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Research Article

Clinical prescription patterns during initial hospitalization in pediatric acute gastroenteritis in Vietnam: A cross-sectional study

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ABSTRACT

Acute gastroenteritis (AGE) remains a leading cause of morbidity and mortality in young children worldwide, yet real-world medication prescribing practices during the first day of hospitalization are poorly characterized. This study aimed to analyze prescription patterns and associated factors during initial hospitalization for AGE among pediatric inpatients at Da Nang Hospital for Women and Children, Vietnam. Our cross-sectional study was conducted using the medical records of children aged 1 month to 5 years, hospitalized with a diagnosis of AGE, who received at least one medication. Missing data analysis was based on the missing at random (MAR) assumption and multivariable logistic regression was used to assess associations between factors and prescription outcome. The most frequently prescribed medication was the probiotic *Bacillus clausii* (99.6% of patients). Reduced-osmolarity oral rehydration solutions (reduced-osmolarity ORS) and lactated Ringer's intravenous solutions were prescribed for 85.1% and 3.9% of the children, respectively. There was a statistically significant association between frequency of vomiting and the prescription of reduced-osmolarity ORS, lactated Ringer's solution, zinc, and ondansetron. Significant associations were also observed between watery stools and racecadotril prescription, as well as between hematochezia and antibiotic use. Our research examined the factors influencing treatment decisions for pediatric AGE during initial hospitalization, highlighting the need to improve the assessment and documentation of clinical information, and strengthen clinical pharmacist involvement in supporting evidence-based drug utilization strategies.

Keywords:
Drug utilization research; Early phase of inpatient management; Pediatric acute gastroenteritis; Antimicrobial therapy; High prevalence of probiotic prescribing; Enhanced clinical pharmacist engagement.

1. INTRODUCTION

Acute gastroenteritis (AGE) is primarily defined by a recent change to loose stool consistency, which is a more reliable indicator of diarrhea than stool frequency (especially in early infancy). It may present with or without fever or vomiting, typically lasting less than seven days and no more than fourteen days [1]. Epidemiological evidence indicates that infectious acute diarrhea constitutes a leading cause of mortality among children younger than five years across 195 countries [2]. The European Society for Pediatric Gastroenterology, Hepatology, and Nutrition (ESPGHAN) update of pediatric AGE guidelines (2014) and the Infectious Diseases Society of America (IDSA) recommendations for infectious diarrhea (2017), together with the World Health Organization (WHO) guideline on the management of pneumonia and diarrhea in children up to 10 years of age (2024), have refined the contemporary evidence base for clinical diagnosis and management. These guidelines addressed fundamental challenges in treatment and clinical practice relating to rehydration,

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water-electrolyte balance, antibiotic and ancillary therapies, as well as the monitoring of the course and complications of AGE from a pediatric perspective [1, 3, 4].

While international guidelines provide general recommendations; real-world prescribing practices, particularly during the first day of hospitalization, remain poorly analyzed across global healthcare systems. The first day of admission is critical, as medical practitioners must make rapid decisions on fluid therapies, antimicrobials, and symptomatic treatments based on the patient's initial clinical presentation [5]. Understanding day-one prescribing patterns relative to clinical features provides essential insights for optimizing early rational pharmacotherapy. This facilitates clinical pharmacists in ensuring appropriate dosing and preventing significant drug-related harm globally. Medication reconciliation is recognized as the beneficial practice since medication errors frequently occur during care transitions [6].

Previous clinical research on pediatric AGE, largely conducted in developed countries, has focused on treatment efficacy, safety, and healthcare utilization [7-10]. Notably, studies on drug utilization during the initial hospitalization period are still limited and receive little attention. In Vietnam, data on early in-hospital management of pediatric AGE remain particularly scarce. Motivated by this gap, the present study was designed to analyze drug utilization patterns and associated factors, with a focus on the first day of hospitalization, among pediatric inpatients with AGE at Da Nang Hospital for Women and Children. This study provides valuable insights that contribute to real-world evidence and inform context-specific guidelines for rational drug use.

2. MATERIALS AND METHODS

2.1. Study period and setting

A cross-sectional study was conducted using medical records of pediatric inpatients with 'acute gastroenteritis', as diagnosed by the admitting physician based on Guidelines for the Diagnosis and Treatment of Common Pediatric Diseases from the Vietnam Ministry of Health and evidence-based guidelines for the management of AGE in children in Europe [1], during the period from May 2025 to August 2025.

Da Nang Hospital for Women and Children is a first-ranked specialized public hospital under the Da Nang Department of Health, established in 2012 pursuant to a decision of the People's Committee of Da Nang City. The hospital has provided comprehensive services in obstetrics-gynecology and pediatrics, including outpatient care, emergency services, inpatient treatment, and rehabilitation. One of the most important divisions in this hospital is the Department of Pediatric Gastroenterology and Nutrition. This department clinical work comprises diagnosis, medical care, and nutritional advice for children under the age of 15 with gastrointestinal disorders. They employ non-surgical treatment approaches, integrating clinical and paraclinical assessments, and collaborate closely with other specialties to ensure comprehensive patient care.

