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Antimicrobial susceptibility pattern of Escherichia coli from various clinical samples of urban health care facilities, Bangladesh

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Abstract

Background: *Escherichia coli is the main cause behind human infections of the urinary tract, ears, wounds, and other tissues. Concern over E. Coli's increasing antibiotic resistance is spreading throughout the world. The aimed of this study to determine antimicrobial susceptibility of E. coli from various clinical sources.* ***Methods:*** *A total of 160 samples of blood urine, wound swab and throat swab were analyzed for identification of bacterial isolates and their antimicrobial susceptibility pattern. Patient data was analyzed using descriptive statistical methods, including sample processing, organism identification, microscopic examination, and antimicrobial sensitivity testing, in accordance with Clinical and Laboratory Standards Institute guidelines.* ***Results:*** *Escherichia coli (E. coli) was isolated from 87 (54.37%) samples. The blood samples contained the majority of the E. Coli, 60 (68.96%), followed by urine 15 (17.24%) and throat swab 07 (8.05%). Nitrofurantoin (40%), nalidixic acid (32.8%), netilmycin (31.8%), and cotrimoxazole (26.9%) had the highest rate of resistance.* ***Conclusions:*** *Escherichia coli exhibits varying antibiotic sensitivity patterns, with high resistance to commonly used antibiotics. Effective antibiotics include nitrofurantoin, nalidixic acid, netilmycin, and cotrimoxazole, suggesting the need for antibiotic sensitivity testing.*

Keywords: *Antimicrobial susceptibility, Escherichia coli, Antibiotics, Bangladesh.*

Introduction

Escherichia coli is a rod-shaped, gram-negative bacterium usually inhabits the lower intestines of humans. It can result in nosocomial infections and is also present in hospital environments (1). Escherichia coli, often known by its widely used abbreviation, E. coli, is a common gut habitant which can be found in water, soil, and vegetation in among humans and animals. Escherichia coli is one of the most common causes of UTIs and also a major pathogen that can lead to bloodstream infections (2), otitis media, wound infections (3), newborn meningitis, and nosocomial pneumonia (4). Escherichia coli is a common cause of food- and water-borne diarrhea in humans, particularly in developing nations (5). It has been associated with multiple deaths, especially in children under the age of five (6,7).

Antimicrobial resistance poses a severe threat to public health worldwide, especially in developing nations where poverty, malnutrition, and infectious illnesses are rampant (8,9,10). It is one of the primary reasons why infectious disorders, such as those brought on by E. coli, fail to respond well to therapy, which raises morbidity, mortality, and healthcare costs (11). Globally, the problem of multidrug-resistant E. Coli is becoming more and more prevalent (12). There are notable regional variances in the incidence and susceptibility profile of E. coli clinical isolates, in addition to notable changes in different populations, clinical samples, and environmental factors.

Treatment of illnesses becomes more difficult when bacterial resistance to drugs increases. Generally speaking, bacteriological testing is not done in up to 95% of instances with severe symptoms before treatment begins. The susceptibility and occurrence profiles of Escherichia coli show notable changes across different populations and environments, in addition to large geographic variances (13). The region has conducted extensive research on the periodic epidemiology of E. coli to identify patterns of antibiotic resistance in individuals suffering from urinary tract infections (3,14). However, there is a need to look into the antibiotic susceptibility patterns of E. coli that has been isolated from different clinical samples in our area. The development of empirical treatment guidelines for E. coli in the region may be improved by the routine monitoring of antibiotic resistance patterns in E. coli from various specimens. The aimed of this study to determine antimicrobial susceptibility of E. coli from various clinical sources at Ad-din Akij Medical College, Khulna.

Methodology

The study was conducted at Ad-din Akij Medical College, Khulna, from May 2023 to December 2023. Data on microorganism culture and sensitivity was collected from blood, urine, wound swabs, and throat swab. 160 unique samples were collected and informed consent was obtained. Patient data was extracted from case sheets, and the collected data was analyzed using descriptive statistical methods. The procedural aspects encompassed sample processing, organism identification, microscopic examination and antimicrobial sensitivity testing (conducted using disc diffusion test in Mueller Hinton agar media,) in accordance with Clinical and Laboratory Standards Institute guidelines (15).

