Etiology And Risk Factors For Hospital-Acquired Diarrhea In Children

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Abstract

Background and Objectives: Hospital-acquired diarrhea (HAD) remains an underrecognized healthcare-associated infection in low- and middle-income countries, with limited regional data from Iraq. This study aimed to investigate the etiology, risk factors, and clinical characteristics of HAD among hospitalized adults in Erbil's tertiary care hospitals.

Methods: A cross-sectional observational study was carried out for the duration of January to December 2024 in three major hospitals in Erbil, involving 300 children patients (≤18 years) who developed diarrhea ≥ 72 hours after hospital admission. Sociodemographic, clinical, and microbiological data were collected through standardized data collection forms, and stool samples were tested by using culture methods, RT-PCR and parasitological methods.

Results: Of the 300 participants (mean age =10.41 ± 5.06 years; 56.6% male), 66.7% had identifiable pathogens. Bacterial pathogens predominated (E. coli 9.7%, C. difficile 13.0%, Salmonella 5.0%, Shigella 4.3%; p = 0.043), followed by viral (rotavirus 10.0%, norovirus 7.3%, adenovirus 5.0%) and parasitic (Giardia 7.7%, Cryptosporidium 5.0%) infections. The majority occurred in medical wards (40.7%) with mean diarrhea frequency of 5.85 ± 2.82 episodes/day. Significant risk factors included antibiotic exposure (73.3%; p < 0.001), particularly meropenem (19.3%) and azithromycin (16.7%), and proton pump inhibitor use (57.0%; p = 0.006). The mean hospital stay was 12.33 ± 7.46 days.

Conclusion: HAD in hospitals in Erbil is primarily of bacterial origin, most notably Clostridium difficile, and is significantly associated with the use of antibiotics and proton pump inhibitors. Thus, measures to advance antimicrobial stewardship, infection control, and diagnostic surveillance are necessary to limit in-hospital transmission, and improve patient care.

1. Introduction

Diarrhea is a common gastrointestinal condition seen in outpatient or emergency settings, as well in hospitalised patients. There are many causes, including viral causes, dietary/drug related, gastrointestinal, extra-intestinal, and surgical causes (1). Diarrhea is defined as fluidity or frequency of stool resulting in urgency, or abdominal pain. Diarrhea is defined as stool volume greater than 200 gr per day over a period of 24–72 hours (2).

Hospital-acquired diarrhea (HAD), also known as nosocomial or healthcare-associated diarrhea, is a significant clinical challenge that develops in patients after being hospitalized. It is defined as the acute onset of diarrhea (≥3 loose stools for >12 hours) with or without the associated symptom of vomiting

or fever (>38°C), during which there is also the absence of any likely non-infectious cause (e.g., diagnostic tests, therapeutic regimen, acute exacerbation of underlying chronic conditions) (3).

Clostridioides difficile (C. difficile) is still the most common infectious cause of HAD, especially in healthcare facilities across the globe. This gram-positive, spore-forming anaerobic bacterium has become the most prevalent cause of diarrhoea associated with antibiotic use worldwide, with the pathophysiology primarily being mediated by the production of toxin A and toxin B (4). The emergence of hypervirulent strains, specifically the 027 ribotype, has increased the severity and mortality of C. difficile infections (5). In addition to these organisms, other infectious agents that can cause HAD include diarrhoeagenic Escherichia coli (E. coli), which some authors have found to be the most common organism in particular populations, accounting for 37% of cases in some studies (3). Norovirus also is a cause of sporadic healthcare-associated diarrhea, but it varies widely between healthcare facilities (6).

The non-infectious pathways of HAD mainly involve diarrhea due to medications, mainly antibiotics, proton-pump inhibitors, and other therapeutic agents usual seen in hospitalized patients (7). Enteral feeding adds another major non-infectious pathway, usually as a result of intolerance to feedings, osmotic effect of enteral feedings, or rapid advancement of feedings (8). Other risk factors include medical comorbidities, gastrointestinal pathology, and metabolic abnormalities which may predispose hospitalized patients to diarrhea (9). In addition, a comprehensive systematic review and meta-analysis by Carvallo et al. (2024) identified advanced age ($\geq$ 69 years-old), prior antibiotic medication, and prior hospitalization as global risk factors for C. difficile infection, and leukocyte count as an important laboratory risk factor (10).

