ORIGINAL RESEARCH PAPER

Microbiology

"PREVALENCE AND ANTIMICROBIAL SUSCEPTIBILITY OF E. COLI IN CLINICAL SAMPLES FROM SUNCITY - RAJASTHAN"

KEY WORDS:

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ABSTRACT

Background: The prevalence and antimicrobial susceptibility of Escherichia coli (E. coli) are critical for managing infections and guiding treatment strategies. This study assesses these factors in clinical samples from a tertiary care center in Suncity, Rajasthan. **Methods:** This retrospective observational study was conducted at MGH Hospital, affiliated with Dr. SN Medical College (SNMC), from March, 2023, to June, 2023. A total of 2,250 clinical samples, including urine, blood, sputum, wound swabs, and other relevant specimens, were processed. E. coli isolates were identified using colony morphology, Gram staining, and biochemical tests. Antimicrobial susceptibility was determined via the Kirby-Bauer disk diffusion method, with results interpreted according to CLSI guidelines. **Results:** E. coli was isolated from 179 samples, yielding an overall prevalence of 7.9%. The majority of isolates were from inpatient department (IPD) samples (76.5%), with urine samples being the most frequent source (41%). Other sources included pus (38%), sputum (8%), tracheal aspirates (7%), Foley's catheters (3%), stool (2%), and central lines (0.5%). Ward-wise, the medicine ward had the highest incidence (36.5%), followed by the ICU (24%), orthopedic ward (20%), surgery ward (19%), and burns ward (0.5%). Antimicrobial susceptibility testing revealed high sensitivity to imipenem (88.6%), meropenem (80.4%), and piperacillin-tazobactam (80%). Susceptibility was also notable for cefepime (76.3%), amikacin (69%), and gentamicin (65.4%). For urine isolates specifically, fosfomycin (95.8%) and nitrofurantoin (94.5%) showed the highest susceptibility. Conversely, the lowest susceptibility was observed for ampicillin (5%), amoxiclav (9.9%), and ciprofloxacin (33%). Resistance to ceftazidime and ceftriaxone was also significant, with susceptibility rates of 35% and 44%, respectively. **Conclusions:** The study identifies a substantial prevalence of E. coli infections with a notable proportion exhibiting multidrug resistance. High susceptibility to carbapenems and piperacillin-tazobactam is encouraging, but the low susceptibility to commonly used antibiotics like ampicillin and ciprofloxacin highlights a critical need for revised local treatment guidelines. These findings support the implementation of targeted antimicrobial stewardship programs and contribute to regional and national surveillance efforts.

INTRODUCTION

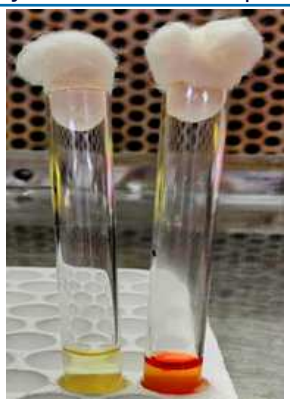
Escherichia coli (E. coli) is a versatile Gram-negative bacterium, traditionally a component of the normal intestinal flora in humans and animals. Despite its generally benign nature, certain strains of E. coli are well-known for their pathogenic potential, contributing to a wide spectrum of infections, including urinary tract infections (UTIs), bacteremia, and gastroenteritis. The increasing incidence of E. coli-related infections and the emergence of multidrug-resistant strains have escalated concerns within the medical community, challenging traditional treatment paradigms and necessitating more refined approaches to infection management.

Western Rajasthan, with its unique geographic and demographic characteristics, presents a distinctive context for studying E. coli infections. This region is characterized by a mix of urban and rural populations, diverse environmental conditions, and varying levels of healthcare access. The tertiary care centers in this region serve as critical hubs for diagnosing and managing infections, yet comprehensive data on the prevalence and antimicrobial susceptibility patterns of E. coli in this setting remain limited.