Medical records were acquired on the initial day of hospital admission and no analytical adjustments for sampling design were required. Medical records corresponding to all cases prescribed within any of the six medication groups were consistently collected at the same time to mitigate potential selection bias. Hospital records of patients admitted to the Department of Pediatric Gastroenterology and Nutrition at Da Nang Hospital for Women and Children were reviewed and extracted using a standardized procedure by trained personnel, and the same data source and definitions were used consistently throughout all subgroups to ensure comparability. To reduce misclassification and enhance internal validity, medications with unclear indications were further reviewed through direct consultation with medical practitioners to verify their relevance to AGE treatment.

2.2. Target conditions

AGE identification was obtained from the admission diagnosis records. Eligible cases were identified using the International Classification of Diseases, 10th Revision (ICD-10) codes A03 (shigellosis), A04 (other bacterial intestinal infections), A08.3 (other viral enteritis), and A09 (diarrhea and gastroenteritis of presumed infectious origin).

2.3. Patient inclusion and exclusion criteria

Eligible subjects included children aged 1 month to 5 years admitted with a diagnosis of AGE, shigellosis, other bacterial intestinal infections, other viral enteritis, diarrhea or gastroenteritis of presumed infectious origin. Children were included if they were prescribed at least one drug with complete information on clinical indication and drug regimen, enabling proper analysis and clinical interpretation.

Exclusion criteria comprised persistent diarrhea (>14 days), immunocompromised status (severe malnutrition, recent measles, or HIV/AIDS), antibiotic exposure within two weeks prior to admission, and incomplete treatment due to transfer or self-discharge.

2.4. Sample size calculations

A 95% confidence level ($\alpha = 0.05$) was utilized for the estimation of sample size. The estimation was grounded in previously published data on prescribing

prevalence of intravenous fluids (99.4%), antibiotics (13.8%), antiemetics (77.5%), and probiotics (8.5%) for pediatric AGE at a tertiary children's hospital in Southern California in 2023 [9]. Based on the prevalence of antiemetic administration (77.5%), which yielded the highest estimate of 268 patients, an additional 5% was added for potential missing data, adjusting the final sample size to 282 patients.

2.5. Statistical analysis

Patient data was collected, quality-checked, and stored in a secure database using Epi Info v7.2.6.0 (Centers for Disease Control and Prevention, Atlanta, GA, USA). Statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS) v26.0 (IBM Corp., Armonk, NY, USA). Data visualization was performed using R v4.4.1 (University of Bristol, UK, 2023) with RStudio v2024.04.2 (Posit Software, Boston, MA, USA, 2023). Clinical characteristics and laboratory data of hospitalized children were summarized using descriptive statistics. Qualitative variables were shown as frequencies and percentages. Our missing data analysis was based on the missing at random (MAR) assumption. Multiple imputation was performed using the Fully Conditional Specification (FCS) approach, with a maximum of 10 iterations per imputation cycle. Ten imputed datasets were generated. Each dataset was independently analyzed using multivariable logistic regression, and the parameter estimates were combined using Rubin's rules to obtain pooled estimates and adjusted standard errors.

Univariable and multivariable logistic regression analyses were performed to identify factors associated with specific prescribing outcomes. Independent variables consisted of age group based upon Munich Age Classification System (1–12 months, >1–2 years, >2–5 years), gender (male, female), frequency of vomiting (episodes per day), fever (absent, present), watery stool (absent, present), hematochezia (absent, present), serum sodium level (normal, hyponatremia), serum potassium level (normal, hypokalemia), white blood cell counts (normal, increased), hemoglobin concentration (normal, decreased), and C-reactive protein concentration (normal, increased) [11]. Dependent variables were the prescribing decision (administered or not administered) of reduced-osmolarity oral rehydration solution (reduced-osmolarity ORS), lactated Ringer's solution, zinc, racecadotril, ondansetron, and antibiotic therapy. Adjusted odds ratios (aORs) with corresponding 95% confidence intervals (CIs) were reported, with a two-tailed *p*-value < 0.05 considered statistically significant. The goodness of fit of each model was assessed using the Hosmer–Lemeshow test and −2 Log Likelihood (−2LL). The overall explanatory power of the model was evaluated using Cox & Snell R^2, and Nagelkerke R^2. A non-significant Hosmer–Lemeshow test ($p > 0.05$) indicates an adequate model fit. Smaller −2LL values indicate better model performance, while higher Cox & Snell and Nagelkerke R^2 values suggest greater explanatory power.

Detailed results of the multiple imputation for missing data, the univariable and multivariable analyses, and the goodness of fit and explanatory power of the multivariable logistic regression models are provided in Tables S2, S3, and S4, respectively. We also conducted two sensitivity analyses to examine the impact of modifying certain analytical parameters on the statistically significant factors identified. Firstly, to mitigate the influence of pertinent confounders, we incorporated diarrhea and mucous stool conditions into the multivariable regression model. Secondly, variables such as serum sodium level, serum potassium level, white blood cell count, hemoglobin, and C-reactive protein concentration were transformed from ordinal scales to continuous metrics to enhance analytical precision.

