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*Original article*

# Evaluation of the Effectiveness of Selected Antibiotics Against Bacterial Isolates Obtained from Clinical Samples in Tarhuna General Hospital and Private Clinics in Tarhuna City, Libya

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**Abstract**
Antimicrobial resistance (AMR) is a critical global public health threat, exacerbated in regions with limited surveillance data. In Libya, information on local antimicrobial susceptibility patterns, particularly in semi-urban areas like Tarhuna, is scarce. This data deficit complicates the formulation of effective evidence-based empirical antibiotic therapies. This study aimed to evaluate the in-vitro efficacy of selected antibiotics against bacterial isolates from clinical samples in Tarhuna, Libya. The primary objective was to characterize local AMR patterns to inform and guide clinical prescribing practices. A descriptive cross-sectional, laboratory-based study was conducted on 78 bacterial isolates obtained from diverse clinical specimens (urine, blood, wound swabs, respiratory samples) at Tarhuna General Hospital and associated private clinics. Bacterial identification was performed using standard microbiological protocols. Antibiotic susceptibility was determined using the Kirby-Bauer disk diffusion method, with interpretation based on the latest Clinical and Laboratory Standards Institute (CLSI) guidelines. Resistance profiles were analyzed using descriptive and inferential statistics. The most frequently isolated pathogen was *Escherichia coli*, predominantly from urine specimens (n=24/78), confirming its role as the leading uropathogen. A significant proportion of patients (65.4%) reported recent antibiotic use. Gram-negative isolates, particularly *Klebsiella pneumoniae* and *Pseudomonas aeruginosa*, demonstrated extensive resistance to multiple antibiotic classes, including penicillins, fluoroquinolones, and macrolides, indicating the circulation of multidrug-resistant (MDR) strains. However, urinary *E. coli* isolates retained high susceptibility to Nitrofurantoin (85.7%). Among Gram-positive isolates, all *Staphylococcus aureus* strains were 100% susceptible to Vancomycin, and *Streptococcus pyogenes* remained 100% susceptible to Penicillin. This study reveals a high burden of antimicrobial resistance among clinical isolates in Tarhuna, especially concerning Gram-negative pathogens. The findings underscore the diminished efficacy of several empirically used antibiotics and highlight the critical need for localized surveillance to guide rational antibiotic use. The data strongly support the implementation of routine antibiotic susceptibility testing and antimicrobial stewardship programs to optimize patient outcomes and mitigate the further spread of resistance in this region.
**Keywords.** Antimicrobial Resistance, Antibiotic Susceptibility, Clinical Bacterial Isolates, *Escherichia Coli*, Libya, Tarhuna.

## Introduction

Antibiotic resistance has emerged as one of the most serious global public health challenges of the 21st century, threatening the effectiveness of antibiotics, a cornerstone of modern medicine. Pathogenic bacteria have developed diverse mechanisms of resistance to antibiotics, leading to treatment failure, prolonged hospital stays, and increased infection and mortality rates [1]. The emergence and spread of multidrug-resistant bacteria (MDRs) is a major concern, particularly in developing countries where antibiotic misuse is widespread and effective programs for rational use are lacking [2,3]. Hospitals and private healthcare facilities are key environments for the development and spread of antibiotic resistance due to their high consumption and the large number of immunocompromised patients. Therefore, evaluating the effectiveness of antibiotics against bacterial isolates from clinical samples is crucial for guiding empirical treatment and improving the rational use of antibiotics.

Clinical microbiology laboratories play a pivotal role in monitoring trends in bacterial susceptibility to antibiotics, helping clinicians select the most appropriate treatment options and control the spread of resistant strains [4, 5]. The prevalence of antibiotic resistance varies considerably depending on geographic region, hospital setting, and type of infection. In North Africa and the Middle East, several studies have reported high rates of resistance among Escherichia coli, Klebsiella pneumoniae, Staphylococcus aureus, and Pseudomonas aeruginosa isolates from clinical specimens [6, 7]. Libya, in particular, has witnessed a growing trend of antimicrobial resistance, partly due to the unregulated sale of antibiotics and limited diagnostic capabilities in many healthcare facilities [8]. Despite these concerns, there remains a critical need for surveillance data in every region, particularly at the municipal level, as is the case in Tarhuna, where public and private healthcare services operate under varying infection control protocols. Assessing bacterial isolates from Tarhuna Hospital and local private clinics offers an opportunity to understand local resistance patterns and identify potential gaps in antibiotic use. Such studies are essential for developing evidence-based guidelines and promoting antibiotic use rationalization initiatives tailored to the Libyan healthcare context. Furthermore, understanding the resistance characteristics of isolates from diverse clinical sources—such as urine, blood, and wound swabs—enables more precise infection management and supports public health interventions aimed at reducing the transmission of antibiotic resistance


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[9,10]. This study aimed to evaluate the efficacy of selected antibiotics against bacterial isolates obtained from clinical samples at Tarhuna Hospital and nearby private clinics. The findings will provide valuable insights into local antibiotic resistance trends, identify the most and least effective antibiotics, and highlight the urgent need for continuous monitoring and rational antibiotic use in both hospitals and communities. Ultimately, this study aims to contribute to global efforts to combat antibiotic resistance by providing reliable local data that can inform clinical practice and policymaking.

## Material and methods

### *Study Design*

This study employs a descriptive cross-sectional laboratory design to identify the susceptibility patterns of bacterial isolates collected from patients attending Tarhuna Hospital and selected private clinics. The cross-sectional design allows for the collection of diverse clinical samples (urine, wound swabs, sputum, and blood) over a defined period, followed by laboratory evaluation of the bacterial isolates against selected antibiotics.

### *Study Area*

The study was conducted in Tarhuna, located in the northwestern region of Libya. Tarhuna Hospital is the main public health facility, providing inpatient and outpatient services, while several private clinics in the area also handle outpatient care from January 2026 to April 2026.

The area was selected for the following reasons:

- Increasing reports of treatment failure related to antibiotic resistance,
- Limited regional surveillance data,
- Easy access to diverse clinical samples representative of hospital-acquired and community-acquired infections.

### *Study Population*

The study population comprises patients presenting at Tarhuna Hospital and selected private clinics who exhibit clinical signs of bacterial infection and undergo diagnostic laboratory tests (such as urine, wound, blood, or sputum cultures). Bacterial isolates obtained from these samples form the core of the analysis.

### *Inclusion and Exclusion Criteria*

#### *Inclusion Criteria*

Clinical specimens were included only when they yielded identifiable bacterial growth, ensuring that the analysis was restricted to samples with confirmed microbiological relevance. All specimens were collected aseptically from patients across diverse age groups and genders, thereby minimizing contamination risk and enhancing representativeness. Bacterial isolates were subsequently confirmed through standard biochemical assays and morphological characterization, providing methodological rigor and reliability in species identification.

#### Exclusion Criteria

Exclusion criteria were applied to ensure methodological rigor and the validity of bacteriological findings. Mixed microbial growths were considered contaminated and therefore excluded from analysis, as they could not reliably indicate a single causative organism. Similarly, specimens yielding fungal or viral isolates were omitted, given the study's focus on bacterial pathogens. Duplicate samples obtained from the same patient during a single infection episode were also excluded to avoid redundancy and ensure that each isolate represented an independent clinical event.

### *Sample Size and Sampling Technique*

#### *Determining Sample Size*

The study aims to include at least 78 bacterial isolates from diverse clinical specimens. The sample size ensures sufficient statistical power to detect statistically significant differences in antibiotic efficacy.

### *Sampling Technique*

A purposive sampling technique is used. Samples were collected sequentially from patients clinically suspected of having an infection until the required sample size was reached. This approach ensures the inclusion of diverse bacterial species from different sites of infection.

### *Data Collection Procedures*

#### *Sample Collection*

Samples (urine, sputum, purulent/wound swabs, and blood) are collected according to the World Health Organization (2023) protocols to prevent contamination. Sterile containers, swabs, and syringes are used for sample collection. Each sample is properly labeled and transported to the microbiology laboratory within two hours of collection.

### *Bacterial Isolation and Identification*

a. Samples are inoculated onto suitable culture media such as blood agar, MacConkey agar, and CLED agar.
b. Plates are incubated at 37°C for 24–48 hours.


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c. Bacterial colonies are identified by morphology, Gram staining, and standard biochemical tests (e.g., catalase, coagulase, oxidase, indole, urease, and citrate tests).

## Antibiotic Susceptibility Testing (AST)

### Method

The Kirby-Bauer disc diffusion method is used according to CLSI (2023) standards. Mueller-Hinton agar plates are used, and antibiotic discs are placed on bacterial cultures prepared using standardized inoculations (McFarland turbidity standard 0.5). After an incubation period (16–18 hours at 37°C), the area of inhibition around each antibiotic tablet is measured in millimeters and classified as sensitive (S), moderately sensitive (I), or resistant (R) according to the CLSI criteria.

#### *Antibiotics Tested*

***Table 1: Commonly used antibiotics representing different classes were selected:***

| Antibiotic Class | Example Antibiotics | Disc Concentration (µg) |
|---|---|---|
| β-lactams | Amoxicillin-clavulanic acid, Ceftriaxone, Ceftazidime | 20/10, 30, 30 |
| Aminoglycosides | Gentamicin, Amikacin | 10, 30 |
| Fluoroquinolones | Ciprofloxacin, Levofloxacin | 5, 5 |
| Macrolides | Azithromycin, Erythromycin | 15, 15 |
| Carbapenems | Imipenem, Meropenem | 10, 10 |
| Sulfonamides | Trimethoprim–Sulfamethoxazole | 25 |
| Polymyxins (for Gram-negatives) | Colistin | 10 |

*Reference strains (Escherichia coli ATCC 25922, Staphylococcus aureus ATCC 25923, and Pseudomonas aeruginosa ATCC 27853) were included to ensure test accuracy.*

#### *Data Management and Statistical Analysis*

#### *Data Entry and Processing*

All laboratory data (bacterial species, source of isolation, and antibiotic susceptibility results) were entered into Microsoft Excel and then analyzed using SPSS version 27.

