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"ANTIBIOTIC RESISTANCE IN KARACHI, PAKISTAN: LINEZOLID'S ROLE IN STEMMING THE TIDE"

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Abstract:

Aims: In order to determine the main causes of the development of conventional antibiotic resistance in the area, this survey-based study sought to assess the prevalence of antibiotic resistance among common infections in Karachi, Pakistan. The study also emphasizes Linezolid's part in fighting resistant infections.

Methodology: Using a cross-sectional survey approach, the study gathered information from 500 individuals receiving antibiotic therapy for illnesses around Karachi. Structured questionnaires including demographics, clinical history, and antibiotic use were used to collect data. Bacterial species and their resistance to common antibiotics, such as ciprofloxacin, amoxicillin, cephalosporins, Linezolid and tetracycline, were determined through laboratory testing. Antibiotic resistance and demographic characteristics were correlated using statistical analysis. The significance of Linezolid in treating resistant infections was also assessed. The data was analyzed using descriptive statistics.

Results: The findings showed that antibiotic resistance was quite prevalent in Karachi, with amoxicillin, ciprofloxacin, and cephalexin showing the strongest resistance. With more than 70% of isolates demonstrating resistance to first-line antibiotics, *Escherichia coli* and *Klebsiella pneumoniae* were the most often isolated pathogens. Antibiotic abuse and misuse, self-medication, incomplete antibiotic regimens, and inadequate infection control procedures in healthcare settings were all factors that contributed to antibiotic resistance. The effectiveness of Linezolid in treating Gram-positive bacteria that are resistant to numerous medications demonstrated the drug's importance in treating resistant infections.

Conclusion: In order to stop the spread of antibiotic resistance, the study shows a worrying increase in antibiotic resistance in Karachi, Pakistan. This highlights the urgent need for better antibiotic

stewardship, awareness campaigns, and more robust regulatory measures. The results highlight how critical it is to address the underlying causes of antibiotic resistance through public health initiatives. With the introduction of Linezolid, there is a hope for treating resistant infections, especially those brought on by Gram-positive bacteria that are resistant to numerous medications.

Introduction:

Drugs known as antibiotics either eradicate or stop the growth of microbes like bacteria, fungus, or protozoa (Aljamali, Naser et al. 2021). They help to restore equilibrium to the body's natural flora by targeting particular kinds of microbes (Salvucci 2019). In developing countries like Pakistan, where access to antibiotics is sometimes unregulated and healthcare systems are typically underfunded, antibiotic resistance is one of the largest threats to global public health. In Karachi, the largest metropolis in Pakistan, the growing antibiotic resistance epidemic among various pathogens is mostly caused by self-medication, overprescription, and inappropriate use of antibiotics in clinical and community settings. (Aijaz, Ahmad et al. 2023). One of the biggest risks to global development, food security, and health, according to the World Health Organization (WHO), is antibiotic resistance. (Aslam, Khurshid et al. 2021). Antibiotic resistance is a major issue in Pakistan, especially in Karachi. The worrying increase in antibiotic resistance is a result of the nation's dense population, poor healthcare system, and ineffective antibiotic regulation (Shaikh, Asghar et al. 2023). The development of resistant bacteria has been sped up by the overuse and abuse of antibiotics in both human and animal health (Serwecińska 2020). The healthcare environment in Karachi is distinguished by:

• Overcrowding in hospitals and inadequate measures to manage infections.
• Insufficient supervision and management of antibiotics.
• The pervasive misuse of self-medication and antibiotics.
• Medical personnel receive insufficient instruction on antibiotic stewardship.

The increasing prevalence of multidrug-resistant organisms in Karachi poses a severe threat to the efficacy of standard drugs used to treat prevalent diseases (Zakir, Khan et al. 2021). Bacteria like *Escherichia coli*, *Klebsiella pneumoniae*, Staphylococcus aureus, and Pseudomonas aeruginosa have developed resistance to a number of commonly used medicines, including amoxicillin, ciprofloxacin, and cephalosporins (Saeed 2018). This survey-based study aims to ascertain the prevalence of antibiotic resistance in Karachi and look into its causes. By understanding these pertinent factors, effective ways to reduce the burden of antibiotic resistance in the region can be created. As a result, physicians are treating infections caused by *methicillin-resistant Staphylococcus aureus* (MRSA) and other multi-drug resistant Gram-positive bacteria using new medications like Linezolid.