3. RESULTS

3.1. Clinical characteristics and laboratory study of pediatric inpatient

A total of 282 medical records of pediatric patients diagnosed with AGE were reviewed in our study. Baseline characteristics, clinical features, and laboratory findings of the study population are summarized in Table 1. With respect to age distribution, 39.7% of the pediatric inpatients were aged 1–12 months, 33.7% were aged >1–2 years, and 26.6% were aged >2–5 years. The sex distribution exhibited a higher percentage of males (60.3%) compared with females (39.7%). With respect to comorbid conditions, the most frequently recorded were upper respiratory infection (3.5%), tonsillitis (2.5%), and pharyngitis (1.8%). The prevalence of some dehydration was documented in 2.5% of cases. The predominant symptom was vomiting (66.7%), followed by fever (39.7%) and diarrhea (31.9%). Other symptoms, such as cough, rhinorrhea, and abdominal pain were observed with lower frequency. Missing data analyses were provided in Table S1.

3.2. Prescription pattern for AGE in pediatric inpatients

As presented in Table 2, the most frequently prescribed therapy was probiotic *Bacillus clausii*, administered to 99.6% of children. Regarding rehydration therapy, 85.1% of cases received reduced-osmolarity ORS, whereas 3.9% received lactated Ringer's intravenous solution. Regarding ancillary therapies, racecadotril was administered as an antisecretory drug

Table 1. Clinical characteristics and laboratory findings of pediatric in patients with acute gastroenteritis**.**

Characteristics	Frequency (n=282)	Percentage (%)
Age group		
1 - 12 months	112	39.7
>1 - 2 years	95	33.7
>2 - 5 years	75	26.6
Gender		
Male	170	60.3
Female	112	39.7
Comorbidities		
Upper respiratory infection	10	3.5
Acute tonsillitis	7	2.5
Pharyngitis	5	1.8
Hypokalemia	3	1.1
Pneumonia	3	1.1
Hb E/β-thalassaemia	3	1.1
Other[b]	25	8.9
Dehydration severity[c]		
No dehydration	275	97.5
Some dehydration	7	2.5
Stool characteristics		
Loose/ watery	136	48.2
Mucous	45	16.0
Hematochezia	21	7.4
Symptoms		
Diarrhea	90	31.9
Vomiting	188	66.7
Fever (>37.5ºC)	112	39.7
Abdominal pain	24	8.5
Cough	36	12.8
Rhinorrhea	24	8.5
Other[d]	9	3.2
Laboratory findings		
Hyponatremia	68	24.1
Hypokalemia	25	8.9
Elevated white blood cell count	182	64.5
Low hemoglobin concentration	168	59.6
Elevated C-reactive protein result	68	24.1

Footnotes:
[b] Other comorbidities include: bronchiolitis, otitis media, anemia, nasopharyngitis, asthma, conjunctivitis, eczema, epistaxis, subconjunctival hemorrhage, tonsillar hypertrophy, oral thrush, seizure, concussion, laryngitis, genital inflammation, cytomegalovirus hepatitis, hepatomegaly, elevated liver enzymes, and allergy.
[c] The severity of dehydration was classified according to the World Health Organization (WHO) criteria [12].
[d] Other symptoms include: headache, nasal congestion.

in 25.9% of cases, and ondansetron was administrated as an antiemetic in 22.7% of cases. Zinc supplementation was administered in 6.4% cases. Use of antibiotic regimens was comparatively uncommon, with azithromycin administered in 5.7% of cases and ciprofloxacin in 2.8% of cases.

Medicine prescription and therapeutic combinations among hospitalized children with AGE were illustrated by an upset plot in Figure 1. A combination of probiotic and rehydration therapy, as the highest frequently administered regimen, observed in 99 children. A lower frequency was noted for triple-therapy combinations, with 53 children receiving probiotic, rehydration therapy and antiemetic medication, and 51 children receiving probiotic, rehydration therapy and antisecretory drug. 31 children were prescribed probiotic therapy alone. Other combinations were observed in lower than 10 cases.

Table 2. Medication groups and prescription patterns for acute gastroenteritis in pediatric inpatients.

Medicine	Administration route	Average dosage	Frequency (n=282)	Percentage (%)
Probiotics				
Bacillus clausii	PO	4 x 10^9 CFU/day	281	99.6
Rehydration therapies				
Reduced-osmolarity ORS	PO	600 mL/day	240	85.1
Lactated Ringer's solution	IV	8 mL/kg/h	11	3.9
Zinc supplements	PO	10 mg/day	18	6.4
Antisecretory drugs				
Racecadotril	PO	6 mg/kg/day	73	25.9
Antiemetics				
Ondansetron	PO	2 mg/day	64	22.7
Antibiotic therapies				
Azithromycin	PO	12 mg/kg/day	16	5.7
Ciprofloxacin	PO	30 mg/kg/day	8	2.8

Footnotes: *PO*, oral administration; *IV*, intravenous administration; *CFU*, Colony Forming Units; *Reduced-osmolarity ORS*, Reduced-osmolarity oral rehydration solution.

