ANALYSIS OF ANTIBIOTIC RESISTANCE IN THE TREATMENT OF SEPSIS CAUSED BY *Escherichia coli* AT CAN THO CITY GENERAL HOSPITAL IN 2022 - 2023

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ABSTRACT

Sepsis is increasingly difficult to control due to the complex and evolving antibiotic resistance of *Escherichia coli* strains, making it a significant challenge in modern medicine. This study analyzes the antibiotic resistance in treating sepsis caused by *E. coli* at Can Tho City General Hospital from 2022 to 2023, based on a cross-sectional descriptive analysis of patient records. The male-to-female ratio was 0.9/1, with 54.8% of patients over 60 years old, 34.2% aged 40-60, and 11% under 40. Among the *E. coli* isolates, 51.2% produced extended-spectrum beta-lactamases (EBSL). The strains showed high resistance to most antibiotics in the Penicillin and Cephalosporin groups, with exceptions like Piperacillin/Tazobactam (19.4%). Resistance rates to Levofloxacin and Ciprofloxacin were also high, at 66.1% and 50.6%, respectively. However, the isolates were highly sensitive to Amikacin (92.8%), Imipenem (83.3%), and Ertapenem (83.3%). Based on these findings, Amikacin, Imipenem, Ertapenem, and Piperacillin/Tazobactam are recommended for empirical treatment in sepsis cases caused by *E. coli*, especially when no antibiogram is available, with special attention to elderly patients with pre-existing conditions.

TÌNH HÌNH KHÁNG KHÁNG SINH TRONG ĐIỀU TRỊ NHIỄM KHUẨN HUYẾT DO *Escherichia coli* TẠI BỆNH VIỆN ĐA KHOA THÀNH PHỐ CẦN THƠ GIAI ĐOẠN 2022 - 2023

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TỪ KHÓA

EBSL
Escherichia coli
Kháng kháng sinh
Nhạy cảm kháng sinh
Nhiễm trùng huyết

TÓM TẮT

Nhiễm khuẩn huyết ngày càng khó kiểm soát do tình trạng kháng kháng sinh phức tạp và phát triển của các chủng *Escherichia coli*, trở thành thách thức lớn trong y học hiện đại. Nghiên cứu này phân tích tình trạng kháng kháng sinh trong điều trị nhiễm khuẩn huyết do *E. coli* tại Bệnh viện Đa khoa Thành phố Cần Thơ từ năm 2022 đến năm 2023, dựa trên phân tích mô tả cắt ngang các hồ sơ bệnh án. Tỷ lệ nam/nữ là 0,9/1, với 54,8% bệnh nhân trên 60 tuổi, 34,2% từ 40-60 tuổi và 11% dưới 40 tuổi. Trong số các mẫu phân lập *E. coli*, 51,2% sản xuất enzyme beta-lactamase phổ rộng (EBSL). Các chủng này kháng cao với hầu hết các kháng sinh thuộc nhóm Penicillin và Cephalosporin, ngoại trừ Piperacillin/Tazobactam (19,4%). Tỷ lệ kháng Levofloxacin và Ciprofloxacin cũng cao, lần lượt là 66,1% và 50,6%. Tuy nhiên, các chủng này vẫn nhạy cảm cao với Amikacin (92,8%), Imipenem (83,3%) và Ertapenem (83,3%). Dựa trên các kết quả này, Amikacin, Imipenem, Ertapenem và Piperacillin/Tazobactam được khuyến nghị sử dụng để điều trị nhiễm khuẩn huyết do *E. coli* trong trường hợp chưa có kết quả kháng sinh đồ, đặc biệt cần chú ý đối với những bệnh nhân cao tuổi có bệnh nền từ trước.

