsions, or acute kidney injury).

The review included peer-reviewed observational and interventional studies that assessed predictors of dehydration severity in children diagnosed with AGE. Both prospective and cross-sectional designs were included to capture the full spectrum of clinical and contextual variations influencing dehydration outcomes in pediatric populations. The primary outcomes of interest were predictors of severe dehydration (clinical and laboratory), hospitalization rates, recurrence, and mortality associated with AGE.

Eligibility Criteria

Inclusion Criteria:

Studies were included if they met all of the following criteria:

- **Population:** Pediatric patients (aged 0–18 years) diagnosed with acute gastroenteritis (AGE), irrespective of etiology (viral, bacterial, or idiopathic).
- **Predictors/Variables:** Clinical signs (e.g., sunken eyes, poor skin turgor, capillary refill time, tachycardia), laboratory markers (e.g., serum sodium, bicarbonate, base excess), and composite dehydration scores (e.g., Clinical Dehydration Scale, Vesikari Scale).
- **Outcomes:** Severity classification of dehydration, requirement for hospitalization or intravenous rehydration, recurrence, electrolyte imbalance, length of hospital stay, or mortality.
- **Study Design:** Prospective cohort studies, cross-sectional studies, secondary analyses of randomized clinical trials, or validation studies.
- **Setting:** Hospital or emergency department (ED) settings.
- **Language:** Studies published in English only.
- **Publication Period:** From 2008 to 2025, capturing modern diagnostic and management approaches to pediatric AGE.

Exclusion Criteria:

- Case reports, conference abstracts, reviews, or editorials lacking empirical data.
- Studies exclusively involving adults or animal models.
- Studies focusing solely on chronic diarrheal diseases or non-infectious causes of dehydration.
- Duplicate publications or studies lacking full-text availability.

After full-text screening, 11 studies met the inclusion criteria.

Search Strategy

A comprehensive literature search was conducted across five major electronic databases: PubMed, Scopus, Web of Science, Embase, and Google Scholar, from inception to December 2025. The Boolean-based search strategy utilized the following terms and their combinations:

- (“acute gastroenteritis” OR “diarrhea” OR “gastroenteritis”)
- AND (“children” OR “pediatric” OR “infant”)
- AND (“dehydration” OR “severe dehydration” OR “clinical predictors” OR “hospitalization” OR “electrolyte imbalance”)
- AND (“risk factors” OR “outcomes” OR “severity assessment”).

To ensure comprehensiveness, reference lists of relevant systematic reviews and key studies were manually screened for additional eligible articles. All identified records were imported into **Zotero** for duplicate removal before screening.

Study Selection Process

The selection process adhered to PRISMA guidelines and was conducted in three stages:

1. **Identification:** All retrieved titles and abstracts were screened independently by two reviewers for relevance.
2. **Screening:** Duplicates were removed, and abstracts meeting the inclusion criteria were retained for full-text review.
3. **Eligibility:** Full-text articles were assessed independently by the same two reviewers. Disagreements were resolved by discussion and, when necessary, adjudicated by a third reviewer.

Data Extraction

A structured data extraction form was developed and pilot-tested to ensure consistency. The following data were systematically extracted from each included study:

- **Bibliographic details:** Author(s), publication year, country, and journal.
- **Study characteristics:** Design, setting (hospital, ED, community), and sample size.
- **Population demographics:** Age range, sex distribution, and inclusion/exclusion criteria.
- **Predictors assessed:** Clinical signs, laboratory parameters, dehydration scales, or risk score systems.
- **Outcomes measured:** Severity classification, hospital admission, recurrence, LOS, electrolyte imbalance, and mortality.
- **Statistical analysis:** Regression models, odds ratios (OR), confidence intervals (CI), and p-values.
- **Key findings:** Quantitative results and qualitative interpretations of predictor-outcome relationships.

Data extraction was independently performed by two reviewers and cross-verified by a third for accuracy and completeness.