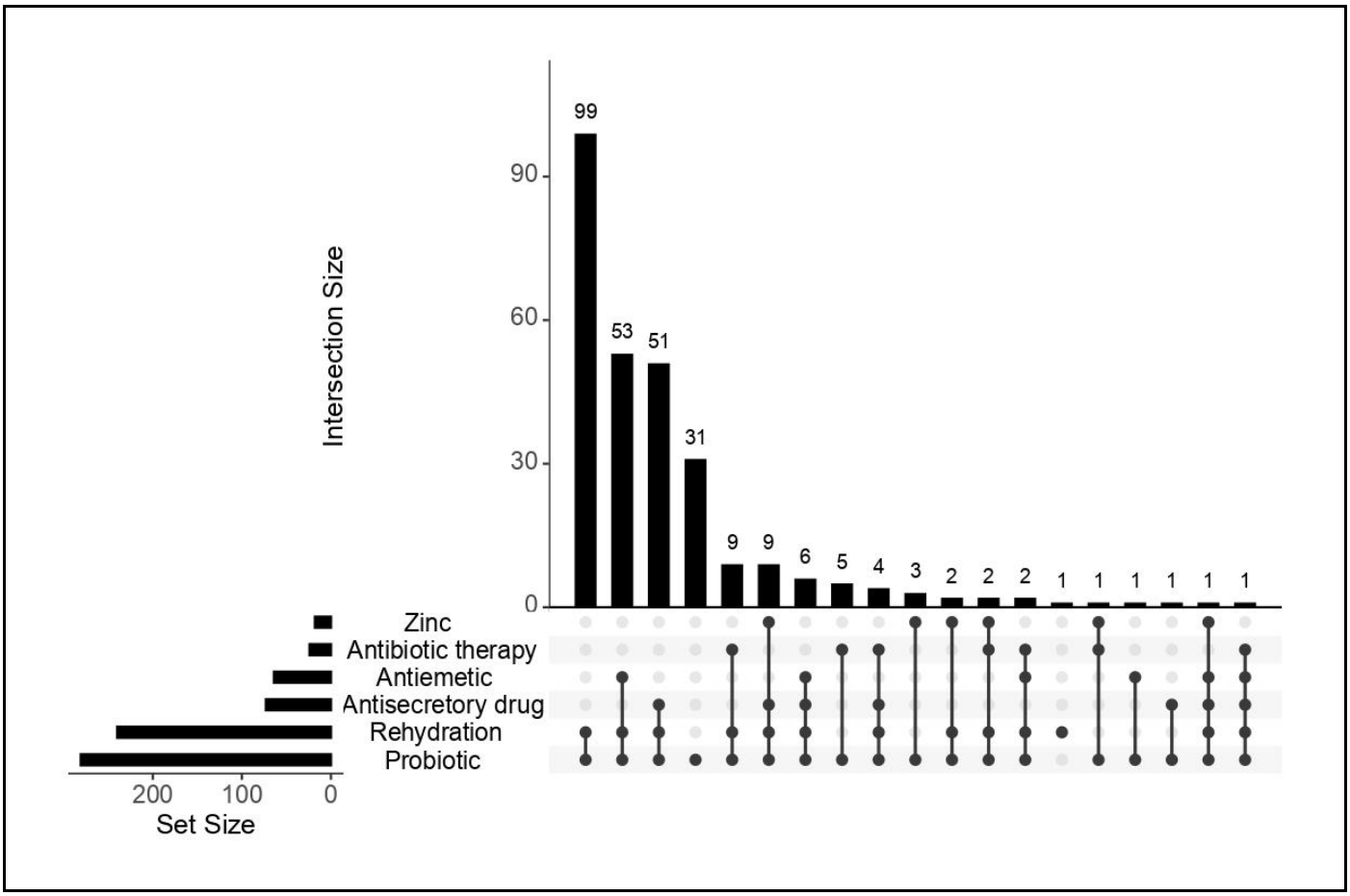


Figure 1. Prescription patterns and therapeutic combinations in pediatric inpatients with acute gastroenteritis. The set size presents the number of children prescribed a single specific medication, whereas the intersection size presents the number of children prescribed a therapeutic combination.

3.3. Multivariable logistic regression analysis of factors associated with prescription of rehydration therapies, zinc supplements, and medications for AGE in pediatric inpatients

The results of univariable and multivariable logistic regression analyses were presented in Table S3. As presented in table 3, our multivariable logistic regression model demonstrated that children aged greater than 2 to 5 years were significantly less likely to be prescribed racecadotril compared to those aged from 1 to 12 months (aOR: 0.107, 95% CI: 0.030 – 0.380). Children who experienced frequent vomiting were significantly more likely to receive reduced-osmolarity ORS, lactated Ringer's solution, and ondansetron than those with infrequent vomiting (aOR: 1.719, 95% CI: 1.298 – 2.277; aOR: 1.42, 95% CI: 1.124 – 1.795; and aOR: 1.851, 95% CI: 1.533 – 2.234, respectively). Conversely, the likelihood of zinc prescription was significantly lower among children with frequent vomiting compared with those with infrequent vomiting (aOR: 0.637, 95% CI: 0.433 – 0.937). Children with fever were significantly less likely to be prescribed ondansetron compared to those without fever (aOR: 0.300, 95% CI: 0.111 – 0.814). Patients with watery stools were significantly more likely to receive reduced-osmolarity ORS and racecadotril than those without (aOR: 3.265, 95% CI: 1.297 – 8.219; and aOR: 16.844, 95% CI: 5.100 – 55.629, respectively). Children presenting with hematochezia were significantly more likely to be prescribed antibiotics (aOR: 133.087, 95% CI: 9.023 – 1963.105). Gender and laboratory parameters (hyponatremia, hypokalemia, and elevated C-reactive protein) were not significant determinants of medication prescription for AGE.

3.4. Sensitivity analyses

When diarrhea and mucous stool conditions were incorporated into the multivariable regression model, significant associations remained between age groups and prescriptions for racecadotril; between vomiting frequency and prescriptions for reduced-osmolarity ORS, lactated Ringer's solution, zinc, and ondansetron; between fever and prescriptions for ondansetron; between watery stool and prescriptions for racecadotril; and between hematochezia and prescriptions for racecadotril and antibiotics.

