Section: Microbiology

Original Research Article

UTILITY OF CULTURE AND ANTIBIOTIC SENSITIVITY TEST TO COMBAT ANTIMICROBIAL RESISTANCE AMONG THE ADMITTED PATIENTS IN A TERTIARY CARE HOSPITAL

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Abstract

Background: AMR (Antimicrobial resistance) has been identified as a severe and rising problem for public health worldwide. **Materials and Methods:** This present cross-sectional study was done in the microbiology department, DUPMC&H, Jalgaon (Kh.) and research study was approved by ethical committee, carried out from May 2022 to April 2023. **Results:** A total of 105 bacterial culture and sensitivity reports of admitted patients from the tertiary care hospital included in this study. One of the most frequent predisposing factors observed in patients with extended hospitalisations and prolonged antimicrobial use, as well as accelerated HTN/HTN, as well as aspirational pneumonia/pneumonia, accounted for the majority of the 59% of bacterial isolates found in the ICU. The most predominant isolates were *Escherichia coli and Klebsiella pneumoniae* from various clinical samples. Ampicillin showed a high level (100%) of resistance in gram-negative bacteria followed by cefuroxime and cefotaxime. Penicillin-G and Azithromycin observed greater level of resistance against the gram-positive bacterial isolates. Of 83 Gram-negative isolates, 66% were MDR and 60% XDR. The highest use of antibiotics as empirical treatment was ceftriaxone (40%). Out of 105 patients 93% were given empirical treatment and antibiotic treatment was adjusted 52% and found with resistance in 45.9% culture reports which the antibiotics used in empirical therapy. The empirical therapy results were statistically analyzed and the p-value was found to be significant (p-value =0.001). **Conclusion:** The present study revealed how culture & sensitivity test help to reduce the irrational use of broad-spectrum antibiotics.

INTRODUCTION

AMR (Antimicrobial resistance) has been identified as a severe and rising problem for public health worldwide. The WHO (World Health Organisation) has named AMR as one of humanity's top ten global health problems. Misuse and overuse of antimicrobials are the primary causes of drug-resistant infections.[1] The proper selection of empiric antibiotics is critical for reducing infection-related morbidity and mortality.[2] India has one of the greatest loads of bacterial illnesses, and crude mortality from infectious disease is quite high.[3] Since the overuse of broad-spectrum antibiotics has been linked to the development of further resistance, simply expanding the available empirical antibiotic alternatives for all patients would not be adequate to lower this risk as antibiotic resistance rates rise.[4,5,6,7] The risk of infection by antimicrobial-resistant bacteria varies from patient to patient, and prior culture results can provide light on this risk. Nevertheless, prescribers often neglect to take this information into account when making an empirical antibiotic selection.[3] The primary cause of antibiotic resistance (AMR) is the irrational use of broad-spectrum antibiotics.[1] While delaying the establishment of antimicrobial resistance, better antimicrobial prescribing enhances therapeutic outcomes.[8]

It is well acknowledged, although, that the majority of the restricted class of wide-spectrum antibiotics are prescribed without an adequate justification, which could raise the rates of antibiotic-resistant bacteria.[9] Drug selection for antimicrobial therapy depends on the early identification of pathogenic microorganisms using culture sensitivity testing. However, wide spectrum antibiotics are often used as an empirical therapy since hospital-associated illnesses have the potential to become resistant to many medications, and because treating a range of bacteria is necessary.[8] Based on the findings of culture and sensitivity test reports, empirical treatment should be modified to reduce the unnecessary use of antibiotics and stop the risk of AMR from rising.[8,10]

The early detection of pathogenic bacteria using culture sensitivity testing and the appropriate selection of antibiotics based on the sensitivity report findings are essential for the efficacy of antimicrobial therapy. These kinds of programmes will help stop the rising rates of antimicrobial resistance (AMR), which are made worse by the misuse of broad-spectrum antibiotics.[8,11-13] Typically, bacterial culture findings are disregarded since patients respond well to empiric treatment; however, this is not always the case.[11,14-16] Antimicrobial stewardship programmes (ASPs) can help combat this by lowering AMR rates and improving hospital antibiotic usage patterns in the future. In an effort to enhance their prescription procedures, ASPs may also promote antibiotic de-escalation.[11] In order to provide antibiotic therapy to patients who have been admitted to a tertiary care hospital, the current study was designed to investigate the antibiotic susceptibility patterns of bacterial isolates and the following use of culture and sensitivity testing.