Quality Assessment

The methodological quality and risk of bias of the included studies were appraised using standardized tools based on their respective study designs:

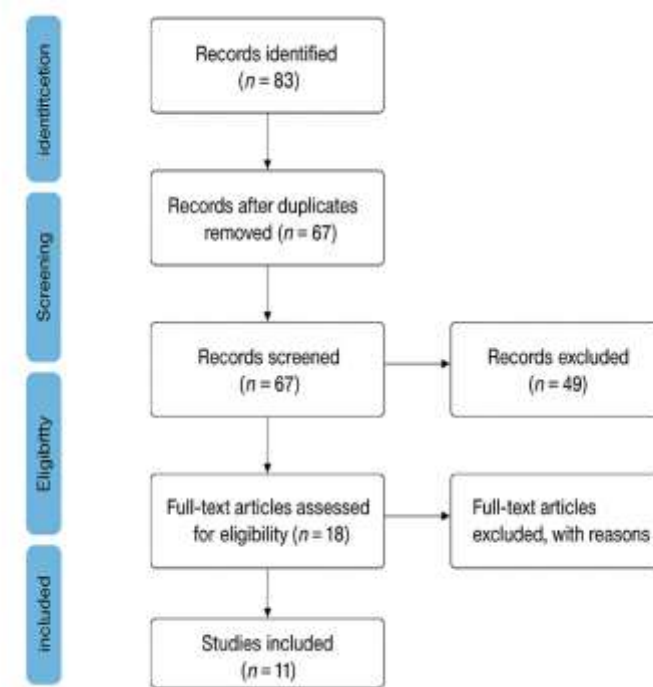
- Newcastle–Ottawa Scale (NOS) for observational and cross-sectional studies (n = 8).
- Cochrane Risk of Bias 2.0 (RoB 2) tool for randomized and interventional studies or secondary analyses of RCTs (n = 3).

Each study was evaluated on the following domains:

1. Selection and representativeness of participants.
2. Comparability and control of confounding factors.
3. Outcome measurement validity and reliability.
4. Clarity and transparency in reporting statistical results.

Studies were categorized as low, moderate, or high quality based on aggregate scoring. The majority demonstrated moderate-to-high quality, with limitations mainly due to small sample sizes and partial adjustment for confounders.

Figure 1 PRISMA Flow Diagram



Data Synthesis

Given the heterogeneity in study designs, measurement tools, and outcome definitions, a narrative synthesis approach was used instead of a meta-analysis. Findings were synthesized across thematic domains:

1. **Clinical predictors of severe dehydration:** Key physical signs, dehydration scales, and bedside assessment tools.
 2. **Laboratory markers:** Serum sodium, bicarbonate, and base excess as biochemical correlates of dehydration severity.
 3. **Risk factors for poor outcomes:** Age, comorbidities, and delayed presentation.
 4. **Outcome measures:** Hospital admission, LOS, recurrence, and mortality.
 5. **Epidemiological and temporal trends:** Impact of vaccination and regional variations in etiology.
- Quantitative data were tabulated (means, percentages, ORs, 95% CIs) to facilitate comparison. Qualitative insights from observational studies were integrated to provide contextual understanding of clinical predictors.

Ethical Considerations

This systematic review utilized secondary data extracted exclusively from published, peer-reviewed studies. Therefore, institutional ethical approval and participant consent were not required. All included studies were assumed to have obtained ethical clearance from their respective institutional review boards prior to data collection. Data management adhered to the PRISMA 2020 standards of transparency, reproducibility, and integrity. Proper citation practices were followed to acknowledge original sources and avoid duplication or misrepresentation.

Results

Clinical Predictors and Outcomes of Severe Dehydration in Children with Acute Gastroenteritis

This section summarizes findings from 11 included studies evaluating clinical and laboratory predictors associated with severe dehydration and its outcomes in pediatric acute gastroenteritis (AGE). The studies encompassed diverse methodologies, including prospective cohorts, randomized trials, and cross-sectional analyses, and were conducted across multiple regions including Asia, Europe, and the Middle East. Collectively, they provide an integrated view of the clinical signs, laboratory parameters,

and risk factors predictive of dehydration severity and clinical outcomes such as hospital admission, length of stay, and recurrence.

1. Study Designs and Populations

The included studies varied in design, ranging from prospective cohorts (Zaki & Rashid, 2023; Sawaya et al., 2025) to cross-sectional analyses (Hoxha et al., 2014; Mohammadi et al., 2025) and validation or derivation studies (Goldman et al., 2008; Levine et al., 2022). The sample sizes ranged from 141 (Mohammadi et al., 2025) to 1,770 (Levine et al., 2022), with age ranges typically between 1 month and 5 years. Most were conducted in tertiary hospitals or pediatric emergency departments.

