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REVIEW ARTICLE

Comparative effectiveness of oral rehydration therapy versus intravenous therapy in pediatric gastroenteritis: a systematic review

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ABSTRACT

Pediatric gastroenteritis, characterized by acute diarrheal illness, poses a significant global health challenge due to its potential to cause severe dehydration and electrolyte imbalance, especially in children under 5 years old. Effective management of dehydration is crucial, yet there is ongoing debate regarding the comparative effectiveness of oral rehydration therapy (ORT) versus intravenous (IV) therapy. This systematic review aimed to critically analyze and compare the effectiveness, safety, and clinical outcomes of ORT and IV therapy in the management of pediatric gastroenteritis. A comprehensive literature search was conducted across PubMed, Cochrane, ResearchGate, Cureus, and ScienceDirect databases, covering the period from the year 2004 to 2024. Studies were selected based on predefined inclusion and exclusion criteria. From an initial pool of 1,287 studies, 25 met the inclusion criteria and were included in this systematic review. The findings suggested that ORT was highly effective in managing mild to moderate dehydration in pediatric gastroenteritis, often reducing the need for hospitalization and associated costs. ORT with hypo-osmolar solutions was found to be superior in rehydration efficacy as compared to IV therapy in many cases. However, IV therapy was preferred in cases of severe dehydration or when ORT was contraindicated or failed. Balanced IV solutions, such as lactated Ringer's, showed better outcomes in terms of plasma bicarbonate levels and reduced risk of hypokalemia as compared to normal saline. The findings highlighted the need for widespread implementation of ORT protocols in clinical practice and suggested further research to refine treatment guidelines, particularly for severe dehydration scenarios.

Keywords: Acute gastroenteritis, oral rehydration therapy, intravenous fluid therapy, pediatric dehydration, systematic review, clinical outcomes.

Introduction

Acute gastroenteritis manifests as a sudden onset of diarrheal illness accompanied by symptoms such as nausea, vomiting, fever, and abdominal pain. It represents an infectious and inflammatory condition affecting the mucous membranes of the gastrointestinal tract, encompassing the stomach and intestines [1,2]. This condition poses a significant global health burden, particularly among pediatric patients under 5 years old, primarily due to rapid dehydration and electrolyte loss secondary to severe diarrhea. Rotavirus gastroenteritis stands out as a leading cause of severe acute gastroenteritis in children worldwide, contributing to high rates of hospitalization and mortality in this age group [2].

Globally, acute gastroenteritis resulted in 2 billion cases and 1.3 million deaths in 2015 alone, underscoring its substantial impact [2]. In the United States, it accounts for approximately 1.5 million office visits, 200,000 hospitalizations, and 300 deaths annually among children

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[1]. Effective management of acute gastroenteritis involves a thorough assessment of fluid status, emphasizing the importance of monitoring fluid intake and output to gauge dehydration levels accurately [1].

The etiology of gastroenteritis is diverse, involving viral, bacterial, parasitic, chemical, and drug-related causes. Infectious gastroenteritis typically results from ingestion of contaminated food or water, with common pathogens including *Escherichia coli*, *Campylobacter*, *Cryptosporidium*, *Giardia*, *Salmonella*, *Shigella*, and various viruses [3]. Clinical presentations vary depending on the causative agent; for instance, toxin-mediated infections like *Staphylococcus aureus* can induce rapid-onset nausea and vomiting within hours of ingestion, while enterotoxin-producing bacteria such as *Clostridium perfringens* and *Bacillus cereus* lead to watery diarrhea within hours to days [2].

Management strategies for pediatric acute gastroenteritis encompass oral rehydration therapy (ORT), diet modification, zinc supplementation, and adjunctive therapies like probiotics [4]. ORT, utilizing oral rehydration solution, leverages glucose/sodium co-transport mechanisms in the small intestine and is generally preferred due to its safety and efficacy across dehydration severities, except in cases of shock [5]. Intravenous (IV) rehydration is reserved for infants under 6 months old, patients with underlying chronic conditions, or those presenting with specific clinical indicators such as persistent vomiting, bloody diarrhea, altered mental status, sunken eyes, or decreased urine output [4].

