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Antibiotic Resistance Profiling of Post-Operative Wound Associated Bacterial Infection in Tertiary Care Hospital of Latur, Maharashtra, India

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ABSTRACT: Post-operative wound infections (POWIs) are one of the greatest challenges in healthcare. It is more common in resource-limited areas and with a rising trend of antibiotic resistance. This study at Vilasrao Deshmukh Government Medical Hospital, Latur, established AMR in bacterial isolates from POWIs by tailoring effective treatments. There were 200 wound swabs collected, and the resistance patterns were determined using Kirby-Bauer disk diffusion. Alarmingly high resistance levels were reported at a prevalence of 38.5% in Gram-positive bacteria, where Penicillin, Cefuroxime, and Ceftriaxone were reported to be resistant at 100%, thereby very few treatment options remain. In Gram-negative isolates, 40.3% resistance was reported, and near 90% resistance was reported by Ceftriaxone and Piperacillin-Tazobactam. Gentamicin and Tobramycin showed low resistance and, hence, some treatment paths could be initiated. It thereby provides an imperative need for the localized AMR surveillance and antimicrobial stewardship toward optimal patient outcomes as well as guides evidence-based treatment in POWIs. There is an increased call to increase AMR surveillance along with strategic infection control interventions in such healthcare facilities as well.

Keywords: Wound infections, antimicrobial stewardship, AMR, Nosocomial infections.

INTRODUCTION

Post-operative wound infections are among the leading nosocomial infections that have been associated with a considerable percentage (Chavan and Kelkar 2017). These are serious challenges to the recovery of patients, mainly in regions with antibiotic resistance. Surgical infections increase the risk of complications and prolong hospital stays and inflate health care costs. This increases the complexity for treatment protocols in both the developed and developing nations alike and makes the case for targeted, localized antimicrobial susceptibility testing to tailor effective treatments (Van Belkum *et al.,* 2019; Singh *et al.,* 2020; Carvalho *et al.,* 2021). The Latur district presents unique challenges to a health care infrastructure, wherein the robust approach to understanding bacterial isolates and thus the patterns of antibiotic resistance become a critical input towards managing infections (Thakral *et al.,* 2022). The research is done at Vilasrao Deshmukh Government Medical Hospital to optimize the antibiotic therapies with respect to the antimicrobial resistance patterns of bacterial pathogens that were isolated from post-operative wound infections. Post-surgical wound infections are primarily induced by Multidrug resistant (MDR) strains of bacteria like *Staphylococcus aureus, Pseudomonas aeruginosa, and Acinetobacter baumannii* that are often resistant to several antibiotics (Basak *et al.,* 2016). The emergence of MDR organisms in wound infections is particularly a cause of concern because treatment options are limited, and the chance of an unfavourable outcome increases. The worldwide trends of antimicrobial resistance within the wound isolates highlight how such continuous local surveillance may change due to geographic factors, practices, or use of antibiotics (Murray *et al.,* 2022). Therefore, this study was based on the Kirby-Bauer disk diffusion method by considering the standardized criteria of Clinical and Laboratory Standards Institute (CLSI) (Hudzicki, 2009). This would therefore give reliable data on the efficacy of different antibiotics, thus guiding evidence-based decisions in clinical practice. The overall aim of present investigation was to establish the antimicrobial susceptibility profiles of bacterial isolates from post-operative wounds and document the prevalent patterns of resistance within the region. Data from this study might be used to inform targeted therapeutic strategies that would subsequently reduce the burden of complications related to infections in these patients. Thus, research that identifies a unique pattern of resistance found within patients in Latur draws much-needed attention toward improvement of antibiotic stewardship programs with the development of appropriate guidelines for infection control.

MATERIALS AND METHODS

Ethical statement. All samples were collected as per standard procedures given by Standard Operating Procedure for Antimicrobial Resistance Surveillance National AMR Surveillance Network (NARS-Net) 2023, India. Prior consent of patient's relatives was obtained for collection of samples. On basis of "One Patient One Sample", Wound swabs were collected aseptically. The laboratory investigation was carried out at Department of Microbiology, Dr. Babasaheb Ambedkar Marathwada University, Sub Campus, Dharashiv, Maharashtra, India.