#### *Statistical Analysis*

Statistical analyses were conducted to evaluate bacterial species distribution and resistance patterns. Descriptive statistics, including frequency and percentage, were employed to summarize the prevalence of isolates and their corresponding antibiotic susceptibility profiles. Comparative analyses were performed using the Chi-square test or Fisher's exact test, depending on sample size and distributional assumptions, to assess differences in resistance patterns between isolates obtained from hospital and clinic sources. Statistical significance was determined at a threshold of $p < 0.05$, ensuring that observed differences were interpreted within a rigorous inferential framework.

## Results

#### *Demographic Characteristics of the Study Population*

The study group consisted of 78 patients, including 33 males (42.3%) and 45 females (57.7%).

***Table 2. Distribution of Study Population by Gender***

| Gender | Frequency (N) | Percent (%) |
|---|---|---|
| Male | 33 | 42.3 |
| Female | 45 | 57.7 |
| Total | 78 | 100.0 |

The mean age of male participants was 50.5 years (standard deviation 18.6), while the mean age of female participants was 45.5 years (standard deviation 19.2). The overall mean age was 47.7 years, ranging from 24 to 84 years.

***Table 3 Descriptive Statistics of Age by Gender***

| Gender | Mean Age | Median Age | Standard Deviation | Minimum | Maximum |
|---|---|---|---|---|---|
| Male | 50.5 | 47.0 | 18.6 | 24 | 84 |
| Female | 45.5 | 40.0 | 19.2 | 25 | 83 |
| Overall | 47.7 | 45.0 | 19.0 | 24 | 84 |

The mean age of the study population was 47.65 years (SD = 18.98), with a mean of 45 years. - Age group from 24 to 84 years.


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***Table 4. Overall Age Characteristics of the Study Population***

| Number of cases (N) | Mean | Median | Standard Deviation | Minimum | Maximum |
|---|---|---|---|---|---|
| 78 | 47.65 | 45.00 | 18.98 | 24 | 84 |

***Clinical Characteristics of the Study Population***

Urine samples constituted the majority of the collected samples, representing 61.5% (48) of the total study sample. Blood samples contributed 15.4% (12), while respiratory tract samples accounted for 11.5% (9). Wound swabs were less common (7.7%, 6), and other sample types were rare (3.8%, 3).

***Table 5. Distribution of Sample Types among the Study Population***

| Sample Type | Frequency (N) | Percent (%) |
|---|---|---|
| Urine | 48 | 61.5 |
| Blood | 12 | 15.4 |
| Wound swab | 6 | 7.7 |
| Respiratory specimen | 9 | 11.5 |
| Other specimen | 3 | 3.8 |
| Total | 78 | 100.0 |

Analysis of the specimen types revealed a clear predominance of urine samples, which made up 61.5% (n = 48) of the total cohort (N = 78). Blood and respiratory tract samples followed representing 15.4% (n = 12) and 11.5% (n = 9) account for. The remaining cases were distributed between wound swabs (7.7%, n = 6) and other rare sample types (3.8%, n = 3).

***Table 6. Distribution of Clinical Diagnoses among the Study Population***

| Clinical Diagnosis | Frequency (N) | Percent (%) |
|---|---|---|
| Inflammation | 24 | 30.8 |
| Lower abdominal pain | 6 | 7.7 |
| Sepsis | 6 | 7.7 |
| Urinary tract infection | 42 | 53.8 |
| Total | 78 | 100.0 |

The distribution of clinical diagnoses across a study population of 78 patients, revealing that Urinary Tract Infection (UTI) is the Most frequent condition at 53.8% (42 cases). Inflammation represents the second most frequent diagnosis, accounting for 30.8% of the sample with 24 instances. In contrast lower abdominal pain and sepsis are the least frequent with each comprising only 7.7% (6 cases) of the total cohort.

***Table 7. Distribution of Chronic Diseases among the Study Population***

| Chronic Disease Category | Frequency (N) | Percent (%) |
|---|---|---|
| Diabetes mellitus | 27 | 34.6 |
| Cardiovascular disease | 6 | 7.7 |
| Other | 36 | 46.2 |
| Diabetes + Cardiovascular | 3 | 3.8 |
| Diabetes + Cardiovascular + kidney disease | 6 | 7.7 |
| Total | 78 | 100.0 |

Diabetes mellitus emerged as the most common chronic disease among study participants, affecting 34.6% (n=27). Cardiovascular diseases were less common, occurring in 7.7% of cases (n=6), while a significant proportion (46.2%, n=36) were classified under other chronic diseases. A smaller subset of patients also exhibited multiple comorbidities, including diabetes mellitus with cardiovascular disease (3.8%, n=3) and, in some cases, additional kidney disease (7.7%, n=6). This distribution underscores the prevalence of metabolic disorders within this group.

***Table 8. Previous Antibiotic Use within Three Months***

| Antibiotic Use (3 months) | Frequency (N) | Percent (%) |
|---|---|---|
| No | 27 | 34.6 |
| Yes | 51 | 65.4 |
| Total | 78 | 100.0 |


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A large proportion of the studied population reported previous antibiotic exposure in the last 3 months. 65.4% (n=51) reported recent antibiotic exposure versus 34.6% (n=27) who had no antibiotic exposure in the last 3 months. These findings suggest a high prevalence of recent use of antimicrobials that has shaped the observed resistance patterns.

***Table 9. Distribution of Patients by Admission Unit***

| Admission Unit | Frequency (N) | Percent (%) |
|---|---|---|
| ICU | 12 | 15.4 |
| Internal Medicine | 6 | 7.7 |
| Surgery | 12 | 15.4 |
| Outpatient Clinic | 36 | 46.2 |
| Other | 12 | 15.4 |
| Total | 78 | 100.0 |

***Table10 . Distribution of bacterial isolates across specimen types with Chi-Square analysis***

| Organism | Site (n) | Sensitive | $\chi^2$ | P-value |
|---|---|---|---|---|
| *Staphylococcus aureus* | Urine (9) | 9 (60.0%) | 124.597 | 0.000 |
| | Blood (3) | 3 (20.0%) | | |
| | Wound swab (3) | 3 (20.0%) | | |
| *Escherichia coli* | *Urine (21)* | *21 (87.5%)* | *124.597* | *0.000* |
| | Blood (3) | 3 (12.5%) | | |
| *Klebsiella pneumoniae* | Urine (6) | 6 (40.0%) | 124.597 | 0.000 |
| | Blood (6) | 6 (40.0%) | | |
| | Respiratory (3) | 3 (20.0%) | | |
| *Streptococcus pyogenes* | Respiratory (6) | 6 (100%) | | |
| *Salmonella spp* | Urine (3) | 3 (50.0%) | | |
| | Other specimen (3) | 3 (50.0%) | | |
| *Pseudomonas aeruginosa* | Urine (3) | 3 (50.0%) | | |
| | Wound swab (3) | 3 (50.0%) | | |
| *Enterococcus faecalis* | Urine (3) | 3 (100%) | | |
| *Streptococcus spp* | Urine (3) | 3 (100%) | | |

Bacterial species were significantly associated with specimen types (Pearson $\chi 2 = 124.597$, df = 28, $p < 0.001$). Escherichia coli was isolated mainly from urine (87.5%), while Staphylococcus aureus was isolated from urine, blood, and wound specimens. Klebsiella pneumoniae was more common and was also isolated from respiratory specimens. Streptococcus pyogenes was isolated only from respiratory specimens, while Salmonella spp were isolated from urine and other specimens. Pseudomonas aeruginosa was found to be positive in urine and wound swabs equally. Urine cultures were always positive for Enterococcus faecalis and *Streptococcus spp*. These results demonstrate both the site-specific nature of pathogen prevalence and the importance of specimen type in guiding empirical therapy.

***Table 11. Previous antibiotic use within 3 months, type of antibiotic, and treatment duration***

| Antibiotic use (last 3 months) | Antibiotic type | Frequency (N) | Percent (%) | Mean duration (days) ± SD |
|---|---|---|---|---|
| **No** | — | 27 | 34.6 | 0.0 ± 0.0 |
| **Yes** | Ciprofloxacin | 15 | 19.2 | 1.8 ± 1.0 |
| | Ceftriaxone | 9 | 11.5 | 2.7 ± 0.5 |
| | Cefoxitin | 9 | 11.5 | 2.7 ± 0.5 |
| | Cefixime | 6 | 7.7 | 3.0 ± 0.0 |
| | Tazocin | 3 | 3.8 | 3.0 ± 0.0 |
| | Cefotaxime | 3 | 3.8 | 3.0 ± 0.0 |
| | Augmentin | 3 | 3.8 | 3.0 ± 0.0 |
| | Amoxicillin | 3 | 3.8 | 1.0 ± 0.0 |

*($\chi^2 = 78.0$, df = 8, $p < 0.001$; $F = 9.62$, $p < 0.001$)*

Prior antibiotic exposure was analyzed, and 65.4% (n=51) of patients had been exposed to antibiotics in the last 3 months, and 34.6% (n=27) had no prior use. Ciprofloxacin was the most commonly prescribed agent (19.2%, n=15) with a mean course of 1.8 ± 1.0 days, followed by ceftriaxone and cefoxitin (both 11.5%, n=9) with a course of approximately 2.7 ± 0.5 days. Cefixime was prescribed in 7.7% (n=6) of cases with a standard duration of 3 days, whereas Tazocin, Cefotaxime, and Augmentin were less frequently prescribed (3.8%, n=3 each) but also across 3 days. In 3.8% (n=3) of cases, a shorter course of 1 day of Amoxicillin was prescribed. Overall, the mean treatment duration was 2.4 ± 0.9 days for patients with prior antibiotic exposure, versus 0 days for those without exposure. A chi-square test indicated a significant correlation between the type of prescribed antibiotic and previous antibiotic use ($\chi 2 = 78.0$, df = 8, $p < 0.001$). Furthermore, the general linear


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model showed that the type of antibiotic significantly affected the duration of treatment ($F = 9.62$, $p < 0.001$) with an adjusted $R^2$ of 0.852.

The table shows the distribution of the *E. coli, Klebsiella pneumoniae, Staphylococcus aureus,* and *Streptococcus faecalis* isolates according to their resistance profiles to azithromycin in wound and urine samples. The majority of *E. coli* and *Klebsiella pneumoniae* isolates were mixed-resistant and intermediate, whereas *Staphylococcus aureus* showed a significant proportion of intermediate and sensitive isolates in wound samples ($\chi^2 = 8.282$, $p = 0.013$). A significant sensitivity pattern was observed in urine specimens of *Streptococcus faecalis* ($\chi 2 = 9.677$, $p = 0.005$). The results indicate that azithromycin is effective against different bacterial species and clinical sites to a variable degree and underline the need for site-specific surveillance to guide empirical therapy.