Leung and Hon [6] conducted a comprehensive narrative review in Canada in 2021, focusing on the evaluation and management of viral gastroenteritis in children. They highlighted that while acute viral gastroenteritis typically resolves spontaneously, it can lead to dehydration and electrolyte imbalances if not managed effectively. The importance of providing adequate fluid replacement with solutions containing glucose and electrolytes was emphasized to compensate for gastrointestinal losses and meet maintenance needs. Their review confirmed that ORT is as effective as IV fluid therapy for children with mild-to-moderate dehydration. It was also discussed that the judicious use of ondansetron enhances the success of ORT, potentially reducing the need for IV therapy and hospitalization [6].

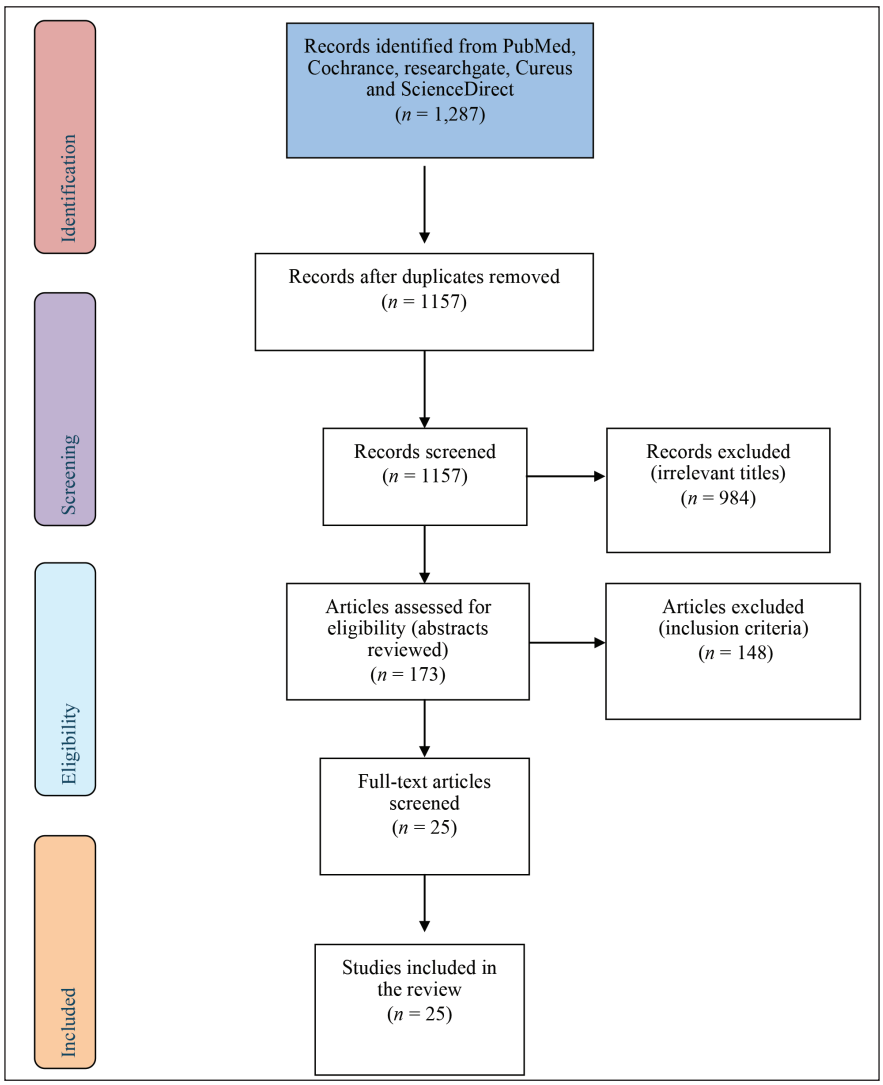

Figure 1. *PRISMA flowchart of this systematic review.*

In Iran, Aghsaeifard et al. [7] conducted a study in 2022 emphasizing that ORT is the preferred initial treatment for fluid loss due to diarrhea and vomiting in gastroenteritis patients. Despite its recognized benefits, the study highlighted challenges in the widespread adoption of ORT, particularly in developing countries. They recommended standardized guidelines to optimize the use of ORT in healthcare settings, underscoring the importance of education and implementation strategies [7].

