Vietnam Journal of Community Medicine, Vol. 67, English version No. 1, 2026, 39-42

# THE PREVALENCE OF ENTEROBACTERIACEAE INFECTIONS IN THE SURGERY DEPARTMENT OF TRA VINH GENERAL HOSPITAL

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Received: 02/03/2026
Revised: 12/04/2026; Accepted: 18/05/2026

## ABSTRACT

Antibiotic resistance among *Enterobacteri*aceae has become a serious threat to human health. Therefore, studying the prevalence of *Enterobacteri*aceae infections is essentia, as it helps determine the level of infection caused by this bacterial family and thereby supports appropriate and effective antibiotic treatment strategies.

**Objective:** To determine the prevalence of *Enterobacteri*aceae infections in the Surgery Department of Tra Vinh General Hospital. Methods: A descriptive cross-sectional study was conducted on 115 isolates obtained from clinical specimens of patients undergoing the treatment in the Surgery Department of Trà Vinh General Hospital from May 2024 to August 2024.

**Results:** The highest infection rate was observed in patients aged 40–60 years (40%), followed by those over 60 years (36.5%). The infection rate of *E. coli* accounted for 68.7%, *Klebsiella* spp. for 13%, *Enterobacter* spp. for 8.7%, *Proteus* spp. for 3.5%, and other intestinal bacteria for 6.1%.

**Conclusion:** It is necessary to raise patients' awareness of adherence to wound care and personal hygiene procedures to prevent infections, as well as to closely monitor infection control practices and hospital infection prevention behaviors among healthcare workers to reduce infection rates during patient treatment.

***Keywords:*** Bacteria, Infection rate, *Enterobacteri*aceae, Surgery Department, Tra Vinh General Hospital.

## 1. INTRODUCTION

Currently, antibiotic resistance among *Enterobacteri*aceae has become a particular concern in developing countries. These Gram-negative bacteria are increasingly exhibiting resistance to carbapenems and third-generation cephalosporins, largely due to their ability to produce beta-lactamases [1].

In 2017, the World Health Organization released a list of twelve antibiotic-resistant bacterial pathogens that pose serious threats to human health. Among them, the *Enterobacteri*aceae family was identified as one of the three groups exhibiting critically high levels of antimicrobial resistance [2]. Members of this family are classified into several groups based on their biochemical characteristics, including commonly encountered genera such as *Escherichia*, *Citrobacter*, *Klebsiella*, *Enterobacter*, and *Proteus*. They are found predominantly in the lower gastrointestinal tract but are also present in the genitourinary tract and the oropharynx [3]. Infections caused by members of the *Enterobacteri*aceae family complicate the selection of appropriate antimicrobial therapy, and the use of inadequate or inappropriate antibiotics further promotes the development of resistance. This situation leads to prolonged hospitalization, increased treatment costs—with substantial economic impacts on individuals, families, and society—and is associated with a higher risk of mortality. In 2021, Bahman Mirzaei and colleagues conducted a study entitled "Prevalence of *Enterobacteri*aceae Infections and the Rate of Multidrug Resistance Among Clinical Isolates". The study estimated the prevalence of clinically isolated *Enterobacteri*aceae from 2,645 clinical specimens, of which 297 samples (11.2%) were confirmed as *Enterobacteri*aceae. Among these, *E. coli* accounted for 93 isolates (31%), *Citrobacter freundii* for 65 isolates (21.9%), *Klebsiella pneumoniae* for 48 isolates (16.2%), *Enterobacter* spp. for 43 isolates (14.5%), and *Proteus* spp. for 23 isolates (7.7%). The resistance rate of *Enterobacteri*aceae to ampicillin was 81.1%, and to cephalexin was 80.9%, indicating that these antibiotics exhibited the highest resistance levels. Therefore, preventive measures are required to eliminate these bacteria from hospital environments [4]. Another study conducted in 2022 by Truong Anh Dung and Phan Van Tinh, entitled "Assessment of Antibiotic Resistance Patterns in Bacterial Isolates at Ho Chi Minh City Oncology Hospital", reported a total of 313 clinical isolates. Among these, *E. coli* accounted for 18.8%, *Enterobacter* for 10.9%, K. pneumoniae for 7.7%, and *Proteus mirabilis* for 4.2%. In addition, members of the *Enterobacteri*aceae family exhibited a high resistance rate (74.6%) to second- and third-generation cephalosporins, whereas the antibiotic with the lowest resistance rate was imipenem (3.4%), a carbapenem agent [5].