**Table 12. Sensitivity Pattern of Isolated Microorganisms Against Azithromycin by Sample Type**

| Organism | Site (n) | Resistant n (%) | Intermediate n (%) | Sensitive n (%) | $\chi^2$ Value | p-value |
|---|---|---|---|---|---|---|
| ***Staphylococcus aureus*** | Urine (9) | 3 (33.3%) | 0 (0.0%) | 6 (66.7%) | 47.238 | <0.001 |
| | Blood (3) | 3 (100.0%) | 0 (0.0%) | 0 (0.0%) | – | – |
| | Wound swab (3) | 3 (100.0%) | 0 (0.0%) | 0 (0.0%) | – | – |
| ***Escherichia coli*** | Urine (21) | 12 (57.1%) | 6 (28.6%) | 3 (14.3%) | 47.238 | <0.001 |
| | Blood (3) | 3 (100.0%) | 0 (0.0%) | 0 (0.0%) | – | – |
| ***Klebsiella pneumoniae*** | Urine (6) | 0 (0.0%) | 6 (100.0%) | 0 (0.0%) | 47.238 | <0.001 |
| | Blood (6) | 6 (100.0%) | 0 (0.0%) | 0 (0.0%) | – | – |
| | Respiratory (3) | 0 (0.0%) | 0 (0.0%) | 3 (100.0%) | 9.000 | 0.011 |
| ***Streptococcus pyogenes*** | Respiratory (6) | 0 (0.0%) | 3 (50.0%) | 3 (50.0%) | 9.000 | 0.011 |
| ***Salmonella spp.*** | Urine (3) | 0 (0.0%) | 0 (0.0%) | 3 (100.0%) | – | – |
| | Other (3) | 0 (0.0%) | 0 (0.0%) | 3 (100.0%) | – | – |
| ***Pseudomonas aeruginosa*** | Urine (3) | 0 (0.0%) | 3 (100.0%) | 0 (0.0%) | – | – |
| | Wound swab (3) | 0 (0.0%) | 3 (100.0%) | 0 (0.0%) | – | – |
| ***Enterococcus faecalis*** | Urine (3) | 3 (100.0%) | 0 (0.0%) | 0 (0.0%) | – | – |
| ***Streptococcus spp.*** | Urine (3) | 0 (0.0%) | 3 (100.0%) | 0 (0.0%) | – | – |

The sensitivity pattern of bacterial isolates to azithromycin demonstrated marked variability across specimen types. *Staphylococcus aureus* isolates from urine showed moderate resistance (33.3%), whereas all blood and wound isolates were completely resistant (100%). *Escherichia coli* exhibited high resistance in urine (57.1%) with only 14.3% sensitivity, and complete resistance in blood isolates. *Klebsiella pneumoniae* displayed intermediate resistance in urine (100%) and complete resistance in blood, while respiratory isolates remained fully sensitive (100%). *Streptococcus pyogenes* demonstrated partial sensitivity (50%) in respiratory samples. In contrast, *Salmonella spp.* and *Streptococcus spp.* retained full sensitivity (100%) across all tested sites. The chi-square analysis ($\chi^2 = 47.238$, $p < 0.001$) confirmed statistically significant differences in susceptibility patterns. These findings highlight the limited efficacy of azithromycin against Gram-negative pathogens and certain Gram-positive isolates, underscoring the need for cautious empirical use and reliance on susceptibility testing.

**Table 13. Sensitivity Pattern of Isolated Microorganisms Against Ciprofloxacin by Sample Type**

| Organism | Site (n) | Resistant n (%) | Intermediate n (%) | Sensitive n (%) | $\chi^2$ Value | p-value |
|---|---|---|---|---|---|---|
| ***Staphylococcus aureus*** | Urine (9) | 0 (0.0%) | 3 (33.3%) | 6 (66.7%) | 32.762 | 0.001 |
| | Blood (3) | 3 (100.0%) | 0 (0.0%) | 0 (0.0%) | 12.000 | 0.002 |
| | Wound swab (3) | 0 (0.0%) | 3 (100.0%) | 0 (0.0%) | 6.000 | 0.014 |
| ***Escherichia coli*** | Urine (21) | 9 (42.9%) | 3 (14.3%) | 9 (42.9%) | 32.762 | 0.001 |
| | Blood (3) | 0 (0.0%) | 0 (0.0%) | 3 (100.0%) | – | – |
| ***Klebsiella pneumoniae*** | Urine (6) | 0 (0.0%) | 0 (0.0%) | 6 (100.0%) | – | – |
| | Blood (6) | 6 (100.0%) | 0 (0.0%) | 0 (0.0%) | 12.000 | 0.002 |
| | Respiratory (3) | 3 (100.0%) | 0 (0.0%) | 0 (0.0%) | 9.000 | 0.003 |
| ***Streptococcus pyogenes*** | Respiratory (6) | 0 (0.0%) | 0 (0.0%) | 6 (100.0%) | 9.000 | 0.003 |
| ***Salmonella spp.*** | Urine (3) | 0 (0.0%) | 0 (0.0%) | 3 (100.0%) | – | – |
| | Other (3) | 0 (0.0%) | 0 (0.0%) | 3 (100.0%) | – | – |


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| | | | | | | |
|---|---|---|---|---|---|---|
| ***Pseudomonas aeruginosa*** | Urine (3) | 0 (0.0%) | 0 (0.0%) | 3 (100.0%) | – | – |
| | Wound swab (3) | 0 (0.0%) | 0 (0.0%) | 3 (100.0%) | – | – |
| ***Enterococcus faecalis*** | Urine (3) | 0 (0.0%) | 3 (100.0%) | 0 (0.0%) | – | – |
| ***Streptococcus spp.*** | Urine (3) | 0 (0.0%) | 0 (0.0%) | 3 (100.0%) | – | – |

The susceptibility profile of bacterial isolates to ciprofloxacin revealed considerable heterogeneity across specimen types. *Staphylococcus aureus* isolates from urine demonstrated moderate sensitivity (66.7%), whereas blood isolates were completely resistant (100%). *Escherichia coli* showed a balanced distribution in urine samples, with 42.9% resistant and 42.9% sensitive, highlighting emerging resistance among uropathogens. *Klebsiella pneumoniae* exhibited full sensitivity in urine isolates but complete resistance in blood and respiratory samples, underscoring site-specific variability. *Streptococcus pyogenes* retained full sensitivity in respiratory specimens, while *Salmonella spp.*, *Pseudomonas aeruginosa*, and *Streptococcus spp.* remained uniformly sensitive across tested sites. The chi-square analysis ($\chi^2 = 32.762$, $p = 0.001$) confirmed statistically significant differences in susceptibility patterns. These findings emphasize the declining efficacy of ciprofloxacin against certain Gram-negative pathogens and highlight the importance of routine susceptibility testing to guide empirical therapy.

**Table 14. Sensitivity Pattern of Isolated Microorganisms Against Ofloxacin by Sample Type**

| Organism | Site (n) | Resistant n (%) | Intermediate n (%) | Sensitive n (%) | $\chi^2$ Value | p-value |
|---|---|---|---|---|---|---|
| ***Staphylococcus aureus*** | Urine (9) | 3 (33.3%) | 6 (66.7%) | 0 (0.0%) | 35.886 | <0.001 |
| | Blood (3) | 3 (100.0%) | 0 (0.0%) | 0 (0.0%) | 15.000 | 0.005 |
| | Wound swab (3) | 0 (0.0%) | 3 (100.0%) | 0 (0.0%) | – | – |
| ***Escherichia coli*** | Urine (21) | 6 (28.6%) | 6 (28.6%) | 9 (42.9%) | 35.886 | <0.001 |
| | Blood (3) | 0 (0.0%) | 0 (0.0%) | 3 (100.0%) | 15.000 | 0.005 |
| ***Klebsiella pneumoniae*** | Urine (6) | 0 (0.0%) | 6 (100.0%) | 0 (0.0%) | 35.886 | <0.001 |
| | Blood (6) | 3 (50.0%) | 3 (50.0%) | 0 (0.0%) | 15.000 | 0.005 |
| | Respiratory (3) | 0 (0.0%) | 0 (0.0%) | 3 (100.0%) | 9.000 | 0.003 |
| ***Streptococcus pyogenes*** | Respiratory (6) | 0 (0.0%) | 0 (0.0%) | 6 (100.0%) | 9.000 | 0.003 |
| ***Salmonella spp.*** | Urine (3) | 0 (0.0%) | 3 (100.0%) | 0 (0.0%) | – | – |
| | Other (3) | 0 (0.0%) | 0 (0.0%) | 3 (100.0%) | – | – |
| ***Pseudomonas aeruginosa*** | Urine (3) | 3 (100.0%) | 0 (0.0%) | 0 (0.0%) | – | – |
| | Wound swab (3) | 0 (0.0%) | 3 (100.0%) | 0 (0.0%) | – | – |
| ***Enterococcus faecalis*** | Urine (3) | 0 (0.0%) | 3 (100.0%) | 0 (0.0%) | – | – |
| ***Streptococcus spp.*** | Urine (3) | 3 (100.0%) | 0 (0.0%) | 0 (0.0%) | – | – |

The susceptibility profile of bacterial isolates to ofloxacin revealed variable responses across specimen types. *Staphylococcus aureus* isolates from urine demonstrated moderate sensitivity (66.7%), while blood isolates were completely resistant (100%). *Escherichia coli* showed partial resistance in urine (28.6%) with 42.9% sensitivity, whereas blood isolates remained fully sensitive. *Klebsiella pneumoniae* exhibited complete intermediate resistance in urine and partial resistance in blood, but respiratory isolates retained full sensitivity. *Streptococcus pyogenes* demonstrated complete sensitivity in respiratory specimens. Conversely, *Pseudomonas aeruginosa* isolates from urine were fully resistant, while wound isolates remained sensitive. The chi-square analysis ($\chi^2 = 35.886$, $p < 0.001$) confirmed statistically significant differences in susceptibility patterns. These findings highlight the limited efficacy of ofloxacin against certain Gram-negative pathogens, particularly *Pseudomonas aeruginosa* and *Klebsiella pneumoniae*, while maintaining effectiveness against *Streptococcus pyogenes* and some *E. coli* isolates.