Furthermore, after transforming serum sodium and potassium levels, white blood cell count, hemoglobin, and C-reactive protein concentration from ordinal variables to continuous measures, the significant associations remained between age groups and prescriptions for racecadotril; between vomiting frequency and prescriptions for reduced-osmolarity ORS, lactated Ringer's solution, zinc, and ondansetron; between fever and prescriptions for ondansetron; between watery stool and prescriptions for reduced-osmolarity ORS and racecadotril; between hematochezia and prescriptions for racecadotril and antibiotics; and between elevated white blood cell count and prescriptions for antibiotics

4. DISCUSSION

To the best of our knowledge, this is the first study to analyze initial medication prescribing patterns and their underlying determinants in pediatric inpatients with AGE at the Da Nang Hospital for Women and Children, Vietnam. Our findings serve as a crucial baseline for evaluating integrated layers of care, which are typically challenging to track longitudinally [8, 13]. This framework provides a foundational model for data integration to establish evaluation benchmarks, rather than directly evaluating the appropriateness of drug use, dose optimization, duration of therapy, or therapeutic outcomes [14]. Six medication groups prescribed for AGE management were analyzed in this study: probiotics, rehydration therapies, zinc supplements, antisecretory drugs, antiemetics, and antibiotics. Among these, probiotics were the most frequently prescribed (99.6% of patients), followed by rehydration therapies (85.1% of patients), and antisecretory drugs (25.9% of patients).

International guidelines provide differing recommendations regarding probiotic use in pediatric AGE. The 2017 IDSA guidelines state that probiotics may be offered to immunocompetent children with infectious diarrhea but do not endorse specific probiotic strains [3]. In contrast, the 2020 ESPGHAN guidelines recommend the use of probiotics in a strain-specific manner [15]. The 2024 WHO guidelines recommend against the use of probiotics in children younger than 10 years with AGE [4]. The prevalence of probiotic prescribing for pediatric AGE was markedly higher in Vietnam, as demonstrated by both our study and a previous study (83.0%) [16], than that reported in the United States (21.1% and 8.6%), Ecuador (6.4%), Japan (46.7%), and India (67.0%) [9, 10, 17-19]. The 2020 ESPGHAN guidelines issued a weak recommendation against the use of *Bacillus clausii* strains O/C, SIN, N/R, and T because of the very low certainty of evidence regarding their efficacy [15]. *Bacillus clausii* may be an effective and well-tolerated treatment for AGE in children. However, additional high-quality randomized controlled trials are needed to clarify its clinical benefits, particularly in comparison to other probiotics [20]. A high prevalence of *Bacillus clausii* prescription was observed in our study. Prescribing patterns may be influenced by pediatric gastroenterologists' prescribing preferences, safety profiles of probiotics, or the availability of specific probiotic preparations approved by the hospital's Pharmacy and Therapeutics Committee.

Table 3. Multivariable logistic regression analysis of factors associated with prescription of rehydration therapies, zinc supplements, and medications in pediatric inpatient with acute gastroenteritis. Results are expressed as adjusted odds ratios (aOR) with 95% confidence intervals (CI) and *p*-values.

A.

Variables included in the analysis	Reduced-osmolarity ORS		Lactated Ringer's solution		Zinc	
	aOR (95% CI)	*p*-value	aOR (95% CI)	*p*-value	aOR (95% CI)	*p*-value
Demographics						
Age group						
1 to 12 months	1		1		1	
>1 to 2 years	1.523 (0.613 – 3.783)	0.365	0.401 (0.088 – 1.817)	0.236	0.977 (0.291 – 3.275)	0.969
>2 to 5 years	1.032 (0.377 – 2.824)	0.951	0.139 (0.012 – 1.581)	0.112	2.054 (0.435 – 9.702)	0.363
Gender						
Male	1		1		1	
Female	0.688 (0.321 – 1.474)	0.336	0.952 (0.245 – 3.696)	0.943	0.808 (0.263 – 2.482)	0.710
Clinical features						
Frequency of vomiting (episodes/day)	**1.719 (1.298 – 2.277)**	**<0.001**	**1.420 (1.124 – 1.795)**	**0.003**	**0.637 (0.433 – 0.937)**	**0.022**
Fever						
Absent	1		1		1	
Present	1.391 (0.626 – 3.090)	0.418	0.882 (0.180 – 4.327)	0.877	0.302 (0.088 – 1.040)	0.058
Watery stool						
Absent	1		1		1	
Present	**3.265 (1.297 – 8.219)**	**0.012**	2.58 (0.469 – 14.202)	0.275	7.45 (0.820 – 67.644)	0.074
Hematochezia						
Absent	1		1		1	
Present	0.682 (0.184 – 2.533)	0.566	NA	NA	0.717 (0.103 – 4.987)	0.736
Laboratory results						
Serum sodium level						
Normal	1		1		1	
Hyponatremia	1.386 (0.453 – 4.245)	0.561	1.602 (0.302 – 8.499)	0.580	0.99 (0.302 – 3.247)	0.987
Serum potassium level						
Normal	1		1		1	
Hypokalemia	0.668 (0.193 – 2.306)	0.518	NA	NA	0.598 (0.068 – 5.304)	0.638

Table 3. Multivariable logistic regression analysis of factors associated with prescription of rehydration therapies, zinc supplements, and medications in pediatric inpatient with acute gastroenteritis. Results are expressed as adjusted odds ratios (aOR) with 95% confidence intervals (CI) and *p*-values. (Continued).