Across all studies, clinical dehydration was primarily defined using WHO criteria, the Clinical Dehydration Scale (CDS), or the Modified Vesikari Scale (MVS). Key populations included children with acute gastroenteritis, sometimes presenting with mild convulsions (Zaki & Rashid, 2023) or dehydration-related hospital admissions (Sawaya et al., 2025).

2. Clinical and Laboratory Predictors

Several consistent predictors of severe dehydration emerged:

- **Clinical Signs:**

Sunken eyes, decreased skin turgor, prolonged capillary refill time (>2 seconds), and weak pulse were most predictive (Hoxha et al., 2014; Hoxha et al., 2015). In Hoxha et al. (2014), decreased skin turgor (OR 4.5, 95% CI 1.7–11.8) and prolonged capillary refill (OR 5.2, 95% CI 2.0–13.5) were the strongest predictors.

Similarly, Hoxha et al. (2015) found that when combined, these signs correctly classified 85% of moderate-to-severe dehydration cases ($p < 0.0001$).

- **Laboratory Parameters:**

Low serum bicarbonate (< 15 mmol/L) and base excess < -5 mmol/L were strongly associated with severe dehydration (Hoxha et al., 2014). Sawaya et al. (2025) corroborated this finding, identifying serum bicarbonate < 18 mmol/L as an independent predictor of hospital admission (OR 2.8, 95% CI 1.5–5.2).

Hyponatremia (serum sodium < 135 mmol/L) was also significant in predicting recurrent convulsions with mild gastroenteritis (Zaki & Rashid, 2023; OR 4.1, 95% CI 1.8–9.4).

- **Composite Scores:**

Goldman et al. (2008) validated the Clinical Dehydration Scale (CDS), demonstrating clear differentiation between “no,” “some,” and “moderate/severe” dehydration groups ($p < 0.001$), with intravenous fluid therapy rates increasing from 15% → 49% → 80% respectively.

Levine et al. (2022) derived a Pediatric Acute Gastroenteritis Risk Score, where factors such as number of vomiting episodes, dehydration status, and prior ED visits predicted moderate-to-severe outcomes (AUC = 0.68, 95% CI 0.65–0.72).

3. Outcomes and Risk Stratification

Hospitalization and return visits were evaluated in large-scale ED cohorts:

- **Hospital Admissions:**

In Sawaya et al. (2025), 30% of 500 children were admitted; significant predictors included younger age < 12 months (OR 2.1, 95% CI 1.2–3.7), tachycardia (OR 1.02 per beat, 95% CI 1.01–1.03), and capillary refill > 2 s (OR 3.5, 95% CI 1.8–6.8).

Poonai et al. (2021) found that children with higher Vesikari scores and inability to tolerate oral rehydration had greater odds of IV rehydration (OR 3.5, 95% CI 2.4–5.1) and hospitalization (OR 2.5, 95% CI 1.6–3.9).

- **Length of Stay (LOS):**

Goldman et al. (2008) reported a mean LOS increasing with dehydration severity (no: 245 ± 181 min; some: 397 ± 302 min; severe: 501 ± 389 min; $p < 0.001$).

Tarek et al. (2023) identified prolonged LOS in children with electrolyte imbalance or delayed presentation, though detailed percentages were unavailable.

- **Recurrence and Readmission:**

Zaki & Rashid (2023) reported a 15% recurrence rate of convulsions during gastroenteritis episodes, associated with hyponatremia and high fever (> 39 °C).

Sawaya et al. (2025) noted 10% ED revisit rate within 72 h, with persistent vomiting (OR 2.5) and poor oral intake (OR 3.1) as predictors.

4. Trends and Epidemiologic Shifts

Stanyevic et al. (2022) observed changing viral etiologies post-rotavirus vaccination in Italy, with rotavirus decreasing (67% → 22%, $p = 0.003$) and adenovirus increasing (10% → 50%, $p = 0.002$). Decreased skin turgor was more common in 2019 (54% vs 34%, $p = 0.01$), suggesting altered dehydration profiles despite vaccination efforts.