Culture and identification

Blood culture samples were collected aseptically in sterile containers following standard procedures (16). Hand hygiene was performed to reduce contamination risk. Blood culture bottles were inoculated with 8-10 mL of blood and sent to the microbiology laboratory. Urine samples were collected and incubated aerobically at 37ºC for 24-48 hours (17). Pus and throat swab samples were collected from wounds and throat with sterile swab stick and inoculated onto Blood agar, Chocolate agar, and MacConkey agar media. The inoculated samples were stored at room temperature and examined after 24 hours (18,19,20).

Microscopic examination

The colonies obtained from Blood agar and MacConkey agar plate were subjected to gram staining and observation under microscope was noted.

Sensitivity test

Susceptibility to various antimicrobial agents were tested by the disk diffusion method following Clinical and Laboratory Standards Institute (CLSI) guidelines (21). The tested antibiotic discs were amikacin, ciprofloxacin, cefixime, cefotaxime, ceftriaxone, cotrimoxazole, gentamycin, imipenem, levofloxacin, nalidixic acid, colistin, vancomycin, linezolid and nitrofurantoin. Nitrofurantoin used only for urinary isolates. After incubation at 37ºC for 24 hours, diameter of the zone of inhibition was measured and the isolates were classified as susceptible, intermediate and resistant according to CLSI criteria (15).

Results

A total of 160 samples were analyzed for isolation and identification of bacteria and antimicrobial susceptibility testing. E coli was isolated from 87 (54.37%) samples. The highest number of isolates (68.96%) were obtained from the blood samples followed by urine (17.24%), sputum (8.05%) and pus sample (5.75%). (Table -1)..

Table I: Distribution of specimens and culture positivity of E. coli

Sample	Number of samples tested	Positive for E. coli	Positive (%)
Blood	90	60/87	68.96
Urine	30	15/87	17.24
Pus	15	05/87	5.75
Sputum	25	07/87	8.05
Total	**160**	**87/160**	**54.37**

Table II: Age group and gender wise distribution of wound infection

Age group (years)	Male	Female	Total (%)
0-10	29	38	67 (41.87)
11-20	09	15	24 (15)
21-30	13	15	28 (17.5)
31-40	07	09	16 (10)
41-50	05	06	11 (6.87)
51-60	04	05	09 (5.62)
61-70	02	03	05 (3.12)
Total	**65**	**95**	**160 (100)**

The age of the patients ranged from 2 months to 70 years. E. coli was most common in the age group of 0-10 years followed by age group up to 10 years. (Table 2)

Table III: Antimicrobial susceptibility pattern of E. coli isolates.

Antimicrobial Agents	Total Number of isolates tested	Susceptible isolates			
		Total No.	%	Total No.	%
Amikacin	145	130	89.66	15	10.34
Cotrimoxazole	130	95	73.08	35	26.92
Ciprofloxacin	142	115	80.98	27	19.02
Ceftriaxone	145	110	75.86	35	24.14
Gentamycin	148	125	84.45	23	15.55
Imipenem	145	135	93.1	10	6.9
Netilmycin	135	92	68.14	43	31.86
nalidixic acid	125	84	67.2	41	32.8
Cefotaxime	125	95	76	30	24
Linezolid	135	115	85.18	20	14.82
Vancomycin	148	128	86.48	20	13.52
levofloxacin	145	132	91.03	13	8.97
Colistin	135	120	88.88	15	11.12
Nitrofurantoin	15	09	60	06	40

The overall antimicrobial susceptibility pattern of E. coli isolates from various clinical sources is given in the table 3.