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1. Introduction

Sepsis is a severe acute infection condition caused by bacteria in the bloodstream, often leading to systemic complications, septic shock, and multiple organ failure, with a high mortality rate ranging from 20-50% [1]. The annual increase in sepsis cases, despite advances in modern medicine, poses a significant burden on healthcare systems globally [2]. *Escherichia coli* (*E. coli*) is a major causative agent of sepsis, known for its severe clinical manifestations and high incidence of septic shock, which contribute to elevated mortality rates [2]. Additionally, even after surviving sepsis, many patients suffer from long-term physical, psychological, and cognitive complications, further emphasizing the impact of the disease [3].

Recent research has demonstrated that prior exposure to microbial pathogens can influence the immune response in sepsis, potentially enhancing the protective effects of CD115(+) monocytes in combating *E. coli* infections, as observed in murine models [4]. However, the challenge of antibiotic resistance in *E. coli* complicates treatment strategies. Cases of multi-drug resistant and extended-spectrum beta-lactamase (ESBL) producing *E. coli* infections have been documented, resulting in fulminant neonatal sepsis and severe pulmonary complications in preterm infants [5], [6]. Such infections not only heighten the risk of mortality but also necessitate prolonged and intensive antibiotic therapies, further complicating patient outcomes [6]. Moreover, integrative omics approaches have revealed conserved and pathogen-specific responses in sepsis-causing bacteria, underlining the need for targeted therapeutic interventions [7].

Given these challenges, this study aims to analyze antibiotic resistance patterns in sepsis caused by *E. coli* at Can Tho City General Hospital during the period 2022-2023, to optimize treatment strategies and mitigate the burden of this life-threatening condition

2. Materials and methods

2.1. Research Subjects

The study focused on patients diagnosed with sepsis caused by *E. coli* at the Can Tho City General Hospital during 2022-2023. The inclusion criteria were patients who met all the necessary standards such as having $\geq 2/4$ criteria of the systemic inflammatory response syndrome and presenting clinical symptoms suggestive of sepsis. Blood cultures must be conducted within the first 48 hours of hospital admission, isolating *E. coli*; patients must had an antibiogram.

The exclusion criteria were patients with blood cultures positive for multiple bacteria or those taken after more than 48 hours of hospitalization. Patients under 18 years of age, HIV-infected patients, or those who did not consent to participate in the study (prospective phase) were also excluded.

2.2. Research Methodology

Study Design: A cross-sectional descriptive study with analysis.

Sample Size: N = 336.

Sampling Method: A convenience sampling approach was employed, where all patients meeting the inclusion criteria were enrolled in the study, with data collected using a standardized case report form designed for the research. Patient information was gathered using a pre-designed research case report form.

Study Content: General characteristics of the study sample; Evaluation of the antibiotic resistance level of *E. coli*.

Data Collection and Processing Method: Data were processed using the SPSS 20.0 statistical software to determine frequencies, proportions, and related factors.

3. Result and Discussion

3.1. General Characteristics of the Study Sample

Table 1. *Characteristics of the Study Subjects*

Characteristic		Number (n)	Percentage (%)
Gender	Male	159	47.3
	Female	177	52.7
Age Group	Under 40	37	11.0
	40-60	115	34.2
	Over 60	184	54.8
Department	ICU	76	22. 6
	General Surgery	61	18.2
	Nephrology	88	26.2
	Other	111	33.0

The male/female ratio is 159/177 (0.9/1); among the age groups, those aged over 60 constitute the highest percentage (54.8%), followed by the 40 - 60 age group (34.2%), and the lowest being the under 40 age group (11.0%); regarding the sampling departments, ICU accounts for 22.6%, General Surgery for 18.2%, Nephrology for 26.2%, and Other departments for 33% (Table 1).