**Table 15. Sensitivity Pattern of Isolated Microorganisms Against Gentamicin by Sample Type**

| Organism | Site (n) | Resistant n (%) | Intermediate n (%) | Sensitive n (%) | $\chi^2$ Value | p-value |
|---|---|---|---|---|---|---|
| ***Staphylococcus aureus*** | Urine (9) | 3 (33.3%) | 0 (0.0%) | 6 (66.7%) | 38.883 | <0.001 |
| | Blood (3) | 0 (0.0%) | 3 (100.0%) | 0 (0.0%) | 15.000 | 0.005 |
| | Wound swab (3) | 0 (0.0%) | 0 (0.0%) | 3 (100.0%) | – | – |
| ***Escherichia coli*** | Urine (21) | 0 (0.0%) | 3 (14.3%) | 18 (85.7%) | 38.883 | <0.001 |


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| | | | | | | |
|---|---|---|---|---|---|---|
| | Blood (3) | 0 (0.0%) | 0 (0.0%) | 3 (100.0%) | – | – |
| ***Klebsiella pneumoniae*** | Urine (6) | 0 (0.0%) | 3 (50.0%) | 3 (50.0%) | 38.883 | <0.001 |
| | Blood (6) | 3 (50.0%) | 3 (50.0%) | 0 (0.0%) | 15.000 | 0.005 |
| | Respiratory (3) | 3 (100.0%) | 0 (0.0%) | 0 (0.0%) | 2.250 | 0.134 |
| ***Streptococcus pyogenes*** | Respiratory (6) | 3 (50.0%) | 3 (50.0%) | 0 (0.0%) | 2.250 | 0.134 |
| ***Salmonella spp.*** | Urine (3) | 0 (0.0%) | 0 (0.0%) | 3 (100.0%) | – | – |
| | Other (3) | 0 (0.0%) | 0 (0.0%) | 3 (100.0%) | – | – |
| ***Pseudomonas aeruginosa*** | Urine (3) | 0 (0.0%) | 3 (100.0%) | 0 (0.0%) | – | – |
| | Wound swab (3) | 0 (0.0%) | 0 (0.0%) | 3 (100.0%) | – | – |
| ***Enterococcus faecalis*** | Urine (3) | 0 (0.0%) | 3 (100.0%) | 0 (0.0%) | – | – |
| ***Streptococcus spp.*** | Urine (3) | – | – | – | – | – |

Gentamicin susceptibility varied across specimen types. *Staphylococcus aureus* showed moderate sensitivity in urine (66.7%), intermediate response in blood (100%), and full sensitivity in wound isolates. *Escherichia coli* retained high sensitivity in urine (85.7%) and complete sensitivity in blood, confirming gentamicin's efficacy against uropathogens. In contrast, *Klebsiella pneumoniae* demonstrated mixed patterns, with partial resistance in blood and full resistance in respiratory isolates. *Streptococcus pyogenes* respiratory isolates lacked full sensitivity, while *Salmonella spp*. and wound *Pseudomonas aeruginosa* remained fully sensitive. Chi-square analysis ($\chi^2$ = 38.883, p < 0.001) indicated significant differences across isolates. These findings highlight gentamicin's strong activity against *E. coli* and *Salmonella spp.*, but reduced effectiveness against *Klebsiella pneumoniae* and respiratory pathogens, underscoring the need for site-specific susceptibility testing.

**Table 16. Sensitivity Pattern of Isolated Microorganisms Against Penicillin V by Sample Type**

| Organism | Site (n) | Resistant ≤9mm n (%) | Intermediate 10–11mm n (%) | Sensitive ≥12mm n (%) | $\chi^2$ Value | p-value |
|---|---|---|---|---|---|---|
| ***Staphylococcus aureus*** | Urine (9) | 9 (100.0%) | 0 (0.0%) | 0 (0.0%) | – | – |
| | Blood (3) | 3 (100.0%) | 0 (0.0%) | 0 (0.0%) | 81.067 | <0.001 |
| | Wound swab (3) | 3 (100.0%) | 0 (0.0%) | 0 (0.0%) | – | – |
| ***Escherichia coli*** | Urine (21) | 15 (71.4%) | 3 (14.3%) | 3 (14.3%) | 30.000 | <0.001 |
| | Blood (3) | 3 (100.0%) | 0 (0.0%) | 0 (0.0%) | – | – |
| ***Klebsiella pneumoniae*** | Urine (6) | 6 (100.0%) | 0 (0.0%) | 0 (0.0%) | – | – |
| | Blood (6) | 6 (100.0%) | 0 (0.0%) | 0 (0.0%) | 81.067 | <0.001 |
| | Respiratory (3) | 3 (100.0%) | 0 (0.0%) | 0 (0.0%) | – | – |
| ***Streptococcus pyogenes*** | Respiratory (6) | 0 (0.0%) | 0 (0.0%) | 6 (100.0%) | – | – |
| ***Salmonella spp.*** | Urine (3) | 0 (0.0%) | 3 (100.0%) | 0 (0.0%) | – | – |
| | Other (3) | 3 (100.0%) | 0 (0.0%) | 0 (0.0%) | – | – |
| ***Pseudomonas aeruginosa*** | Urine (3) | 3 (100.0%) | 0 (0.0%) | 0 (0.0%) | – | – |
| | Wound swab (3) | 3 (100.0%) | 0 (0.0%) | 0 (0.0%) | – | – |
| ***Enterococcus faecalis*** | Urine (3) | 3 (100.0%) | 0 (0.0%) | 0 (0.0%) | – | – |
| ***Streptococcus spp.*** | Urine (3) | 3 (100.0%) | 0 (0.0%) | 0 (0.0%) | – | – |

The susceptibility pattern to Penicillin V showed high resistance among most Gram-negative isolates and *Staphylococcus aureus*. All *S. aureus* isolates from urine, blood, and wound swabs were resistant. *E. coli* urinary isolates showed predominant resistance, while *Klebsiella pneumoniae* isolates were uniformly resistant across urine, blood, and respiratory specimens. In contrast, *Streptococcus pyogenes* respiratory isolates were fully susceptible to Penicillin V. *Pseudomonas aeruginosa*, *Enterococcus faecalis*, and *Streptococcus spp*. were uniformly resistant. These findings indicate the limited empirical value of Penicillin V against most clinical isolates in this study, with preserved activity against *S. pyogenes*


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**Table 17. Sensitivity Pattern of Isolated Microorganisms Against Penicillin G by Sample Type**

| Organism | Site (n) | Resistant ≤9mm n (%) | Intermediate 10–11mm n (%) | Sensitive ≥12mm n (%) | $\chi^2$ Value | p-value |
|---|---|---|---|---|---|---|
| ***Staphylococcus aureus*** | Urine (9) | 9 (100.0%) | 0 (0.0%) | 0 (0.0%) | – | – |
| | Blood (3) | 3 (100.0%) | 0 (0.0%) | 0 (0.0%) | 81.067 | <0.001 |
| | Wound swab (3) | 3 (100.0%) | 0 (0.0%) | 0 (0.0%) | – | – |
| ***Escherichia coli*** | Urine (21) | 15 (71.4%) | 3 (14.3%) | 3 (14.3%) | 30.000 | <0.001 |
| | Blood (3) | 3 (100.0%) | 0 (0.0%) | 0 (0.0%) | – | – |
| ***Klebsiella pneumoniae*** | Urine (6) | 6 (100.0%) | 0 (0.0%) | 0 (0.0%) | – | – |
| | Blood (6) | 6 (100.0%) | 0 (0.0%) | 0 (0.0%) | 81.067 | <0.001 |
| | Respiratory (3) | 3 (100.0%) | 0 (0.0%) | 0 (0.0%) | – | – |
| ***Streptococcus pyogenes*** | Respiratory (6) | 0 (0.0%) | 0 (0.0%) | 6 (100.0%) | – | – |
| ***Salmonella spp.*** | Urine (3) | 0 (0.0%) | 3 (100.0%) | 0 (0.0%) | – | – |
| | Other (3) | 3 (100.0%) | 0 (0.0%) | 0 (0.0%) | – | – |
| ***Pseudomonas aeruginosa*** | Urine (3) | 3 (100.0%) | 0 (0.0%) | 0 (0.0%) | – | – |
| | Wound swab (3) | 3 (100.0%) | 0 (0.0%) | 0 (0.0%) | – | – |
| ***Enterococcus faecalis*** | Urine (3) | 3 (100.0%) | 0 (0.0%) | 0 (0.0%) | – | – |
| ***Streptococcus spp.*** | Urine (3) | 3 (100.0%) | 0 (0.0%) | 0 (0.0%) | – | – |

The susceptibility pattern to Penicillin G was largely consistent with that observed for Penicillin V. High resistance was detected among most Gram-negative isolates and all *Staphylococcus aureus* isolates. *Escherichia coli* urinary isolates showed predominant resistance, while *Klebsiella pneumoniae* isolates were uniformly resistant across urine, blood, and respiratory specimens. *Pseudomonas aeruginosa* isolates from urine and wound swabs were also completely resistant to Penicillin G. In contrast, *Streptococcus pyogenes* respiratory isolates remained fully susceptible. These findings indicate the limited empirical value of Penicillin G against most clinical isolates in this study, with preserved activity mainly against S. pyogenes.

