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INCIDENCE AND ANTIBIOTIC RESISTANCE PROFILE OF *KLEBSIELLA PNEUMONIAE* ISOLATED FROM URINE OF PATIENTS ATTENDING PRIMARY HEALTH CARE CENTERS IN LAFIA METROPOLIS AND ITS ENVIRONS, NASARAWA STATE, NIGERIA

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ABSTRACT

Urinary tract infections (UTIs) affect around 150 million people globally annually. This study examines the incidence and antibiotic resistance profile of *Klebsiella pneumoniae* in urine samples from patients attending Primary Health Care Centers in Lafia Metropolis, Nasarawa State, Nigeria. The study includes four Primary healthcare facilities, including Isa Mustapha Agwai 1 Polytechnic Clinic, Comprehensive Healthcare Center in Kwandere, Primary Health Care Center in Assakio, and Primary Health Care Center in Adogi. A comprehensive analysis of gender, location, patient type, and age-related incidence patterns is conducted, encompassing a total of 266 samples. Additionally, the study delves into the antimicrobial resistance of *K. pneumoniae*. The overall incidence of *K. pneumoniae* is 12.78%, with higher prevalence in females (11.88%) compared to males (6.14%). The Isa Mustapha Agwai 1 Polytechnic Clinic exhibits the highest prevalence (19.14%) among locations. Among inpatients, the incidence is 7.25%, while outpatients show a higher prevalence of 14.72%. The age group of 25-34 years has the highest incidence (11.82%), while individuals aged 75 and older show a higher positivity rate of 21.62%. Antimicrobial resistance analysis reveals high resistance to Ampicillin (91.18%), Gentamicin (76.47%), and Streptomycin (55.88%). Most isolates are classified as Multi-Drug Resistant (67.65%), with 44.11% exhibiting Extensive Drug Resistance. The study underscores the need for targeted treatment strategies and antimicrobial stewardship programs to address the challenges of *K. pneumoniae* infections and antibiotic resistance in this region.

Keywords: Urinary Tract Infections, *Klebsiella pneumoniae*, Incidence, Antibiotic Resistance, Primary Health Care Centers, Nasarawa State, Nigeria.

INTRODUCTION

Approximately 150 million people worldwide are affected by urinary tract infections (UTIs) each year, constituting widespread bacterial infections (Cai *et al*., 2020). These infections are a significant source of illness for individuals of various age groups, including infants, older men, and females of all ages (Foxman, 2014). UTIs can result in a range of complications, such as recurrent infections, severe kidney infections leading to sepsis, renal damage in young children, preterm birth, and problems arising from the frequent use of antibiotics, such as antibiotic resistance (Flores-Mireles *et al*., 2015; Schwaderer *et al*., 2019).

The prevalence of *K. pneumoniae*, as a clinical pathogen in specific conditions underscores its role in infectious diseases, contributing to ailments such as urinary tract infections (UTI), pneumonia, bloodstream infections, osteomyelitis, and soft tissue and wound infections (Martin & Bachman, 2018; Ngwai *et al*., 2023). Notably, *K. pneumoniae* ranks second in detection rate among gram-negative bacteria, trailing only *Escherichia coli* (Tantry & Rahiman, 2021; Hao *et al*., 2022).

Infections from this pathogen are treated with antibiotics, however, the indiscriminate use of antibiotics in clinical settings has led to a yearly increase in resistant strains, with the emergence of multidrug-resistant (MDR) strains notably compromising the efficacy of antibacterial treatments and prolonging the duration of diseases (Karaiskos & Giamarellou, 2014). This concerning situation not only results in elevated medical costs for patients but also amplifies the mortality risk for hospitalized individuals, presenting a pressing threat to public health (Ashefo *et al*., 2023a). The convergence of prevalent pathogens like *K. pneumoniae* and the growing challenge of antibiotic resistance highlights the urgency for judicious and strategic antibiotic use to combat this global health threat.