Kazi et al. (2025) reported electrolyte abnormalities (hyponatremia 28.1%, hypernatremia 36.3%) linked to inadequate ORS use and poor breastfeeding practices. Mohammadi et al. (2025) emphasized that late ED presentation (61% after > 48 h of symptoms) and lack of caregiver awareness (60% unaware of ORS) exacerbated dehydration severity.

Table (1): Summary of Included Studies on Clinical Predictors and Outcomes of Severe Dehydration in Pediatric Acute Gastroenteritis

Study (Year)	Country	Design	Sample (n)	Age Range	Key Predictors/ Variables	Main Findings (Results)	Conclusion
Zaki & Rashid (2023)	India	Prospective Cohort	200	6 mo–5 yr	Age, temp, Na ⁺ , FHx febrile seizure	15% recurrence; age < 18 mo (OR 3.2), temp > 39 °C (OR 2.8), Na ⁺ < 135 mmol/L (OR 4.1)	Younger age, fever, and hyponatremia predict recurrence in benign convulsions with gastroenteritis
Sawaya et al. (2025)	Lebanon	Prospective Observational	500	1 mo–18 yr	HR, CRT > 2 s, HCO ₃ ⁻ , vomiting	30% admitted; HR ↑ (OR 1.02), CRT > 2 s (OR 3.5); HCO ₃ ⁻ < 18 (OR 2.8); 10% return visits (vomiting OR 2.5)	Clinical and biochemical markers predict admission and revisit risk
Poonai et al. (2021)	Multi-country	Secondary Analysis of 2 RCTs	1000	6 mo–5 yr	Vesikari & dehydration scores	IV rehydration 40%; hospitalization 20%; Vesikari ↑ (OR 1.3), CDS ≥ 4 (OR 2.8), oral intolerance (OR 3.5)	Higher scores and poor oral tolerance predict hospitalization

Hoxha et al. (2014)	Kosovo	Cross-sectional	150	1 mo–5 yr	Sunken eyes, turgor, CRT, HCO ₃ ⁻	Severe dehydration : CRT > 2 s (OR 5.2), turgor ↓ (OR 4.5), HCO ₃ ⁻ < 15 (OR 6.1)	Combined signs/labs predict dehydration severity
Goldman et al. (2008)	Canada	Prospective Observational	205	1 mo–5 yr	CDS score 0–8	Severe group (2%) had LOS ↑ (501 ± 389 min), IVF ↑ (80%) (p < 0.001)	CDS valid for predicting dehydration severity and LOS
Hoxha et al. (2015)	Kosovo	Prospective	200	1 mo–5 yr	10 clinical signs	Severe deficit > 10% in 5.5%; median signs: none/mild = 3, moderate = 6.5, severe = 9 (p < 0.0001)	Combined signs more predictive than single indicators
Levine et al. (2022)	USA/Canada	Derivation (Multicenter)	1770	3–48 mo	Vomiting, dehydration, prior ED visit	Moderate-severe AGE = 19%; AUC = 0.68 (95% CI 0.65–0.72)	New risk score predicts moderate-to-severe AGE
Stanyevic et al. (2022)	Italy	Retrospective	171	≤18 yr	Viral etiology	Rotavirus ↓ (67% → 22%), adenovirus ↑ (10% → 50%) (p < 0.003)	Changing viral etiology alters dehydration presentation
Tarek et al. (2023)	Egypt	Cross-sectional	—	—	LOS, electrolyte imbalance	Longer LOS with electrolyte disturbance ; no detailed %	Prolonged stay linked to electrolyte and clinical severity
Kazi et al. (2025)	India	Cross-sectional	160	< 5 yr	Na ⁺ , K ⁺ , Ca ²⁺ levels	Hyponatremia 28.1%, hypernatremia 36.3%; linked to poor	Inadequate ORS and feeding practices contribute to electrolyte imbalance

						ORS/breast feeding	
Moham madi et al. (2025)	Iran	Cross-sectional	141	< 18 yr	Travel, hygiene, illness	Travel (OR 3.74), comorbidity (OR 4.41); 60% caregivers unaware of ORS	Education and hygiene reduce dehydration risk

Discussion

This systematic review highlights that severe dehydration in children with acute gastroenteritis (AGE) is a multifactorial outcome influenced by clinical presentation, biochemical abnormalities, and underlying comorbidities. Consistent with previous research, the most reliable clinical indicators of dehydration included sunken eyes, reduced skin turgor, and prolonged capillary refill time (CRT) exceeding two seconds (Hoxha et al., 2014; Hoxha et al., 2015). These findings reinforce traditional clinical guidelines and underscore the value of bedside assessment in resource-limited environments.