**Table 18. Sensitivity Pattern of Isolated Microorganisms Against Erythromycin by Sample Type**

| Organism | Site (n) | Resistant n (%) | Intermediate n (%) | Sensitive n (%) | $\chi^2$ Value | p-value |
|---|---|---|---|---|---|---|
| ***Staphylococcus aureus*** | Urine (9) | 6 (66.7%) | 3 (33.3%) | 0 (0.0%) | 26.182 | 0.010 |
| | Blood (3) | 3 (100.0%) | 0 (0.0%) | 0 (0.0%) | 12.000 | 0.002 |
| | Wound swab (3) | 0 (0.0%) | 3 (100.0%) | 0 (0.0%) | 6.000 | 0.014 |
| ***Escherichia coli*** | Urine (21) | 12 (57.1%) | 3 (14.3%) | 6 (28.6%) | 26.182 | 0.010 |
| | Blood (3) | 3 (100.0%) | 0 (0.0%) | 0 (0.0%) | – | – |
| ***Klebsiella pneumoniae*** | Urine (6) | 6 (100.0%) | 0 (0.0%) | 0 (0.0%) | 26.182 | 0.010 |
| | Blood (6) | 6 (100.0%) | 0 (0.0%) | 0 (0.0%) | 12.000 | 0.002 |
| | Respiratory (3) | 3 (100.0%) | 0 (0.0%) | 0 (0.0%) | 9.000 | 0.003 |
| ***Streptococcus pyogenes*** | Respiratory (6) | 0 (0.0%) | 0 (0.0%) | 6 (100.0%) | 9.000 | 0.003 |
| ***Salmonella spp.*** | Urine (3) | 3 (100.0%) | 0 (0.0%) | 0 (0.0%) | – | – |
| | Other (3) | 3 (100.0%) | 0 (0.0%) | 0 (0.0%) | – | – |
| ***Pseudomonas aeruginosa*** | Urine (3) | 3 (100.0%) | 0 (0.0%) | 0 (0.0%) | – | – |
| | Wound swab (3) | 3 (100.0%) | 0 (0.0%) | 0 (0.0%) | 6.000 | 0.014 |
| ***Enterococcus faecalis*** | Urine (3) | 3 (100.0%) | 0 (0.0%) | 0 (0.0%) | – | – |
| ***Streptococcus spp.*** | Urine (3) | 3 (100.0%) | 0 (0.0%) | 0 (0.0%) | – | – |

The susceptibility pattern of clinical isolates to Erythromycin demonstrated high levels of resistance across most tested pathogens. Staphylococcus aureus exhibited substantial resistance in blood (100.0%) and urine (66.7%) specimens, while


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all wound isolates showed intermediate susceptibility. Gram-negative *bacilli,* including *Klebsiella pneumoniae*, *Pseudomonas aeruginosa*, and *Salmonella spp*., were uniformly resistant (100.0%) across all clinical sites, which is consistent with their intrinsic resistance to macrolides. Although a minority of urinary *Escherichia coli* isolates (28.6%) showed apparent susceptibility, Erythromycin is not clinically indicated for Gram-negative bacilli, and these in-vitro findings should be interpreted with caution. In contrast, *Streptococcus pyogenes* respiratory isolates retained full sensitivity (100.0%) to Erythromycin, confirming its continued efficacy against *streptococci* in this region.

**Table 19. Sensitivity Pattern of Isolated Microorganisms Against Co-trimoxazole by Sample Type**

| Organism | Site (n) | Resistant n (%) | Intermediate n (%) | Sensitive n (%) | $\chi^2$ Value | p-value |
|---|---|---|---|---|---|---|
| ***Staphylococcus aureus*** | Urine (9) | 3 (33.3%) | 0 (0.0%) | 6 (66.7%) | 44.865 | <0.001 |
| | Blood (3) | 0 (0.0%) | 0 (0.0%) | 3 (100.0%) | 12.000 | 0.002 |
| | Wound swab (3) | 0 (0.0%) | 0 (0.0%) | 3 (100.0%) | 6.000 | 0.014 |
| ***Escherichia coli*** | Urine (21) | 3 (14.3%) | 12 (57.1%) | 6 (28.6%) | 44.865 | <0.001 |
| | Blood (3) | 3 (100.0%) | 0 (0.0%) | 0 (0.0%) | 12.000 | 0.002 |
| ***Klebsiella pneumoniae*** | Urine (6) | 6 (100.0%) | 0 (0.0%) | 0 (0.0%) | 44.865 | <0.001 |
| | Blood (6) | 6 (100.0%) | 0 (0.0%) | 0 (0.0%) | 12.000 | 0.002 |
| | Respiratory (3) | 3 (100.0%) | 0 (0.0%) | 0 (0.0%) | – | – |
| ***Streptococcus pyogenes*** | Respiratory (6) | 0 (0.0%) | 6 (100.0%) | 0 (0.0%) | – | – |
| ***Salmonella spp.*** | Urine (3) | 0 (0.0%) | 0 (0.0%) | 3 (100.0%) | – | – |
| | Other (3) | 3 (100.0%) | 0 (0.0%) | 0 (0.0%) | – | – |
| ***Pseudomonas aeruginosa*** | Urine (3) | 3 (100.0%) | 0 (0.0%) | 0 (0.0%) | – | – |
| | Wound swab (3) | 3 (100.0%) | 0 (0.0%) | 0 (0.0%) | 6.000 | 0.014 |
| ***Enterococcus faecalis*** | Urine (3) | 3 (100.0%) | 0 (0.0%) | 0 (0.0%) | – | – |
| ***Streptococcus spp.*** | Urine (3) | 3 (100.0%) | 0 (0.0%) | 0 (0.0%) | – | – |

The susceptibility pattern to Co-trimoxazole showed variable responses among the tested bacterial isolates. *Staphylococcus aureus* demonstrated generally good susceptibility, particularly in blood and wound swab isolates, while urinary isolates showed partial resistance. Urinary *Escherichia coli* isolates showed a predominance of intermediate response, with limited resistance and partial susceptibility, whereas blood isolates were completely resistant. *Klebsiella pneumoniae* and *Pseudomonas aeruginosa* isolates were uniformly resistant across the tested specimen types, indicating limited effectiveness of Co-trimoxazole against these Gram-negative pathogens. *Salmonella spp.* showed site-dependent variation, with urinary isolates being fully susceptible and isolates from other specimens being resistant. These findings highlight the variable activity of Co-trimoxazole and support the need for susceptibility-guided therapy rather than empirical use.

**Table 20. Sensitivity Pattern of Isolated Microorganisms Against Clindamycin by Sample Type**

| Organism | Site (n) | Resistant n (%) | Intermediate n (%) | Sensitive n (%) | $\chi^2$ Value | p-value |
|---|---|---|---|---|---|---|
| ***Staphylococcus aureus*** | Urine (9) | 3 (33.3%) | 6 (66.7%) | 0 (0.0%) | 23.314 | 0.025 |
| | Blood (3) | 0 (0.0%) | 0 (0.0%) | 3 (100.0%) | 12.000 | 0.002 |
| | Wound swab (3) | 0 (0.0%) | 0 (0.0%) | 3 (100.0%) | 6.000 | 0.014 |
| ***Escherichia coli*** | Urine (21) | 12 (57.1%) | 6 (28.6%) | 3 (14.3%) | 23.314 | 0.025 |
| | Blood (3) | 3 (100.0%) | 0 (0.0%) | 0 (0.0%) | 12.000 | 0.002 |
| ***Klebsiella pneumoniae*** | Urine (6) | 6 (100.0%) | 0 (0.0%) | 0 (0.0%) | – | – |
| | Blood (6) | 6 (100.0%) | 0 (0.0%) | 0 (0.0%) | 14.000 | 0.173 |
| | Respiratory (3) | 3 (100.0%) | 0 (0.0%) | 0 (0.0%) | 9.000 | 0.003 |
| ***Streptococcus pyogenes*** | Respiratory (6) | 0 (0.0%) | 0 (0.0%) | 6 (100.0%) | 9.000 | 0.003 |
| ***Salmonella spp.*** | Urine (3) | 0 (0.0%) | 3 (100.0%) | 0 (0.0%) | – | – |
| | Other (3) | 0 (0.0%) | 3 (100.0%) | 0 (0.0%) | – | – |
| ***Pseudomonas aeruginosa*** | Urine (3) | 3 (100.0%) | 0 (0.0%) | 0 (0.0%) | – | – |
| | Wound swab (3) | 0 (0.0%) | 3 (100.0%) | 0 (0.0%) | 6.000 | 0.014 |


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| | | | | | | |
|---|---|---|---|---|---|---|
| ***Enterococcus faecalis*** | Urine (3) | 3 (100.0%) | 0 (0.0%) | 0 (0.0%) | – | – |
| ***Streptococcus spp.*** | Urine (3) | 3 (100.0%) | 0 (0.0%) | 0 (0.0%) | – | – |

Overall Pearson Chi-Square = 124.597, df = 28, p < 0.001

The sensitivity profile of clinical isolates to Clindamycin showed distinct patterns across different species and specimen types. *Staphylococcus aureus* exhibited high susceptibility in blood and wound isolates (100.0%), but a predominant intermediate response (66.7%) in urinary isolates. *Streptococcus pyogenes* respiratory isolates were fully susceptible (100.0%). Conversely, *Enterococcus faecalis*, *Streptococcus spp.*, and *Klebsiella pneumoniae* isolates were uniformly resistant (100.0%). Although some in-vitro susceptibility and intermediate zones were observed among *Escherichia coli*, *Salmonella spp.*, and *Pseudomonas aeruginosa* isolates, these findings must be interpreted with extreme caution. Gram-negative bacilli are clinically intrinsically resistant to Clindamycin due to the impermeability of their outer membrane; thus, these in-vitro zones do not translate into clinical efficacy. The overall chi-square analysis confirmed a highly significant association between bacterial species, specimen source, and Clindamycin susceptibility patterns ($\chi^2$ = 124.597, df = 28, p < 0.001).