While previous studies have investigated antibiotic resistance in *K. pneumoniae* (Ogbukagu *et al*., 2016; Mofolorunsho *et al*., 2021;Ngwai *et al*., 2023), there is a lack of comprehensive information regarding ESBL resistance and the molecular characteristics of *K. pneumoniae* in the study area. Primary health care centers are the first point pf contact for health care services for rural dwellers serving as the primary healthcare providers for a significant portion of the population, are at the forefront of diagnosing and treating these infections (Zilberberg & Shorr, 2013). However, the prevalence and molecular characteristics of *K. pneumoniae* isolated from urine samples of patients attending these primary health care centers in Lafia and its environs have not been extensively studied. This knowledge gap in comprehensive molecular characterization studies in Lafia Metropolis and its environs limits our understanding of the local epidemiology, antimicrobial resistance profiles, and genetic diversity of *K. pneumoniae* isolates in this specific region. Therefore, it is essential to investigate the prevalence, antimicrobial resistance patterns, and genetic diversity of *K. pneumoniae* in this region to guide infection control measures, treatment strategies, and public health interventions.

METHODS

Study Area and Locations

The study area for this study include Isa Mustapha Agwai 1 Polytechnic Clinic, Ombi 1, Comprehensive Healthcare Center, Kwandere, Primary Health care Center (Now General Hospital), Assakio and Primary Health care Center, Adogi

Ethical Clearance

Ethical clearance for this study will be obtained from the National Health Research Ethic Committee (NHREC) in the Nasarawa State Ministry of Health, Lafia.

Sample Size

The sample size will be determined using the formula (Odoki et al., 2019):

$$N = \frac{Z^2pq}{d^2}$$

Where: N= calculated sample size

Z= level of confidence according to the standard normal distribution (for a level of confidence of 95%, z = 1.96)

p= prevalence rate of *K. pneumoniae* (33.0% by Orole and Hadi, 2020)

q= (1-p)

d= tolerated margin of error (5%)

$$N = \frac{(1.96)^2 \text{x } 0.33 \text{ x } (1 - 0.33)}{(0.05)^2}$$

$N = 340N$

Actual Sample size= Calculated sample size + 10% Attrition rate

But 10% Attrition rate =34

Actual Sample size= 340 + 34 = 374

Inclusion Exclusion Criteria

Patients with suspected UTIs attending the selected primary health care centers will be selected for this study. Patients with suspected UTIs and on antibiotics attending the selected hospitals will be excluded from this study.

Sample Collection and Isolation

A total of 375 sterile universal containers were given to patients with suspected cases of UTI (75 samples from each hospital) to collect their early morning mid-stream urine samples, however, a total of 266 samples were recovered. The collected samples were transported using ice pack to Microbiology Laboratory, Dalhatu Araf Specialist Hospital (DASH), Lafia for analyses. *K. pneumoniae* was isolated from urine samples as follows: a loopful of urine sample was streaked on MacConkey Agar/CLED plate and incubated at 37°C for 24 h. Pinkish mucoid colonies that grew on MacConkey agar were selected as presumptive *K. pneumoniae.*

Phenotypic characterization of *K. pneumoniae*

The presumptive *K. pneumoniae* isolates will be confirmed using the KB003 H125TM Kit following the manufacturer's instructions. First, two pure colonies of suspected isolates from an agar plate will be transferred to 5 ml of sterile normal saline in a tube to prepare a suspension, and the suspension's turbidity will be adjusted to match that of a 0.5 McFarland standard. Next, the kit will be opened aseptically by peeling off the sealing foil, and 50 µl of the adjusted suspension will be inoculated into each well of the kit. The sealing foil will be replaced, and incubated at 37ºC for 24 hours. After incubation, specific reagents will be added to different wells will (e.g., 3 drops of reagent R036 and 1 drop of reagent R015 will be added to well No. 5, 2 drops of reagent R009 will be added to well No. 6; 3 drops of reagent R029 and 1 drop of reagent R030 will be added to well No. 9; 1 drops of reagent 1007 will be added to well No. 10 and finally 1 drops of reagent R008 will be added to well No. 11), and the results will be interpreted according to the standard given in the identification index (Ngwai et al., 2023).

Antimicrobial Susceptibility Testing

The bacterial isolates will undergo antimicrobial susceptibility testing following the Clinical and Laboratory Standards Institute protocol (CLSI, 2017). Three pure colonies of each isolate will be inoculated into 5 ml sterile 0.85% (w/v) NaCl (normal saline) and the turbidity will be adjusted to match 0.5 McFarland's standard, which will be prepared by adding 0.5 ml of 1.172% (w/v) $BaCl_2.2H_2O$ into 99.5 ml of 1% (w/v) H_2SO_4. Standardized bacteria suspension will be applied to Mueller-Hinton agar plates using a sterile swab stick, and antibiotic discs will be placed at the center of the plates. The plates will be left to stand for 1 hour to allow for pre-diffusion, and then incubated at 37ºC for 24 hours. The diameter of the resulting zone of inhibition in millimeters will be measured, and the susceptibility of the bacteria will be determined using the susceptibility breakpoint as described by the CLSI (2017).