MATERIALS AND METHODS

The current cross-sectional research was carried out from May 2022 to April 2023 at the Dr. Ulhas Patil Medical College and Hospital (DUPMC&H), located in Jalgaon, in the Department of Microbiology. This study comprised 105 reports of culture and sensitivity tests performed on hospitalised patients.

Data collection

Step 1: All the culture and sensitivity reports were collected from the Microbiology clinical laboratory. The Information from the lab reports were collected and documented in a standardized data collection sheet with Patient Age, Gender, IPD No., Department, Ward/ICU, Type of Specimen, Date of Specimen collection, Date of Reporting, Provisional diagnosis, Microorganism isolated and Antimicrobial Sensitivity Patterns (AST).[17,18,19] The Kirby-Bauer DD (Disc Diffusion) Method was used to assess the antibiotic sensitivity pattern of all bacterial isolates, and the findings were interpreted as resistant or intermediate or sensitive based on Clinical and Laboratory Standards Institute (CLSI) guidelines.[19]

Step 2: Visited the wards / ICUs to take the follow-up of antimicrobial therapy given to patients based on antimicrobial sensitivity results. If antimicrobial therapy was already started and were there any adjustments in antimicrobial therapy after culture and sensitivity reports received and till discharge of the patient follow-up was continued.

Step 3: Additional data was collected from the patient case sheet/medical file which included medical history, predisposing factors and length of hospital stay.

Step 4: All the information was filled in the datasheet consisting of 1st antibiotic therapy, if it was continued after getting culture and sensitivity report (Yes/No), 2nd antibiotic therapy (adjustment after getting culture and sensitivity report), and if it is adjusted details were noted.

Statistical Analysis: The SPSS (Statistical Package for the Social Sciences) 27 - 2019 programme was used to analyse the collected data. The results were reported as percentages, frequency, mean, and standard deviation in both figures and tabular formats.

RESULTS

A total of 105 bacterial culture and sensitivity reports of admitted patients from the tertiary care hospital included in this study. Among 105 the males 61 (58%) were high as compared with females 44 (42%). The patients' average age was 48.54 ± 17.97 years. Patients in the age groups of 51–70 years and 31–50 years had higher rates of bacterial isolates 42% (44) and 32% (33) respectively, while patients in the 19–30 years age group and the 71–86 years age group had lower rates of bacterial isolates16% (17) and 10% (11) respectively. Compared with General wards, where 41% (43) of bacterial isolates were discovered, the ICU had a noticeably higher percentage 59% (62). [Table 1]

Most of the bacterial isolates from individuals with underlying/diagnosed diseases, like Accelerated HTN/HTN 21 (20%), Aspirational Pneumonia/Pneumonia 17 (16%), CVA/Haemorrhagic shock 12 (11.4%), CKD/AKI 11 (10.5%), Resp. failure 10 (9.5%), Sepsis & Septic shock 7 (6.6%) and less common were Trauma/burns 4 (4%) and Others (Hyperthyroidism, Meningitis and UTI) 4 (4%). The risk factors that are most frequently seen in patients with Extended Hospital Stay and Prolonged antimicrobial use 62 (59%), Mechanical ventilation and less common factors were DM 18 (17%), Chronic obstructive pulmonary disease (COPD) 13 (12%), Catheterization 10 (9.5%), Cancer 9 (8.5%) SSI 5 (4.7%). [Table 1]

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A total number of 105 bacterial isolates, the most predominant isolates were *Escherichia coli* and *Klebsiella pneumoniae* 22 (21%), followed by *Acinetobacter baumannii/ Acinetobacter baumannii* complex 17 (16%), *Pseudomonas aeruginosa* 12 (12%), *Enterococcus faecalis* 11 (10%), *Staphylococcus aureus* 9 (9%), NFGNB's 8 (7%), *Proteus mirabilis/vulgaris* and CoNS (Coagulase Negative *Staphylococcus*) 2 (2%) were isolated from various kind of clinical samples. Among the 105 most of the bacterial isolates, 28 (27%) were obtained from the respiratory specimen, such as bronchoalveolar lavage (BAL) and sputum, followed by pus or wound swab and tissue 25 (24%), urine 22 (21%), endotracheal tube/ aspiration 18 (17%), pleural/ ascitic fluid 7 (6%), blood 4 (4%) and stool 1 (1%). [Figure 1]

