Section: Microbiology

Original Research Article

ANTIBIOGRAM OF PATIENT SAMPLES AND A STEP TOWARDS ANTIMICROBIAL STEWARDSHIP IN ESIC MEDICAL COLLEGE & HOSPITAL JAIPUR, RAJASTHAN

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ABSTRACT

Background: The expansion of antimicrobial resistance is an ever growing concern globally. In a developing country like ours this increasing antimicrobial resistance is imposing a threat to health care centres and patients pockets. Irrational and overuse of antibiotics are leading to unavailability of antibiotics. The study contributes to promoting responsible antibiotic use and addressing antimicrobial resistance in Indian tertiary hospitals. India faces unique challenges in tackling antimicrobial resistance (AMR) due to the high prevalence of infections, irrational antibiotic use, and varied healthcare infrastructure. Integrated stewardship practices are key to combating AMR. Antimicrobial resistance (AMR) stands as one of the most pressing global health challenges of the 21st century, threatening to undermine decades of medical progress and rendering once-effective antibiotics, ineffective.

Materials and Methods: Two year data was retrospectively analyzed from a 300 bedded tertiary care centre.

Results: A total of 5630 samples were received, out of which 2479 isolates were studied, their Antibiogram profiles were analyzed. Percentage of Gram negative bacteria obtained were 59.6%, while Gram Positive bacteria were obtained in 40.4% of the isolates. *Escherichia coli* (22.8%) was the most common organism isolated, followed by *Staphylococcus aureus* (16.2%), Other *Staphylococcal sp*. (12.8%), *Enterococcus sp.* (12.6%), *Klebsiella pneumoniae* (10%), *Pseudomonas aeruginosa* and *Acinetobacter baumanii complex* (7.4%), Miscellaneous Bacteria (11.4%). An alarming number of isolates were found to be Multidrug resistant isolates (MDRs). With the panel of antibiotics tested for Extended Spectrum Beta lactamase (ESBL) prevalence was estimated to be 63.6% in *E.coli*, 82.4% in *Klebsiella pneumoniae*. Methicillin resistant *Staphylococcus aureus* (MRSA) was seen in 54% of the isolates, while Inducible clindamycin resistance was observed in 35.9% of the isolates. Among the main organisms identified, 72% of *E. coli* and 63% of *Klebsiella spp.* were resistant to 3rd generation cephalosporins due to extended-spectrum beta-lactamase (ESBL), and 53% of the *Staph. aureus* were Methicillin-resistant. Overall, more than half of Enterobacteriaceae were resistant to carbapenem (66%) and resistance to 3rd generation cephalosporins due to ESBL (70%) was alarmingly high. The carbapenem resistance in Pseudomonas aeruginosa was high (45%).

Conclusion: Antibiotic stewardship will ensure faster patient recovery at a lesser cost and also prevent surplus progression of drug resistance.

Keywords: Antimicrobial resistance (AMR), Antimicrobial Stewardship, Antibiogram, ESBL; MRSA.

INTRODUCTION

This study aimed to determine the spectrum and Antibiogram of the isolated bacteria from patients. Antimicrobial stewardship programs are intended to improve patient outcomes, reduce side effects, bacterial resistance, and costs. Antimicrobial resistance is a matter of concern as its compromises

the management of infectious diseases and increases the cost of health care as well.[1] Routine surveillance of baseline resistance, expressing of hospital antibiotic policy and compliance with current guidelines will go long way in reducing multi drug resistance among pathogens.[2]