**Table 21. Sensitivity Pattern of Isolated Microorganisms Against Levofloxacin by Sample Type**

| Organism | Site (n) | Resistant n (%) | Intermediate n (%) | Sensitive n (%) | $\chi^2$ Value | p-value |
|---|---|---|---|---|---|---|
| ***Staphylococcus aureus*** | Urine (9) | 3 (33.3%) | 0 (0.0%) | 6 (66.7%) | 26.390 | 0.009 |
| | Blood (3) | 3 (100.0%) | 0 (0.0%) | 0 (0.0%) | 15.000 | 0.005 |
| | Wound swab (3) | 0 (0.0%) | 3 (100.0%) | 0 (0.0%) | 6.000 | 0.014 |
| ***Escherichia coli*** | Urine (21) | 3 (14.3%) | 6 (28.6%) | 12 (57.1%) | 26.390 | 0.009 |
| | Blood (3) | 0 (0.0%) | 3 (100.0%) | 0 (0.0%) | 15.000 | 0.005 |
| ***Klebsiella pneumoniae*** | Urine (6) | 0 (0.0%) | 3 (50.0%) | 3 (50.0%) | 26.390 | 0.009 |
| | Blood (6) | 3 (50.0%) | 0 (0.0%) | 3 (50.0%) | 15.000 | 0.005 |
| | Respiratory (3) | 3 (100.0%) | 0 (0.0%) | 0 (0.0%) | 9.000 | 0.011 |
| ***Streptococcus pyogenes*** | Respiratory (6) | 0 (0.0%) | 6 (100.0%) | 0 (0.0%) | 9.000 | 0.011 |
| ***Salmonella spp.*** | Urine (3) | 0 (0.0%) | 0 (0.0%) | 3 (100.0%) | – | – |
| | Other (3) | 0 (0.0%) | 0 (0.0%) | 3 (100.0%) | – | – |
| ***Pseudomonas aeruginosa*** | Urine (3) | 3 (100.0%) | 0 (0.0%) | 0 (0.0%) | – | – |
| | Wound swab (3) | 3 (100.0%) | 0 (0.0%) | 0 (0.0%) | 6.000 | 0.014 |
| ***Enterococcus faecalis*** | Urine (3) | 3 (100.0%) | 0 (0.0%) | 0 (0.0%) | – | – |
| ***Streptococcus spp.*** | Urine (3) | 3 (100.0%) | 0 (0.0%) | 0 (0.0%) | – | – |

The susceptibility pattern to Levofloxacin showed variable activity across bacterial species and specimen types. Urinary *Escherichia coli* isolates demonstrated moderate susceptibility, while blood isolates showed an intermediate response. *Klebsiella pneumoniae* displayed mixed susceptibility patterns in urine and blood specimens, with complete resistance among respiratory isolates. *Pseudomonas aeruginosa*, *Enterococcus faecalis*, and *Streptococcus spp.* were uniformly resistant. In contrast, *Salmonella spp.* isolates from urine and other specimens were fully susceptible, although interpretation is limited by the small number of isolates. These findings suggest that Levofloxacin activity was species- and site-dependent and should be guided by susceptibility testing.

**Table 22. Sensitivity Pattern of Isolated Microorganisms Against Amikacin by Sample Type**

| Organism | Site (n) | Resistant n (%) | Intermediate n (%) | Sensitive n (%) |
|---|---|---|---|---|
| ***Staphylococcus aureus*** | Urine (9) | 6 (66.7%) | 0 (0.0%) | 3 (33.3%) |
| | Blood (3) | 0 (0.0%) | 3 (100.0%) | 0 (0.0%) |
| | Wound swab (3) | 0 (0.0%) | 0 (0.0%) | 3 (100.0%) |
| ***Escherichia coli*** | Urine (21) | 0 (0.0%) | 9 (42.9%) | 12 (57.1%) |
| | Blood (3) | 0 (0.0%) | 3 (100.0%) | 0 (0.0%) |
| ***Klebsiella pneumoniae*** | Urine (6) | 0 (0.0%) | 0 (0.0%) | 6 (100.0%) |
| | Blood (6) | 6 (100.0%) | 0 (0.0%) | 0 (0.0%) |
| | Respiratory (3) | 3 (100.0%) | 0 (0.0%) | 0 (0.0%) |
| ***Streptococcus pyogenes*** | Respiratory (6) | 3 (50.0%) | 3 (50.0%) | 0 (0.0%) |
| ***Salmonella spp.*** | Urine (3) | 0 (0.0%) | 0 (0.0%) | 3 (100.0%) |
| | Other (3) | 0 (0.0%) | 0 (0.0%) | 3 (100.0%) |
| ***Pseudomonas aeruginosa*** | Urine (3) | 0 (0.0%) | 0 (0.0%) | 3 (100.0%) |


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| | | | | |
|---|---|---|---|---|
| | Wound swab (3) | 0 (0.0%) | 0 (0.0%) | 3 (100.0%) |
| ***Enterococcus faecalis*** | Urine (3) | 0 (0.0%) | 3 (100.0%) | 0 (0.0%) |
| ***Streptococcus spp.*** | Urine (3) | 0 (0.0%) | 3 (100.0%) | 0 (0.0%) |

The susceptibility pattern to Amikacin demonstrated variable efficacy depending on the bacterial species and the clinical site of isolation. Among Gram-negative pathogens, Pseudomonas aeruginosa and Salmonella spp. were fully susceptible (100.0%) across all tested specimens. Escherichia coli urinary isolates showed moderate susceptibility (57.1%) alongside a significant intermediate response (42.9%). Interestingly, Klebsiella pneumoniae exhibited a highly site-dependent pattern, being fully susceptible in urine but completely resistant in blood and respiratory specimens. For Gram-positive isolates, Staphylococcus aureus showed complete susceptibility in wound swabs but notable resistance (66.7%) in urinary isolates. Enterococcus faecalis and Streptococcus spp. displayed uniformly intermediate responses; however, these in-vitro results should be interpreted with caution, as aminoglycosides are typically not recommended as monotherapy for these organisms. The overall statistical analysis indicated a significant association between isolate distribution and susceptibility (Pearson $\chi^2 = 124.597$, df = 28, $p < 0.001$), though the presence of small expected cell counts necessitates cautious interpretation of the *p*-value

**Table 23. Sensitivity Pattern of Isolated Microorganisms Against Nitrofurantoin by Sample Type**

| Organism | Site (n) | Resistant n (%) | Intermediate n (%) | Sensitive n (%) |
|---|---|---|---|---|
| ***Staphylococcus aureus*** | Urine (9) | 3 (33.3%) | 0 (0.0%) | 6 (66.7%) |
| | Blood (3) | 0 (0.0%) | 3 (100.0%) | 0 (0.0%) |
| | Wound swab (3) | 3 (100.0%) | 0 (0.0%) | 0 (0.0%) |
| ***Escherichia coli*** | Urine (21) | 0 (0.0%) | 3 (14.3%) | 18 (85.7%) |
| | Blood (3) | 3 (100.0%) | 0 (0.0%) | 0 (0.0%) |
| ***Klebsiella pneumoniae*** | Urine (6) | 0 (0.0%) | 0 (0.0%) | 6 (100.0%) |
| | Blood (6) | 3 (50.0%) | 0 (0.0%) | 3 (50.0%) |
| | Respiratory (3) | 3 (100.0%) | 0 (0.0%) | 0 (0.0%) |
| ***Streptococcus pyogenes*** | Respiratory (6) | 0 (0.0%) | 6 (100.0%) | 0 (0.0%) |
| ***Salmonella spp.*** | Urine (3) | 0 (0.0%) | 0 (0.0%) | 3 (100.0%) |
| | Other (3) | 0 (0.0%) | 0 (0.0%) | 3 (100.0%) |
| ***Pseudomonas aeruginosa*** | Urine (3) | 0 (0.0%) | 0 (0.0%) | 3 (100.0%) |
| | Wound swab (3) | 0 (0.0%) | 3 (100.0%) | 0 (0.0%) |
| ***Enterococcus faecalis*** | Urine (3) | 0 (0.0%) | 0 (0.0%) | 3 (100.0%) |
| ***Streptococcus spp.*** | Urine (3) | 0 (0.0%) | 0 (0.0%) | 3 (100.0%) |

The susceptibility pattern to Nitrofurantoin showed strong activity against urinary isolates, particularly *Escherichia coli* and *Klebsiella pneumoniae*, which demonstrated high susceptibility rates in urine specimens. *Enterococcus faecalis*, *Streptococcus spp.*, and *Salmonella spp.* urinary isolates were also fully susceptible. In contrast, isolates from non-urinary specimens showed more variable responses, including resistance among blood and respiratory isolates of *Klebsiella pneumoniae* and blood isolates of *Escherichia coli*. Although *Pseudomonas aeruginosa* urinary isolates appeared susceptible in vitro, Nitrofurantoin is not generally considered a reliable clinical option for this organism and such findings should be interpreted cautiously. Overall, the results support the usefulness of Nitrofurantoin mainly for urinary tract infections, especially those caused by *E. coli*, while emphasizing the need for susceptibility-guided therapy.

**Table 24. Sensitivity Pattern of Isolated Microorganisms Against Linezolid by Sample Type**

| Organism | Site (n) | Resistant n (%) | Intermediate n (%) | Sensitive n (%) |
|---|---|---|---|---|
| ***Staphylococcus aureus*** | Urine (9) | 3 (33.3%) | 6 (66.7%) | 0 (0.0%) |
| | Blood (3) | 0 (0.0%) | 0 (0.0%) | 3 (100.0%) |
| | Wound swab (3) | 0 (0.0%) | 0 (0.0%) | 3 (100.0%) |
| ***Escherichia coli*** | Urine (21) | 3 (14.3%) | 18 (85.7%) | 0 (0.0%) |
| | Blood (3) | 0 (0.0%) | 0 (0.0%) | 3 (100.0%) |
| ***Klebsiella pneumoniae*** | Urine (6) | 3 (50.0%) | 3 (50.0%) | 0 (0.0%) |
| | Blood (6) | 6 (100.0%) | 0 (0.0%) | 0 (0.0%) |
| | Respiratory (3) | 3 (100.0%) | 0 (0.0%) | 0 (0.0%) |
| ***Streptococcus pyogenes*** | Respiratory (6) | 0 (0.0%) | 0 (0.0%) | 6 (100.0%) |
| ***Salmonella spp.*** | Urine (3) | 0 (0.0%) | 3 (100.0%) | 0 (0.0%) |
| | Other (3) | 0 (0.0%) | 3 (100.0%) | 0 (0.0%) |
| ***Pseudomonas aeruginosa*** | Urine (3) | 0 (0.0%) | 3 (100.0%) | 0 (0.0%) |
| | Wound swab (3) | 0 (0.0%) | 0 (0.0%) | 3 (100.0%) |
| ***Enterococcus faecalis*** | Urine (3) | 0 (0.0%) | 0 (0.0%) | 3 (100.0%) |
| ***Streptococcus spp.*** | Urine (3) | 3 (100.0%) | 0 (0.0%) | 0 (0.0%) |


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The susceptibility profile of clinical isolates to Linezolid demonstrated selective activity predominantly against Gram-positive organisms. *Staphylococcus aureus* showed complete susceptibility in blood and wound swab isolates, while urinary isolates exhibited mixed resistance and intermediate responses. *Streptococcus pyogenes* and *Enterococcus faecalis* isolates were fully susceptible. In contrast, *Klebsiella pneumoniae* isolates were uniformly resistant in blood and respiratory specimens. Although some in-vitro intermediate responses were observed among Gram-negative bacilli such as *Escherichia coli*, *Salmonella spp.*, and *Pseudomonas aeruginosa*, these findings must be interpreted with caution, as Linezolid is not clinically indicated for Gram-negative infections due to intrinsic resistance mechanisms. The overall chi-square analysis confirmed a statistically significant association between bacterial species, specimen source, and Linezolid susceptibility patterns (Pearson $\chi^2 = 124.597$, df = 28, $p < 0.001$).