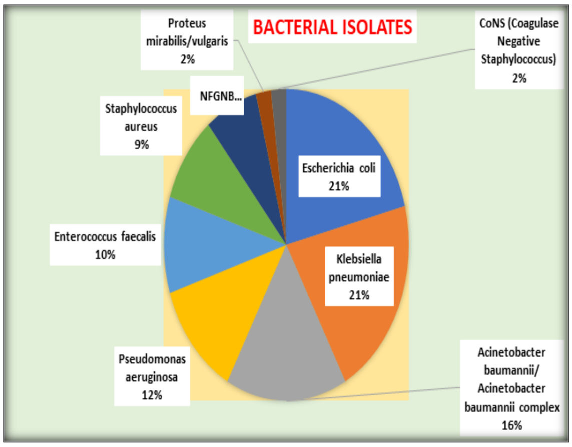

Figure 1: Distribution of bacterial isolates from various clinical samples (n = 105)

The antibiotic susceptibility testing (AST) results showed higher susceptibility to colistin (84%) followed by tigecycline, piperacillin-tazobactam and tetracycline (76%), doxycycline and aztreonam (64%), amikacin (57%) and gentamicin (47%) against the gram-negative bacterial isolates. The antibiotics tested towards the gram-positive bacterial isolates showed greater level of susceptibility to vancomycin (100%), linezolid and chloramphenicol (91%), clindamycin (82%), ceftriaxone (73%) and oxacillin (55%). [Table 2]

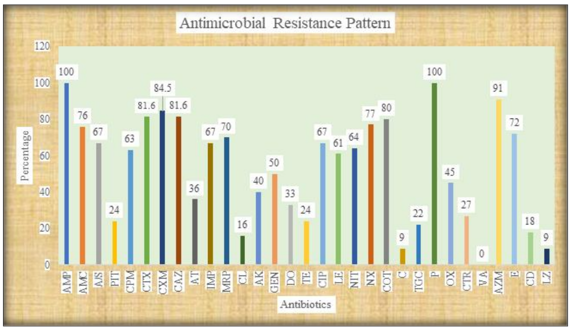

Figure 2: Antimicrobial Resistance Pattern of Bacterial Isolates

Ampicillin showed a high level (100%) of resistance in gram-negative bacteria followed by other antibiotics such as cefuroxime (84.5%), cefotaxime and ceftazidime (81.6%), trimethoprim-sulfamethoxazole (80%), amoxicillin- clavulanic acid (76%), meropenem (70%), imipenem and ciprofloxacin (67%), cefepime (63%), levofloxacin (61%). Penicillin-G (100%), Azithromycin (91%) and Erythromycin (72%) observed greater level of resistance against the gram-positive bacterial isolates (Figure 2). Of 83 Gram-negative isolates, 55 (66%) were multidrug-resistant (MDR) and 50 (60%) extensively resistant (XDR). [Table 3]

The highest use of antibiotics as empirical treatment was ceftriaxone (40%) followed by piperacillin-tazobactam (34%), amoxycillin + clavulanic acid (21.4%), amikacin (14.2%), levofloxacin (14.2%), meropenem (4%), cefoperazone + sulbactam (2%) and colistin (2%). [Table 4]

Out of 105 patients 98 (93%) were given empirical treatment and antibiotic treatment was adjusted to the patients after culture report 55 (52%), among the 55 patients 34 (61.8%) were done with de-escalation of antibiotic therapy and 21 (38.1%) of them had escalation of antibiotic therapy. Out of 98 patients who started with empirical therapy found with resistance in 45(45.9%) culture reports which the antibiotics used in empirical therapy. The antibiotic treatment given to the patients before culture report (empirical therapy) was analyzed statistically and the p-value was found to be significant (p-value =0.001). [Table 5]

Table 1: Demographic Data of Patients

Parameter	Number	Percentage
Gender		
Male	61	58%
Female	44	42%
Age Group Division		
19-30 years	17	16%
31-50 years	33	32%
51-70 years	44	42%
71-86 years	11	10%
ICU/ Ward		
MICU	53	50.4%
SICU	8	7.6%
CICU	1	1%
OBGY	10	9.5%
MMW	10	9.5%