3.2. Assessment of Antibiotic Resistance in E. coli

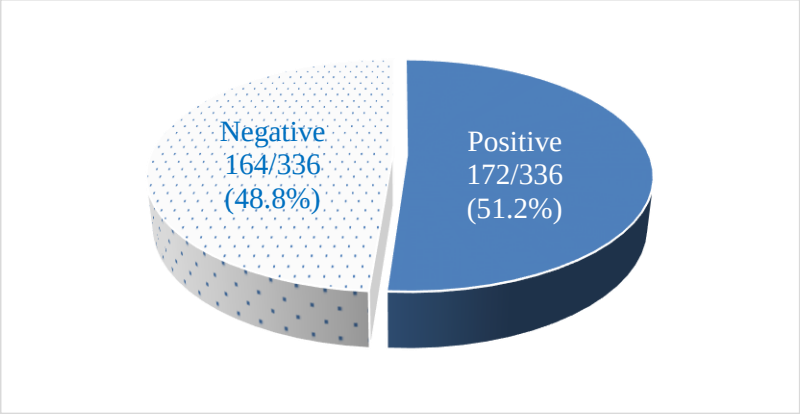

Figure 1. *Proportion of ESBL-producing E. coli strains*

Out of the total samples, the positive rate is 51.2%, and the negative rate is 48.8% (Figure 2).

Table 2. *Antibiotic Resistance Levels of E. coli to Penicillin and Cephalosporin Groups*

Identification	Sensitive n (%)	Intermediate n (%)	Resistant n (%)
Ampicillin	14 (4.2)	105 (31.2)	217 (64.6)
Ampicillin/Sulbactam	88 (26.2)	79 (23.5)	169 (50.3)
Piperacillin/Tazobactam	238 (70.8)	33 (9.8)	65 (19.4)
Ceftazidime	102 (30.4)	82 (24.4)	152 (45.2)
Ceftriaxone	92 (27.4)	72 (21.4)	172 (51.2)
Cefazolin	78 (23.2)	46 (13.7)	212 (63.1)
Cefepime	113 (33.6)	8 (2.4)	215 (64.0)

With the exception of the antibiotic Ampicillin (4.2%), the bacterium *E. coli* exhibits high sensitivity to most antibiotics. Regarding antibiotic resistance levels, the bacteria generally show a high degree of resistance; however, the intermediate resistance levels of *E. coli* are relatively high except for Piperacillin/Tazobactam (9.7%) and Cefepime (2.4%) (Table 2).

