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ORIGINAL RESEARCH

Acute Diarrhea In Children With Moderate To Severe Dehydration: A Literature Review

Disman Maitora Usman[1*], Astriani Pattiwael[1], Nadia Mulya[1], Anisa Anisa[1], Waode Zamrina[1], Ayu Yuliana Sari[1], Suci Ramadani[1], Fahril Fahril[1], Anisa Purnamasari[2]

Affiliation

[1]Undergraduate Students, Nursing Study Program, Faculty of Health Sciences, Mandala Waluya University, Kendari, Indonesia
[2]Nursing Study Program, Faculty of Health Sciences, Mandala Waluya University, Kendari, Indonesia
*Corresponding author: maitorausman@gmail.com

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Corresponding Author:
Disman Maitora Usman
Universitas Mandala Waluya

Email:
maitorausman@gmail.com

Abstract

Background: Acute diarrhea is a medical condition with the second highest mortality rate after pneumonia. It is characterized by more than 14 days of frequent bowel movements with watery stools, leading to dehydration and the risk of electrolyte imbalance, often caused by *Escherichia coli* (E. coli) infection.

Purpose: To explore therapeutic interventions for acute diarrhea in children with moderate and severe dehydration.

Methods: A systematic literature search was conducted across multiple databases, including ScienceDirect, PubMed, and Google Scholar, using Boolean terms and specific filters to identify relevant articles. The inclusion criteria were full-text articles published between 2022 to 2025.

Results: A total of 10 articles met the predefined keywords and selection criteria.

Conclusion: Although rotavirus vaccination has proven to be effective, the selection and adaptation of vaccination strategies must be tailored to local conditions to achieve optimal outcomes in children with acute diarrhea accompanied by moderate to severe dehydration.

Background

Diarrhea is a condition characterized by the passage of loose or watery stools, or in some cases, only liquid, with a frequency of more than three times per day (Wahyuni, S et al., 2022). Diarrhea remains highly prevalent in Indonesia and requires special attention from medical teams and other healthcare professionals. It is known that children with abnormal growth patterns are more vulnerable to diarrhea, as prolonged episodes can hinder their physical development (Jones et al., 2024).

In India, data from 2010 (Lahiri et al., 2022) identified diarrhea as the third most common cause of child mortality, accounting for approximately 300,000 deaths per year. Other consequences of diarrhea in children include malnutrition and impaired cognitive development and growth. Diarrheal diseases also impose a substantial economic burden on healthcare services, causing one-third of all pediatric hospitalizations in the country (Andas et al., 2022).

According to the World Health Organization (WHO) and UNICEF, an estimated two billion cases of diarrhea occur annually worldwide, with approximately 1.9 million deaths in

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children under five years of age (Purnamasari et al., 2024), primarily in developing countries. This represents 18% of all deaths in children under five and equates to over 5,000 child deaths each day due to diarrhea (Purnamasari et al., 2024).

The World Health Organization (WHO) also reports that diarrheal disease is the second leading cause of death among children under five, causing an estimated 525,000 deaths each year (Mokodompit et al., 2025). In developing countries in 2010, approximately 1.731 billion cases of diarrhea were recorded among children under five, with around 36 million requiring hospitalization. According to the 2017 health statistics published by the Indonesian Ministry of Health, around 32.3% of children aged 0–6 years had experienced diarrhea at least once within a six-month period (Jones et al., 2024).

The objective of this literature review is to assess the effectiveness of acute diarrhea therapy in children with moderate and severe dehydration.

Method

This literature review utilized Boolean terms and was conducted systematically across several databases, including ScienceDirect, PubMed, and Google Scholar. The articles selected were assessed based on their relevance to the research question, research methods used, sample size, type of study, results, and the level of evidence provided.