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MSW	7	6.6%
FSW	6	5.7%
FMW	4	3.8%
Ortho Ward	4	3.8%
ENT Ward	2	1.9%
Pre-Disposing Factors / Underlying Diseases		
SSI	5	4.7%
DM	18	17%
Cancer	9	8.5%
Extended Hospital Stay and Prolonged antimicrobial use	62	59%
Mechanical ventilation	18	17%
COPD	13	12%
Catheterization	10	9.5%
Trauma/burns	4	4%
Sepsis & Septic shock	7	6.6%
Accelerated HTN/HTN	21	20%
CVA/Haemorrhagic shock	12	11.4%
CKD/AKI	11	10.5%
Resp. failure	10	9.5%
Aspirational Pneumonia/Pneumonia	17	16%
Others (Hyperthyroidism, Meningitis and UTI)	4	4%
Clinical Samples		
Sputum and BAL	28	27%
Pus/Wound Swab and Tissue	25	24%
Urine	22	21%
Endotracheal Tube/ Aspiration	18	17%
Pleural/ Ascitic Fluid	7	6%
Blood	4	4%
Stool	1	1%

Table 2: Antibiogram of Bacterial Isolates

Antibiotic			Number of Isolates	Susceptible	Intermediate	Resistance
Name	Code	Conc.		Number (%)	Number (%)	Number (%)
Ampicillin	AMP	10 mcg	**71**	00 (00)	00 (00)	71 (100)
Amoxicillin- clavulanic acid	AMC	20/10 mcg	**71**	15 (21)	2 (3)	54 (76)
Ampicillin-Sulbactam	A/S	10/10 mcg	**71**	20 (27)	3 (6)	48 (67)
Piperacillin-Tazobactam	PIT	100/10 mcg	**76**	58 (76)	0 (00)	18 (24)
Cefepime	CPM	30 mcg	**71**	22 (31)	4 (6)	45 (63)
Cefotaxime	CTX	30 mcg	**71**	11 (15.4)	2 (3)	58 (81.6)
Cefuroxime	CXM	30 mcg	**71**	10 (14)	1 (1.5)	60 (84.5)
Ceftazidime	CAZ	30 mcg	**71**	11 (15.4)	2 (3)	58 (81.6)
Aztreonam	AT	30 mcg	**56**	36 (64)	0(00)	20 (36)
Imipenem	IMP	10 mcg	**83**	25 (30)	2 (3)	56 (67)
Meropenem	MRP	10 mcg	**83**	24 (29)	1 (1)	58 (70)
Colistin	CL	10 mcg	**37**	31 (84)	0 (00)	6 (16)
Amikacin	AK	30 mcg	**80**	46 (57)	2 (3)	32 (40)
Gentamicin	GEN	10 mcg	**80**	38 (47)	2 (3)	40 (50)
Doxycycline	DO	30 mcg	**87**	56 (64)	2 (3)	29 (33)
Tetracycline	TE	30 mcg	**49**	37 (76)	0 (00)	12 (24)
Ciprofloxacin	CIP	5 mcg	**93**	27 (29)	4 (4)	62 (67)
Levofloxacin	LE	5 mcg	**93**	33 (35)	3 (4)	57 (61)
Nitrofurantoin	NIT	300 mcg	**22**	8 (36)	0 (00)	14 (64)
Norfloxacin	NX	10 mcg	**22**	5 (23)	0 (00)	17 (77)
Trimethoprim-sulfamethoxazole	COT	1.25/23.75 mcg	**81**	15 (19)	1 (1)	65 (80)
Chloramphenicol	C	30 mcg	**11**	10 (91)	0 (00)	1 (9)
Tigecycline	TGC	15 mcg	**37**	28 (76)	1 (2)	8 (22)
Penicillin-G	P	10 unit	**22**	0 (00)	0 (00)	22 (100)
Oxacillin	OX	1 mcg	**11**	6 (55)	0 (00)	5 (45)
Ceftriaxone	CTR	30 mcg	**11**	8 (73)	0 (00)	3 (27)
Vancomycin	VA	30 mcg	**11**	11 (100)	0 (00)	0 (00)
Azithromycin	AZM	15 mcg	**11**	1 (9)	0 (00)	10 (91)
Erythromycin	E	15 mcg	**22**	6 (28)	0 (00)	16 (72)
Clindamycin	CD	2 mcg	**11**	9 (82)	0 (00)	2 (18)
Linezolid	LZ	30 mcg	**22**	20 (91)	0 (00)	2 (9)

Table 3: MDR and XDR Gram-negative isolates (n=83)

Sr. No.	Antibiotic Resistance	Gram-negative isolates	
		Number	Percentage
1.	MDR	55	66%

2.	XDR	50	60%

Table 4: Antibiotics used for Empirical Therapy (n=98)