Antimicrobial resistance (AMR) in E. coli is a growing global concern. Resistance to commonly used antibiotics, such as cephalosporins, fluoroquinolones, and aminoglycosides, complicates treatment regimens and increases the risk of adverse outcomes. Factors contributing to AMR include inappropriate antibiotic use, inadequate infection control measures, and environmental contamination. In Western Rajasthan, the patterns of E. coli resistance may be influenced by regional practices, healthcare infrastructure, and socio-economic factors, necessitating region-specific research.

This study seeks to address this knowledge gap by investigating the prevalence of E. coli and its antimicrobial susceptibility patterns in various clinical samples obtained from a tertiary care center in Western Rajasthan. By providing an in-depth analysis of local E. coli epidemiology and resistance trends, the research aims to enhance understanding of the region's infection dynamics and support the development of targeted strategies for effective treatment and infection control. The findings from this study are expected to have significant implications for clinical practice, public health policies, and the overall management of E. coli infections in the region.

Escherichia coli (E. coli) is a versatile, Gram-negative bacterium that is commonly found in the intestines of humans and warm-blooded animals. Its presence in the gut is generally beneficial, aiding in digestion and synthesizing certain vitamins. However, the bacterium's adaptability allows it to exist in various environments and, under certain conditions, to exhibit pathogenic behaviors.



Pathogenic Strains and Infections

While most E. coli strains are non-pathogenic, several distinct types are associated with various infections:

1. Urinary Tract Infections (UTIs): E. coli is the most common cause of UTIs, including cystitis (bladder infection) and pyelonephritis (kidney infection). Pathogenic strains possess specific virulence factors, such as fimbriae, which facilitate adherence to the urinary tract and contribute to the development of infection.

2. Bacteremia and Sepsis: E. coli can enter the bloodstream and cause bacteremia, which can progress to severe sepsis. This is particularly dangerous in vulnerable populations, such as the elderly or immunocompromised individuals, leading to systemic inflammation and potential organ failure.

3. Gastroenteritis: Some strains of E. coli, such as enterotoxigenic E. coli (ETEC) and enterohemorrhagic E. coli (EHEC), are implicated in gastrointestinal illnesses. ETEC produces toxins that cause traveler's diarrhea, while EHEC (including the infamous O157 serotype) can lead to severe bloody diarrhea and, in some cases, hemolytic uremic syndrome (HUS), a serious complication affecting the kidneys.

Emergence of Antimicrobial Resistance

The rise in E. coli infections is compounded by the increasing prevalence of antimicrobial resistance (AMR). Resistance arises from several factors:

- **Overuse and Misuse of Antibiotics**: Frequent and inappropriate use of antibiotics in both human medicine and agriculture promotes the selection of resistant strains. For instance, broad-spectrum antibiotics can kill off susceptible bacteria while allowing resistant strains to proliferate.
- **Genetic Mechanisms**: E. coli can acquire resistance genes through horizontal gene transfer, involving mechanisms like plasmid exchange. This genetic adaptability enables the bacterium to rapidly develop resistance to multiple antibiotic classes.
- **Healthcare and Environmental Factors**: Inadequate infection control practices in healthcare settings and contamination of water sources with resistant strains also contribute to the spread of resistant E. coli.

Clinical and Public Health Implications

The growing incidence of multidrug-resistant E. coli poses significant challenges for clinical management. Treatment options become limited, leading to higher morbidity, longer hospital stays, and increased healthcare costs. This situation necessitates ongoing surveillance, stewardship programs to promote appropriate antibiotic use, and research into alternative therapies and infection prevention strategies.

Understanding the local prevalence and resistance patterns of E. coli is crucial for developing effective treatment guidelines and public health policies tailored to specific regional needs. Addressing these challenges requires a multidisciplinary approach involving clinicians, microbiologists, and public health professionals to mitigate the impact of resistant E. coli strains and improve patient outcomes.