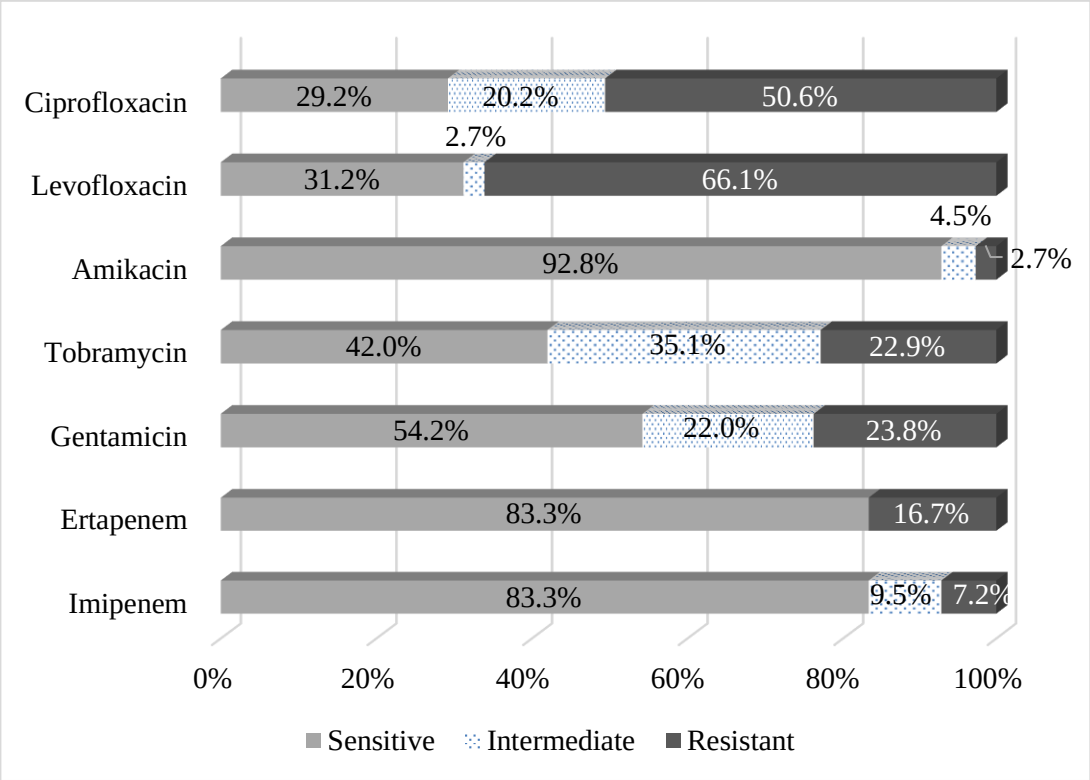

Figure 2. *Antibiotic resistance levels of E. coli to Carbapenem, Quinolone, and Aminoglycoside groups*

The study notes that *E. coli* is most sensitive to the antibiotics Amikacin (92.8%), Ertapenem (83.3%), and Imipenem (83.3%). In terms of antibiotic resistance, aside from Imipenem (7.2%) and Amikacin (2.7%), the bacteria exhibit high resistance levels, particularly to Levofloxacin (66.1%) and Ciprofloxacin (50.6%). The intermediate resistance levels are relatively low, except for Tobramycin (35.1%) and Gentamicin (22.0%) (Figure 2).

Table 3. *Antibiotic resistance levels of ESBL-producing E. coli to β-lactam antibiotic group*

Antibiotic Group		Resistance Rate n(%)		P
		ESBL-producing	Non-ESBL-producing	
Penicilin	Ampicillin	138 (80.2)	79 (48.2)	<0.001
	Ampicillin/Sulbactam	97 (56.4)	72 (43.9)	0.054
	Piperacillin/Tazobactam	47 (28.7)	18 (10.5)	<0.001
Cephalosporin	Ceftazidime	92 (53.5)	60 (36.6)	<0.001
	Ceftriaxone	115 (66.9)	57 (34.8)	<0.001
	Cefazolin	157 (91.3)	55 (33.5)	<0.001
	Cefepime	167 (97.1)	48 (29.3)	<0.001
Carbapenem	Imipenem	21 (12.8)	3 (1.7)	<0.001
	Ertapenem	40 (24.4)	16 (9.3)	<0.001
Quinolon	Levofloxacin	139 (80.8)	83 (50.6)	<0.001
	Ciprofloxacin	105 (61.0)	65 (39.6)	<0.001
Aminoglycoside	Gentamicin	58 (33.7)	22 (13.4)	<0.001
	Tobramycin	43 (26.2)	34 (19.8)	<0.001
	Amikacin	7 (4.3)	1 (0.6)	0.065

ESBL-producing *E. coli* exhibits significantly higher resistance to most antibiotics compared to non-ESBL-producing *E. coli* ($p<0.001$) (Table 3).

3.3. Discussing the General Characteristics of Research Samples

In a study of 336 clinical samples from Can Tho General Hospital, we observed the following: Among three age groups, individuals over 60 years old had the highest rate of bloodstream infections at 54.8%, followed by those aged 40-60 years at 34.2%, and the group under 40 years at the lowest rate of 11%. These findings are consistent with the research of Trinh et al. [1], [8], where patients aged 60 and above accounted for the highest percentage at 53.3%. Similarly, Tran [9] found the highest infection rate in the over-60 age group at 60.8%, followed by the 41-60 age group at 32.1%, the 20-40 age group at 6.3%, and the lowest in the under-20 age group at 0.8%. This indicated a higher incidence of bloodstream infections in the elderly, who often have multiple health conditions such as diabetes, hypertension, and cardiovascular diseases, leading to reduced immunity and increased susceptibility to infections.