Laboratory identification: BD Phoenix M50 System.[3]
The BD Phoenix NMIC-421 panel (BD Catalog Number: 448442) was used to determined MICs of imipenem (range: 0.25–8 mg/L), meropenem (range: 0.125–8 mg/L), and ertapenem (range: 0.25–2 mg/L) according to the manufacturer's instructions. In short, the identification broth was regulated with bacterial colonies from Blood Agar Plates to 0.5 McFarland standards using a spectrophotometric device. Transferred 25 µL 0.5 McFarland identification broth suspensions to the Phoenix Antibiotic susceptibility testing (AST) broth, which was supplemented with 50 µL of the Phoenix AST indicator for the organism growth detecting before added to the panels. The panels were loaded into the Phoenix device (M50). The results were analyzed using Epicenter data management software version 6.61A (BD Diagnostic Systems) after 16 h of incubation. The AST broth was poured into a selected panel, which was next placed into the instrument to incubate for 16 h. The colonies from overnight incubation were tested using the BD Phoenix TM M50 AST system4 with priority given to critically important antibiotics, including NMIC/ID-421, PMIC/ID-70, and NMIC-500 panels, which contain 15 antimicrobials for GN bacteria, 11 antimicrobials for non-Streptococcus GP bacteria and 5 antimicrobials for Streptococcus, respectively. M50 AST not only provides AST (Sensitive: S/Resistant: R) results but also automatically detects MIC.

Samples were incubated in the automated BacT/ALERT 3D system (BIOMERIEUX, USA) and BACTEC 9050 (BD Bactec™ 9050 Blood Culture System)6 for 7 days. The negative results were followed up to 7 days and final report was issued. The preliminary signal of bacterial growth was detected and displayed on the 3D monitor of BacT/ALERT system and BD Bactec™ 9050 Blood Culture System mentioning the detection time. Further identification of all blood culture positive samples was accomplished by sub-culture.
Updated annually according to the standard guidelines (CLSI, EUCAST).[5,6]

MATERIALS AND METHODS

Place of Study: This study was conducted at Microbiology Department of ESIC Medical College and Hospital, Jaipur, Rajasthan.
Duration of study: Two year (January 2023–December 2024).

Type of Study: This was a retrospective, descriptive, and observational study.
Data collection: Surveillance programs collect relevant data on BSIs, including the type of pathogen, patient demographics, and site of infection, associated risk factors, and antimicrobial susceptibility results. These data are stored in electronic databases or specialized surveillance systems.
Data analysis and reporting: Analyzing the collected data helps identify trends, patterns. This information can guide infection prevention strategies, antibiotic stewardship programs, and public health interventions. Statistical Analysis the analysis of data obtained from this study was done using SPSS statistical software package (version 20). Percentage and frequency were used to show distribution of descriptive data using tables.[7] Bi-variable and multivariable analyses were done using logistic regression model for the outcome variable (significant culture positivity) and independent variables (socio-demographic characteristics and health related factors) for further interpretation based on the odds ratio and level of statistically significant at $P < 0.05$. In addition, Chi-square test was employed to see the association between infection status and pathogen growth.[7] The Spearman correlation coefficients (P-value) were calculated by SPSS 26.0. The linear regression curve was performed using GraphPad Prism8, and the R2-value was obtained at same time.

RESULTS & DISCUSSION

The assimilated data was analyzed to obtain relevant conclusions. The conclusion is depicted in form of Pie charts and bar diagrams.

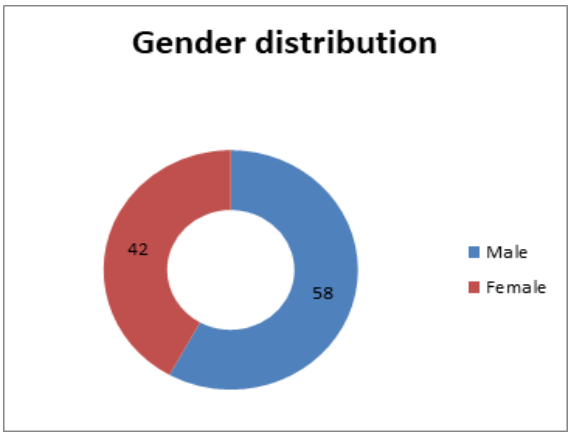

Figure 1: Gender wise distribution.