Discussion

One of the most frequent bacteria that causes infections is Escherichia coli. Pub-patterns are still seriously threatened by E. Coli's antimicrobial resistance patterns. Overall, E. Coli showed a significant level of resistance to antibiotics in this investigation. The outcome agrees with the conclusions of earlier research (22). In this investigation, the resistance rates were found to be higher than in Khan (23) results and lower than in Iqbal and Patel's and Okonko (25) results. According to studies done in Slovenia (26) and Ethiopia (27), there is a high level of resistance in E. coli to erythromycin and tetracycline. The isolation rate of E. coli in the present study was 54.37% and it was commonly isolated from blood samples (68.96%). These findings are in conformity with the reports by other researchers (14). Although E. coli is generally perceived as an ‘antibiotic friendly’ pathogen, resistance has increased over the past decade (15). In this study, the overall resistance of E. coli to antimicrobial agents was high. Increasing irrational consumption rate of antibiotics, self-medication due to over- the-counter availability of antibiotics, non-compliance with medication, sales of substandard drug, consumption of food from animals that have received antibiotics, and transmission of resistant isolates between people may account for the rise in antibiotic resistance. Among the various antibiotics tested, it showed highest rate of resistance to nitrofurantoin (40%), followed by nalidixic acid (32.8%), netilmycin (31.8%) and cotrimoxazole (26.9%).

Nitrofurantoin exhibits efficiency against prevalent sources of urinary tract infections, such as Enterococcus, Citrobacter, and E. Coli. Less consistently susceptible are Enterobacter and Klebsiella. Typically, resistant bacteria include Serratia, Acinetobacter, Morganella, Proteus, and Pseudomonas. In general, nitrofurantoin resistance is rare, and many organisms that are resistant to many drugs yet show susceptibility (28,29). Since nitrofurantoin was first used in clinical practice more than 50 years ago, susceptibility to it has essentially not changed. The use of regular nitrofurantoin therapy is limited to cases with complex cystitis since it does not reach therapeutic quantities in the bloodstream. This study found that nitrofurantoin has a remarkably high degree of sensitivity (60%) which is consistent with findings from earlier research carried out in Nepal (1,14). High rate of resistance (32.8%) has been detected in the present study for nalidixic acid, one of the important members of monocarboxylic acid. Consequently, new therapies must be developed when there is significant resistance to fluoroquinolones. One study they found that out of 50 E. Coli isolates that were tested, 100% of them showed resistance to penicillin and erythromycin. They also showed resistance to nalidixic acid (49%) and cephalexin (47%) as well as amoxicillin (86%), ampicillin (42%) and ciprofloxacin (37%), tetracycline (32%) and cefixime (18%) (30).

In this study, E. coli exhibited 10.34% and 15.55% resistance to the commonly used amynoglycosides i.e amikacin and gentamicin respectively. Resistance to aminoglycoside antibiotics, which are the only medications that may be used to treat serious Gram-negative infections acquired in hospitals, is concerning because persistent infections may need to be treated with more expensive, newer medications as a last resort. One of the antibiotics of last choice for numerous bacterial infections, including E. Coli and Klebsiella pneumoniae (31), is carbapenems, such as imipenem. Recently, there has been concern about these coliforms developing drug resistance to carbapenem antibiotics because they produce the New Delhi metallo β-lactamase, or NDM-1. Since bacteria resistant to carbapenems are now unaffected by new antibiotics, the global expansion of the resistance gene is viewed as a possible worst-case scenario (32,33). Thankfully, less isolates resistant to Imipenem were found during the current investigation. Imipenem is therefore a medication that should only be used to treat infections that have not responded to other antibiotics.

Conclusion

E. coli remains common pathogen among patients with urinary tract infection, wound infection and respiratory tract infection. It exhibits high rate of resistance to the commonly used antibiotics. Therefore, we must adapt guidelines to recommend antibiotics and design a comprehensive control program to reduce the high levels of bacterial antibiotic resistance among our population.

Conflict of interest: There is no conflict of interest relevant to this paper to disclose.

Ethical approval

This study was approved by the Institutional Ethics Review Committee (IERC) of Ad-din Akij Medical College, Khulna.

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