Regarding gender, the incidence was 47.3% in males (159 samples) and 52.7% in females (177 samples). This contrasted with the results documented by [9], where the incidence was higher in males at 52.8% compared to females at 47.7%. Overall, the likelihood of contracting bloodstream infections appears to be nearly equal between genders.

Concerning the source of clinical samples, specimens from the ICU department accounted for 22.6%, while those from the general surgery and nephrology departments were 18.2% and 26.2%, respectively, and other departments accounted for 33% of the samples. The infection rates suggest that the potential for bloodstream infection complications is present across all departments. Therefore, it is imperative for all departments to have treatment protocols and preventive measures in place to absolutely prevent hospital-acquired infections.

3.4. Discussing the Evaluation of Antibiotic Resistance in E. coli

The results in this study showed that *E. coli* bacteria were largely resistant to most antibiotics in the Penicillin and Cephalosporin groups, except for Piperacillin/Tazobactam, to which a high sensitivity remains (70.8%). However, there was still a significant minority of *E. coli* bacteria resistant to Piperacillin/Tazobactam (19.4%), differing from Nghiem et al. [10], which reported a resistance rate of only 5.75%. In contrast, *E. coli* bacteria show very high sensitivity to the Carbapenem, Quinolone, and Aminoglycoside antibiotic groups, notably Imipenem (83.3%), Ertapenem (83.3%), and Amikacin (92.8%). Still, a small percentage of *E. coli* bacteria were resistant to these, such as Amikacin (2.7%), Imipenem (7.2%), and a relatively high resistance rate to Ertapenem (16.7%). Although *E. coli* bacteria were quite sensitive to this group of antibiotics, there were drugs like Levofloxacin (66.1%) and Ciprofloxacin (50.6%) to which *E. coli* showed high resistance rates. Comparing the results of the study [10] on the antibiotic resistance of *E. coli*, except for Amipicillin, which showed moderate results, other antibiotics like Imipenem (1.04%), Ertapenem (0%), showed higher resistance rates. The discrepancy was due to significant differences in sample size and the timing of the research, indicating an increase in the resistance level of *E. coli* bacteria to Imipenem and Ertapenem.

Amikacin is an injectable antibiotic, and most strains of *E. coli* are sensitive to this medication, making it highly suitable for treating infections caused by *E. coli*. In addition to this antibiotic, other drugs such as Imipenem, Ertapenem, or Piperacillin/Tazobactam can be used for treatment. However, Ertapenem and Piperacillin/Tazobactam have a relatively high rate of antibiotic resistance, so their clinical use should be carefully considered for patients.

Our research also found that up to 51.2% of the isolated *E. coli* strains produced ESBL, a result that aligns closely with the findings of Nghiem et al. (51.49%) [10], Que (54.5%) [9], and Vo et al. [11] (51.2%). Conversely, the study by Hoang et al. [3] showed a lower prevalence, with only 34.8% of *E. coli* strains producing ESBL, which was less than our trial. The differences between studies may relate to variations in sample sizes, the timing of the research, and regional differences in antibiotic usage practices.

4. Conclusion

This study highlights the increasing antibiotic resistance of *Escherichia coli* strains causing sepsis, particularly in Can Tho City General Hospital during 2022–2023. The findings indicate high resistance rates to Penicillin, Cephalosporins, and fluoroquinolones, while sensitivity remains high for Amikacin, Imipenem, Ertapenem, and Piperacillin/Tazobactam. These antibiotics are crucial for empirical treatment when antibiogram results are unavailable, especially in elderly patients with pre-existing conditions. The research provides practical insights for optimizing antibiotic use, contributing to better management of sepsis and mitigating the impact of drug-resistant *E. coli*. However, the study is limited to a single institution, which may restrict the generalizability of the results.

Future studies should expand to multicenter analyses to assess broader resistance patterns and investigate the efficacy of combination therapies. Enhancing antimicrobial stewardship programs can further support the containment of resistance and improve sepsis treatment outcomes.

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