S. No.	Antibiotics used for Empirical Therapy	Number (%)
1.	Ceftriaxone	39 (40)
2.	Piperacillin-tazobactam	33 (34)
3.	Amoxycillin + Clavulanic Acid	21 (21.4)
4.	Amikacin	14 (14.2)
5.	Levofloxacin	14 (14.2)
6.	Meropenem	4 (4)
7.	Cefoperazone+sulbactam	2 (2)
8.	Colistin	2 (2)

Table 5: Adjustment of Empirical Therapy (n = 105)

Adjustment of Empirical Therapy	Number (%)	p value
Antibiotic Treatment given to the Patients before culture report (Empirical Therapy)	98 (93)	0.001
Antibiotic Treatment adjusted to the Patients after culture report (Definitive Therapy)	55 (52)	0.696
Found resistance in culture report to the antibiotic used in Empirical Therapy	45(45.9)	0.172

(If the p-value is < 0.05, show the significant association)

DISCUSSION

The purpose of this study was to determine how culture and sensitivity testing effected the following prescription of antimicrobial agents and the continuation of empirical therapy in clinical settings. Reducing the quantity of antibiotics and reducing the scope of antibiotic therapy resulted from providing information on antimicrobial therapy based on culture and sensitivity results. According to other studies, out of 105 patients, a considerably higher percentage (59%) of patients were discovered in the ICU compared to general wards (41%).[2] Zikria Saleem et al. (2023) conducted a study in Pakistan that produced somewhat inconsistent results, with the ICU and wards showing 15% and 85% of the total, respectively.[11] The incidences of infections are most commonly seen in male (58%) patients as compared with female (42%) patients which is documented the same in other studies.[2,11,20] B.J. Langford et al. (2021) from Canada reported that the incidences of infections were most commonly seen in females (85%) as compared with male (15%) patients, which is not consistence with the present study.[21]

In the current study, the most common bacterial isolates from various clinical samples were gram-negative bacteria than gram-positive bacteria. The most predominant gram-negative bacteria were *E. coli* and *Klebsiella pneumoniae* (21%) and the second most predominant organism was *Acinetobacter baumannii* (16%). In gram-positive the most common organisms were *Enterococcus faecalis* (10%) and *Staphylococcus aureus* (9%) which is similar to studies conducted by Zikria Saleem et al. (2023) and B.J. Langford et al. (2021) and not similar with Diwakar et al. 2023.[11,21,20] The majority of the bacterial isolates were obtained samples from respiratory tract (50%), which is consistent with the findings of earlier research,[22-25] but not in parallel with other studies. However, the sample size is mater.[26,27]

Most bacterial isolates from patients with underlying illnesses, like accelerated HTN/HTN (20%), aspirational pneumonia/pneumonia (16%), CVA/Haemorrhagic shock (11.4%) and the most prevalent risk factors seen in individuals who require an extended hospital stay and prolonged antimicrobial use (59%), mechanical ventilation and less common factors were DM (17%). The results are similar to the study by Zikria Saleem et al. (2023) and only one study was found on these particular parameters.[11]

The greater proportions of resistance patterns towards ampicillin (100%) and cephalosporins such as cefuroxime (84.5%), cefotaxime, ceftazidime (81.6%), cefepime (63%) and amoxicillin-clavulanic acid (76%), the results following recent studies conducted by Riti JS et al. (2018), M. Gupta et al. 2019, Ramakrishna et al. (2021), Bhargava et al. (2022).[28,29,30,31] The other antibiotics such as trimethoprim-sulfamethoxazole (80%), which is similar to the study of Diwakar et al. (2023) and not similar to Riti JS et al. (2018), Ramakrishna et al. (2021).[20,28,30] The carbapenems such as meropenem (70%), and imipenem (67%), resistance patterns were nearly too similar to the study of Bhargava et al. (2022) and high and low ranges of resistance patterns recorded by M. Gupta et al. (2019) and Mood et al. (2022) respectively.[31,29,32] Trends of resistance patterns fluoroquinolones; ciprofloxacin (67%) and levofloxacin (61%) in the present study, which is consistence with Riti JS et al. (2018) and Ramakrishna et al. (2021), and not in consistence with Mood et al. (2022) and Diwakar et al. (2023).[28,30,32,20] Penicillin-G (100%), Azithromycin (91%) and Erythromycin (72%) observed greater levels of resistance against the gram-positive bacterial isolates in the current study and the results following recent studies conducted by Riti JS et al. 2018, Ramakrishna et al. (2021) and Bhargava et al. (2022).[28,30,31]