Sample collection. A total of 200 swab samples were collected from patients clinically suspected for wound infection at In-patient Department (IPD) of VDGMH Latur, Maharashtra, during 2022-2023. All samples were collected aseptically by using sterile culture collection device (HiMedia, Mumbai, India) were brought to Microbiology Department Laboratory; Dr. Babasaheb Ambedkar Marathwada University, Sub Campus, Dharashiv, Maharashtra, India and processed for isolation of suspected causative agents and their AMR profiling.

Isolation and Identification of Bacteria -Wound swabs were processed for isolation and characterization of suspected causative agents. Briefly, the swabs were directly inoculated into on sterile plates of Nutrient Agar and MacConkey Agar (HiMedia, India). Bacterial colonies with typical morphology were verified by Gram's staining. All characterized isolates were additionally tested for haemolysis on Sheep Blood Agar (SBA) plates. All obtained isolates were preserved in 20% glycerol stock for further analysis.

Antimicrobial's susceptibility test. Antibiogram pattern of phenotypically confirmed isolates was performed by standard disc diffusion method following the Clinical Laboratory Standard Institute (CLSI) guidelines (M100). Antimicrobial profiling was conducted using two distinct antibiotic panels: one featuring 32 discs (HiMedia, Mumbai, India) with Gram-positive-targeting antibiotics including Cefazolin (CZ 30mcg), Chloramphenicol (30 mcg), Ciprofloxacin (CIP 5mcg), Clindamycin (2 mcg), Erythromycin (E 15mcg), Levofloxacin (LUX 5mcg), Oxacillin (OX 1mcg), Penicillin (P 10mcg), Roxithromycin (RXT), Rifampicin (RD), Tetracycline (TE), Vancomycin (VA), Ampicillin-Sulbactam (SAM), Cefdinir (CN 05mcg), Cefuroxime (CXM 30mcg), Clarithromycin (CLR 15 mcg), Benzylpenicillin (G), Linezolid (LZ 30mcg), Amoxicillin (AX 25mcg), Amoxicillin-Clavulanic Acid (AC 20/10mcg), Cefotaxime (CT), Cefepime (CP), Cephalothin (CEP 30mcg), Methicillin (MET 5mcg), Teicoplanin (TEI 30mcg), Amikacin (30mcg), Ampicillin (10mcg), Azithromycin (AZ 15mcg), Piperacillin (PC 100mcg), Cefuroxime sodium (CR 30mcg), Cephalexin (CP 30mcg), Co-trimoxazole (CT 25mcg).

The another panel comprising 31 discs (HiMedia, Mumbai, India) with a Gram-negative-targeting lineup including, Imipenem (IPM 10mcg), Ciprofloxacin (CIP 5mcg), Tobramycin (TOB 10mcg), Moxifloxacin (MO 5mcg), Ofloxacin (OFX 5mcg), Norfloxacin (NX 10mcg), Sparfloxacin (SPX 5mcg), Levofloxacin (LE 5mcg), Co-Trimoxazole (COT 25mcg), Colistin (CL 10mcg), Nalidixic acid (NA 30mcg), Augmentin (AMC 30mcg), Kanamycin (K 30mcg), Gatifloxacin (GAT 05), Gentamicin (Gen 10mcg), Amikacin (AK 30mcg), Streptomyces (S 25mcg), Ceftriaxone (CTR (30mcg), Cefpodoxime (CPD 10mcg), Ticarcillin (TI 75mcg), Cefazolin (CZ 30mcg), Cefuroxime (CXM 30mcg), Chloramphenicol (C 30mcg), Piperacillin (PIP 100mcg), Piperacillin + Tazobactam (TZP 100/10mcg), Cefdinir (CN 5mcg), Lomefloxacin (LOM 10mcg), Linezolid (LZ 30mcg), Meropenem (MEM 50mcg), Ampicillin + Sulbactam (20mcg), Ceftazidime +Clavulanic acid (CAC 40mcg). According to results obtained the tested isolates were categorized as sensitive, intermediately resistant or resistant based on the results interpreted following the recommendations of CLSI M100 (CLSI, 2023).