A.

Variables included in the analysis	Reduced-osmolarity ORS		Lactated Ringer's solution		Zinc	
	aOR (95% CI)	*p*-value	aOR (95% CI)	*p*-value	aOR (95% CI)	*p*-value
WBC						
Normal	1		1		1	
Increase	0.721 (0.315 – 1.651)	0.439	0.489 (0.109 – 2.188)	0.350	0.953 (0.308 – 2.955)	0.934
Hgb						
Normal	1		1		1	
Decrease	0.865 (0.379 – 1.974)	0.730	0.428 (0.108 – 1.700)	0.228	1.47 (0.422 – 5.125)	0.546
CRP						
Normal	1		1		1	
Increase	1.881 (0.634 – 5.586)	0.249	1.137 (0.104 – 12.469)	0.914	1.103 (0.254 – 4.793)	0.894

B.

Variables included in the analysis	Racecadotril		Ondansetron		Antibiotic therapy	
	aOR (95% CI)	*p*-value	aOR (95% CI)	*p*-value	aOR (95% CI)	*p*-value
Demographics						
Age group						
1 to 12 months	1		1		1	
>1 to 2 years	0.853 (0.395 – 1.844)	0.686	1.719 (0.606 – 4.882)	0.309	0.560 (0.112 – 2.799)	0.479
>2 to 5 years	**0.107 (0.030 – 0.380)**	**0.001**	1.256 (0.435 – 3.631)	0.674	2.855 (0.484 – 16.861)	0.245
Gender						
Male	1		1		1	
Female	0.513 (0.238 – 1.106)	0.089	1.169 (0.513 – 2.665)	0.711	0.452 (0.113 – 1.808)	0.261
Clinical features						
Frequency of vomiting (episodes/day)	0.848 (0.706 – 1.018)	0.077	**1.851 (1.533 – 2.234)**	**<0.001**	0.996 (0.706 – 1.405)	0.981

Table 3. Multivariable logistic regression analysis of factors associated with p rescription of rehydration therapies, zinc supplements, and medications in pediatric inpatient with acute gastroenteritis. Results are expressed as adjusted odds ratios (aOR) with 95% confidence intervals (CI) and *p*-values. (Continued).

B.

Variables included in the analysis	Racecadotril		Ondansetron		Antibiotic therapy	
	aOR (95% CI)	***p*-value**	**aOR (95% CI)**	***p*-value**	**aOR (95% CI)**	***p*-value**
Fever						
Absent	1		1		1	
Present	1.030 (0.477 – 2.226)	0.940	**0.300 (0.111 – 0.814)**	**0.018**	1.775 (0.461 – 6.837)	0.403
Watery stool						
Absent	1		1		1	
Present	**16.844 (5.100 – 55.629)**	**<0.001**	0.566 (0.164 – 1.956)	0.359	1.399 (0.314 – 6.226)	0.659
Hematochezia						
Absent	1		1		1	
Present	**0.093 (0.014 – 0.599)**	**0.013**	NA	NA	**133.087 (9.023 – 1963.105)**	**0.001**
Laboratory results						
Serum sodium level						
Normal	1		1		1	
Hyponatremia	0.676 (0.205 – 2.227)	0.507	0.765 (0.276 – 2.119)	0.606	0.278 (0.029 – 2.678)	0.260
Serum potassium level						
Normal	1		1		1	
Hypokalemia	0.559 (0.154 – 2.029)	0.369	1.409 (0.360 – 5.514)	0.621	0.663 (0.107 – 4.126)	0.658
WBC						
Normal	1		1		1	
Increase	0.684 (0.328 – 1.429)	0.312	1.520 (0.590 – 3.919)	0.386	**7.135 (1.152 – 44.200)**	**0.035**
Hgb						
Normal	1		1		1	
Decrease	**0.420 (0.186 – 0.951)**	**0.037**	1.662 (0.716 – 3.859)	0.237	2.032 (0.506 – 8.158)	0.317
CRP						
Normal	1		1		1	
Increase	2.016 (0.756 – 5.378)	0.158	0.961 (0.295 – 3.136)	0.947	2.750 (0.317 – 23.858)	0.347

Footnotes: *aOR*, adjusted odds ratio*; CI*, confidence interval*; WBC*, white blood cell count*; Hgb*, hemoglobin concentration*; CRP*, C-reactive protein concentration; *NA*, not available.

While our study did not assess prescribing appropriateness, these findings highlight a notable gap between clinical practice and evidence-based guidelines, underscoring the need for future research into prescribing behaviors.

According to the ESPGHAN guidelines, oral rehydration therapy with a reduced-osmolarity ORS containing 50–60 mmol/L of sodium is recommended as the first-line treatment for pediatric AGE. Reduced-osmolarity formulations have demonstrated superior clinical efficacy compared with standard oral rehydration solutions, including significant reductions in stool output, vomiting frequency, and the need for intravenous rehydration [1, 3]. Our analysis revealed that children presenting with a high frequency of vomiting and watery stools were significantly more likely to receive reduced-osmolarity ORS therapy. These findings may indicate that reduced-osmolarity ORS utilization at Da Nang Hospital for Women and Children aligns with current international, evidence-based guidelines in the management of pediatric AGE.