**Table 25. Sensitivity Pattern of Isolated Microorganisms Against Doxycycline by Sample Type**

| Organism | Site (n) | Resistant n (%) | Intermediate n (%) | Sensitive n (%) |
|---|---|---|---|---|
| ***Staphylococcus aureus*** | Urine (9) | 3 (33.3%) | 3 (33.3%) | 3 (33.3%) |
| | Blood (3) | 0 (0.0%) | 0 (0.0%) | 3 (100.0%) |
| | Wound swab (3) | 0 (0.0%) | 0 (0.0%) | 3 (100.0%) |
| ***Escherichia coli*** | Urine (21) | 3 (14.3%) | 9 (42.9%) | 9 (42.9%) |
| | Blood (3) | 0 (0.0%) | 0 (0.0%) | 3 (100.0%) |
| ***Klebsiella pneumoniae*** | Urine (6) | 0 (0.0%) | 0 (0.0%) | 6 (100.0%) |
| | Blood (6) | 3 (50.0%) | 3 (50.0%) | 0 (0.0%) |
| | Respiratory (3) | 3 (100.0%) | 0 (0.0%) | 0 (0.0%) |
| ***Streptococcus pyogenes*** | Respiratory (6) | 0 (0.0%) | 0 (0.0%) | 6 (100.0%) |
| ***Salmonella spp.*** | Urine (3) | 0 (0.0%) | 3 (100.0%) | 0 (0.0%) |
| | Other (3) | 3 (100.0%) | 0 (0.0%) | 0 (0.0%) |
| ***Pseudomonas aeruginosa*** | Urine (3) | 0 (0.0%) | 0 (0.0%) | 3 (100.0%) |
| | Wound swab (3) | 0 (0.0%) | 3 (100.0%) | 0 (0.0%) |
| ***Enterococcus faecalis*** | Urine (3) | 3 (100.0%) | 0 (0.0%) | 0 (0.0%) |
| ***Streptococcus spp.*** | Urine (3) | 0 (0.0%) | 0 (0.0%) | 3 (100.0%) |

The susceptibility profile of clinical isolates to Doxycycline revealed variable responses across species and specimen types. *Staphylococcus aureus* urinary isolates showed equal distribution among resistant, intermediate, and sensitive categories, while blood and wound isolates were fully susceptible. *Escherichia coli* demonstrated mixed intermediate and sensitive responses in urine, but complete susceptibility in blood. *Klebsiella pneumoniae* exhibited full resistance in respiratory isolates and partial resistance in blood specimens. *Streptococcus pyogenes* remained fully susceptible, whereas *Enterococcus faecalis* showed complete resistance. *Salmonella spp.* and *Pseudomonas aeruginosa* displayed site-dependent intermediate or sensitive responses. These findings highlight the importance of specimen source in interpreting antimicrobial susceptibility patterns.

**Table 26. Sensitivity Pattern of Isolated Microorganisms Against Tetracycline by Sample Type**

| Organism | Site (n) | Resistant n (%) | Intermediate n (%) | Sensitive n (%) |
|---|---|---|---|---|
| ***Staphylococcus aureus*** | Urine (9) | 3 (33.3%) | 6 (66.7%) | 0 (0.0%) |
| | Blood (3) | 0 (0.0%) | 0 (0.0%) | 3 (100.0%) |
| | Wound swab (3) | 0 (0.0%) | 0 (0.0%) | 3 (100.0%) |
| ***Escherichia coli*** | Urine (21) | 6 (28.6%) | 9 (42.9%) | 6 (28.6%) |
| | Blood (3) | 0 (0.0%) | 0 (0.0%) | 3 (100.0%) |
| ***Klebsiella pneumoniae*** | Urine (6) | 0 (0.0%) | 3 (50.0%) | 3 (50.0%) |
| | Blood (6) | 6 (100.0%) | 0 (0.0%) | 0 (0.0%) |
| | Respiratory (3) | 3 (100.0%) | 0 (0.0%) | 0 (0.0%) |
| ***Streptococcus pyogenes*** | Respiratory (6) | 0 (0.0%) | 0 (0.0%) | 6 (100.0%) |
| ***Salmonella spp.*** | Urine (3) | 0 (0.0%) | 3 (100.0%) | 0 (0.0%) |
| | Other (3) | 3 (100.0%) | 0 (0.0%) | 0 (0.0%) |
| ***Pseudomonas aeruginosa*** | Urine (3) | 0 (0.0%) | 0 (0.0%) | 3 (100.0%) |
| | Wound swab (3) | 3 (100.0%) | 0 (0.0%) | 0 (0.0%) |
| ***Enterococcus faecalis*** | Urine (3) | 3 (100.0%) | 0 (0.0%) | 0 (0.0%) |
| ***Streptococcus spp.*** | Urine (3) | 3 (100.0%) | 0 (0.0%) | 0 (0.0%) |

The susceptibility pattern to Tetracycline showed variable activity across bacterial species and specimen types. *Staphylococcus aureus* demonstrated complete susceptibility in blood and wound swab isolates, while urinary isolates showed a predominance of intermediate responses. *Escherichia coli* urinary isolates exhibited a mixed pattern of resistance, intermediate, and sensitive responses, while blood isolates were fully susceptible. *Klebsiella pneumoniae* showed site-dependent variation, with urinary isolates displaying intermediate and sensitive responses, but blood and


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respiratory isolates were uniformly resistant. *Streptococcus pyogenes* respiratory isolates were fully susceptible. In contrast, *Pseudomonas aeruginosa* wound isolates, *Enterococcus faecalis*, and *Streptococcus spp.* were uniformly resistant. These findings highlight the limited and variable activity of Tetracycline, supporting the need for susceptibility-guided therapy rather than empirical use.

**Table 27. Sensitivity Pattern of Isolated Microorganisms Against Clarithromycin by Sample Type**

| Organism | Site (n) | Resistant n (%) | Intermediate n (%) | Sensitive n (%) |
|---|---|---|---|---|
| ***Staphylococcus aureus*** | Urine (9) | 3 (33.3%) | 0 (0.0%) | 6 (66.7%) |
| | Blood (3) | 3 (100.0%) | 0 (0.0%) | 0 (0.0%) |
| | Wound swab (3) | 3 (100.0%) | 0 (0.0%) | 0 (0.0%) |
| ***Escherichia coli*** | Urine (21) | 9 (42.9%) | 6 (28.6%) | 6 (28.6%) |
| | Blood (3) | 0 (0.0%) | 3 (100.0%) | 0 (0.0%) |
| ***Klebsiella pneumoniae*** | Urine (6) | 0 (0.0%) | 0 (0.0%) | 6 (100.0%) |
| | Blood (6) | 6 (100.0%) | 0 (0.0%) | 0 (0.0%) |
| | Respiratory (3) | 3 (100.0%) | 0 (0.0%) | 0 (0.0%) |
| ***Streptococcus pyogenes*** | Respiratory (6) | 0 (0.0%) | 3 (50.0%) | 3 (50.0%) |
| ***Salmonella spp.*** | Urine (3) | 0 (0.0%) | 0 (0.0%) | 3 (100.0%) |
| | Other (3) | 0 (0.0%) | 0 (0.0%) | 3 (100.0%) |
| ***Pseudomonas aeruginosa*** | Urine (3) | 0 (0.0%) | 0 (0.0%) | 3 (100.0%) |
| | Wound swab (3) | 0 (0.0%) | 0 (0.0%) | 3 (100.0%) |
| ***Enterococcus faecalis*** | Urine (3) | 3 (100.0%) | 0 (0.0%) | 0 (0.0%) |
| ***Streptococcus spp.*** | Urine (3) | 3 (100.0%) | 0 (0.0%) | 0 (0.0%) |

The susceptibility pattern to Clarithromycin showed variable activity across bacterial species and specimen types. *Staphylococcus aureus* demonstrated complete resistance in blood and wound swab isolates, while urinary isolates showed a predominance of sensitivity. *Escherichia coli* urinary isolates exhibited a mixed pattern of resistance, intermediate, and sensitive responses, while blood isolates showed an intermediate response. *Klebsiella pneumoniae* urinary isolates were fully susceptible, but blood and respiratory isolates were uniformly resistant. *Streptococcus pyogenes* respiratory isolates showed a mixed intermediate and sensitive response. *Salmonella spp.* and *Pseudomonas aeruginosa* isolates were fully susceptible across all tested specimens. In contrast, *Enterococcus faecalis* and *Streptococcus spp.* were uniformly resistant. These findings highlight the variable activity of Clarithromycin and support the need for susceptibility-guided therapy rather than empirical use.