RESULTS

Isolation of suspected causative agents from wound samples. Out of 200 swabs collected from POWIs, 140 isolates were retrieved successfully, with 26% (52/140) and 44% (88/140) identified as Gram-positive and Gram-negative respectively.Obtained data underscoring the predominance of Gram-negative bacteria in POWIs (Fig. 1).

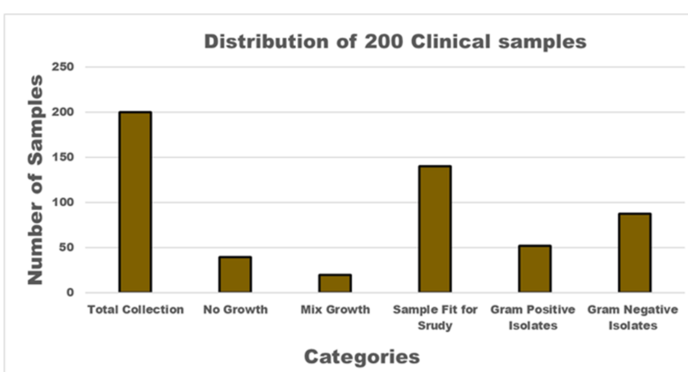

Fig. 1. Design of sampling plan used in the study.

Antibiotic Susceptibility of Isolates. The antibiotic resistance patterns obtained from present study highlighted worrisome pattern for both Gram-positive and Gram-negative bacteria, where the effectiveness of certain antibiotics is critically challenged. In Gram-positive bacteria, an average resistance prevalence of 38.5% was observed across 30 antibiotics, with various key antibiotics like Penicillin (P), Cefuroxime (CXM), Amoxicillin (AX), and Ceftriaxone (CT) exibited complete (100%) resistance (Fig. 2A). This high resistance rate implies limited therapeutic options for these commonly prescribed antibiotics. On other hand, antibiotics like Cloxacillin (OX), Ampicillin (AMP), and Cefoperazone (CR) show high resistance (50%-90%), although some, including Gentamicin (CN) and Erythromycin (E), display minimal to no resistance, which could provide alternative treatment pathways.

For Gram-negative bacteria, the resistance pattern remains equally challenging, with an average resistance prevalence of 40.3% across 29 antibiotics (Fig. 2B). Here, crucial antibiotics like Ceftriaxone (CTR), Piperacillin-Tazobactam (TZP), and Trimethoprim-Sulfamethoxazole (SXT) show resistance rates near 90%, highlighting the challenge in treating infections caused by these bacteria. Moderate resistance was noted for Ciprofloxacin (CIP) and Cefpodoxime (CPD), while Gentamicin (GEN) and Tobramycin (TOB) showed low or no resistance, suggesting viable options. These findings represented the alarming need for antibiotic use, and urgency in development of new antimicrobials, and to develop stewardship policies, especially for those antibiotics that are crucial in treatment regimens (Fig. 3).

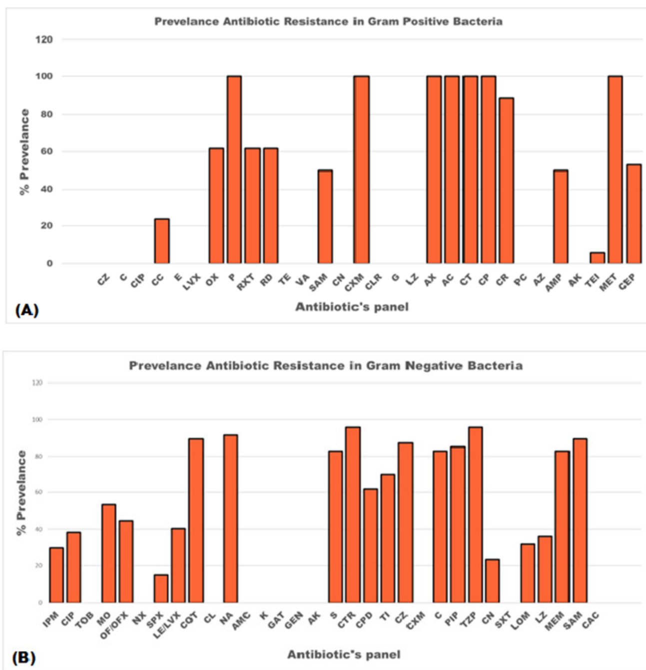

Fig. 2. Antimicrobial resistance pattern in POWIs. (A) Resistance pattern in Gram Positive isolates (B) Resistance pattern in Gram Negative isolates.