With respect to intravenous rehydration, isotonic crystalloid solutions are recommended for children with shock, severe dehydration, failure of oral rehydration therapy, persistent vomiting, altered consciousness, metabolic acidosis, or ileus [3, 21, 22]. In our study, lactated Ringer's solution was prescribed to 3.9% of children, although none were classified as having severe dehydration. Because the clinical rationale for intravenous fluid prescribing was not documented in the medical records, it remains unclear whether lactated Ringer's solution was prescribed for failure of oral rehydration therapy or other guideline-supported indications. In the multivariable logistic regression analysis, children who experienced frequent vomiting were significantly more likely to receive lactated Ringer's solution, suggesting that vomiting may have influenced rehydration therapy decisions. These findings highlight the potential role of clinical pharmacists in promoting guideline-adherent dehydration management by advising medical practitioners on the appropriate use and selection of intravenous rehydration solutions and monitoring therapy to minimize electrolyte and acid–base disturbances [23].

The WHO recommends zinc supplementation for the management of pediatric AGE, particularly in low- and middle-income countries. Zinc deficiency, especially common among children in low-income countries, is associated with greater susceptibility to gastrointestinal infections and impaired immune function [24]. For children up to 10 years of age with acute watery or persistent diarrhea, the WHO recommends adjunctive treatment with oral zinc and suggests a daily oral dose of 5 mg for up to 14 days [4]. The prevalence of zinc prescribing was relatively low (6.4%) in the present study. This low prevalence may be explained by several factors. One possible explanation is that children with more frequent vomiting were less likely to receive zinc prescriptions. This association may reflect medical practitioners' concerns about the tolerability of oral zinc in children with frequent vomiting, particularly given that vomiting was reported in a substantial proportion of patients (66.7%). Another possible explanation is that the metallic taste and gastric irritation induced by oral zinc may cause nausea and vomiting, potentially compromising treatment tolerability [25].

International clinical guidelines provide differing recommendations regarding the use of racecadotril. The 2014 ESPGHAN guidelines state that racecadotril can be considered in the management of pediatric AGE [1]. In contrast, the 2025 Australian and 2024 Chinese guidelines do not recommend the use of racecadotril [26, 27]. The 2024 WHO, 2019 American Academy of Family Physicians (AAFP), and 2017 IDSA guidelines do not provide specific recommendations regarding its use [3, 4, 28]. The 2018 Federation of International Societies of Pediatric Gastroenterology, Hepatology, and Nutrition (FISPGHAN) international consensus did not include racecadotril in its final recommendations because the level of expert agreement was only 67.6% [29]. In the present study, racecadotril was prescribed in 25.9% of children with AGE.

The multivariable analytical model examining the association between age groups and racecadotril prescribing was appropriately adjusted for diarrhea as a potential confounder. Although diarrhea frequency could have impacted prescribing patterns, adjustment for stool consistency minimized residual bias. Furthermore, younger age, such as 1 to 12 months child, was associated with greater vulnerability to dehydration and electrolyte imbalance, consistent with the higher burden of viral gastroenteritis in this subgroup. Racecadotril may be considered as a beneficial therapy in mitigating these risks in AGE children [30, 31]. Our results revealed that children aged greater than 2 to 5 years were significantly less likely to be prescribed racecadotril compared to those aged from 1 months to 2 years. These findings may present practitioners' therapeutic decision-making processes based on dehydration risk stratification among different pediatric age cohorts within the epidemiological context of acute viral gastroenteritis.

Most AGE cases resolve without antibacterial intervention. Unnecessary prescription of these agents offers no clinical utility, potentially triggering antibiotic-associated diarrhea and other adverse drug reactions, while fueling the long-term selection of resistant microbial populations [32-35]. Empiric antimicrobial therapy should be considered for infants under three months with suspected bacterial etiology, children presenting with severe *Shigella*-like dysentery, recent international travelers with high fever or sepsis signs, immunocompromised patients with severe illness and

bloody diarrhea, or those with suspected enteric fever [3, 33]. Crucially, antibiotic therapy must be avoided in suspected Shiga toxin-producing *Escherichia coli* (STEC) infections to prevent serious complications like hemolytic-uremic syndrome (HUS) [3]. Antimicrobial regimens should be de-escalated to narrow-spectrum agents as soon as susceptibility data is available [1, 3].

For nontyphoidal *Salmonella* spp., antimicrobial treatment is not routinely recommended for all patients and is reserved strictly for high-risk children, with ceftriaxone serving as the primary agent and azithromycin or ciprofloxacin used as alternatives [1]. Conversely, empirical or targeted treatment is indicated for *Shigella* infections, for which azithromycin, ciprofloxacin, or ceftriaxone are recommended as first-line options [1, 3]. In the case of enterotoxigenic *Escherichia coli* (ETEC), antibiotic intervention is primarily indicated for traveler's diarrhea; preferred regimens include azithromycin, while cefixime, trimethoprim-sulfamethoxazole (TMP/SMX), ciprofloxacin, and rifaximin serve as alternative therapies [1]. For *Campylobacter* enteritis, azithromycin is the first-choice treatment, with ciprofloxacin recommended as an alternative agent [3]. Ciprofloxacin is usually avoided in children under 17, but medical practitioners may use it if no other options are available [1].