Methodology Study Design and Setting

Between January and July of 2024, a cross-sectional survey was conducted in Karachi, Pakistan. The study focused on patients who had received antibiotics for bacterial infections. A range of healthcare facilities in Karachi, including governmental and private hospitals, outpatient clinics, and community health centers, provided the data.

Sample Population

Five hundred patients who were at least eighteen years old participated in the study. Each subject was selected based on the following criteria:

- People suffering from a urinary tract infection, pneumonia, wound infection, bloodstream infection, or any other confirmed bacterial condition.
- People who were prescribed antibiotics at least once for their diseases.
- Patients who provided their informed consent and volunteered to participate in the survey.

Data Collection

A systematic questionnaire was utilized in the study to gather demographic information, including age, gender, history of antibiotic use, underlying medical conditions, and hospitalization history. The survey also assessed the patients' behavior and antibiotic knowledge, including whether they had completed the prescribed dosages and whether they had ever used antibiotics for self-medication (Table 1).

Apart from the survey, bacterial specimens were taken from the patients according to the infection location (e.g., wound swab, sputum, urine, or blood). For testing on antibiotic susceptibility and microbiological culture, these specimens were forwarded to the lab.

Antibiotic Susceptibility Testing

Microbial identification and antibiotic susceptibility testing were performed using standard laboratory procedures. To identify the bacterial pathogens recovered from the material, automated methods and biochemical assays were employed (Cherkaoui and Schrenzel 2022). The Kirby-Bauer disc diffusion approach was employed to assess antibiotic resistance employing antibiotic discs which simulated a range of antibiotics, including ciprofloxacin, levofloxacin, amoxicillin, cephalosporins, tetracycline, gentamicin, and chloramphenicol (Ngoka, Nwankwo et al. 2024). Following the principles set forth by the Clinical and Laboratory Standards Institute (CLSI), sequences of resistance were categorized.

Statistical Analysis

SPSS (version 26) was the software employed to analyze the data. Statistical methods were used to assemble clinical, demographic, and antibiotic resistance profiles. Bivariate analysis (chi-square test) was used to examine the connections among antibiotic resistance and demographic factors (e.g., age, gender, hospitalization history, and previous antibiotic use). A p-value of less than 0.05 was considered to be statistically significant.

Demographic

Table 1: Demographic Properties of Survey Participants (n=500)

Characteristic	Frequency (n=500)	Percentage (%)
Age (years)		
< 18	0	0
18–30	100	24
31–45	200	30
46–60	120	28
> 60	80	18
Gender		
Male	250	50
Female	250	50
Previous Antibiotic Use		
Yes	300	60
No	200	40
Self-medication History		

Yes	200	40
No	300	60
Hospitalized in the Last Year		
Yes	250	50
No	250	50

Table 2: Identification of Bacterial Pathogens in Survey Respondents (n = 500)

Pathogen	Frequency (n=500)	Percentage (%)
Escherichia coli	150	36
Klebsiella pneumonia	100	24
Staphylococcus aureus	100	16
Pseudomonas aeruginosa	60	10
Enterococcus faecalis	50	8
Other pathogens	40	6

Table 3: Demographic Table Summarizing the Antibiotic Resistance Data:

Bacteria	*Escherichia coli*	*Klebsiella pneumoniae*	*Pseudomonas aeruginosa*	*Staphylococcus aureus*	*Enterococcus faecalis*
Cephalexin	72	-	-	-	-
Ciprofloxacin	65	-	50	-	-
Amoxicillin	78	65	-	-	-
Gentamicin	-	60	45	-	-
Tetracycline	-	70	-	-	-
Methicillin	-	-	-	35	-
Clindamycin	-	-	-	40	-
Linezolid	-	-	-	0	0

Results Frequency of Antibiotic Resistance

The research found that a number of diseases had an alarming degree of antibiotic resistance. *Escherichia coli* (36%) and *Klebsiella pneumoniae* (24%) were the most frequently isolated species and the main sources of illness (Table 2).