Aims and Objectives

Aims:

The primary aim of this study is to determine the prevalence and antimicrobial susceptibility patterns of Escherichia coli (E. coli) isolated from various clinical samples in a tertiary care center in Western Rajasthan. This research seeks to provide insights into the current trends of E. coli infections and the effectiveness of commonly used antibiotics in this region.

Objectives:

1. To Determine the Prevalence of E. coli:

- Identify the frequency and distribution of E. coli isolates from different clinical samples (e.g., urine, blood, sputum, wound swabs) collected from patients at the tertiary care center.
- Categorize the E. coli isolates based on the type of infection (e.g., urinary tract infections, bloodstream infections, respiratory infections, and wound infections).

2. To Assess Antimicrobial Susceptibility Patterns:

- Evaluate the susceptibility of E. coli isolates to a range of commonly used antibiotics, including but not limited to beta-lactams, fluoroquinolones, aminoglycosides, and carbapenems.
- Identify the resistance patterns and rates among the isolates, highlighting any multidrug-resistant strains.

3. To Analyze Demographic and Clinical Correlates:

- Correlate the prevalence and resistance patterns of E. coli with patient demographics, such as age, gender, and underlying medical conditions.
- Explore potential risk factors associated with the acquisition of resistant E. coli strains, including previous antibiotic use, hospitalization history, and comorbidities.

4. To Provide Data for Local Antimicrobial Stewardship:

- Utilize the findings to inform and guide local antimicrobial stewardship programs and infection control policies.
- Offer recommendations for empiric therapy for E. coli infections based on the local antimicrobial resistance patterns observed in the study.

5. To Contribute to Regional and National Databases:

- Share the data with regional and national surveillance programs to enhance the understanding of E. coli epidemiology and antimicrobial resistance trends in India.
- Compare the findings with other studies conducted in different regions to identify potential geographical variations in prevalence and resistance patterns.

6. To Support Future Research and Policy Development:

- Provide a foundation for future research on the mechanisms of resistance in E. coli and the development of novel therapeutic strategies.
- Support policymakers in designing targeted interventions to combat the spread of resistant E. coli strains in healthcare settings.

MATERIALS AND METHODS

Study Design:

This research is a retrospective observational study conducted at MGH Hospital, affiliated with Dr. SN Medical College (SNMC) in Jodhpur, Rajasthan. The study spanned a three-month period, from March 15, 2023, to June 15, 2023.

Sample Collection and Processing:

Clinical samples, including urine, blood, sputum, and wound

swabs, were collected from patients at the tertiary care center during the study period. These samples were processed using standard microbiological techniques to isolate Escherichia coli (E. coli) strains.

Identification of E. coli:
E. coli isolates were identified based on colony morphology, Gram staining, and biochemical tests such as indole production, lactose fermentation on MacConkey agar, and other relevant biochemical assays.

Antimicrobial Susceptibility Testing:
The antimicrobial susceptibility of E. coli isolates was determined using the Kirby-Bauer disk diffusion method. This involved placing antibiotic-impregnated disks on agar plates inoculated with the E. coli isolates. The plates were then incubated to allow bacterial growth and the formation of inhibition zones around the disks.

The size of the inhibition zones was measured and interpreted according to the Clinical and Laboratory Standards Institute (CLSI) guidelines for 2023. This allowed for the categorization of isolates as susceptible, intermediate, or resistant to the tested antibiotics.

Data Analysis:
Data on the prevalence of E. coli and its antimicrobial susceptibility patterns were analyzed to identify trends and correlations. Factors such as patient demographics and clinical history were also considered to understand potential influences on the observed patterns.

RESULTS

Sample Overview:
During the three-month study period, a total of 2,250 clinical samples were processed. Escherichia coli (E. coli) was isolated in 179 samples, resulting in an overall prevalence of 7.9% among the tested specimens.