The male patients had marginally higher incidence of infection. [Figure 1]

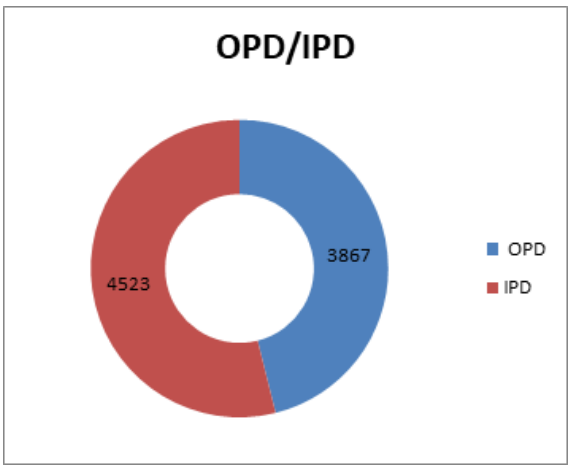

Figure 2: Outdoor and indoor patient ratio

Outdoor and indoor patient ratio is presented [Figure 2].

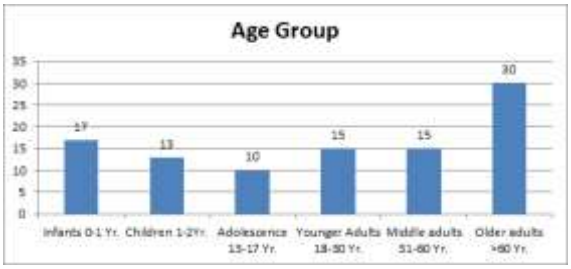

Figure 3: Age wise distribution.

Age group is consequential criteria in our study, extremes of age groups showed more prevalence of infection. This is in mesh with similar studies [6-10] done globally, representing the diminished immune status in extremes of age groups.

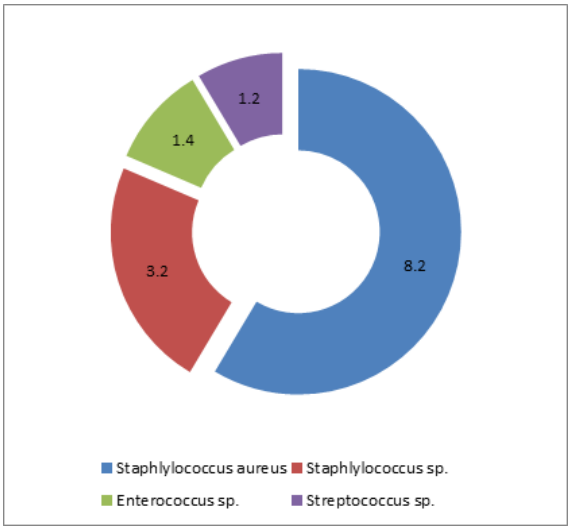

Figure 4 Bacterial spectrum of GPCs.

Bacterial spectrum and Antibiogram: Only aerobic infection was included in the study. Organisms were assorted based on Gram's stain result. Gram positive cocci and Gram negative bacilli were assessed separately [Figure 4 & 6]. GPC isolates were predominantly *Staphylococcus aureus*. Generally, the highest susceptibilities of gram-positive pathogens to antimicrobials were seen towards vancomycin, linezolid, Daptomycin, Clindamycin, Teicoplanin. Moreover, Staphylococcus aureus was found to be sensitive to gentamicin (64.4%), clindamycin (92%), penicillin (30%) and erythromycin (92.5%); MRSA was most sensitive to clindamycin (82.6%); CoNS was sensitive to vancomycin(95.1%) and cefoxitin (81.3%); and *Enterococci spp.* showed maximum sensitivity toward Vancomycin (90%), Linezolid (86.2%), Gentamicin (75.0%), and maximum resistance to fluroquinolones (50%). Vancomycin resistance was detected in 10%. In opposite, lowest susceptibilities of gram-positive pathogens to antimicrobials were seen to ampicillin and penicillin by CoNS, MRSA, and *Staphylococcus aureus*.