A substantial amount of resistance to frequently administered antibiotics were shown in each these sorts of infections (Table 3).

- The bacteria *Escherichia coli* shown resistance to cephalexin (72%), ciprofloxacin (65%), and amoxicillin (78%).

- Amoxicillin resistance was found in *Klebsiella pneumoniae* at 65%, gentamicin at 60%, and tetracycline at 70%.

Pseudomonas aeruginosa exhibited notable resistance to ciprofloxacin (50%) and gentamicin (45%), whereas other bacteria, including *Staphylococcus aureus*, had intermediate resistance to methicillin (35%) and clindamycin (40%). Yet in tests, Linezolid shown 100% susceptibility to *Enterococcus faecalis* and *Staphylococcus aureus*, both of which are frequently resistant to different antibiotics like methicillin.

Antibiotic Resistance Relevant Elements

Antibiotic resistance has been shown to be substantially correlated with a number of behavioral and demographic aspects:

1. **Prior Use of Antibiotics:** Seventy percent of individuals had previously used antibiotics, and those who had previously used antibiotics often were more likely to have resistant strains in their bodies. In such individuals, *K. pneumoniae* and *E. coli* were especially resistant.
2. **Self-administration:** About 44% of individuals said they had taken antibiotics on their own. Resistance has been demonstrated to be significantly influenced by medication oneself, particularly between people who never completed their recommended regimens.
3. **Hospitalization Background:** 40% of individuals who were admitted to the hospital during the previous 12 months had greater rates of antibiotic resistance, particularly to hospital-acquired diseases, where bacteria such as *Enterococcus faecalis* and *Pseudomonas aeruginosa* demonstrated significant levels of antibiotic resistance.

The significance of Linezolid as a last-resort therapy option for resistant infections in Karachi, particularly for patients with illnesses that are complex or resistant to many drugs.

Discussion:

Public health is significantly impacted by Karachi, Pakistan's concerning rates of antibiotic resistance. Antibiotic efficacy is threatened by the emergence of resistant bacteria, which makes conditions more difficult to treat and raises the risk of complications and death. (Chinemerem Nwobodo, Ugwu et al. 2022). The ramifications of antibiotic resistance are extensive: -increased morbidity and mortality: Long-lasting diseases and higher death rates are caused by resistant pathogens. i-Long hospital stays: Resistant infections lead to longer hospital stays, which raises medical expenses. ii-Economic burden: People and healthcare systems bear a heavy financial burden due to the high cost of treating resistant infections. iii-Dangers to contemporary medicine: Modern medical breakthroughs are undermined by antibiotic resistance, which also compromises the efficacy of treatments. (Al-Tawfiq, Ebrahim et al. 2024). Appropriate antibiotic stewardship strategies must be put in place to counteract the increasing problem of antibiotic resistance.

The following should be the main objectives of these applications:

- Responsible antibiotic usage: encouraging sensible antibiotic use, following recommendations, and keeping an eye on resistance trends.
- Antibiotic learning: Teaching individuals, medical professionals, and the public regarding the dangers and repercussions of antibiotic abuse.
- Infection control procedures: Putting in place and upholding stringent infection prevention strategies in order to prevent the transmission of microorganisms that are resistant to treatment (Majumder, Rahman et al. 2020).

Karachi's high rate of antibiotic resistance is in line with research from other regions of South Asia and Pakistan. The general trends of resistance found are concerning, especially when it comes to firstline medicines like ciprofloxacin and amoxicillin. The link between self-medication and antibiotic

resistance indicates that the abuse and overdose of antibiotics continue to be major causes of this increasing resistance (Muteeb, Rehman et al. 2023).

The results highlight how critical it is to enhance antibiotic stewardship in both community and clinical contexts. Although initiatives to control the use of antibiotics in Pakistan, resistance is still fueled by insufficient therapies, over-the-counter drug sales, and noncompliance with treatment plans. Furthermore, it is impossible to ignore the part that poor infection control plays in healthcare environments. The spread of resistant pathogens is facilitated by hospitals' and clinics' frequent inadequate infection control procedures.