Given the aforementioned situation, investigating the prevalence of *Enterobacteri*aceae infections is critically important in the current context, as it enables timely and effective therapeutic decision-making based on the detection of infection levels caused by this bacterial family. At present, there is a lack of comprehensive studies on the prevalence of *Enterobacteri*aceae infections at Tra Vinh General Hospital. Therefore, we conducted the study entitled "Determination of the Prevalence of *Enterobacteri*aceae Infections in the Surgery Department of Tra Vinh General Hospital" in order to assess the actual infection rate within the

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hospital and to propose appropriate management strategies that enhance the effectiveness of antibiotic use.

## 2. MATERIALS AND METHODS

### 2.1. Study subjects

*Enterobacteri*aceae bacteria were isolated from clinical specimens of inpatients in the Surgery Department who were indicated for culture, identification, and antimicrobial susceptibility testing.

- Inclusion Criteria: All isolated *Enterobacteri*aceae strains with available antimicrobial susceptibility test results were included.

- Exclusion Criteria:

+ *Enterobacteri*aceae isolated from different specimens of the same patient.

+ The same bacterial species isolated from the same specimen in subsequent occasions.

### 2.2. Study Design and Methods

***2.2.1. Study Design:*** Descriptive cross-sectional study.

***2.2.2. Study site, duration, and sample size***

The study was conducted in the Surgery Department of Tra Vinh Provincial General Hospital from May 2024 to August 2024.

Sample size:

$$n = Z^2_{1-\alpha/2} \frac{p(1-p)}{d^2}$$

In which:

n: The required sample size.

$Z_{1-\alpha/2}$ : The Z-score corresponding to the confidence level. For a 95% confidence interval (CI), this value is $Z_{1-\alpha/2} = 1.96$.

d: The allowable margin of error in the study (d = 0.08)

p: The prevalence of *Enterobacteri*aceae infection in patients, chosen as p = 78% (The prevalence of *Enterobacteri*aceae infections according to the study by Que Anh Tram in 2022 at Huu Nghi Hospital) [6].

Based on the above formula, the minimum required sample size for the study was 103 samples. The total number of samples collected in the study was 115.

***2.2.3. Data collection and processing methods***

Study samples were taken from archived microbiology records of inpatients at the Surgery Department of Tra Vinh Provincial General Hospital. *Enterobacteri*aceae strains were identified and tested for antibiotic susceptibility using the WalkAway 96 Plus automated system. The data were entered using Microsoft Excel and analyzed with Stata version 14.0.

### 2.3. Research Ethics

The study was reviewed and approved by the Biomedical Research Ethics Committee of Tra Vinh University under decision number 235/GCT-HĐĐĐ, evaluated through an expedited review process and approved on May 15, 2024

## 3. RESEARCH RESULTS

### 3.1. Characteristics of the Study Population

**Table 1, General Characteristics of the Study Participants**

| Characteristic | n=115 | % |
|---|---|---|
| Age (Years): Mean ± SD | 52,70 ± 17,66 | |
| **Age Group** | | |
| <40 years | 27 | 23,5 |
| 40 - 60 years | 46 | 40,0 |
| >60 years | 42 | 36,5 |
| **Sex** | | |
| Male | 59 | 51,3 |
| Female | 56 | 48,7 |
| **Department** | | |
| General Surgery 1 | 91 | 79,1 |
| General Surgery 2 | 7 | 6,1 |
| Trauma and Orthopedic Surgery | 14 | 12,2 |
| Neurosurgery | 3 | 2,6 |

The patients had a mean age of 52.7 years, with the 40–60 age group representing the highest proportion at 40%. Male patients were more prevalent than female patients, and the majority of patients were admitted to General Surgery Department 1, accounting for 79.1%.

### 3.2. Prevalence of isolated *Enterobacteriaceae* strains

**Table 2. Prevalence of isolated bacterial strains**

| Bacterial strain | n=115 | % |
|---|---|---|
| *Escherichia coli* | 79 | 68,7% |
| *Klebsiella spp.** | 15 | 13,0% |
| *Enterobacter spp.*** | 10 | 8,7% |
| *Proteus spp.**** | 4 | 3,5% |
| Other *Enterobacteriaceae* ***** | 7 | 6,1% |

**: Klebsiella pneumoniae, Klebsiella oxytoca;*
***: Enterobacter cloacae, Enterobacter aerogenes;*
****: Proteus mirabilis, Proteus vulgaris;*
*****: Salmonella enterica, Citrobacter murliniae, Serratia marcescens, Kluyvera ascorbata, Morganella morganii, Citrobacter werkmanii.*