Hom and Sinert [8] conducted a systematic review in the United States comparing the efficacy of ORT versus IV therapy in managing dehydration from gastroenteritis in children. Their meta-analysis included 17 trials with a total of 1,811 participants, where 56% were randomized to ORT. A statistical advantage was found favoring IV therapy for hydration and maintenance, with a risk difference of 4% (95% CI 1%-7%) and a number needed to treat 25 (95% CI 14-100). The failure rate for ORT was reported at 4.9%, compared to 1.3% for IV therapy, suggesting IV therapy might be preferable in certain clinical scenarios [8].

In Nigeria, Emmanuel Ademola Anigilaje reviewed the pathophysiology of water and sodium metabolism and clinical approaches to managing different types of dehydration using isotonic fluid solutions. Despite longstanding research, consensus on fluid management protocols remains elusive, with reported adverse events from fluid administration more frequent than with other treatments. The study emphasized the safety of parenteral fluid therapy in severe cases and those with electrolyte imbalances, advocating for the use of isotonic fluids for correcting dehydration types [9].

Spandorfer et al. [10] conducted a study in the United States to test whether ORT failure rates would not exceed those of IV therapy by more than 5%. Their findings supported ORT's non-inferiority to IV therapy for primary outcomes, with secondary outcomes favoring ORT. Patients receiving ORT initiated therapy more quickly (mean time 19.9 minutes *vs.* 41.2 minutes for IV therapy) and showed comparable improvements in dehydration scores at 2 hours (78.8% *vs.* 80% for IV therapy). Hospitalization rates were lower in the ORT group (30.6% *vs.* 48.7% for IV therapy), and patient preference for future therapy was similar between groups (61.3% *vs.* 51.4%, respectively) [10].

While ORT remains the cornerstone of management, some clinicians advocate for IV rehydration, believing it might offer superior and more rapid outcomes in certain cases [4]. This research aimed to systematically review and compare the efficacy, safety, and clinical outcomes of ORT versus IV therapy in pediatric gastroenteritis, addressing the ongoing debate in clinical practice.

Subjects and Methods

Search strategies and data sources

Relevant studies were retrieved from multiple electronic databases through extensive searches. The databases included PubMed, Cochrane, ResearchGate, Cureus, and ScienceDirect. The search period ranged from the year 2004 to 2024. Keywords used in the search were "Gastroenteritis," "Rehydration," "Pediatric," "Emergency Department," and "Children." Boolean operators "OR" and "AND" were utilized to combine search terms. A total of 1,287 studies were initially identified.

Study selection

The inclusion and exclusion criteria were developed to identify the most relevant articles and guide the selection process. The search was restricted to publications in English language. The publication date was limited to the last 20 years (2004-2024), primarily focusing on full-text articles. Articles deemed irrelevant or inappropriate after thorough review were excluded. Participants needed to have experienced a particular condition (e.g., given a specific drug, or had a disease at a particular graded level or higher) to be included. The review was limited to studies targeting similar population groups or countries with comparable demographic or economic factors. Only English-language publications were included unless a specific clinical outcome required every applicable paper, regardless of language. The review was restricted to studies involving pediatric patients. Non-peer-reviewed literature was excluded unless grey literature such as technical reports and web-based guidelines were relevant to the research question. Studies were included based on whether they reported outcomes of interest in a consistent, appropriate manner. Self-reported outcomes

Table 1. *The quality assessment of the included studies.*

	Study	Quality assessment
1	Florez et al. [13]	Good
2	Mosegui et al. [14]	Fair
3	Carson et al. [15]	Good
4	Azarfar et al. [16]	Fair
5	Waddell et al. [17]	Fair
6	Mora-Capín et al. [18]	Fair
7	Poonai et al. [19]	Fair
8	Toaimah and Mohammad [20]	Good
9	Rinawi et al. [21]	Fair
10	Poonai et al. [22]	Fair
11	Freedman et al. [23]	Good
12	Freedman et al. [24]	Good
13	Pelc et al. [25]	Good
14	Hendrickson et al. [26]	Good
15	Seo et al. [27]	Good
16	Bahm et al. [28]	Good
17	Florez et al. [13]	Good
18	Ravelomanana et al. [29]	Good
19	Kinlin et al. [30]	Good
20	Freedman et al. [31]	Good
21	Nager and Wang [32]	Good
22	Levy et al. [33]	Good
23	Colletti et al. [34]	Fair
24	Lee and Haden [35]	Fair
25	Chow et al. [36]	Fair