Fig. 3. Antimicrobial Susceptibility profiling of Isolates as per CLSI guidelines.

DISCUSSION

POWIs is still a challenge in fighting against it, and this is more challenging because of the involvement of MDR bacteria, which is not only a challenge in the recovery of the patient but also in the healthcare costs (Hope *et al.,* 2019; Jamrozik and Selgelid 2020). Recent publications have already shown an increasing trend with such MDR strains and continue to necessitate the constant surveillance in the regions, respectively, with regards to local resistance (Sharma *et al.,* 2022; Yang *et al.,* 2023). The research conducted at Vilasrao Deshmukh Government Medical Hospital in Latur has produced critical information on AMR profiles of Gram-positive and Gram-negative bacteria isolated from POWIs, which would be a high-risk area for complications and minimal efficacy antibiotics available. Present investigation showed an overall average resistance prevalence of 38.5% among the Gram-positive isolates. More precisely, most commonly applied antibiotics such as Penicillin (P), Cefuroxime (CXM), Amoxicillin (AX), and Ceftriaxone (CT) had a resistance of 100% in Gram-positive isolates, thereby showing the least application in managing POWI. The remaining drugs were Cloxacillin (OX), Ampicillin (AMP), and Cefoperazone (CR), which showed resistance at an intermediate level ranging from 50% to 90%. The results are akin to international trends that cite a high degree of resistance in POWIs owing to an increased prescription of antibiotics in these conditions (Ikuta *et al.,* 2022). This therefore implies that Gentamicin (CN) and Erythromycin (E) with low or no resistance are alternatives whose viable pathways there may exist when resistance to the more commonly prescribed antibiotics is available. The Gram-negative had a similar threat with the average resistance prevalence at 40.3% across 29 antibiotics. More than 90% resistances were noted in the case of Ceftriaxone (CTR), Piperacillin-Tazobactam (TZP), and Trimethoprim-Sulfamethoxazole (SXT). This trend of resistance agrees with a recent study published by Ali *et al.* (2021), which shows greater resistance rates of similar antibiotic classes among MDR Gram-negative bacteria isolated from POWIs. Resistance to CIP and CPD at moderate levels reflect that the antibiotics are still relevant for use but their application should not be over-relied on. However, Gentamicin (GEN) and Tobramycin (TOB) exhibited low or no resistance among Gram-negative isolates, hence offering some promising targeted therapy options. Data from this study raise a grave concern in the domain of antibiotic stewardship. Low efficacy of conventional antibiotics against both Gram-positive and Gram-negative isolates reflects judicious use of antibiotics in hospitals, especially in places like Latur, where health infrastructure is under strain due to resource constraints. The findings of the study back the global demand for Antimicrobial Stewardship Programme (ASP), as pointed out by Kanj *et al.* (2022) ASPs are essential to steward the judicious use of antibiotics, preserve the efficacy of last-line antibiotics, and reduce the selective pressure that fuels AMR. Localized susceptibility testing is rapidly becoming an important tool for tailoring treatment protocols according to the specific resistance profile within a region (Kalashnikov *et al.,* 2017). This research activity using the Kirby-Bauer disk diffusion method offers healthcare professionals an evidence-based approach to decision making in clinical practice with the potential for actionable information regarding the optimization of patient outcomes. Additionally, the trend whereby frontline antibiotics for wound infections have increasingly been resisted by most of the infecting pathogens underscores the need for alternative therapeutic strategies such as combination therapies, adjunctive treatments, and perhaps even new antimicrobials (Gupta *et al*., 2019). Further, addition of the rapid diagnostic technologies capable to identify resistant pathogens in the real time is found to increase early identification and specifically tailored therapy that are advised by Peng *et al.* (2022), for the clinical results associated with combining rapid diagnostics with ASPs in infection treatment through MDR organisms. Also, the current work drew attention to TZP antibiotics along with CTR exhibited high resistance by the Gram-negative isolates against those TZP and CTR. Both are drugs of choice in the treatment of POWIs, but the development of resistance against them may require alternative approaches, such as the increased use of aminoglycosides like Gentamicin (GEN) and Tobramycin (TOB). Although these antibiotics showed low resistance rates in this study, their use should also be monitored to prevent the development of resistance over time. Balanced interaction between the efficacy of therapy and resistance development demand continuing monitoring systems that identify arising trends of resistance. This data from Latur has not only been observed along general trends of antimicrobial resistance but also portrays particular trends of this district as well. This strengthens a purpose for local AMR data (Hudepohl *et al.,* 2016). In areas with little health care infrastructure, high resistance levels may be much more dramatic, with long hospital stays, higher health care costs, and adverse outcomes. This is one of the reasons why the need to strengthen infection control practices becomes even more important, a point emphasized by WHO's 2023 report, which states enhanced infection prevention and control as one of the measures that will help combat the AMR crisis (Villanueva *et al.*, 2022). The training of health care workers, good enforcement of sanitation protocols, and education of patients concerning the use of antibiotics shall inhibit the cycle of resistant pathogens (Ayukekbong *et al.,* 2017). This report joins the ever-growing body of evidence on regional variations in AMR and gives pertinent information that will inform public health strategies and hospital policies (Liu *et al.,* 2022). Findings will prove that the ASP could actually decrease unnecessary antibiotic prescriptions, as well as lead to an environment of evidence-based practice. Future research is required, such as observing long-term effects from implementation on outcomes of POWI and developing alternative therapy including bacteriophage, with which several early-stage studies showed some promise for treating MDR infections in adjunctive use (Gorgy *et al*., 2021). Thus, a holistic approach to address the problem of antibiotic resistance in POWIs would require local surveillance, stewardship of antimicrobial therapy, infection control, and education of the community. The steps undertaken would thus enable providers at the regional level of Latur to manage infections effectively while minimizing the proliferation of resistance and enhancing outcomes for patients.