Among the 115 samples collected, *E. coli* was the most prevalent strain, accounting for 68.7%, followed by *Klebsiella* spp. at 13.0%, *Enterobacter* spp. at 8.7%, while other enteric bacteria accounted for the lowest proportion (Salmonella enterica, *Citrobacter* murliniae, Serratia marcescens, Kluyvera ascorbata, Morganella morganii, *Citrobacter* werkmanii)

### 3.3. Prevalence of *Enterobacteriaceae* isolates according to different types of clinical specimens

**Table 3. Prevalence of bacteria isolated by specimen type**

| Bacterial strain (n=115) | Specimen | | | |
|---|---|---|---|---|
| | Sputum n (%) | Urine n (%) | Pus n (%) | Abdominal cavity fluid n (%) |
| *E. coli* (n=79) | 1 (1,3%) | 6 (7,6%) | 9 (11,4%) | 63 (79,7%) |
| *Klebsiella* spp. (n=15) | 0% | 1 (6,7%) | 3 (20,0%) | 11 (73,3%) |

| Bacterial strain (n=115) | Specimen | | | |
|---|---|---|---|---|
| | Sputum n (%) | Urine n (%) | Pus n (%) | Abdominal cavity fluid n (%) |
| *Enterobacter* spp. (n=10) | 0% | 0% | 6 (60,0%) | 4 (40,0%) |
| *Proteus* spp. (n=4) | 0% | 1 (25,0%) | 2 (50,0%) | 1 (25,0%) |
| Other *Enterobacteriaceae* (n=7) | 0% | 0% | 3 (42,9%) | 3 (57,1%) |

Our study shows a high prevalence of pathogenic *E. coli* in abdominal cavity fluid samples (79.7%), followed by pus samples (11.4%) and urine samples (7.6%).

## 4. DISCUSSION

From May 2024 to August 2024, our study recorded 115 clinical specimens from inpatients in the Surgery Department of Tra Vinh General Hospital. The patients had a mean age of 52.7 years, with the 40–60 age group representing the highest proportion at 40%. Male patients were more prevalent than female patients, and the majority of patients were admitted to General Surgery Department 1, accounting for 79.1%.

Our study results are also quite consistent with the findings of Nguyen Vinh Nghi and colleagues (2023) [7] at Ninh Thuan Hospital, where the 40–60 age group accounted for 46.8%. This is a relatively older patient group, with reduced resistance and immune capacity, making them more susceptible to infectious diseases.

Regarding gender, our results are quite consistent with those of several other studies. For instance, the study by Hong Thi Khanh Ngan (2022) [8] at Binh Dan Hospital reported that female patients accounted for 48.74% and male patients for 51.26%. Similarly, the study by Nguyen Vinh Nghi and colleagues (2023) [7] found that among patients infected with Gram-negative enteric bacteria, 54% were female and 46% were male. In contrast, the proportion of female patients in our study was higher than that reported by Hong Thi Xuan Lieu (2023) [9], whose study at Can Tho City General Hospital found that females accounted for 38.9%.

Regarding the department of the study subjects, the results indicated that inpatients in General Surgery Department 1 at Tra Vinh General Hospital had a significantly higher rate of *Enterobacter*iaceae infections compared to other surgical department. This is because General Surgery Department 1 primarily manages and monitors post-operative patients with conditions such as appendiceal peritonitis, gallstone disease, and anorectal abscesses. These conditions are related to the gastrointestinal system, which predisposes patients to a higher risk of infections.

The prevalence of *E. coli* isolated in our study was quite similar to that reported by Hoang Huynh Huong (2021) [10] Study on antibiotic resistance status of some strains of *Enterobacter*iaceae causing sepsis isolated at Thai Binh general hospital in 2018 - 2019, with *E. coli* accounting for 66% of the isolates; However, the prevalence of *E. coli* in our study was higher than that reported in other studies, such as Nguyen Vinh Nghi et al. (2023) [7], where *E. coli* accounted for 57.1%; Pham Thi Van et al. (2023) [11] at E Hospital, with a prevalence of 53.0%; Mohammad Aminul Islam et al. (2022) [12] in Bangladesh, where *E. coli* accounted for 51.6%; and Feleke Moges et al. (2021) [13] in Ethiopia, with a prevalence of 32.6%.