Table 2. *The characteristics of the included studies.*

Authors/ Year	Objectives	Research design	Study results
Ricciuti et al. [12]	To evaluate the short-term metabolic effects of different maintenance fluids in children	Retrospective observational study.	Compared normal saline, dextrose-supplemented saline, and lactated Ringer. Dextrose-supplemented saline and lactated Ringer improved plasma bicarbonate levels and had similar effects on sodium and potassium.
Florez et al. [13]	To assess the benefits and harms of balanced solutions versus 0.9% saline for rapid rehydration in children with severe dehydration due to acute diarrhea.	Systematic review of randomized controlled trials	Balanced solutions reduced hospital stay (mean difference -0.35 days), improved blood pH and bicarbonate levels, and decreased hypokalemia risk. Evidence on mortality effect was uncertain.
Mosegui et al. [14]	To evaluate the cost-effectiveness of ORT versus IV rehydration in children with non-severe dehydration.	Cost-effectiveness study	ORT was more cost-effective with a cost of $14.28 and an effectiveness of 0.89 QALYs. ORT was underutilized, while IVT increased costs without significant effective gains.
Carson et al. [15]	To provide guidelines for treating dehydrated children in outpatient settings.	Systematic review	ORT combined with ondansetron is effective for managing dehydration and vomiting. Recommended as first-line treatment for mild to moderate dehydration.
Azarfar et al. [16]	To evaluate the effect of rapid IV rehydration on vomiting in children with acute gastroenteritis.	To evaluate the effect of rapid IV rehydration on vomiting in children with acute gastroenteritis.	Rapid IV rehydration resolved vomiting in 63 out of 75 children in the intervention group. No significant difference in vomiting resolution between rapid IV and control groups.
Waddell et al. [17]	To assess the impact of a rapid rehydration guideline in an emergency department.	Quasi-experimental study	Implementation of the guideline increased ED length of stay and admissions but improved the initiation and timeliness of rehydration therapy.
Mora-Capín et al. [18]	To develop evidence-based recommendations for Rapid Intravenous Rehydration (RIR) in children.	GRADE methodology project	Recommendations included the safe use of RIR for mild-moderate dehydration with isotonic fluids, particularly saline supplemented with glucose for normoglycemia and ketosis.
Poonai et al. [19]	To identify factors associated with IV rehydration and hospitalization in children with acute gastroenteritis	Secondary analysis of RCTs	Higher Clinical Dehydration Scale scores and previous healthcare visits predicted IV rehydration; ondansetron use was associated with reduced IV rehydration and hospitalization.
Toaimah and Mohammad [20]	To compare the efficacy of rapid IV rehydration with the standard method in children with gastroenteritis.	Systematic review	Rapid IV rehydration and standard rehydration had similar success rates and discharge times. Rapid rehydration was associated with longer hospital stays and higher readmission rates.
Rinawi et al. [21]	To update evidence-based recommendations for diagnosing and managing acute gastroenteritis in children.	Systematic review	Preferred treatment includes ORT with hypo-osmolar solutions and continued breastfeeding. Enteral rehydration was found to be superior to IV rehydration. Antimicrobial therapy is recommended only in exceptional cases.
Poonai et al. [22]	To study predictors of IV rehydration in children with acute gastroenteritis in the US and Canada.	Secondary analysis of RCTs	Higher Clinical Dehydration Scale scores, previous visits, and being in the US were predictors of IV rehydration. US children more likely to receive IV fluids compared to Canadian children.
Freedman et al. [23]	To determine if dilute apple juice/preferred fluids are noninferior to electrolyte maintenance solution in children with mild gastroenteritis.	Randomized clinical trial	Dilute apple juice reduced treatment failures (16.7% *vs.* 25.0%) and IV rehydration (2.5% *vs.* 9.0%) compared to electrolyte maintenance solutions.
Freedman et al. [24]	To compare pediatric gastroenteritis care in emergency departments in Canada and the United States.	Preplanned analysis of clinical trials	Higher IV fluid use and hospitalization rates at the index visit in the US compared to Canada. No significant difference in unscheduled revisits within 7 days.
Pelc et al. [25]	To describe rehydration strategies in pediatric emergency departments across Europe.	Observational study	ORT was the first line of treatment; France preferred IV rehydration, while other countries (Belgium, Netherlands, Switzerland) used the nasogastric route more frequently.
Hendrickson et al. [26]	To determine if a triage-based protocol for early ondansetron and ORT provision improves pediatric ED care.	Observational study	Increased ondansetron use (36%-75%), decreased blood testing (37%-21%), and IV fluid use (23%-9%) without significant changes in ED length of stay or admissions.
Seo et al. [27]	To survey the guidelines followed by Korean pediatricians for treating acute gastroenteritis.	Observational study	Most pediatricians used IV fluid infusions (98.2% PG, 92.9% GP); common use of antiemetics (87.3% PG, 96.6% GP) and probiotics (89.1% PG, 100% GP). Dietary changes are more frequently recommended by GPs.
Bahm et al. [28]	To evaluate the impact of clinical decision tools on pediatric acute gastroenteritis outcomes.	Retrospective cohort study	Medical directive for ORT was associated with lower return visit rates (aOR 0.86); printed discharge instructions were associated with higher return visit rates (aOR 1.33).
Ravelomanana et al. [29]	To compare the efficacy and safety of nasogastric tube versus spoon administration of ORS.	Open comparative study	Spoon administration was more effective (62.5% rehydrated at 4 hours) and better tolerated than nasogastric tube administration (39.3% rehydrated at 4 hours).
Kinlin et al. [30]	To describe clinical decision tools for pediatric gastroenteritis in Ontario emergency departments.	Cross-sectional study	ORT was initiated at triage in 38% of EDs. High-volume EDs were more likely to have clinical practice guidelines and pathways.
Freedman et al. [31]	To compare pediatric gastroenteritis treatment practices in Canada and the US.	Cross-sectional study	Canadian physicians more frequently initiated ORT for moderate dehydration compared to US physicians, who were more likely to use antiemetics and IV fluids.