The authors employed the PICO method as a framework for systematically identifying relevant scientific articles, as outlined below:

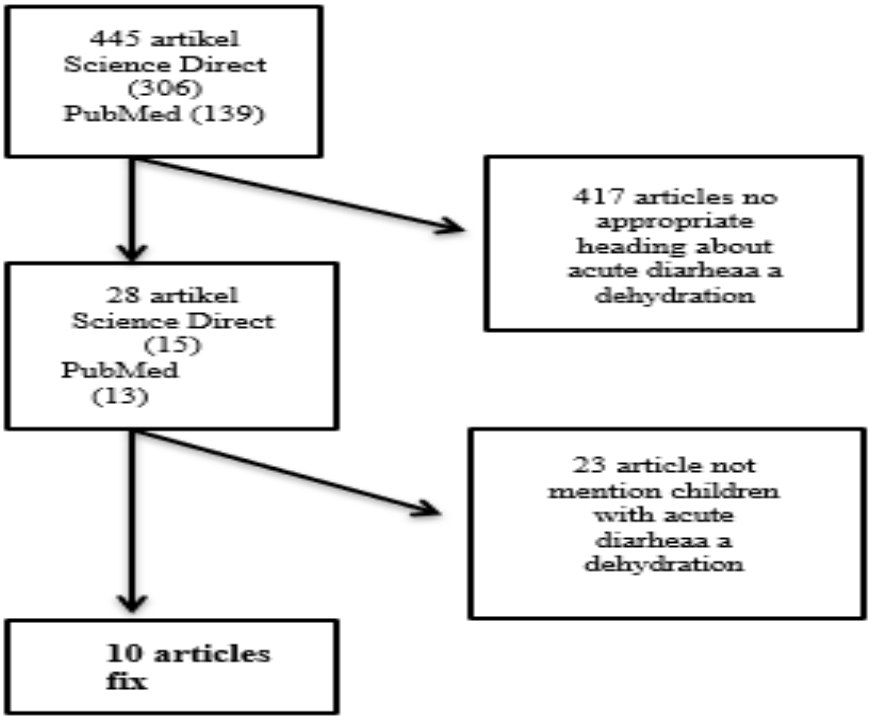
Patient : Children

Intervention : Dehydration

Comparison : -

Outcome : Acute Diarheaa

Subsequently, the authors conducted a literature search across several databases, including ScienceDirect, PubMed, and Google Scholar, using Boolean terms and specific limitations to identify articles that appropriately addressed the research question. The Boolean terms used were: **“dehydration” AND “acute diarrhea” AND “children”**, with the inclusion criteria limited to **full-text articles** published between the years **2022 and 2025**.



Gambar 1. Literature Search Process

Results

First article: *Clinical evaluation scale and laboratory tests are sufficient to determine the degree of dehydration in acute diarrhea?*. This study included data from 108 children with acute diarrhea. The sensitivity of WHODO was 50%, CAS 75%, and GS 97%, with mild dehydration in 87.5%, moderate dehydration in 26% (CAS) and 53% (GS), and severe dehydration in 96.3%, 86%, and 44%, respectively. To identify patients with a dehydration level of 10%, the positive test likelihood ratio was 11.0 for WHODS and 14.7 for GS. For patients with mild dehydration, the positive test likelihood ratio for GS was 18.0. These findings showed a significant correlation between the actual dehydration level and pH, HCO_3, creatinine, and urine concentration ($p < 0.05$) (Can et al., 2022).

Second article: *Balanced crystalloid solutions versus 0.9% saline for treating acute diarrhea and severe dehydration in children*. Analysis of 0.9% saline showed that balanced solutions may slightly reduce hospital stay duration (mean difference [MD] -0.35 days, 95% confidence interval [CI] -0.60 to -0.10; 2 studies; moderate-certainty evidence). However, the evidence is highly uncertain regarding the impact of balanced solutions on in-hospital mortality in children with severe dehydration (risk ratio [RR] 0.33, 95% CI 0.02 to 7.39; 1 study, 22 children; very low-certainty evidence) (Florez et al., 2023).

Third article: *Efficacy and safety of Bacillus clausii (O/C, N/R, SIN, T) probiotic combined with oral rehydration therapy (ORT) and zinc in acute diarrhea in children: a randomized, double-blind, placebo-controlled study in India.* A total of 457 patients were randomized, and 454 were treated. A similar proportion of patients recovered from diarrhea within 120 hours after randomization (97.0% in the *B. clausii* group [n=227] and 98.0% in the placebo group). The mean recovery time was also comparable: 42.83 hours (95% CI: 40.90–44.90) in the *B. clausii* group and 42.13 hours (95% CI: 39.80–43.87) in the placebo

group. No statistically significant differences were observed between groups (hazard ratio = 0.93 [95% CI: 0.77–1.13]; p = 0.6968), and there were no significant differences in secondary endpoints. Treatment with *B. clausii* was well tolerated, with adverse event rates (9.7%) similar to placebo (12.3%) (Lahiri et al., 2022).