The research conducted by Hamad et al. (2022) indicated that nosocomial diarrhea was associated with 5% of medical ward admissions in AL-Sader medical city (Iraq) with a strong correlation noting advanced age, antibiotic exposure, and use of immunosuppressive agents associated strongly with severe episodes of diarrhea (2). Likewise, Harb et al. (2019) reported certain findings from their research in Thi-Qar Governorate in Iraq indicating adenovirus was the most prevalent enteropathogen (34.2%) identified in pediatric diarrheal cases, followed by Salmonella species (14.8%) and Entamoeba species (13.5%) noted in their study (11). While there have been a few studies in the region, there is still a considerable gap of knowledge regarding current epidemiology, antimicrobial resistance, and specific risk factors for HAD in the Iraqi Kurdistan region.

The novelty aspect of the present study is that it partially fulfills a gap in knowledge by evaluating HAD etiology and specific risk factors related to illness in the healthcare system of Erbil which provides new regional data and contributes to knowledge of specific pathogen distributions, patterns of antimicrobial susceptibility, and rates of transmission of healthcare-associated transmission dynamics.

2. Methods and Materials

2.1. Study design and setting

This cross-sectional observational research was conducted for a period of 12 months, from January 2024 to December 2024, at three major tertiary care hospitals within Erbil, Kurdistan Region of Iraq: Erbil Teaching Hospital, Rizgary Teaching Hospital, and Raparin Hospital for children.

2.2. Participants

The researchers recruited study participants using systematic sampling from all patients who were ≤18 years old and had been admitted to medical, surgical, and pediatric intensive care units across all three hospitals. The authors employed a consecutive sampling technique, using any appropriate patients eligible for study enrollment from the defined population who developed diarrhea after 72 hours of hospitalization, throughout the study time period.

The inclusion criteria consisted of medically stable children aged ≤18 years that experienced HAD (defined as three or more loose or watery stools during a 24 hours period that occurred after 72 hours of hospital admission). Patients were required to experience a hospital stay of at least 72 hours before developing diarrhea and to be willing to provide stool samples for microbiological culture. Exclusion

criteria consisted of unstable patients or admitted to the hospital with pre-existing diarrhea conditions, patients with pre-existing inflammatory bowel disease, patients receiving palliative care, and patients with significant cognitive impairment making it impossible to provide informed consent, and patients who developed diarrhea within the first 72 hours after admission. Patients were also excluded if they had incomplete medical records, refused to provide stool samples or were discharged prior to stool sample collection.

To determine the sample size, the researcher employed the single population proportion formula for cross-sectional studies. Previous studies in similar health settings in Iraq suggested a prevalence of HAD of 5% (2). Based on a confidence level of 95%, a margin of error of 5% and a 10% non-response rate, the sample size was determined using the following formula:

$$n = \frac{z^2 \cdot p(1-p)}{d^2}$$

Where: n = required sample size; Z= 1.96 (critical value for 95% confidence level); p = expected prevalence (0.05); d = margin of error (0.05).

Taking into consideration a 10% non-response rate and a design effect of 1.5 due to the multi-center nature of the study, the minimum sample size needed would be 121 total participants. Because of the need for power for subgroup analyses and specificity in terms of pathogen in the pathogen specific aim, the final target sample size was set to be a total of 300, which allocated in response to the number of recruited participants across the three hospitals.

2.3. Data Collection

Data collection was carried out according to a standardized protocol performed by research assistants and laboratory technicians who had received training in the particulars of this project. When eligible participants were identified, demographic and clinical data were gathered from electronic medical records according to a study-specific structured data collection form. The data collection process comprised several aspects that systematically occurred throughout the data collection period.

Stool samples were taken within 24 hours of onset diarrhea in sterile containers (Sarstedt AG & Co. KG, Germany) and delivered immediately to the microbiology laboratory maintaining cold chain conditions using insulated transportation boxes at 2-8°C. Microbiological analysis utilized standard culture methods on a selective media including MacConkey agar, Salmonella-Shigella agar, and Campylobacter blood agar (Oxoid Ltd., UK). Bacterial identification was confirmed via the VITEK 2 automated system (bioMérieux, France) while antimicrobial susceptibility testing followed Clinical and Laboratory Standards Institute (CLSI) standards with disk diffusion method on Mueller-Hinton agar plates.