Determination of Multiple Antibiotic Resistance (MAR) Index

The MAR index of the isolates was determined using the formula as described previously (Ngwai *et al.*, 2014).

$$\text{MAR Index} = \frac{\text{No.antibiotics isolate is resistant to}}{\text{No.of antibiotics tested}} \text{ x } 100$$

Classification of Antibiotic Resistance

Antibiotic resistance in the isolates was classify into: multidrug resistance (MDR: non-susceptible to ≥1 agent in ≥3 antimicrobial categories); extensive drug resistance (XDR: non-susceptible to ≥1 agent in all but ≤2 antimicrobial categories); pan drug resistance (PDR: non-susceptible to all antimicrobial listed) (Magiorakos *et al.*, 2012).

RESULTS

Isolation and Identification of *K. pneumoniae*

The bacterium under study was isolated and identified based on cultural, morphological and biochemical characteristics as shown in Table 1. Colonies (pink, round, smooth, mucoid colonies on MacConkey agar; gray on blood agar; and large, yellowish, elevated, mucoid on CLED agar) that were Gram negative, rod in shape, with indole-negative, catalase-positive, oxidase-negative, Voges-Proskauer positive, slide agglutination positive, glucose-positive, and lactose-positive were taken as *K. pneumoniae*. The overall incidence of *K. pneumoniae* in the 266 clinical samples from Nasarawa South Senatorial District is 12.78% as shown in Table 2.

Antimicrobial Resistance Profile of the *K. pneumoniae* isolates

The resistance profile of the isolates to common antimicrobial agents is as shown in Table 3. Resistance was high to Ampicillin (91.18%), Gentamycin (gentamicin

(76.47%). amoxicillin-clavulanic acid (52.94%) and Ciprofloxacin (35.94%) but low (less than 30%) to cefotaxime (14.70%), ceftriaxone (20.59%), ceftazidime (23.60%), and cefoxitin (17.65%)

Multiple Antibiotic Resistance (MAR) Index of the *K. pneumoniae* isolates

The MAR index of the isolates is shown in Table 4 The highest (31.57%) MAR index is for resistance to three antibiotics; while the least (2.63%) is for resistance to one, seven or eight antibiotics.

Classes of Antimicrobial Resistance

The confirmed *K. pneumoniae* isolates were classified into different categories of antibiotic resistance namely; Multi-drug resistance (MDR), Extensive-drug resistance (XDR) and Pan drug resistance (PDR) as shown in Table 8. Most of the isolates were multi-drug resistant (MDR; 67.65%) and Extensive-drug resistance (XDR; 44.11%).

Table 1: Cultural, Morphological and Biochemical characteristics of *K. pneumoniae from* urine of patients attending Primary Health Care Centers in Lafia Metropolis and Its Environs, Nasarawa State, Nigeria.

Parameters	
Cultural characteristic	Smooth, mucoid pink round colonies on MacConkey agar, Gray on Blood agar and Large, yellowish, elevated, mucoid colonies on CLED agar
Morphological characteristics	Rod
Indole	-
Catalase	+
Voges Proskauer	+
Oxidase	-
Slide Agglutination	-
Lactose fermentation	+
Glucose fermentation	+
Inference	*K. pneumoniae*

Table 2: Incidence of the urinary *K. pneumoniae isolated* in Primary Health Care Centers in Lafia Metropolis and Its Environs, Nasarawa State, Nigeria.

Parameter	Number Examined	Number (%) Positive
Gender		
Male	83 (31.2)	7 (6.14)
Female	183 (68.8)	27 (11.88)

Location		
ISM	94 (35.53)	18(19.14)
CHC	80 (30.07)	9 (11.25)
GHA	51 (19.17)	4 (7.84)
PHA	41 (15.41)	3(7.32)
Patient		
Inpatient	69 (47.46)	5 (7.25)
Outpatient	197 (52.53)	29 (14.72)
Age Range (Years)		
<15	12 (5.31)	2 (9.52)
15-24	46 (20.35)	6(12.50)
25-34	78 (34.51)	9(11.82)
35-44	46 (20.35)	3 (7.41)
45-54	33 (14.60)	2 (4.65)
54-64	28 (12.39)	1 (3.57)
64-74	16 (7.08)	1 (3.85)
≥75	7 (3.10)	2 (21.62)
Total	**266 (100.0)**	**34 (12.78)**

* Values in parenthesis are in percentage.