Authors/ Year	Objectives	Research design	Study results
Nager and Wang [32]	To compare the efficacy of ultrarapid versus rapid IV hydration in pediatric patients with moderate dehydration.	Comparative study	No significant difference in rehydration success or complications; higher oral fluid administration in the ultrarapid group.
Levy et al. [33]	To determine if IV dextrose in saline reduces hospitalization and serum ketone levels compared to saline	Double-blind, randomized controlled trial	No difference in hospitalization rates; greater reduction in serum ketone levels with dextrose in saline.
Colletti et al. [34]	To review evidence on dehydration assessment, rehydration methods, and antiemetic use in children with gastroenteritis	Systematic review	ORT and nasogastric rehydration were as effective as IV rehydration. Ondansetron reduced vomiting and the need for IV rehydration.
Lee and Haden [35]	To audit rehydration practices in children under 3 years with gastroenteritis in an ED	Audit study	Nasogastric rehydration was most common, followed by IV and oral rehydration.
Chow et al. [36]	To assess the management and impact of diarrhea etiology and severity in children.	Retrospective study	High IV fluid use in mixed infections; rotavirus and bacterial infections were associated with greater severity.

were excluded if not supported by objective measures. Inclusion depended on the setting of the study, such as hospital, inpatient, or community-based care. After a thorough screening, 25 studies were included in this systematic review.

Data extraction

Following the initial search, all downloaded literature was imported into Rayyan software, and duplicates were removed. Title and abstract screenings were performed, focusing on studies reporting oral rehydration and intravenous therapy in pediatric gastroenteritis. Eligible studies were subjected to a full-text review for secondary screening. Studies meeting the eligibility criteria for design, language, and year of publication were shortlisted. Participants included in the studies were pediatric patients in emergency departments with documented gastroenteritis who received oral and/or intravenous fluids. Data from selected studies were extracted using a predesigned data extraction form in MS Excel. The form captured information on general aspects (author, study title, year of publication, and country), methods (study design, study setting, type of population, gender, study location, and study period), management, outcome, and influencing factors. The extracted data were analyzed using STATA software version 16. Studies with missing or incomplete data were excluded from the analysis.