Molecular identification of viral pathogens, such as the rotavirus, norovirus, and adenovirus, was undertaken through real-time polymerase chain reaction (RT-PCR) employing the Allplex GI-Virus Assay (Seegene Inc., South Korea) on the CFX96 Touch Real-Time PCR Detection System (Bio-Rad Laboratories, USA). Parasitological examinations were performed using direct wet mounts and concentration techniques employing formalin-ethyl acetate sedimentation method, followed by modified acid-fast staining for identification of Cryptosporidium and Cyclospora species.

Clinical data obtained consisted of patient demographics, underlying comorbidities, medication history focusing on antibiotic exposure, duration of hospital stay, ward type, invasive procedures, and clinical outcomes. Healthcare-associated factors measuring hand hygiene compliance, isolation precautions, and environmental contamination were assessed by means of structured observation and environmental sampling protocols.

2.4. Ethical Considerations

The protocol received approval from the research ethics committee of ministry of health. Written informed consent was obtained from parents or guardians prior to undertaking the research in accordance with regulatory and ethical standards. Participation was voluntary and participants were free to withdraw at any time without compromising care. Confidentiality was maintained through coded

identifiers and data access was restricted. The study adhered to the Declaration of Helsinki (2013) and applicable local regulations.

2.5. Statistical Analysis

Analysis of the data was conducted using the Statistical Package for the Social Sciences (SPSS), Version 27.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were computed to summarize demographic and clinical characteristics such as means, standard deviations, frequencies, and percentages. Inferential analyses consisted of the Chi-square (χ^2) test for categorical variables and the Kruskal–Wallis H test to compare continuous non-normally distributed variables across hospitals. A p-value of less than 0.05 was determined to be statistically significant.

3. Results

Table 1 presents the demographic characteristics of 300 patients diagnosed with HAD across three hospitals in Among the total participants, males constituted 170 (56.6%) and females 130 (43.4%), with no significant difference in sex distribution among hospitals (p = 0.403). Regarding residence, 157 patients (52.3%) were from urban areas and 143 (47.7%) from rural areas, also without significant variation across hospitals (p = 0.234). The mean age of participants was 10.41 ± 5.06 years, with patients from Erbil Teaching, Rizgary, and West Erbil Hospitals having mean ages of 10.70 ± 3.87, 8.96 ± 4.20, and 11.57 ± 6.41 years, respectively, showing a statistically significant difference (p <0.001).

Table 1. Demographic characteristics of the participants (N=300).

Variables		Hospitals			Total	P-value
		Erbil Teaching	Rizgary	West Erbil		
Sex	Male	62 (36.5%)	55 (32.4%)	53 (31.1%)	170 (56.6%)	0.403
	Female	38 (29.2%)	45 (34.6%)	47 (36.2%)	130 (43.4%)	
	Total	100 (33.3%)	100 (33.3%)	100 (33.3%)	300 (100%)	
Residence	Urban	58 (36.9%)	46 (29.3%)	53 (33,8%)	157 (52.3%)	0.234
	Rural	42 (29.4%)	54 (37.8%)	47 (32.9%)	143 (47.7%)	
	Total	100 (33.3%)	100 (33.3%)	100 (33.3%)	300 (100%)	
Age	Mean ± SD	10.70 ± 3.87	8.96 ± 4.20	11.57 ± 6.41	10.41 ± 5.06	<0.001

Chi-square test (χ^2); Kruskal–Wallis test

Table 2 summarizes the main clinical characteristics of 300 patients with HAD. The majority of cases were found in medical wards (122; 40.7%), followed by surgical wards (100; 33.3%), while the fewest were in pediatric intensive care units (78; 26.0%), showing a highly significant difference among hospitals (p < 0.001). The mean length of hospital stay was 12.33 ± 7.46 days, considerably longer in West Erbil Hospital (16.22 ± 7.47 days) compared with Rizgary (7.99 ± 6.79 days) and Erbil Teaching (12.79 ± 5.61 days), which was statistically significant (p < 0.001).

Table 2. Clinical information of participants (n=300).