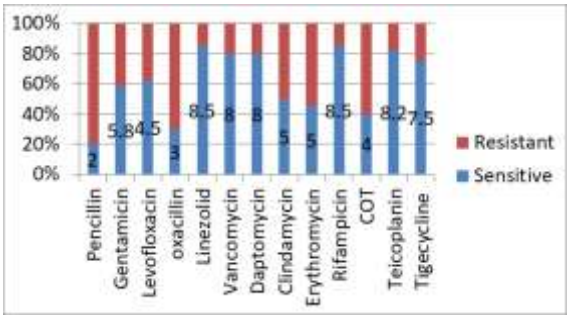

Figure 5: Antibiogram for GPCs

Antibiogram for GPCs.

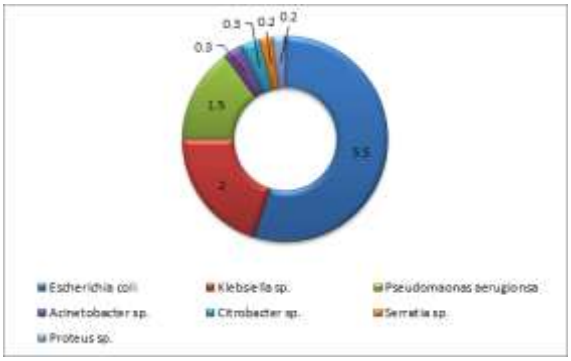

Figure 6: Bacterial spectrum of GNBs

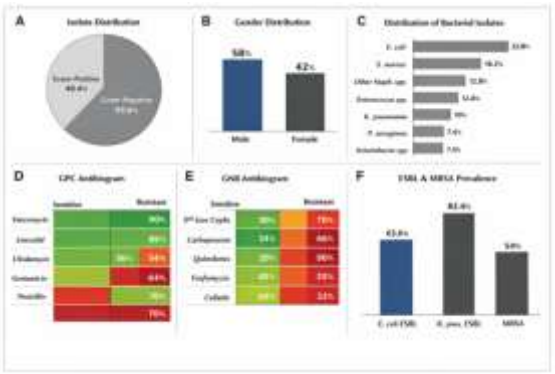

Figure 8: Article summary

Bacterial spectrum for GNBs: The Gram negative bacilli (59.6%) dominated our study. *Escherichia coli*

is a global menace [11], our bacterial spectrum is almost same to similar studies done nation wide. This hints toward growing MDR, ESBL in GNBs. This could be due to the overuse use of these antibiotics.Carbapenem, Nitrofurantoin, Quinolones, and Fosfomycin. We observed that resistance toward Fosfomycin and Colistin is in upward trends. [Figure 6]

Multidrug resistance: ESBL detection-The BD Phoenix identified ESBL in (56.2%) of the Enterobacteriaceae isolates. *E. coli* (57.1%) and *Klebsiella spp.* (27.3%). isolates were ESBL producers. ESBL-producing isolates also carried genes for at least one broad-spectrum beta-lactamase (e.g., TEM-1/2, SHV-1, and SHV-11)16. The BD phoenix ESBL test is a new tool for rapid detection of ESBL production which is based on simultaneous assessment of the inhibitory effects of cefepime, cefotaxime, and ceftazidime, alone and in the presence of clavulanate [12]. BD phoenix automated system were used for performing antimicrobial susceptibility patterns and reported according to standard (Clinical Laboratory Standards Institute—CLSI) guidelines.[5]

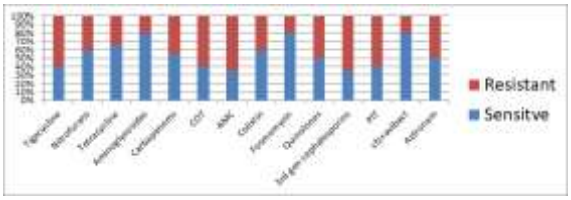

Figure 7: Antibiogram of GNBs.