Distribution of E. coli Isolates:
- **Inpatient vs. Outpatient:**
- The majority of E. coli isolates (76.5%) were obtained from inpatient department (IPD) samples, while 23.5% were from outpatient department (OPD) samples.
- **Sample Type Distribution:**
- **Urine:** The highest number of isolates came from urine samples, accounting for 73 cases (41% of all isolates).
- **Pus:** Pus samples yielded 68 isolates (38%).
- **Sputum:** There were 14 isolates (8%) from sputum samples.
- **Tracheal Aspirates:** 12 isolates (7%) were obtained from tracheal aspirates.
- **Foley's Catheter:** 6 isolates (3%) were found in samples associated with Foley's catheters.
- **Stool:** Stool samples had 4 isolates (2%).
- **Central Line:** There was 1 isolate (0.5%) from a central line sample.

Ward-wise Distribution:
- **Medicine Ward:** The medicine ward had the highest number of E. coli isolates, accounting for 36.5% of the total isolates.
- **Intensive Care Unit (ICU):** The ICU contributed 24% of the isolates.
- **Orthopedic Ward:** 20% of the isolates were from the orthopedic ward.
- **Surgery Ward:** The surgery ward accounted for 19% of the isolates.
- **Burns Ward:** The burns ward had the least number of isolates, with only 0.5%.

Antimicrobial Susceptibility Patterns:
The study evaluated the antimicrobial susceptibility of E. coli isolates to various antibiotics using the Kirby-Bauer disk diffusion method. The following are the key findings:

- **Highest Susceptibility:**
- **Imipenem:** E. coli showed the highest susceptibility to imipenem, with 88.6% of isolates being sensitive.
- **Meropenem:** 80.4% susceptibility was observed for meropenem.
- **Piperacillin-Tazobactam:** 80% of isolates were susceptible to piperacillin-tazobactam.
- **Cefepime:** 76.3% of isolates were susceptible to cefepime.
- **Amikacin:** 69% susceptibility was recorded for amikacin.
- **Gentamicin:** 65.4% of isolates were susceptible to gentamicin.

- **Urine Sample Specific Susceptibility:**
- **Fosfomycin:** In urine samples, fosfomycin showed the highest susceptibility rate at 95.8%.
- **Nitrofurantoin:** 94.5% susceptibility was observed for nitrofurantoin.

- **Lowest Susceptibility:**
- **Ampicillin:** E. coli showed the least susceptibility to ampicillin, with only 5% of isolates being sensitive.
- **Amoxiclav:** Susceptibility to amoxiclav was 9.9%.
- **Ofloxacin:** 28% of isolates were susceptible to ofloxacin.
- **Ciprofloxacin:** 33% susceptibility was recorded for ciprofloxacin.
- **Ceftazidime:** 35% of isolates were susceptible to ceftazidime.
- **Ceftriaxone:** 44% susceptibility was observed for ceftriaxone.

Interpretation:
The results highlight a significant prevalence of E. coli infections, particularly in hospitalized patients. The data also reveal a concerning level of resistance to commonly used antibiotics, such as ampicillin and ciprofloxacin, underscoring the need for targeted antimicrobial stewardship interventions. The high susceptibility to carbapenems and specific agents like fosfomycin and nitrofurantoin in urinary isolates suggests these could be considered as preferred treatment options in the study's geographical and clinical context.

CONCLUSION

This study provides a comprehensive overview of the prevalence and antimicrobial susceptibility patterns of Escherichia coli (E. coli) isolated from clinical samples at MGH Hospital, associated with Dr. SN Medical College (SNMC) in Jodhpur, Rajasthan. The key findings and implications are summarized as follows:

1. Prevalence and Distribution:
- E. coli was isolated in 7.9% of the total samples processed, with the highest prevalence observed in urine samples, followed by pus, sputum, tracheal aspirates, Foley's catheter samples, stool, and central line samples.
- The majority of E. coli isolates were obtained from inpatient settings, with significant contributions from the medicine ward, ICU, orthopedic ward, surgery ward, and burns ward.