Variables		Hospitals			Total	P-value
		Erbil Teaching	Rizgary	West Erbil		
Ward type	Medical	45 (36.8%)	49 (40.2%)	28 (23.0%)	122 (40.67%)	<0.001
	Surgical	23 (23.0%)	38 (38.0%)	39 (39.0%)	100 (33.3%)	
	PICU	32 (41.0%)	13 (16.7%)	33 (42.3%)	78 (26.0%)	
	Total	100 (33.3%)	100 (33.3%)	100 (33.3%)	300 (100%)	
Length of stay (days)		12.79 ± 5.61	7.99 ± 6.79	16.22 ± 7.47	12.33 ± 7.46	<0.001

Chi-square test (χ^2); Kruskal–Wallis test

Table 3 presents the main clinical characteristics of diarrhea episodes among 300 patients with HAD. The average frequency of diarrhea was 5.85 ± 2.82 times per day, with patients in West Erbil Hospital reporting the highest frequency (7.50 ± 2.89) compared with those in Erbil Teaching (5.40 ± 2.59) and Rizgary Hospitals (4.64 ± 2.13) ($p < 0.001$). The majority of cases were moderate in severity (119; 39.7%), followed by mild (102; 34.0%), and severe (79; 26.3%), with no significant difference across hospitals ($p = 0.704$). Regarding stool consistency, loose stools were most common (106; 35.3%), followed by semi-formed (97; 32.4%) and watery consistency (97; 32.3%), showing a significant difference between hospitals ($p = 0.031$). Most patients did not have blood in the stool (214; 71.3%), while 86 (28.7%) presented with bloody diarrhea, a difference that was statistically significant across the three hospitals ($p = 0.002$). The presence of mucus in stool was noted in 128 (42.7%) patients, while 172 (57.3%) had none, also differing significantly between hospitals ($p = 0.009$).

Table 3. Characteristics of diarrhea in participants (n=300).

Variables		Hospitals			Total	P-value
		Erbil Teaching	Rizgary	West Erbil		
Frequency per day		5.40 ± 2.59	4.64 ± 2.13	7.50 ± 2.89	5.85 ± 2.82	<0.001
Severity grade	Mild	33 (32.4%)	35 (34.3%)	34 (33.3%)	102 (34.0%)	0.704
	Moderate	43 (36.1%)	41 (34.5%)	35 (29.4%)	119 (39.7%)	
	Sever	24 (30.4%)	24 (30.4%)	31 (39.2%)	79 (26.3%)	
	Total	100 (33.3%)	100 (33.3%)	100 (33.3%)	300 (100%)	
Consistency	Watery	40 (41.2%)	21 (21.6%)	36 (37.1%)	97 (32.3%)	0.031
	Loose	35 (33.0%)	38 (35.8%)	33 (31.1%)	106 (35.3%)	
	Semi-formed	25 (25.8%)	41 (42.6%)	31 (32.0%)	97 (32.4%)	
	Total	100 (33.3%)	100 (33.3%)	100 (33.3%)	300 (100%)	
Blood in stool	No	71 (33.2%)	83 (38.8%)	60 (28.0%)	214 (71.3%)	0.002
	Yes	29 (33.7%)	17 (19.8%)	40 (46.5%)	86 (28.7%)	
	Total	100 (33.3%)	100 (33.3%)	100 (33.3%)	300 (100%)	
Mucus in stool	No	48 (27.9%)	69 (40.1%)	55 (32.0%)	172 (57.3%)	0.009
	Yes	52 (40.6%)	31 (24.2%)	45 (42.7%)	128 (42.7%)	
	Total	100 (33.3%)	100 (33.3%)	100 (33.3%)	300 (100%)	

Kruskal-Wallis H; Chi-Square Tests

Table 4 highlights major risk factors associated with HAD among 300 patients across Erbil Teaching, Rizgary, and West Erbil Hospitals. Most patients had a history of antibiotic exposure (220; 73.3%), showing a highly significant difference among hospitals ($p < 0.001$). The most frequently used antibiotics were meropenem (58; 19.3%), azithromycin (50; 16.7%), and ciprofloxacin (42; 14.0%), with variations across hospitals ($p = 0.001$). The mean duration of antibiotic use was 5.95 ± 4.71 days, differing significantly among hospitals ($p = 0.005$). More than half of the patients reported proton pump inhibitor (PPI) use (171; 57.0%), which was significantly different among hospitals ($p = 0.006$). Regarding invasive procedures, endoscopy (104; 34.7%) was the most common, followed by catheterization (68; 22.7%), with notable differences among hospitals ($p < 0.001$). In addition, nasogastric tube insertion was performed in 58 (31.4%) patients at Erbil Teaching, 72 (38.9%) at Rizgary, and 55 (29.7%) at West Erbil, totaling 185 (61.7%), also significant ($p = 0.031$).