In our study, of 83 Gram-negative isolates, 66% were MDR and 60% XDR; the most effective antimicrobial agents to treat infections caused by MDR & XDR bacterial isolates was colistin followed by tigecycline, piperacillin-tazobactam, doxycycline, aztreonam, amikacin and gentamicin against the gram-negative bacterial isolates. The antibiotics for the gram-positive bacterial isolates were vancomycin, linezolid and clindamycin, which showed a greater level of susceptibility, which is in concordance with recent studies of Zikria Saleem et al. (2023), Bhargava et al. (2022) and Ramakrishna et al. (2021).[11,31,30]

The highest use of antibiotics as empirical treatment was ceftriaxone followed by piperacillin-tazobactam, amoxycillin + clavulanic acid, amikacin, levofloxacin, meropenem, cefoperazone + sulbactam and colistin in the present study. Zikria Saleem et al. (2023) carried out a study in Pakistan which revealed that amikacin was the most frequently utilised empirical treatment, followed by cefoperazone + sulbactam.[11] Meropenem and piperacillin-tazobactam were employed as empirical treatments, according to other studies. To improve future antimicrobial usage in this and other hospitals, we are conscious that further research is necessary to understand the main factors influencing the decision to use antibiotics for empirical therapy.

A high proportion of patients (93%) were given empirical treatment or before the availability of culture and sensitivity reports in our study, which is similar to other studies.[33,34] The aforementioned prescribing practice may be explained by a desire to safeguard patients from severe infections without awaiting reports of susceptibility. But empirical treatment can be modified in response to culture and sensitivity results, which can minimise the needless use of broad-spectrum antibiotics.[11,33,34]

Upon obtaining culture and sensitivity reports, 52% of patients in our study received empiric therapy; this is higher than Chuodhary et al. (2017)'s 47% but lower than Zikria Saleem et al. (2023)'s 69% and Berild et al. (2005)'s 88%.[14,11,16] The antibiotic treatment given to the patients before culture report (empirical therapy) was analyzed statistically and the p-value was found to be significant (p-value =0.001) (Table 5) in the current study. The reason why culture report results were frequently disregarded in the hospital is still unknown, though. This could be the case because doctors tend to depend more on the patient's apparent clinical status than on the findings of culture reports.[35] However, since this is concerning, it will be looked into more in subsequent research. In order to reduce the prescription of broad-spectrum antibiotics, we will also make sure that the results of any culture sensitivity tests are quickly communicated to the prescribing physicians after they have been determined.

In this current study we found 45.9% antibiotic resistance in culture report which the antibiotics used in empirical therapy. There no studies found related this parameter. Usually in empirical treatment clinicians start with both gram-positive and gram-negative bacterial treatment; after getting culture and sensitivity report they need change accordingly. In present study, out of 105 patients 93% were given empirical treatment and antibiotic treatment was adjusted to the patients after culture report 55, among the 55 most of patients (61.8%) were done with de-escalation of antibiotic therapy and 38.1% of them had escalation of antibiotic therapy. This indicate burden or usage of antibiotics will be reducing after getting the culture and sensitivity reports.

CONCLUSION

There was remarkably high antibiotic resistance recorded against the various classes of antibiotics in all bacterial isolates. Alarming high rates of MDR and XDR were flagged in bacterial isolates and the emergence of XDR and MDR is a severe worldwide risk to public health. The present study revealed how culture & sensitivity test help to reduce the irrational use of broad-spectrum antibiotics, thereby decreasing the hospital stay and reducing the costs of antibiotics prescribed. This scenario emphases the need of culture and sensitivity test and its utility while prescribing the antimicrobial treatment in admitted patients. Moreover, strict infection control, local and national surveillance information, and antimicrobial stewardship are required. There is need to develop the culture of sending requestions for culture and sensitivity test before starting of antimicrobial therapy for proper antimicrobial treatment of patients. The appropriate usage of antibiotics is essential to preventing a catastrophic outbreak of microbial resistance.

Declarations

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Conflict of Interest: The authors declare that there is no conflict of interest.

Authors' Contribution: ANB performed the experiments and wrote the manuscript. Conceptualized and designed, guided and revised the manuscript by PKG. BSV and KBW helped while writing and revised the manuscript. All authors read and approved the final manuscript for publication.

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Data Availability: All datasets generated or analyzed during this study are included in the manuscript.

Ethics Statement: Ethical committee approval was received for this study from the Institutional Ethics Committee (IEC) of DUPMC&H Jalgaon. (IEC/DUPMCH/2022/06).

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