Fourth article: *Etiology of severe dehydrating diarrhea in infants and young children living in low- and middle-income countries***.** According to the analysis, the major pathogens associated with severe dehydration varied by age group and corresponded with the need for intravenous hydration and hospitalization. The most common pathogens among children aged 0–11 months were rotavirus (30.9%), cryptosporidium (12.0%), and heat-stable enterotoxigenic *Escherichia coli* (ST-ETEC) (10.3%). Among children aged 12–23 months, *Shigella*/enteroinvasive *E. coli* (EIEC) (25.8%), rotavirus (19.3%), and ST-ETEC (10.9%) were predominant. *Shigella*/EIEC (25.8%), *Vibrio cholerae* (10.4%), and rotavirus were among the most common pathogens (Jones et al., 2024).

Fifth article: *Prevalence and factors associated with rotavirus diarrhea among children aged 3–24 months after the introduction of the vaccine at a referral hospital in Uganda: a cross-sectional study.* Among 268 children with acute watery diarrhea, 133 (49.6%) were female. Rotavirus was detected in 42 cases (15.7%), the majority of whom (66.7%) were dehydrated. Independent factors associated with rotavirus diarrhea included age <12 months (adjusted odds ratio [AOR] = 8.87, p = 0.014), male gender (AOR = 0.08, p = 0.001), presence of other diarrhea cases in the household (AOR = 17.82, p = 0.001), and use of well water as the household water source (AOR = 50.17, p = 0.002) (Laker et al., 2024).

Sixth article: *Norovirus and rotavirus in children hospitalized with diarrhea after rotavirus vaccine introduction in Burkina Faso.* This study included 151 children with severe acute gastroenteritis. Stool samples could not be collected from five subjects, leaving 146 for final analysis. Rotavirus was found in 14% (20/146) and norovirus in 20% (29/146) of stool samples, with no co-infections identified. Norovirus was more common in the 7–12 month age group (27% of samples) and was absent in children older than 24 months. In contrast, rotavirus was present across all age groups, ranging from 10% in children aged 7–12 months to 18% in those aged 0–6 months (Rönnelid et al., 2023).

Seventh article: *Derivation of the first clinical diagnostic model for the severity of dehydration in patients with acute diarrhea over five years.* The analysis involved 2,172 patients, with complete data available for 2,139 (98.5%). Bootstrapping was used to correct for overfitting and compare model performance with the currently used WHO algorithm. The intraclass correlation coefficient (reliability) for the full model was 0.90 (95% CI: 0.87–0.91) and 0.82 (95% CI: 0.77–0.86) for the simplified model. The area under the receiver operating characteristic curve (accuracy) was 0.79 (95% CI: 0.76–0.82) for severe dehydration and 0.73 (95% CI: 0.70–0.76) for the simplified model (Levine et al., 2024).

Eighth article: *Rotavirus infections and their genotype distribution in Rwanda before and after the introduction of rotavirus vaccination.* The results showed that among vaccinated children, other pathogens became relatively more common, particularly norovirus GII (18% vs. 10%), astrovirus (10% vs. 4%), and sapovirus (13% vs. 4%). Similarly, previous studies have reported higher norovirus GII infection rates in children with acute gastroenteritis following the introduction of rotavirus vaccination (Kabayiza et al., 2023).

Ninth article: *Clinical and nutritional correlates of bacterial diarrhea etiology in young children: a secondary cross-sectional analysis of the ABCD trial.* Among 6,692 children with moderate-to-severe diarrhea (MSD), qPCR results were available and 28% were likely to have bacterial diarrhea etiology. Compared to children with severe stunting, those with moderate acute malnutrition (MAM) (adjusted OR [aOR] 1.56, 95% CI: 1.18–2.08), partial/severe dehydration (aOR 1.66, 95% CI: 1.25–2.22), or both (aOR 2.21, 95% CI: 1.61–3.06), had higher odds of bacterial diarrhea. Similar trends were observed for ST-ETEC. Clinical signs such as fever and prolonged diarrhea duration were not associated with bacterial etiology; however, children with more than six stools in the previous 24 hours were more likely to have bacterial diarrhea (aOR 1.20, 95% CI: 1.05–1.36) (Somji et al., 2024).