In addition to WHO guidelines, many countries have established customized national antimicrobial stewardship programs tailored to their local healthcare systems [33, 36-40]. In accordance with Hospital Antimicrobial Stewardship Guidelines issued in 2020 in Vietnam, ciprofloxacin belongs to group 2- antibiotics subject to usage monitoring and supervision [38]. Recent studies have reported a significant prevalence of antibiotic-resistant pathogens causing AGE in pediatric patients, particularly multidrug-resistant *Salmonella* spp., antibiotic-resistant *Shigella* spp. in immunocompromised patients, and distinct antimicrobial resistance patterns among diarrheagenic *Escherichia coli* (DEC) strains [41-43]. Published data from Vietnam indicates declining ciprofloxacin susceptibility among *Escherichia coli* and *Salmonella* spp. strains, with a notable 47.8% of *Salmonella* spp. isolates exhibiting resistance to ciprofloxacin [44].

The present study identified that hospitalized children presenting with hematochezia and elevated white blood cell counts had a significantly higher likelihood of receiving antibacterial prescriptions. However, the large point estimate for hematochezia (aOR: 133.087, 95% CI: 9.023 - 1963.105) and its extremely wide confidence interval suggest potential model instability driven by sparse events and small-sample effect. Consequently, this association should be considered primarily as a qualitative clinical signal rather than a precise quantitative effect size, underscoring the need for confirmation in larger-scale cohorts using advanced confounder-adjustment methodologies or model selection criteria [32, 42].

Missing data and potential confounders may bias or affect generalizability of study results. The diagnostic parameters assessing the performance of the multiple imputation method for missing data in our study indicated good model fit and appropriateness of the imputation procedure. The results showed that the multiple imputation adequately addressed missingness and did not introduce bias or substantially affect the associations observed in the analysis. Beyond this, the study implemented a sensitivity analysis. Our results suggested that the mentioned association between clinical factors and prescribing decisions was robust to changes in confounders, measurement strategies, and cutoff-setting methods. Nevertheless, our study is observational, and we cannot exclude the possibility of unmeasured confounding.

A limitation of this study was its cross-sectional design, which relied on clinical and prescribing records from the first day of admission. This approach hindered the comprehensive identification of microbiological evidence and other diagnostic laboratory test data in the hospital records. Data on the medical practitioners' diagnostic timeframe could also confound the analysis of the associations between clinical factors, epidemiological etiologies, and medication utilization patterns of AGE in children [32, 45, 46]. Because the information is not routinely documented in electronic medical records, it could not be analyzed or integrated into the model. Consequently, these unmeasured confounders could impact the observed associations in the present study. On the other hand, we lacked information on disease-related factors (e.g., suspected etiology, time of symptom onset, and severity of dehydration as defined by different clinical guidelines) as well as provider- and system-related factors (e.g., practitioners' clinical knowledge, professional experience, and hospital medication accessibility), all of which might have influenced the treatment received in the hospital. Due to the cross-sectional design, this study could not establish causal relationships between clinical determinants and pharmacotherapy patterns in pediatric AGE. Finally, given the small sample size of patients treated with intravenous fluids or antibiotics, there is a potential risk of overfitting in the multivariable logistic regression models. As a single-center study conducted at a specialized care hospital, the findings may lack generalizability to the broader pediatric population in Vietnam.

5. CONCLUSIONS

The present study analyzes drug utilization patterns and their associated factors in the early phase of hospital care for pediatric AGE management. The markedly high rate of probiotic prescribing observed

in our study, along with inconsistencies among current guidelines, underscores the need for future research into prescribing behaviors. The low rate of zinc supplementation and the use of racecadotril with limited evidence support require further clinical evaluation. The use of antibiotics in the management of pediatric AGE requires thorough evaluation based on empirical and definitive therapy principles, antibiotic stewardship programs, and regional resistance patterns. This study highlights the need to improve the assessment and documentation of clinical information, and strengthen clinical pharmacist involvement in supporting evidence-based drug utilization strategies.

Additional research is warranted to analyze other factors influencing clinical decision-making, particularly patient characteristics (children's medical history, comorbidities, and BMI), microbiological findings, as well as disease progression and treatment adherence. Longitudinal studies are also needed to explore patterns and trends of inpatient prescribing for children with AGE.

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Author contributions

T.D.L.N. and Q.D.L. contributed equally to this work. T.D.L.N. was responsible for data collection, visualization, formal analysis, and original draft preparation. Q.D.L. was responsible for conceptualization, methodology, data curation, formal analysis, and supervision. Both authors jointly participated in drafting, reviewing, editing, and approving the final manuscript.

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Conflicts of interest

The authors have no relevant financial or non-financial interests to disclose.

Ethics approval

This study involved human participants and received ethical approval from the Ethics Committee in Biomedical Research at the Institutional Level, School of Medicine and Pharmacy, The University of Danang (Approval No. 35, dated April 10, 2025), and from Da Nang Hospital for Women and Children, Da Nang, Vietnam (Approval dated September 5, 2025). The research was conducted in accordance with institutional ethical guidelines and the principles of the Declaration of Helsinki. All participant data were anonymized, securely stored, and confined to research purposes.

Data availability

Supplementary information is provided upon request.

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