CONCLUSIONS

The present research on antibiotic resistance profiling of post-operative wound infections (POWIs) at Latur's tertiary care hospital has thrown light upon critical insights into the escalating challenge of AMR. Alarming rates of resistance, especially to common antibiotics such as Penicillin, Cefuroxime, and Ceftriaxone, highlight the imperative requirement of strong antimicrobial stewardship and localized surveillance strategies. The research throws up a considerable contrast between the effectiveness of front-line drugs and the increasingly prominent profile of multidrug-resistant organisms, requiring an evolution in the treatment protocols. Low resistance seen in agents such as Gentamicin and Tobramycin pose a glimmer of hope but require to be watched intently against any potential rise in the future.

This study also strengthens the importance of region-specific data on AMR while pointing out infection control practice strengthening, education, and rapid development of diagnostics that can aid tailoring of therapies. Through an integration of antimicrobial stewardship programs, infection control strategies, and efforts to forge alternative treatments such as combination therapies and bacteriophage application, healthcare systems can be relieved of the impacts of AMR. The results open avenues for future research focused on longitudinal tracking of resistance trends, new antimicrobial evaluations, and strategic interventions to lower the burden of POWIs. Lastly, these efforts are urgently needed to preserve the efficacy of antibiotics, improve patient outcomes, and combat the growing global threat of AMR.

FUTURE SCOPE

Future work with respect to postoperative wound infections in Latur, Maharashtra, could include antibiotic resistance profiling with an interest in the longitudinal tracking of resistance patterns, genetic mechanisms of resistance, novel treatment evaluations, and preventive strategies. A further study could analyze the impact of antimicrobial stewardship programs on resistance rates in tertiary care hospitals in that region.

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Conflict of Interest. None.

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