Tenth article: *Established and new rotavirus vaccines: a comprehensive review for healthcare professionals.* Each vaccine concept and individual vaccine within these concepts exhibits different biological properties (e.g., virus strain type and concentration), which can result in differing characteristics such as dosage schedules, efficacy, effectiveness, and safety profiles (Vetter et al., 2022).

Tabel 1. Journal Literature Review

Author	Title	Objective	Method	Results	Conclusion
Can et al., 2022	*Are Clinical Evaluation Scales and Laboratory Tests Sufficient to Determine the Degree of Dehydration in Acute Diarrhea?*	To evaluate the reliability of the "World Health Organization Dehydration Scale (WHODO)", "Clinical Dehydration Scale (CAS)", and "Gorelick Scale (GS)" in determining the degree of dehydration (DH) compared to laboratory findings.	The study was conducted on children aged 3 months to 5 years diagnosed with acute diarrhea.	A total of 108 children with acute diarrhea participated. Sensitivity levels of WHODO, CAS, and GS: 90%, 52%, 54% for mild DH; 49.4%, 80%, 83% for moderate DH; and 96.3%, 86%, 44% for severe DH. Specificity levels: 50%, 75%, 97% for mild DH; 87.5%, 26%, 53% for moderate DH; and 44.4%, 73.9%, 96% for severe DH.	It was concluded that WHODO and GS successfully detected ≥10% dehydration, GS accurately identified mild dehydration, and these scales can be used in situations where the child's weight is unknown. Additionally, pH, HCO, creatinine, and urine density may be useful in determining dehydration levels when weight is unknown.
Florez et al., 2023	*Balanced Crystalloid Solutions versus 0.9% Saline for Treating Acute Diarrhea and Severe Dehydration in Children*	To evaluate the benefits and risks of balanced solutions for rapid rehydration in children with severe dehydration due to acute diarrhea, in terms of	Standard and extensive Cochrane search methods were used.	Compared to 0.9% saline, balanced solutions likely resulted in a slight reduction in hospital stay (mean difference (MD) -0.35 days, 95% confidence interval (CI) -0.60 to -0.10; 2 studies; moderate-certainty evidence).	Evidence suggests balanced solutions may not significantly change the need for additional IV fluids or affect biochemical measures like sodium, chloride, potassium, and creatinine levels.

Author	Title	Objective	Method	Results	Conclusion
		hospital stay duration and mortality compared to 0.9% saline.			
Lahiri et al., 2022	*Efficacy and Safety of Bacillus clausii (O/C, N/R, SIN, T) Probiotic Combined with Oral Rehydration Therapy (ORT) and Zinc in Acute Diarrhea in Children: A Randomized, Double-Blind, Placebo-Controlled Study in India*	To investigate the efficacy of 5-day treatment with *B. clausii* added to ORT and zinc, compared to placebo plus ORT and zinc, in infants and children in the Indian subcontinent with acute diarrhea (<48 hours duration).	Phase 3, randomized, double-blind, placebo-controlled, parallel-group study conducted at nine centers across India.	A total of 457 patients were randomized; 454 treated. Similar proportions of patients recovered from diarrhea within 120 hours after randomization (97.0% in the control group).	The study did not demonstrate significant clinical benefit of *B. clausii* when added to recommended therapy for treating acute diarrhea in children in India.
Jones et al., 2024	*Etiology of Severe Dehydrating Diarrhea in Infants and Young Children Living in Low- and Middle-Income Countries*	To use a large dataset from a multi-country pediatric diarrhea study to examine pathogens associated with severe dehydration. A secondary aim was to assess IMCI case definition performance in identifying *V. cholerae*.	WHO IMCI and GTFCC guidelines were used to define severe dehydration, and a PCR-based quantitative attribution model was applied to determine diarrhea etiology.	Most common pathogens: rotavirus (30.9%), *Cryptosporidium* (12.0%), and heat-stable enterotoxigenic *Escherichia coli* (ST-ETEC) (10.3%) for ages 0–11 months; *Shigella*/enteroinvasive *E. coli* (EIEC) (25.8%), rotavirus (19.3%), and ST-ETEC (10.9%) for ages 12–23 months.	Findings inform prioritization of pathogens, besides *V. cholerae*, that cause severe dehydration for future prevention and treatment efforts. Prioritization was largely age-stratified.
Laker et al., 2024	*Prevalence and Factors Associated with Rotavirus Diarrhea among Children Aged 3–24 Months after the Introduction of the Vaccine at a Referral Hospital in Uganda: A Cross-sectional Study*	To determine the prevalence, dehydration severity, and factors associated with rotavirus diarrhea among children aged 3–24 months at Fort Portal Regional Referral Hospital.	Hospital-based cross-sectional study involving children with acute watery diarrhea.	Among 268 children, 133 (49.6%) were female. Rotavirus-positive in 42 (15.7%), with most experiencing dehydration (28, 66.7%).	Rotavirus diarrhea prevalence was three times lower post-vaccine compared to pre-vaccine periods. Most rotavirus-positive children experienced dehydration. Access to clean water is crucial for all households.
Rönnelid et al., 2023	*Norovirus and Rotavirus in*	To investigate detection rates,	Real-time antigen or	151 children with severe acute	Higher proportion of norovirus found