2. Antimicrobial Susceptibility Patterns:
- The study identified a high susceptibility of E. coli isolates to carbapenems (imipenem and meropenem), piperacillin-tazobactam, cefepime, amikacin, and gentamicin, suggesting these antibiotics as effective options for treatment.
- For urinary tract infections specifically, fosfomycin and nitrofurantoin demonstrated high efficacy, indicating their potential as preferred agents in this setting.
- A concerning level of resistance was noted against

commonly used antibiotics such as ampicillin, amoxiclav, ofloxacin, ciprofloxacin, ceftazidime, and ceftriaxone. This resistance profile highlights the challenge of treating E. coli infections and the necessity for regular surveillance to guide empirical therapy.

3. Clinical and Public Health Implications:
- The findings underscore the importance of robust antimicrobial stewardship programs to optimize antibiotic use and curb the spread of resistant E. coli strains.
- There is a need for ongoing monitoring of antimicrobial resistance patterns to inform local treatment guidelines and ensure the efficacy of empiric therapies.
- The significant prevalence of E. coli in hospitalized patients, particularly in specific wards, emphasizes the importance of stringent infection control measures to prevent nosocomial infections.

4. Recommendations for Future Research:
- Further studies are recommended to investigate the molecular mechanisms of resistance in E. coli and the potential risk factors associated with the acquisition of resistant strains.
- Comparative studies across different regions could provide insights into geographical variations in E. coli prevalence and resistance patterns, aiding in the development of region-specific treatment protocols.

Recommendations for Future Studies

Based on the findings of the current study, the following recommendations are proposed for future research and healthcare practices:

1. Longitudinal Surveillance Studies:
- Conduct longitudinal studies to monitor trends in E. coli prevalence and antimicrobial resistance over time. This will help track the emergence of new resistance patterns and assess the impact of interventions.

2. Molecular Characterization of Resistant Strains:
- Perform molecular studies to identify the specific genetic mechanisms and plasmids responsible for antimicrobial resistance in E. coli isolates. This can help in understanding the spread of resistance genes and in developing targeted strategies to counteract them.

3. Geographical and Temporal Comparisons:
- Expand the scope of surveillance to include multiple healthcare centers across different regions and time periods. This can help identify regional variations in resistance patterns and inform the development of localized treatment guidelines.

4. Evaluation of Antibiotic Stewardship Programs:
- Assess the effectiveness of existing antibiotic stewardship programs in the hospital and identify areas for improvement. Implement and evaluate new interventions aimed at optimizing antibiotic use and reducing the prevalence of resistant E. coli strains.

5. Infection Control Measures:
- Investigate the role of hospital infection control practices in preventing the spread of E. coli, especially in high-risk wards such as ICUs. Future studies should explore the effectiveness of specific infection control measures and protocols.

6. Exploration of Alternative Therapies:
- Research the potential of alternative therapies, such as bacteriophage therapy, probiotics, or the use of novel antimicrobial agents, in treating infections caused by multidrug-resistant E. coli.

7. Risk Factor Analysis:
- Conduct studies to identify patient-specific risk factors for acquiring resistant E. coli infections, such as previous antibiotic use, comorbidities, or recent hospitalization. This can aid in developing targeted prevention strategies.

8. Public Awareness and Education:
- Investigate the impact of public and healthcare professional education on antimicrobial resistance and proper antibiotic use. Future studies could assess knowledge gaps and the effectiveness of educational interventions.

9. Collaborative Research and Data Sharing:
- Foster collaboration between different hospitals, research institutions, and public health bodies to share data and resources. This can enhance the understanding of resistance patterns and support coordinated public health responses.

10. Cost-Benefit Analysis of Interventions:
- Conduct economic evaluations of various interventions, including antimicrobial stewardship programs and infection control measures, to determine their cost-effectiveness in reducing the burden of resistant E. coli infections.

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