Key: ISM: Isa Mustapha Agwai 1 Polytechnic Clinic, Ombi 1, CHC: Comprehensive Healthcare Center, Kwandere, GHA: Primary Health care Center (Now General Hospital), Assakio and PHA: Primary Health care Center, Adogi.

Table 3: Antimicrobial Resistance Profile of the urinary *K. pneumoniae* isolated in Primary Health Care Centers in Lafia Metropolis and Its Environs, Nasarawa State, Nigeria.

n=34

Antimicrobial Agent	Disc Content (µg)	Number (%) Resistance
Ampicillin (AMP)	10	31 (91.18)
Amoxicillin-Clavulanic acid (AMT)	30	18 (52.94)
Cefotaxime (CTX)	30	5 (14.70)
Ceftazidime (CAZ)	30	8 (23.52)
Ceftriaxone (CRO)	30	7 (20.59)
Cefoxitin (FOX)	30	6 (17.65)
Ciprofloxacin (CIP)	5	12 (35.94)

Co-trimoxazole (SXT)	25	10 (29.41)
Gentamicin (CN)	10	26 (76.47)
Streptomycin (S)	10	19 (55.88)

n= No. of isolates

Table 4: Multiple Antibiotic Resistance (MAR) Indices of the urinary *Klebsiella pnuemoniae* isolated in Primary Health Care Centers in Lafia Metropolis and Its Environs, Nasarawa State, Nigeria.

Number of Antibiotics isolate is resistant to (a)	Number of Antibiotics tested (b)	MAR index (a/b)	Frequency (%)
8	10	0.8	1 (2.63)
7	10	0.7	1 (2.63)
6	10	0.6	3 (13.16)
5	10	0.5	5 (15.79)
4	10	0.4	9 (10.52)
3	10	0.3	7 (31.57)
2	10	0.2	4 (15.79)
1	10	0.1	1 (2.63)

Table 5: Classes of Antimicrobial Resistance in *K. pneumoniae* from the urine of the patients

Classes of Antimicrobial Resistance	No. (%) Isolates (n=34)
NMDR	1(2.94)
MDR	23(67.65)
XDR	15(44.11)
PDR	0(0)

Key: NMDR= Non-multi-drug resistance; MDR= Multi-drug resistance (non-susceptible to ≥1 agent in ≥3 antimicrobial categories); XDR = Extensive drug resistance (non-susceptible to ≥1 agent in all but ≤2 antimicrobial categories); PDR=Pan drug resistance (non-susceptible to all antimicrobial listed) (Magiorakos *et al.*, 2012). No. = Number, % = Percentage

DISCUSSION OF FINDINGS

The study on the incidence of urinary *K. pneumoniae* in Primary Health Care Centers in Lafia Metropolis and its environs, Nasarawa State, Nigeria, reveals noteworthy patterns in gender distribution and incidence rates. Among the total 266 individuals examined, 34 (12.78%) tested positive for *K. pneumoniae*, indicating a moderate overall incidence. The percentage of occurrence of *K. pneumoniae* as observed in this study was less than 26.9% and 75.7% as earlier reported by Lawal et al. (2018) and Shahina et al., (2011) respectively, but higher than that of Ashefo et al. (2023b) who reported an incidence of 10.13%. This may be due to the difference and the sampling area and size as the stay focused on public hospitals in Nasarawa south senatorial district and assessed 375 clinical samples. Females exhibited a significantly higher prevalence (11.88%) compared to males (6.14%), suggesting potential gender-specific factors influencing susceptibility. This is in agreement with that of Odoki et al. (2019) who reported that urinary tract infection was highest in females with 66/176 (37.5%) as compared to 20/91 (22.0%) in men. The higher incidence in female is not surprising, since females who are always at high risk of developing asymptomatic bacteriuria due the structure of their urogenital organ (Kabugo et al., 2017). The occurrence of *K. pneumoniae* in urine of suspected urinary tract infection was an indication that such organism may be responsible for urinary tract infection and this finding is in agreement with the study earlier reported Ngwai et al. (2023) that *K. pneumoniae* is the most common etiological agent of urinary tract infections after E. coli.