Regarding the prevalence of *Klebsiella* spp. in our study, it was similar to the findings of Mohammad Aminul Islam et al. (2022) [12] in their study on the prevalence, etiology, and antibiotic resistance patterns of community-acquired urinary tract infections in Dhaka, Bangladesh, which reported a *Klebsiella* spp. prevalence of 12.1%. However, our results were lower than those reported by Feleke Moges et al. [13], with a prevalence of 26.5%, and Nguyen Vinh Nghi [7], who reported a prevalence of 34.5%.

The prevalence of *Enterobacter* spp. in our study was higher than that reported in several other studies, including Hoang Huynh Huong [10], where *Enterobacter* spp. accounted for 5%; Pham Thi Van et al. [11], with a prevalence of 4.4%; James Sampah [14] in Ghana, where the prevalence was 3.5%; and Nguyen Vinh Nghi [7], with a prevalence of 0.9%. Conversely, our results were lower than those reported by Bahman Mirzaei et al. [4] in Iran, where *Enterobacter* spp. accounted for 14.5% of isolates.

Regarding the prevalence of *Proteus* spp., our findings were quite similar to those of Pham Thi Van [11], who reported a prevalence of 3.4%. However, our results were lower than those reported by Feleke Moges et al. [13], with a prevalence of 9.2%, as well as lower than the findings of Bahman Mirzaei et al. [4] and Nguyen Vinh Nghi (2023) [7], where *Proteus* spp. accounted for 7.7% and 7.5% of isolates, respectively.

Results from both domestic and international studies indicate that the prevalence of *Enterobacter*iaceae, including *E. coli*, *Klebsiella* spp., *Enterobacter* spp., and *Proteus* spp., varies across different regions, countries, and studies. These differences may be attributed to the demographic characteristics of the local population or the specific study area. In addition, variations in the timing and location of hospital-based studies may also contribute to these discrepancies.

Our study shows a high prevalence of pathogenic *E. coli* in abdominal cavity fluid samples (79.7%), followed by pus samples (11.4%) and urine samples (7.6%). The prevalence in our study was lower compared to that reported by Phan Nu Dieu Hong (2021) [1], where pus specimens accounted for 30.8%, and lower than the findings of Danh Tien Thanh et al. [15], with *E. coli* detected in 20.7% of pus specimens and 50% of urine specimens. Regarding *Klebsiella* spp., the highest prevalence was observed in abdominal cavity fluid specimens (73.3%), followed by pus (20.0%) and urine (6.7%). Our results did not align with the study by Hoang Thi Hau et al. (2024) [16], which reported prevalence rates of 20.9% in urine specimens and 14.7% in fluid and pus specimens; For *Enterobacter* spp., the prevalence was 60.0% in pus specimens and 40.0% in abdominal cavity fluid specimens, which did not correspond with the findings of Danh Tien Thanh et al., who reported *Enterobacter* spp. in 41.4% of pus specimens and 15% of urine specimens [15]. *Proteus* spp. showed the highest prevalence in pus specimens (50.0%), followed by abdominal cavity fluid (25.0%) and urine specimens (25.0%), which was broadly consistent with the findings of Nguyen Van An et al., reporting a prevalence of 21.2% in urine specimens [17], and also comparable to the study by Nguyen Trung Binh et al., where *Proteus mirabilis* accounted for 58% in pus and 37% in urine specimens [18].

Our study also revealed some discrepancies in the prevalence of *Enterobacter*iaceae species compared to several domestic and international studies. These differences may be attributed, in part, to variations in sample size, study population, and study settings.

## 5. CONCLUSIONS AND RECOMMENDATIONS

The prevalence of *Enterobacter*iaceae infections in the General Surgery Department 1 was relatively high. Patients aged 40 years and older accounted for the highest proportion of *Enterobacter*iaceae infections at 40%, while those over 60 years accounted for 36.5%. Among the isolates, *E. coli* accounted for 68.7%, *Klebsiella* spp. for 13.0%, *Enterobacter* spp. for 8.7%, *Proteus* spp. for 3.5%, and other intestinal bacteria (*Salmonella enterica, Citrobacter murliniae, Serratia marcescens, Kluyvera ascorbata, Morganella morganii, Citrobacter werkmanii*) accounted for 6.1%. To help reduce the incidence of infections in patients during treatment, our study proposes the following recommendations: healthcare facilities should promote awareness and enhance patients' adherence to wound care and personal hygiene practices to prevent infections. Simultaneously, strict monitoring of infection prevention protocols and the compliance of healthcare personnel with hospital infection control practices should be ensured.

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