Author	Title	Objective	Method	Results	Conclusion
	Children Hospitalised with Diarrhoea after Rotavirus Vaccine Introduction in Burkina Faso	clinical manifestations, and genetic diversity of viral gastroenteritis after rotavirus vaccine introduction in Burkina Faso.	PCR testing, genotyping by nucleotide sequencing or multiplex PCR.	gastroenteritis were included. Rotavirus was found in 14% (20/146), norovirus in 20% (29/146), with no co-infection. Norovirus was more common in ages 7–12 months (27%), while rotavirus was found across all age groups.	causing severe symptoms post-rotavirus vaccination, highlighting its growing role in pediatric diarrhea.
Levine et al., 2024	*Derivation of the First Clinical Diagnostic Model for the Severity of Dehydration in Patients with Acute Diarrhea over Five Years*	To develop a clinical diagnostic model for assessing dehydration severity in patients with acute diarrhea over five years in resource-limited settings.	Complete and simplified ordinal logistic regression models were developed to predict no dehydration (9%). Model reliability and accuracy were assessed.	Area under the ROC curve (accuracy) for severe dehydration: 0.79 (95% CI: 0.76–0.82) for the full model, 0.73 (95% CI: 0.70–0.76) for the simplified model.	Both models significantly outperformed clinical algorithms in assessing dehydration severity in patients over five years.
Kabayiza et al., 2023	*Rotavirus Infections and Their Genotype Distribution in Rwanda before and after the Introduction of Rotavirus Vaccination*	To analyze rotavirus frequency and genotype distribution before and after vaccine introduction in Rwanda.	Fisher's exact test used for categorical data; Mann-Whitney U test for numerical data.	Among vaccinated children, other pathogens were relatively more frequent: norovirus GII (18% vs. 10%), astrovirus (10% vs. 4%), sapovirus (13% vs. 4%). Previous studies also reported increased norovirus GII post-rotavirus vaccine introduction.	After rotavirus vaccination, other pathogens (e.g., norovirus GII, astrovirus, sapovirus) became relatively more common in vaccinated children.
Somji et al., 2024	*Clinical and Nutritional Correlates of Bacterial Diarrhea Aetiology in Young Children: A Secondary*	To assess the relationship between nutritional and clinical characteristics and qPCR-based bacterial diarrhea	ABCD Trial (NCT03130114)	Among 6692 children with MSD and qPCR results, 28% had a likely bacterial diarrhea etiology. Children with MAM, dehydration, or both were more	Presence of MAM, dehydration, or high stool frequency can help identify MSD children who may benefit from antibiotics.

Author	Title	Objective	Method	Results	Conclusion
	Cross-sectional Analysis of the ABCD Trial	diagnosis in a multicenter cohort of children under 2 with moderate-to-severe diarrhea (MSD).		likely to have bacterial causes.	
Vetter et al., 2022	*Established and New Rotavirus Vaccines: A Comprehensive Review for Healthcare Professionals*	To reduce the risk of rotavirus disease in children under 5 years.	Large post-marketing studies and high-quality safety databases were used to assess HRV safety.	Each vaccine type shows different biological properties (e.g., strain type, virus concentration), leading to differences in dose schedule, efficacy, effectiveness, and safety profile.	Generally, promoting compliance and completion of the vaccination schedule is key to increasing coverage and maximizing vaccine impact.