The investigation into the location-related incidence of urinary *K. pneumoniae* provides nuanced insights into specific clinic settings. Among the locations studied, the Isa Mustapha Agwai 1 Polytechnic Clinic (ISM) stands out with the highest prevalence, both in terms of the number examined (35.53%) and the percentage of positive cases (19.14%). The primary health care center that caters for both the students of the polytechnic and the Ombi 1 community which may be the main reason for the higher number of incidence. The Comprehensive Healthcare Center (CHC) in Kwandere follows closely, indicating a substantial presence but with a lower incidence compared to ISM. The Primary Health Care Center (now General Hospital) in Assakio (GHA) and the Primary Health Care Center in Adogi (PHA) exhibit lower prevalence rates, suggesting a relatively lower burden of urinary *K. pneumoniae* in these areas. The increased incidence in ISM and CHC is attributed to the clinics having their highest number of patrons from students in the Polytechnic and College of Science in Lafia. These students are typically young, sexually active, and often reside in accommodations where they share toilets. These factors are known contributors to the higher incidence of urinary *K. pneumoniae*, as highlighted in studies by Meatherall et al. (2009) and Ashefo et al. (2023b).

The analysis of patient type-related incidence of urinary *K. pneumoniae*, reveals distinct patterns in infection prevalence among inpatients and outpatients. Among inpatients, comprising 47.46% of the total sample, the percentage of positive cases is 7.25%, indicating a relatively lower incidence compared to outpatients. These findings align with those of Ostojic et al. (2021), whose research indicates that 153 (35.6%) patients with *K. pneumoniae* urinary infections were hospitalized, while 277 (64.4%) were treated as outpatients. This outcome is also consistent with the study by Sokhn et al. (2020), where in-patients exhibited a lower rate of *K. pneumoniae* urinary infections at 39.7%, compared to outpatients with a 60.3% infection rate. However, the results reported by Acheampong et al. (2011) differ. In their study, out of the 152 cases of *K. pneumoniae* recovered, 58.6% were from in-patients, and 41.4% were from outpatients. This may be attributed to the controlled environment of healthcare facilities with stringent infection prevention measures (Collins, 2008). In contrast, outpatients, constituting the majority at 52.53%, exhibit a higher prevalence of 14.72%, suggesting an elevated incidence among individuals seeking healthcare outside inpatient settings. This disparity is exacerbated by the fact that most individuals in the community may not want to be hospitalized. Other factors such as community-acquired infections and varied levels of hygiene may also contribute to this disparity (Monegro et al., 2023).

The examination of age-related incidence of urinary *K. pneumoniae* provides valuable insights into the prevalence of the infection across different age groups. Notably, age group of 25-34 years, representing the largest proportion of those examined, demonstrates a moderate incidence at 11.82%. Young adults, aged 15-24 years, also show a higher incidence of 12.50%, indicating potential susceptibility in this age group. This findings align with that of Odoki et al. (2019) who reported that the prevalence of bacterial UTI was highest in the age group 20–29 with 28/86 (32.6%) Meanwhile, the individuals aged less than 15 years exhibit a higher positivity rate of 9.52%, suggesting a notable incidence among this younger demographic. As age increases, there is a trend of declining incidence, with older age groups, especially those aged 54 years and above, exhibiting lower positivity rates. Notably, individuals aged 75 years and older show a significantly higher positivity rate of 21.62%, highlighting the vulnerability of the elderly population to urinary *K. pneumoniae*. This agrees with the findings of Meatherall et al. (2009) who reported that Elderly patients were at highest risk for *K. pneumoniae* bacteremia due to their reduced immunity.