Table 4. Risk factors for diarrhea among patients.

Variables	Hospitals	Total	P-value

		Erbil Teaching	Rizgary	West Erbil		
Antibiotic exposure	No	29 (36.3%)	12 (15.0%)	39 (48.8%)	80 (26.7%)	<0.001
	Yes	71 (32.3%)	88 (40.0%)	61 (27.7%)	220 (73.3%)	
	Total	100 (33.3%)	100 (33.3%)	100 (33.3%)	300 (100%)	
Antibiotic type	No	29 (36.3%)	12 (15.0%)	39 (48.8%)	80 (26.7%)	0.001
	Penicillin	14 (36.8%)	12 (31.6%)	12 (31.6%)	38 (12.7%)	
	Meropenem	14 (24.1%)	29 (50.0%)	15 (25.9%)	58 (19.3%)	
	Azithromycin	15 (30.0%)	24 (48.0%)	11 (22.0%)	50 (16.7%)	
	Ciprofloxacin	14 (33.3%)	15 (35.7%)	13 (31.0%)	42 (14.0%)	
	Metronidazole	14 (33.3%)	8 (25.0%)	10 (31.3%)	32 (10.7%)	
	Total	100 (33.3%)	100 (33.3%)	100 (33.3%)	300 (100%)	
Duration of antibiotics		7.18 ± 5.53	5.54 ± 3.55	5.14 ± 4.63	5.95 ± 4.71	0.005
PPI use	No	49 (38.0%)	30 (23.3%)	50 (38.8%)	129 (43.0%)	0.006
	Yes	51 (29.8%)	70 (41.0%)	50 (29.2%)	171 (57.0%)	
	Total	100 (33.3%)	100 (33.3%)	100 (33.3%)	300 (100%)	
Invasive procedures	None	27 (38.0%)	19 (26.8%)	25 (35.2%)	71 (23.7%)	<0.001
	Catheter	25 (36.8%)	18 (26.5%)	25 (36.8%)	68 (22.7%)	
	Endoscopy	25 (24.0%)	53 (51.0%)	26 (25.0%)	104 (34.7%)	
	Intubation	23 (40.4%)	10 (17.5%)	24 (42.1%)	57 (19.0%)	
	Total	100 (33.3%)	100 (33.3%)	100 (33.3%)	100 (33.3%)	
Nasogastric tube	No	42 (36.5%)	28 (24.3%)	45 (39.1%)	115 (38.3%)	0.031
	Yes	58 (31.4%)	72 (38.9%)	55 (29.7%)	185 (61.7%)	
	Total	100 (33.3%)	100 (33.3%)	100 (33.3%)	100 (33.3%)	

Kruskal-Wallis H; Chi-Square Tests

Among the 300 patients included across three hospitals, pathogens were identified in 67 (33.5%) cases at Erbil Teaching Hospital, 65 (32.5%) at Rizgary Hospital, and 68 (34.0%) at West Erbil Hospital, amounting to a total of 200 (66.7%) positive cases (0.900) (Figure 1).