**Table 28. Sensitivity Pattern of Isolated Microorganisms Against Moxifloxacin by Sample Type**

| Organism | Site (n) | Resistant n (%) | Intermediate n (%) | Sensitive n (%) |
|---|---|---|---|---|
| ***Staphylococcus aureus*** | Urine (9) | 9 (100.0%) | 0 (0.0%) | 0 (0.0%) |
| | Blood (3) | 3 (100.0%) | 0 (0.0%) | 0 (0.0%) |
| | Wound swab (3) | 0 (0.0%) | 3 (100.0%) | 0 (0.0%) |
| ***Escherichia coli*** | Urine (21) | 6 (28.6%) | 12 (57.1%) | 3 (14.3%) |
| | Blood (3) | 3 (100.0%) | 0 (0.0%) | 0 (0.0%) |
| ***Klebsiella pneumoniae*** | Urine (6) | 3 (50.0%) | 3 (50.0%) | 0 (0.0%) |
| | Blood (6) | 3 (50.0%) | 3 (50.0%) | 0 (0.0%) |
| | Respiratory (3) | 3 (100.0%) | 0 (0.0%) | 0 (0.0%) |
| ***Streptococcus pyogenes*** | Respiratory (6) | 0 (0.0%) | 3 (50.0%) | 3 (50.0%) |
| ***Salmonella spp.*** | Urine (3) | 0 (0.0%) | 3 (100.0%) | 0 (0.0%) |
| | Other (3) | 0 (0.0%) | 3 (100.0%) | 0 (0.0%) |
| ***Pseudomonas aeruginosa*** | Urine (3) | 0 (0.0%) | 3 (100.0%) | 0 (0.0%) |
| | Wound swab (3) | 0 (0.0%) | 0 (0.0%) | 3 (100.0%) |
| ***Enterococcus faecalis*** | Urine (3) | 0 (0.0%) | 3 (100.0%) | 0 (0.0%) |
| ***Streptococcus spp.*** | Urine (3) | 0 (0.0%) | 3 (100.0%) | 0 (0.0%) |

The susceptibility profile of clinical isolates to Moxifloxacin revealed heterogeneous activity across species and specimen types. *Staphylococcus aureus* showed complete resistance in urinary and blood isolates, but wound swab isolates were fully intermediate. *Escherichia coli* urinary isolates demonstrated a predominance of intermediate responses, with limited sensitivity, while blood isolates were fully resistant. *Klebsiella pneumoniae* exhibited mixed resistance and intermediate responses in urine and blood, but complete resistance in respiratory specimens. *Streptococcus pyogenes* respiratory isolates showed a balanced intermediate and sensitive response. *Salmonella spp.*, *Pseudomonas aeruginosa*, *Enterococcus faecalis*, and *Streptococcus spp.* displayed intermediate or sensitive responses depending on specimen type. These findings highlight the variable efficacy of Moxifloxacin and emphasize the importance of specimen-specific susceptibility testing before clinical application.


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**Table 29. Sensitivity Pattern of Isolated Microorganisms Against Cefoxitin by Sample Type**

| Organism | Site (n) | Resistant ≤9mm n (%) | Intermediate 10–11mm n (%) | Sensitive ≥12mm n (%) |
|---|---|---|---|---|
| ***Staphylococcus aureus*** | Urine (9) | 3 (33.3%) | 3 (33.3%) | 3 (33.3%) |
| | Blood (3) | 3 (100.0%) | 0 (0.0%) | 0 (0.0%) |
| | Wound swab (3) | 3 (100.0%) | 0 (0.0%) | 0 (0.0%) |
| ***Escherichia coli*** | Urine (21) | 6 (28.6%) | 6 (28.6%) | 9 (42.9%) |
| | Blood (3) | 0 (0.0%) | 0 (0.0%) | 3 (100.0%) |
| ***Klebsiella pneumoniae*** | Urine (6) | 0 (0.0%) | 6 (100.0%) | 0 (0.0%) |
| | Blood (6) | 6 (100.0%) | 0 (0.0%) | 0 (0.0%) |
| | Respiratory (3) | 3 (100.0%) | 0 (0.0%) | 0 (0.0%) |
| ***Streptococcus pyogenes*** | Respiratory (6) | 0 (0.0%) | 0 (0.0%) | 6 (100.0%) |
| ***Salmonella spp.*** | Urine (3) | 0 (0.0%) | 3 (100.0%) | 0 (0.0%) |
| | Other (3) | 3 (100.0%) | 0 (0.0%) | 0 (0.0%) |
| ***Pseudomonas aeruginosa*** | Urine (3) | 0 (0.0%) | 3 (100.0%) | 0 (0.0%) |
| | Wound swab (3) | 0 (0.0%) | 0 (0.0%) | 3 (100.0%) |
| ***Enterococcus faecalis*** | Urine (3) | 0 (0.0%) | 0 (0.0%) | 3 (100.0%) |
| ***Streptococcus spp.*** | Urine (3) | 0 (0.0%) | 0 (0.0%) | 3 (100.0%) |

The susceptibility profile of clinical isolates to Cefoxitin revealed heterogeneous responses across species and specimen types. *Staphylococcus aureus* urinary isolates showed equal distribution among resistant, intermediate, and sensitive categories, while blood and wound isolates were fully resistant. *Escherichia coli* demonstrated mixed resistance, intermediate, and sensitivity in urine, but complete susceptibility in blood. *Klebsiella pneumoniae* exhibited full resistance in blood and respiratory specimens, with intermediate responses in urine. *Streptococcus pyogenes* remained fully susceptible, whereas *Salmonella spp.* and *Pseudomonas aeruginosa* showed site-dependent intermediate or sensitive responses. *Enterococcus faecalis* and *Streptococcus spp.* were uniformly susceptible. These findings emphasize the importance of specimen source in interpreting antimicrobial susceptibility patterns and support the need for susceptibility-guided therapy.

## Discussion

The purpose of this study is to interpret the findings of the present study in the light of the previous studies reviewed in the introduction, to place the results in their scientific and clinical context, and to clarify areas of agreement or divergence with earlier local, regional, and international research. The results showed that Escherichia coli was the most commonly isolated bacterial species, particularly in urine samples. This finding is clearly in line with many regional and global studies. [2,9]. reported that E. coli is the most common cause of urinary tract infections in both hospital and community settings, a finding also confirmed by Libyan studies such as [11]. This consistency indicates that the epidemiological pattern of infections in Tarhuna is not greatly different from well-established global trends, while highlighting the need for targeted therapeutic strategies against this pathogen. The study also found a high proportion of patients with recent antibiotic exposure, consistent with the findings of [3] and [2], who emphasized the pivotal role of inappropriate use of antibiotics in accelerating antimicrobial resistance. The high resistance pattern in this study could be due to the unregulated dispensing of antibiotics and self-medication in Libya, as reported by [11], as the major contributors to increasing resistance rates in Libya. High resistance levels to most tested antibiotic classes were observed in Gram-negative bacteria, especially K. pneumoniae and P. aeruginosa. These results are in agreement with the findings of [12] in Tripoli, with wide resistance of these organisms and very few therapeutic options available. In addition, [13] reported a global increase of carbapenem-resistant Klebsiella pneumoniae, which supports the assumption of a circulation of multidrug-resistant strains in the clinical environment of Tarhuna. However, Nitrofurantoin was highly susceptible to *Escherichia coli* urinary isolates. Such observation is in line with findings from Europe [14], where surveillance data emphasized the importance of maintaining effective agents such as Nitrofurantoin against urinary tract pathogens.

Likewise, World Health Organization reports [1] have highlighted Nitrofurantoin's continued efficacy against urinary *E. coli* isolates, despite increasing resistance to many commonly used oral antibiotics. This result emphasizes the importance of site-specific selection of antibiotics. With regard to Gram-positive bacteria, *Staphylococcus aureus* showed 100% susceptibility to Vancomycin. This was in agreement with previous studies in Libya [15], which reaffirmed the ongoing efficacy of Vancomycin against resistant staphylococcal strains. Furthermore, the global definitions of multidrug resistance proposed by international experts [16] underscore the importance of standardized criteria when evaluating resistance patterns. However, the high resistance to penicillins and macrolides is consistent with the principles of antimicrobial therapy [17], which emphasize the global challenge of preserving the effectiveness of traditional antibiotics against *S.*


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*aureus* and the need for prudent antibiotic use. Streptococcus pyogenes was fully susceptible to penicillin, which is consistent with the worldwide data. [1,18] both highlighted the rare occurrence of resistance to β-lactam antibiotics among streptococci. This agreement supports the continued use of penicillin for the treatment of streptococcal respiratory infections and reinforces current clinical guidelines. Overall, these findings are in agreement with regional and global reports of a worrying increase in antimicrobial resistance, particularly among Gram-negative organisms, as reported by WHO [19]. The scientific value of this study is in the new local data from Tarhuna, a semi-urban area that has so far been neglected in previous studies that focused on the two major Libyan cities of Tripoli and Benghazi. The results, in comparison to previous studies, highlight the urgent need for the implementation of antimicrobial stewardship programs, improvement of routine resistance surveillance, and reliance on susceptibility testing in the antibiotic therapy selection. These measures are critical to limit the dissemination of resistant strains and improve clinical outcomes.

## Conclusion

This study aimed to evaluate the effectiveness of selected antibiotics against bacterial isolates obtained from clinical specimens from Tarhuna Hospital and surrounding private clinics, providing local evidence for antimicrobial resistance patterns in a semi-urban Libyan setting. Our findings indicate a high level of resistance to antimicrobials, especially to Gram-negative bacteria, confirming that the issue of antimicrobial resistance is a key and increasing clinical challenge in this part of the world. The most frequent pathogen identified was Escherichia coli, particularly in urinary tract infections, in accordance with the global and regional epidemiology. Resistance was noted to some of the more commonly prescribed antibiotics. Nitrofurantoin maintained a high level of efficacy for urinary E. coli isolates, thus supporting its continued use as a first-line agent for uncomplicated UTIs. On the other hand, Klebsiella pneumoniae and Pseudomonas aeruginosa showed wide resistance to different classes of antibiotics, indicating probable dissemination of multidrug-resistant strains and narrowing the scope of empiric therapy significantly. In Gram-positive organisms, Staphylococcus aureus was susceptible to Vancomycin, but resistance to penicillins and macrolides was common, limiting the clinical use of these drugs. Streptococcus pyogenes remained fully susceptible to penicillin, which confirms the continued effectiveness of β-lactam antibiotics against streptococcal infections. The resistance patterns observed probably were due to the high percentage of recent antibiotic exposure for the patients, which highlights the impact of inappropriate use of antibiotics. Overall, the study underscores that empirical antibiotic prescribing in Tarhuna without reference to local susceptibility data may lead to suboptimal treatment outcomes and further propagation of resistance. This study produces municipality-level data on antimicrobial resistance to fill an important knowledge gap and to provide evidence for the more rational, data-driven use of antibiotics in both hospital and outpatient settings.

***Conflict of interest.*** Nil

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