The Antimicrobial Resistance Profile of urinary *K. pneumoniae* isolated in Primary Health Care Centers (PHCs) in Lafia Metropolis and its environs, Nasarawa State, Nigeria, reveals concerning patterns of resistance to various antimicrobial agents. Among the 34 isolates tested, the resistance rates are particularly striking, with Ampicillin (AMP), Gentamicin (CN), and Streptomycin (S) exhibiting high resistance percentages of 91.18%, 76.47%, and 55.88%, respectively. These findings highlight the limited efficacy of these commonly prescribed antibiotics against the isolated *K. pneumoniae* strains. These findings are in agreement with those of Varghese et al., (2016), Hamza et al., (2016) and Ashefo et al. (2023b) whose findings reveals that most of the K. pnuemoniae isolated from urine are resistant to Ampicillin. As stated by Varghese et al., (2016), *K. pneumoniae* isolates are naturally resistant to Amoxicillin and Ampicillin, due to a constitutively expressed chromosomal class β lactamase. Additionally, Amoxicillin-Clavulanic acid (AMT), Ciprofloxacin (CIP), and Ceftriaxone (CRO) demonstrate intermediate resistance levels, suggesting a nuanced landscape of susceptibility to these agents. Notably, Cefotaxime (CTX), Ceftazidime (CAZ), Cefoxitin (FOX), and Co-trimoxazole (SXT) exhibit relatively lower resistance rates, providing potential options for treatment. This aligns with the findings of Ostojic et al. (2021). However, the overall resistance patterns underscore the need for careful consideration in antibiotic selection. These results carry significant public health implications, emphasizing the importance of antimicrobial stewardship programs and tailored treatment guidelines based on local resistance profiles.

The Multiple Antibiotic Resistance (MAR) Indices of urinary *K. pneumoniae*, as presented in Table 4 offer a comprehensive assessment of the extent of antibiotic resistance within the studied population. The MAR Indices, ranging from 0.1 to 0.8, reflect varying degrees of resistance among the isolated *K. pneumoniae* strains. Notably, isolates with higher MAR Indices (0.7 to 0.8) demonstrate resistance to a substantial proportion of the tested antibiotics, albeit with a lower frequency of 2.63% each. Moderately resistant isolates, with MAR Indices of 0.5 to 0.6, constitute 15.79% and 13.16%, highlighting a significant resistance to approximately half of the antibiotics tested. Additionally, isolates with lower MAR Indices (0.1 to 0.4) exhibit varied resistance patterns, representing frequencies ranging from 10.52% to 31.57%. These finding as are similar to what was reported by Ngwai et al. (2023) which underscore the diverse landscape of antibiotic resistance among *K. pneumoniae* strains, emphasizing the need for nuanced treatment strategies and heightened vigilance in antibiotic use.

The classification of antimicrobial resistance in *K. pneumoniae* reflects a complex resistance profile with significant implications for patient care and public health. The presence of Non-Multi-Drug Resistant (NMDR) isolates, albeit at a low percentage (2.94%), suggests a degree of antibiotic susceptibility; however, the existence of even a small proportion emphasizes the need for ongoing vigilance to monitor emerging resistance (Ngwai et al., 2023). The predominant classification as Multi-Drug Resistant (MDR) in a substantial majority (67.65%) underlines the challenges in treating urinary tract infections caused by *K. pneumoniae*, necessitating careful consideration of alternative therapeutic options. The high prevalence of Extensively Drug Resistant (XDR) isolates (44.11%) further compounds the complexity of antibiotic choices, highlighting the urgency of implementing effective antimicrobial stewardship programs. Encouragingly, the absence of Pan-Drug Resistant (PDR) isolates signifies that, currently, there is no resistance to all tested antibiotics.

CONCLUSION

The study on the incidence of urinary *K. pneumoniae* in Primary Health Care Centers in Lafia Metropolis and its environs, Nasarawa State, Nigeria, reveals notable patterns in gender distribution, location-related incidence, patient type-related incidence, and age-related incidence. Among the 266 individuals examined, 12.78% tested positive for *K. pneumoniae*, with females exhibiting a significantly higher prevalence than males. The Isa Mustapha Agwai 1 Polytechnic Clinic (ISM) stood out with the highest prevalence, and outpatients showed a higher incidence compared to inpatients. Young adults and individuals aged less than 15 years demonstrated higher positivity rates. Antimicrobial resistance analysis indicated high resistance to Ampicillin, Gentamicin, and Streptomycin, with varying levels of resistance to other antibiotics. The Multiple Antibiotic Resistance (MAR) Indices revealed diverse resistance patterns, and the majority of isolates were classified as Multi-Drug Resistant (MDR), emphasizing challenges in treatment. Encouragingly, no Pan-Drug Resistant (PDR) isolates were found, highlighting the importance of ongoing vigilance and tailored treatment strategies based on local resistance profiles.

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