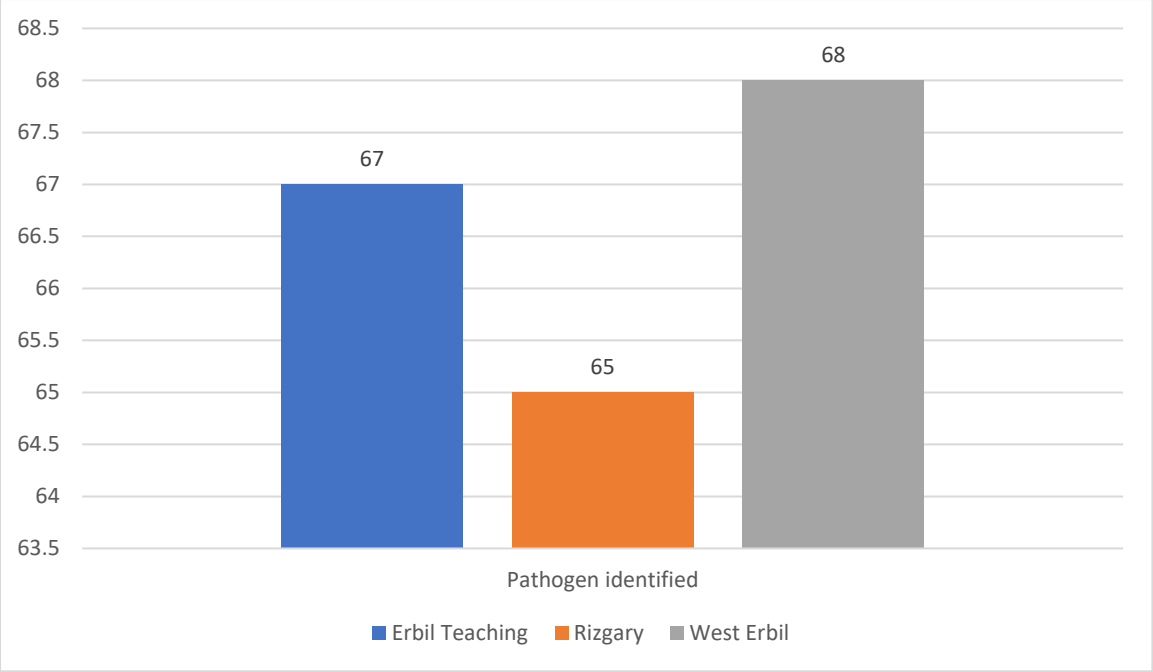

Figure 1. Distribution of Pathogen Identification Across Hospitals.

Across the three hospitals, a variety of bacterial, viral, and parasitic pathogens were detected among patients with HAD. For bacterial pathogens, E. coli was identified in 6 (20.7%) patients from Erbil Teaching Hospital, 15 (51.7%) from Rizgary, and 8 (27.6%) from West Erbil, totaling 29 (9.7%); Salmonella in 5 (33.3%), 6 (40.0%), and 4 (26.7%), respectively, totaling 15 (5.0%); C. difficile in 19 (48.7%), 11 (28.2%), and 9 (23.1%), totaling 39 (13.0%); and Shigella in 8 (61.5%), 3 (23.1%), and 2 (15.4%), totaling 13 (4.3%). The distribution of bacterial pathogens differed significantly among hospitals ($p = 0.043$). Viral pathogens were less frequent, identified in cases with rotavirus (30; 10.0%), norovirus (22; 7.3%), and adenovirus (15; 5.0%), without a statistically significant difference among hospitals ($p = 0.239$). Parasitic infections were rare, with Giardia lamblia (23; 7.7%) and Cryptosporidium spp. (15; 5.0%), showing no significant variation ($p = 0.504$). The mean white blood cell count was $11.24 \pm 3.97 \times 10^3/\mu L$, ranging from 10.40 ± 4.08 in Rizgary Hospital to 11.81 ± 3.77 in Erbil Teaching Hospital, with a statistically significant difference among hospitals ($p = 0.030$) (Table 5).

Table 5. Identified Pathogens and Laboratory Findings Among Patients with HAD.

Variables		Hospitals			Total	P-value
		Erbil Teaching	Rizgary	West Erbil		
Bacterial pathogens	E. coli	6 (20.7%)	15 (51.7%)	8 (27.6%)	29 (9.7%)	0.043
	Salmonella	5 (33.3%)	6 (40.0%)	4 (26.7%)	15 (5.0%)	
	C.diff	19 (48.7%)	11 (28.2%)	9 (23.1%)	39 (13.0%)	
	Shigella	8 (61.5%)	3 (23.1%)	2 (15.4%)	13 (4.3%)	
Viral pathogens	Rotavirus	5 (14.3%)	9 (11.7%)	16 (53.3%)	30 (10.0%)	0.239
	Norovirus	7 (31.8%)	7 (31.8%)	8 (36.4%)	22 (7.3%)	
	Adenovirus	4 (26.7%)	5 (33.3%)	6 (40.0%)	15 (5.0%)	
Parasitic pathogens	Giardia	9 (39.1%)	4 (17.4%)	10 (43.5%)	23 (7.7%)	0.504
	Cryptosporidium	6 (40.0%)	5 (33.3%)	4 (26.7%)	15 (5.0%)	