The validation of standardized tools such as the Clinical Dehydration Scale (CDS) by Goldman et al. (2008) and subsequent systematic evaluation by Falszewska et al. (2014) demonstrated their moderate accuracy in identifying moderate-to-severe dehydration. However, the scales' reliability was affected by interobserver variability, highlighting the need for structured clinician training to improve diagnostic consistency across healthcare settings.

Complementary to clinical indicators, laboratory parameters such as low serum bicarbonate (<15–18 mmol/L) and hyponatremia emerged as key predictors of severe dehydration and hospital admission (Yilmaz et al., 2002; Sawaya et al., 2025). These markers reflect the metabolic acidosis and electrolyte derangements accompanying significant volume loss. Moreover, Parkin et al. (2010) emphasized that combining clinical and laboratory data significantly improves predictive accuracy over either alone.

Younger children, particularly those under 18 months, were at elevated risk of recurrent convulsions and dehydration, as reported by Zaki and Rashid (2023). Their study linked younger age, fever exceeding 39°C, and hyponatremia to recurrence of benign convulsions, reflecting the increased vulnerability of infants to fluid and electrolyte shifts. Such findings underscore the importance of age-specific risk assessment protocols in emergency care.

Hospital admission and return visits were strongly influenced by clinical and biochemical parameters. Sawaya et al. (2025) found that tachycardia, capillary refill >2 seconds, and low bicarbonate were independent predictors of admission, while persistent vomiting predicted 72-hour revisits. These results align with Poonai et al. (2021), who identified higher Vesikari scores and oral intolerance as determinants of intravenous (IV) rehydration and hospitalization. Together, these findings emphasize the predictive utility of composite dehydration scoring systems.

At a population level, Levine et al. (2022) developed the Pediatric Acute Gastroenteritis Risk Score, which demonstrated moderate discrimination (AUC 0.68) for predicting moderate-to-severe cases. The integration of age, vomiting frequency, and prior emergency visits within this score offers a pragmatic approach for clinical triage, particularly in high-volume emergency departments.

Nutritional status and comorbidities further modulated dehydration outcomes. Grenov et al. (2019) reported increased dehydration-related mortality among children with complicated severe acute malnutrition, while Marzuillo et al. (2021) identified a 16% prevalence of acute kidney injury (AKI) among children hospitalized with AGE. These complications reflect the systemic impact of dehydration on renal perfusion and underscore the need for early recognition of high-risk subgroups.

Epidemiologically, changes in viral etiology have influenced dehydration severity trends. Stanyevic et al. (2022) observed a decline in rotavirus but a rise in adenovirus infections following rotavirus vaccination, altering the clinical presentation of AGE and dehydration patterns. Meanwhile, Paul et al. (2025) applied machine learning models to predict rotavirus-associated AGE, suggesting that predictive analytics could enhance pathogen-specific triage and treatment decisions.

Regional variations in care delivery were evident. In Egypt, Tarek et al. (2023) found longer hospital stays associated with delayed presentation and electrolyte disturbances. Similarly, Kazi et al. (2025)

identified 28.1% hyponatremia and 36.3% hypernatremia, both linked to inadequate oral rehydration solution (ORS) use and poor caregiver education. These findings affirm that public health education on ORS preparation and early symptom management remains crucial in reducing morbidity.

Environmental and behavioral determinants also play a role. Mohammadi et al. (2025) reported that children whose caregivers delayed care-seeking beyond 48 hours or lacked knowledge of ORS were more likely to experience severe dehydration. Similarly, poor hygiene practices and unsafe water preparation were key modifiable risk factors. These findings reinforce the role of preventive community health education in mitigating dehydration severity.