Discussion

Based on an analysis of ten journals discussing moderate to severe diarrhea in children, it was found that recovery time and treatment success are greatly influenced by several key factors. These factors include nutritional status, timeliness of vaccination, support through nutritional therapy, and appropriate complementary care approaches (Andas et al., 2024).

The first and seventh articles specifically discuss the accuracy of clinical and laboratory evaluation scales in measuring the degree of dehydration. The sensitivity of the gold standard (GS), clinical assessment scale (CAS), and WHO dehydration scale (WHODO) varies in determining severe dehydration, with the GS being the most effective (97%) (Hadju et al., 2024). There is a significant correlation between the level of dehydration and laboratory parameters such as pH, HCO3−, creatinine, and urine concentration. This indicates that a combination of clinical and laboratory assessments yields more accurate results (Can et al., 2022). Additionally, Levine et al. (2024) developed a new diagnostic model that outperforms the conventional WHO algorithm with high accuracy (AUC up to 0.79).

The second article compares balanced crystalloid solutions to 0.9% saline. Results show a slight reduction in the length of hospital stay with balanced solutions; however, there is insufficient evidence to prove an effect on mortality (Islamiah et al., 2024). This suggests that while balanced solutions may offer marginal benefits, more data is needed to support strong recommendations (Florez et al., 2023).

Although safe and well-tolerated, Bacillus clausii did not significantly accelerate recovery or shorten the duration of diarrhea compared to placebo, as shown in the third article. This indicates that B. clausii probiotics do not offer significant clinical benefits when added to conventional zinc and ORT therapy (Lahiri et al., 2022).

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The fourth and ninth articles discuss the most common pathogens causing severe diarrhea in low- and middle-income countries. The most frequently identified pathogens include rotavirus, Shigella/EIEC, and ST-ETEC. Furthermore, a correlation was found between severe dehydration and bacterial etiology, particularly in children with severe dehydration or moderate stunting (Darmayanti Waluyo et al., 2022). Nutritional status and clinical conditions may indicate a higher risk of bacterial etiology (Jones et al., 2024; Somji et al., 2024).

The impact of rotavirus vaccination is discussed in the fifth, sixth, and eighth articles. Although the number of infections from pathogens such as norovirus, sapovirus, and astrovirus has increased post-vaccination, rotavirus remains the leading cause of severe diarrhea (Kabayiza et al., 2023; Rönnelid et al., 2023). In Uganda, rotavirus continues to be associated with severe dehydration despite a decrease in rotavirus infections. Being under 12 months of age, male gender, and poor household conditions are major risk factors for rotavirus infection (Laker et al., 2024).

According to a review by Vetter et al. (2022), each rotavirus vaccine has unique biological and immunological characteristics that impact the vaccination schedule and its success rate. Local epidemiology and logistical capacity of each country determine the appropriate vaccine selection.

Conclusion

To address acute diarrhea and dehydration in children, a comprehensive approach is necessary. This includes accurate clinical evaluation, appropriate fluid therapy, precise identification of causative agents, and nutritional and preventive solutions through vaccination and environmental improvements. Since conventional clinical scales like the WHO scale lack sensitivity, dehydration severity should not be assessed using them alone. Using a combination of clinical and laboratory parameters such as blood pH, $HCO3^-$, creatinine, and urine concentration, along with data-based predictive models, has proven to be more reliable for assessing dehydration severity, especially in severe cases. Compared to 0.9% saline, balanced crystalloid solutions show slight benefits in reducing the length of hospital stay during treatment, but they have yet to demonstrate significant impact on mortality. Although Bacillus clausii probiotics are safe and well-tolerated, they do not offer substantial clinical benefits when administered alongside oral rehydration therapy and zinc. Etiologically, rotavirus remains the leading cause of severe diarrhea, followed by pathogens such as *Cryptosporidium*, *ETEC*, and *Shigella*. After the introduction of rotavirus vaccination, infection patterns have shifted toward norovirus, astrovirus, and sapovirus, highlighting the importance of ongoing monitoring of etiological patterns post-vaccination. The risk of severe diarrhea infections caused by viral or bacterial agents has been linked to factors including age under 12 months, poor nutritional status (such as stunting and moderate acute malnutrition), frequent defecation, inadequate sanitation, and close contact with infected individuals. Finally, although rotavirus vaccines are effective, the selection and

adjustment of vaccination strategies must be tailored to local conditions in order to achieve optimal outcomes.

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