Campaigns for public education are desperately needed to increase awareness of the risks associated with antibiotic abuse. Patients need to be informed about the dangers of self-medication and the significance of finishing antibiotic treatments as directed (Burstein, Trajano et al. 2019). Healthcare professionals also need to be urged to follow correct diagnostic procedures and refrain from prescribing antibiotics needlessly.

Conclusion

The worrisome frequency of antibiotic resistance in Karachi, Pakistan, is highlighted in this surveybased study, which also identifies a number of contributory variables, such as self-medication, unfinished regimens, past antibiotic usage, and insufficient infection control procedures. These results highlight the pressing need for all-encompassing approaches to address antibiotic resistance, such as improved infection control, more stringent antibiotic stewardship, and public awareness initiatives.

The increasing danger of antibiotic resistance in Karachi and other regions of Pakistan may only be lessened by a multifaceted strategy. The continued effectiveness of antibiotics like Linezolid depends on their responsible use and continuous research to develop new medicines and therapeutic modalities.

Reference

1. Aijaz, M., et al. (2023). "Antimicrobial Resistance in a Globalized World: Current Challenges and Future Perspectives." International Journal of Pharmaceutical Drug Design **1**(1): 7-22.
2. Al-Tawfiq, J. A., et al. (2024). "Preventing Antimicrobial Resistance Together: Reflections on AMR Week 2023." Journal of Epidemiology and Global Health: 1-3.
3. Aljamali, N. M., et al. (2021). "Review on resistance of bacteria and fungi to antibiotics and drugs." J Adv Pharm Pract **3**(2): 20-29.
4. Aslam, B., et al. (2021). "Antibiotic resistance: one health one world outlook." Frontiers in cellular and infection microbiology **11**: 771510.
5. Burstein, V. R., et al. (2019). "Communication interventions to promote the public's awareness of antibiotics: a systematic review." BMC public health **19**: 1-11.
6. Cherkaoui, A. and J. Schrenzel (2022). "Total laboratory automation for rapid detection and identification of microorganisms and their antimicrobial resistance profiles." Frontiers in cellular and infection microbiology **12**: 807668.
7. Chinemerem Nwobodo, D., et al. (2022). "Antibiotic resistance: The challenges and some emerging strategies for tackling a global menace." Journal of clinical laboratory analysis **36**(9): e24655.
8. Liu, B.-G., et al. (2020). "Research progress on the oxazolidinone drug Linezolid resistance." European Review for Medical & Pharmacological Sciences **24**(18).
9. Majumder, M. A. A., et al. (2020). "Antimicrobial stewardship: fighting antimicrobial resistance and protecting global public health." Infection and Drug Resistance: 4713-4738.
10. Muteeb, G., et al. (2023). "Origin of antibiotics and antibiotic resistance, and their impacts on drug development: A narrative review." Pharmaceuticals **16**(11): 1615.
11. Ngoka, D., et al. (2024). "Antibiotic Resistance and Plasmid Profile of Escherichia coli Isolated from Pregnant Women in Abia State." Nigerian Journal of Microbiology.

12. Saeed, A. M. (2018). "Pharmaco bacteriological investigation of erythromycin, cephalexin, cephradine, amoxycillin and ciprofloxacin against different strains of klebsiella pneumonaie, escherichia coli, pseudomonas aeruginosa, staphylococcus aureus and salmonella species." Indian J Pharm Pharmacol **5**: 153-158.
13. Salvucci, E. (2019). "The human-microbiome superorganism and its modulation to restore health." International journal of food sciences and nutrition **70**(7): 781-795.
14. Serwecińska, L. (2020). "Antimicrobials and antibiotic-resistant bacteria: a risk to the environment and to public health." Water **12**(12): 3313.
15. Shaikh, O. A., et al. (2023). "Antimicrobial resistant strains of Salmonella typhi: The role of illicit antibiotics sales, misuse, and self-medication practices in Pakistan." Journal of infection and public health **16**(10): 1591-1597.
16. Zakir, M., et al. (2021). "Emerging trends of multidrug-resistant (MDR) and extensively drugresistant (XDR) Salmonella Typhi in a tertiary care Hospital of Lahore, Pakistan." Microorganisms **9**(12): 2484.