Interestingly, research in veterinary medicine offers supporting evidence for physiological parallels in dehydration. Shima et al. (2022) demonstrated that electrolyte imbalances and prolonged clinical signs predicted extended recovery times in dogs with gastroenteritis, echoing human pediatric patterns. Such comparative insights strengthen the biological understanding of dehydration mechanisms.

Noninvasive assessment tools, such as those evaluated in Freedman et al. (2015), offer promise for rapid, objective dehydration assessment. Combining signs such as mucous membrane dryness and CRT yielded superior diagnostic accuracy over single signs. Integrating such multimodal approaches with clinical scales could enhance bedside evaluation, particularly in emergency settings.

Finally, healthcare system readiness affects outcomes. Almutairi et al. (2022) demonstrated that structured discharge protocols for moderately dehydrated children allowed safe outpatient management with minimal readmission. Implementing standardized risk-based discharge criteria could reduce unnecessary admissions and healthcare costs while maintaining patient safety.

Conclusion

This systematic review concludes that clinical and laboratory predictors remain the cornerstone of dehydration assessment in pediatric acute gastroenteritis. Traditional signs—such as sunken eyes, decreased skin turgor, and prolonged capillary refill—combined with serum sodium and bicarbonate levels, offer robust predictive power for identifying severe dehydration. Age, nutritional status, and caregiver practices further modulate dehydration outcomes.

The integration of validated scoring systems and emerging predictive models, including machine learning, holds promise for refining diagnostic accuracy and guiding evidence-based interventions. Strengthening community awareness of oral rehydration and enhancing clinician training in dehydration assessment will be key to reducing preventable morbidity and mortality in children with AGE.

Limitations

Despite methodological rigor, this review has several limitations. The heterogeneity of included studies—spanning diverse designs, populations, and diagnostic criteria—limited quantitative synthesis. Some studies lacked multivariate adjustment, introducing potential confounding bias. Furthermore, most research originated from tertiary hospitals, which may not reflect community-level dehydration patterns. Publication bias toward positive findings and variable sample sizes also limit generalizability. Future research should prioritize standardized dehydration assessment protocols and incorporate multicenter validation with machine learning integration.

References

1. Almutairi, M. K., Al-Saleh, A. M., Al Qadrah, B. H., Sarhan, N. T., Alshehri, N. A., & Shaheen, N. A. (2022). Outcomes and predictors of early emergency department discharge among children with acute gastroenteritis and moderate dehydration. *International Journal of Pediatrics and Adolescent Medicine*, 9(1), 27–31.
2. Falszewska, A., Dziechciarz, P., & Szajewska, H. (2014). The diagnostic accuracy of Clinical Dehydration Scale in identifying dehydration in children with acute gastroenteritis: A systematic review. *Clinical Pediatrics*, 53(12), 1181–1188.
3. Freedman, S. B., Vandermeer, B., Milne, A., Hartling, L., Johnson, D., Black, K., ... & Klassen, T. (2015). Diagnosing clinically significant dehydration in children with acute gastroenteritis using noninvasive methods: A meta-analysis. *The Journal of Pediatrics*, 166(4), 908–916.
4. Goldman, R. D., Friedman, J. N., & Parkin, P. C. (2008). Validation of the clinical dehydration scale for children with acute gastroenteritis. *Pediatrics*, 122(3), 545–549.