Quality assessment

The quality of selected studies was assessed using the critical appraisal tool by Hawker et al. [11]. This tool evaluates various aspects including abstract and title, introduction and objectives, methodology, sampling techniques, data analysis, ethics and biases, findings/ results, generalizations, usefulness, and implications. Each aspect was scored on a scale from 1 (critically low quality) to 4 (high quality) to ensure rigor in study selection.

Results

The initial search across databases yielded 1,287 articles. After removing 130 duplicates, 1,157 articles remained for screening. Title and abstract reviews led to the exclusion of 1,132 articles that did not meet the inclusion criteria, leaving 25 articles for full-text reviews. Upon further assessment, 25 studies were included in this systematic review [13-36] (Figure 1).

The quality of the included studies was evaluated using the critical appraisal tool by Hawker et al. [11], with most studies rated as either “Good” or “Fair” (Table 1).

Overall, the evidence supports ORT as the preferred initial treatment for pediatric gastroenteritis-induced dehydration, with IV therapy reserved for more severe cases or when ORT is not feasible. This review underscored the importance of widespread ORT implementation and suggests further research to refine treatment guidelines, particularly for severe dehydration scenarios (Table 2).

Discussion

The findings indicated that ORT is highly effective for treating mild to moderate dehydration in pediatric gastroenteritis. Studies consistently showed that ORT reduces the need for hospitalization and is cost-effective.

For instance, Mosegui et al. [14] highlighted that initiating ORT in children under 5 years old is the most efficient practice, with a cost of $14.28 and an effectiveness of 0.89 quality-adjusted life years [14]. Carson et al. [15] emphasized that ORT, combined with ondansetron, is effective for managing dehydration and persistent vomiting in outpatient settings [15].

Additionally, Freedman et al. [23] found that using dilute apple juice for ORT resulted in fewer treatment failures compared to electrolyte maintenance solutions. In comparison, intravenous (IV) therapy was predominantly reserved for severe dehydration cases or when ORT failed.

Florez et al. [13] demonstrated that balanced IV solutions, such as lactated Ringer’s, provided better outcomes in terms of plasma bicarbonate levels and reduced hypokalemia risk compared to normal saline. Studies like Azarfar et al. [16] and Mohammad and Toaimah [20] reported that rapid intravenous rehydration (RIR) is safe for children with mild to moderate dehydration but might be associated with longer hospital stays and higher readmission rates. RIR did not show significant advantages over standard IV rehydration in terms of discharge time or rehydration success [16,20].

Cost-effectiveness analyses revealed that ORT was more cost-effective compared to IV therapy. Mosegui et al. [14] highlighted that the over prescription of IV therapy increases costs without a corresponding significant increase in effectiveness. The comparative analysis across different countries revealed a preference for ORT as the first-line treatment.

For example, Pelc et al. [25] found that ORT was the preferred initial treatment in European countries, whereas IV rehydration was more commonly used in the United States, as reported by Freedman et al. [31] and Poonai et al. [22].

Additional findings showed that implementing a triage-based protocol for ORT in pediatric emergency departments increased ondansetron use and decreased IV fluid use without significantly changing ED length of stay or admissions, as demonstrated by Hendrickson et al. [26]. Seo et al. [27] reported that most Korean pediatricians preferred IV fluid infusions for managing dehydration, with the common use of antiemetics and probiotics.

Conclusion

ORT remains a cornerstone in the management of pediatric gastroenteritis-induced dehydration due to its effectiveness, safety, and cost-efficiency. Further studies should focus on optimizing ORT protocols and investigating the circumstances under which IV therapy might be necessary to ensure the best outcomes for pediatric patients.

List of abbreviations

aOR	Adjusted odds ratio
ED	Emergency department
GP	General practitioners
IV	Intravenous
ORT	Oral rehydration therapy
PG	Pediatric gastroenterologists
QALYs	Quality-adjusted life years
RCT	Randomized controlled trial
RIR	Rapid intravenous rehydration

Conflict of interest

The authors declare that there is no conflict of interest regarding the publication of this article.

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Consent to participate

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