WBC count ($10^3/\mu L$)	11.81 ± 3.77	10.40 ± 4.08	11.51 ± 3.96	11.24 ± 3.97	0.030

Kruskal-Wallis H; Chi-Square Tests

4. Discussion

Hospital-acquired diarrhea (HAD) remains a common complication of inpatient care, caused by a combination of clinical and iatrogenic factors. The aim of this study was to determine the etiology, risk factors for HAD, and to describe patient demographics, clinical severity, and pathogens tested for across three hospitals in Erbil, Iraq. The main findings include: two-thirds of cases had an identifiable pathogen, with C. difficile, rotavirus, and E. coli among the most common; cases often reported prior exposure to an antibiotic, PPI and/or invasive procedure, and NG tube use; diarrhea was usually characterized between mild to moderate severity; and length of stay differed vastly between hospitals.

The predominance of antibiotic-associated etiology in this research corresponds with recent literature documenting the central role of antimicrobial therapy in disrupting the normal gut microbiota. Investigators have recently shown that exposure to antibiotic agents is the single most important modifiable risk factor associated with HAD, with broad-spectrum antibiotics the highest risk (12, 13). The finding of meropenem (19.3%) and azithromycin (16.7%) being the most frequent antibiotics implicated is supported by the literature indicating that carbapenem and macrolide antibiotics are particularly associated with gastrointestinal events (14, 15). Some studies have reported a higher association of clindamycin and fluoroquinolones with gastrointestinal events, but these conflicts may represent regional differences in antibiotic prescribing practices and resistance mechanisms (16). The mean duration of antibiotic exposure (5.95 days) was shorter than the course of 7-14 days generally associated with increased risk of diarrhea in the UK and European population, which may also reflect differences in prescribing practice or disease severity among the cohorts (17, 18).

The relatively high use of proton pump inhibitors (PPIs) found in this study (57.0%) as an independent risk factor supports the growing literature on acid suppression therapy and nosocomial gastrointestinal infections (19, 20). Recent studies have demonstrated that PPI therapy increases susceptibility to enteric pathogens by modifying gastric pH levels and the gastric acid barrier. This is particularly concerning in light of the well-documented increased use of PPIs in hospitalized patients for stress ulcer prophylaxis (21).

The results of the microbial epidemiology reveal a complex distribution of pathogens, which are both globally and regionally distinct. C. difficile emerged as the most common bacterial pathogens (13.0%), followed by E. coli (9.7%), Salmonella (5.0%), and Shigella (4.3%). The findings are partially compatible with recent studies from China, where Li et al. reported C. difficile infected 11.8% of HAD (22). It is important to note that the prevalence of E. coli as a hospital-acquired pathogen in this study was much higher than reported in Western countries where C. difficile typically accounts for 15-25% of cases. This difference may relate to the local difference in infection control, antibiotic prescribing or the local microbial ecology (23). The identification of viral pathogens, such as rotavirus (10.0%) and norovirus (7.3%) and adenovirus (5.0%), demonstrates the complex, multifactorial nature of HAD (24).

The determination of invasive procedures as major risk factors, with endoscopy being the most prevalent (34.7%), catheterization (22.7%), and the insertion of a nasogastric tube (61.7%), emphasizes the role of procedural risks in the development of nosocomial infections. This finding corroborates more recent studies demonstrating that invasive procedures disrupt normal barrier functions and creates conduits to allow for the translocation of pathogens (25, 26).

5. Conclusions

This research presents the first detailed investigation into HAD in the major tertiary hospitals in Erbil, with identification of an infectious etiology in two-thirds of the cases, mainly of bacterial origin, with C. difficile as the most frequent pathogen identified. The significant associations with broad-spectrum antimicrobial exposure, PPI exposure and invasive procedures highlight the multifactorial nature of HAD and the need for timely intervention to create a robust infection prevention and antimicrobial stewardship program. The findings emphasize the need for consideration of the use of targeted

diagnostic screening, responsible antimicrobial policies, and ongoing staff training to mitigate the burden of hospital-associated diarrhea to help improve patient safety and strengthen evidence-based infection control practices in the Kurdistan Region's health care system.

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