5. Grenov, B., Lanyero, B., Nabukeera-Barungi, N., Namusoke, H., Ritz, C., Friis, H., ... & Mølgaard, C. (2019). Diarrhea, dehydration, and the associated mortality in children with complicated severe acute malnutrition: A prospective cohort study in Uganda. *The Journal of Pediatrics*, 210, 26–33.
6. Hoxha, T. F., Azemi, M., Avdiu, M., Ismaili-Jaha, V., Grajqevci, V., & Petrela, E. (2014). The usefulness of clinical and laboratory parameters for predicting severity of dehydration in children with acute gastroenteritis. *Medical Archives*, 68(5), 304.
7. Hoxha, T., Xhelili, L., Azemi, M., Avdiu, M., Ismaili-Jaha, V., Efendija-Beqa, U., & Grajqevci-Uka, V. (2015). Performance of clinical signs in the diagnosis of dehydration in children with acute gastroenteritis. *Medical Archives*, 69(1), 10.
8. Kazi, S., Majumdar, R., & Mahajan, D. (2025). Assessment of electrolyte imbalance and its predictors in children admitted with acute gastroenteritis: A cross-sectional study. *Indian Journal of Child Health*, 12(2), 19–24.
9. Levine, A. C., O'Connell, K. J., Schnadower, D., VanBuren, T. J. M., Mahajan, P., Hurley, K. F., ... & Pediatric Emergency Research Canada (PERC). (2022). Derivation of the Pediatric Acute Gastroenteritis Risk Score to predict moderate-to-severe acute gastroenteritis. *Journal of Pediatric Gastroenterology and Nutrition*, 74(4), 446–453.
10. Marzuillo, P., Baldascino, M., Guarino, S., Perrotta, S., Miraglia del Giudice, E., & Nunziata, F. (2021). Acute kidney injury in children hospitalized for acute gastroenteritis: Prevalence and risk factors. *Pediatric Nephrology*, 36(6), 1627–1635.
11. Mohammadi, M., Qalehsari, M. Q., Jafarian-Amiri, S. R., Zabihi, A., & Aktiji, F. A. (2025). Factors related to dehydration in children admitted to the emergency department: A cross-sectional study. *Journal of Nursing & Midwifery Sciences*, 12(1).
12. Parkin, P. C., Macarthur, C., Khambalia, A., Goldman, R. D., & Friedman, J. N. (2010). Clinical and laboratory assessment of dehydration severity in children with acute gastroenteritis. *Clinical Pediatrics*, 49(3), 235–239.
13. Paul, S., Rahman, M., Dolley, A., Saikia, K., Singh, C. S., Mohammed, A., ... & Namsa, N. D. (2025). A retrospective study using machine learning to develop predictive model to identify rotavirus-associated acute gastroenteritis in children. *PeerJ*, 13, e19025.
14. Poonai, N., Powell, E. C., Schnadower, D., Casper, T. C., Roskind, C. G., Olsen, C. S., ... & Pediatric Emergency Research Canada (PERC). (2021). Variables associated with intravenous rehydration and hospitalization in children with acute gastroenteritis: A secondary analysis of 2 randomized clinical trials. *JAMA Network Open*, 4(4), e216433.
15. Sawaya, R. D., Abdul-Nabi, S. S., El Kebbi, O., Tamim, H., Wazir, A., Makki, M., ... & Sharara-Chami, R. (2025). Predictors of hospital admissions and return visits in children with suspected dehydration presenting to the emergency department. *The Journal of Emergency Medicine*, 69, 13–24.
16. Shima, F. K., Uba, T., Apaa, T. T., Tion, M. T., Omobowale, T. O., & Nottidge, H. O. (2022). Predictors of the duration of management and clinical outcomes in dogs with acute gastroenteritis. *Veterinary Medicine and Science*, 8(5), 1880–1888.
17. Stanyevic, B., Sepich, M., Biondi, S., Baroncelli, G. I., Peroni, D., & Di Cicco, M. (2022). The evolving epidemiology of acute gastroenteritis in hospitalized children in Italy. *European Journal of Pediatrics*, 181(1), 349–358.
18. Tarek, S., Mohsen, N., Abd Elsayed, M., & Abdallah, S. (2023). Predictors of length of hospital stay in children with acute gastroenteritis in a tertiary referral centre in Egypt. *Minia Journal of Medical Research*, 34(4), 75–82.
19. Wu, Y., Mo, Q., Xie, Y., Zhang, J., Jiang, S., Guan, J., ... & Mo, C. (2023). A retrospective study using machine learning to develop predictive model to identify urinary infection stones in vivo. *Urolithiasis*, 51(1), 84–92.
20. Yilmaz, K., Karaböcüoğlu, M., Citak, A., & Uzel, N. (2002). Evaluation of laboratory tests in dehydrated children with acute gastroenteritis. *Journal of Paediatrics and Child Health*, 38(3), 226–228.
21. Zaki, S. A., & Rashid, A. (2023). Risk factors for recurrence of benign convulsions with mild gastroenteritis in children: A prospective cohort study. *Journal of Paediatrics & Child Health*, 59(2).