Antimicrobial stewardship: In the hindsight view of our study we came to this deduction that commonly use antibiotics like AMC, PIT, 3rd generation cephalosporin's, COT need to be use meticulously as their resistance is on a surge for GNB's.[20] Starting of empirical therapy without getting antibiogram done on patient sample is a major contributing factor to this status quo.[21]. Equivalently, for GPC's Vancomycin, Daptomycin, Linezolid, Teicoplanin, Tigecycline are showing good sensitivity but Cot, Pencillin, aminoglycosides and Oxacillin resistance (MRSA) continues to dominate.[21]

Antimicrobial Stewardship Programs (AMSPs) are essential components of modern healthcare systems, particularly in tertiary care hospitals where the burden of severe infections and antimicrobial resistance (AMR) is substantial.[22,23] These institutions cater to critically ill, immune-compromised, and post-surgical patients, thereby increasing the likelihood of broad-spectrum antimicrobial use and the emergence of multidrug-resistant organisms (MDROs).[24]

AMSP is a structured, multidisciplinary approach aimed at optimizing antimicrobial use to achieve the best clinical outcomes while minimizing toxicity, resistance development, and healthcare costs.[25] The core stewardship team typically includes a clinical microbiologist, infectious disease physician, clinical pharmacist, and infection control personnel.[24]

Key AMSP interventions include the development of institutional antibiotic policies based on local epidemiological data, implementation of formulary restriction and pre-authorization for reserve antibiotics, and prospective audit with feedback to prescribers.[22,24]. Additionally, the preparation and regular dissemination of cumulative antibiogram guide evidence-based empirical therapy.[24]

Quantitative indicators play a crucial role in monitoring the effectiveness of AMSP. Antimicrobial consumption is commonly assessed using Defined Daily Dose (DDD) per 100 bed-days, while process indicators such as adherence to antibiotic policy and timely de-escalation are routinely evaluated.

Studies.[21-25] have demonstrated that implementation of AMSP in tertiary care settings can lead to:

- 20–30% reduction in inappropriate antimicrobial use
- 10–20% decrease in antimicrobial expenditure
- Reduction in incidence of MDRO infections by ~15–25%
- Improved clinical outcomes, including reduced length of hospital stay.

Additionally, AMSP functions in synchronized with Infection Prevention and Control (IPC) practices such as hand hygiene compliance, surveillance of healthcare-associated infections (HAIs), and isolation protocols.

In conclusion, AMSP serves as a critical strategy in tertiary care hospitals to ensure judicious antimicrobial use, enhance patient safety, and curb the escalating threat of antimicrobial resistance.

Figure 9: Antimicrobial Stewardship Programs (AMSPs)

CONCLUSION

Hospitalized patients are the principal causeof origin of multidrug-resistant (MDR) bacterial strains, largely due to frequent and inappropriate or incorrect use of broad-spectrum antibiotics that leads to development of drug-resistant strains,[13] and bacterial exchange of resistance traits, including plasmid-encoded β-lactamases, aminoglycosides modifying enzymes, quinolone resistance gene, in the environment through horizontal gene transfer.[14] In

previously, done studies in India,[13-17] and Globally,[18,19], the pattern of development drug resistance is similar, this infer that the increasing antimicrobial resistance is making infectious illness untreatable and also it increases the burden of treatment for both the doctor and patient. The antimicrobial resistance (AMR) predicament is the increasing incidence of infectious diseases affecting the human population, which are not curable with any known antimicrobial agent.[12,16]Increasing AMR is the tip of the iceberg, its sitting on the top of pandemic that is waiting to happen. If antibiotics are not prudently used it will lead the world to inevitable doom of incurable infectious illnesses.

Based on this data, measures such as improving infection control and implementing antibiotic stewardship should be implemented with the urgency required to reduce the spread of resistance, limit the morbidity and mortality associated with multidrug resistant strains.

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