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Antibiogram Profile of Clinical Isolates from Intensive Care Unit Patients with Infectious Diseases at a Tertiary Care Hospital in Bengaluru

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Abstract

Background: Antimicrobial resistance is an increasing problem in intensive care settings where empirical antibiotic selection is often needed before culture data are available. Institution-specific antibiograms are useful for clinicians to identify suitable empirical therapy and promote antimicrobial stewardship activities.

Objective: The objective of this study was to describe the in vitro antibiotic susceptibility patterns of bacterial isolates from patients admitted to the intensive care unit with infectious diseases at a tertiary care hospital in Bengaluru as part of a larger prospective observational study correlating the neutrophil to lymphocyte ratio with antibiotic efficacy and clinical outcomes.

Methods: This antibiogram analysis was a part of a six-month prospective observational study conducted in the intensive care unit of ESIC MC-PGIMSR and Model Hospital, Rajajinagar, Bengaluru, involving 102 eligible patients recruited after institutional ethics committee approval and informed consent. Bacterial isolates collected from clinical specimens were identified by standard microbiological procedures, and antibiotic susceptibility testing was performed according to Clinical and Laboratory Standards Institute standards. Susceptibility was represented as the percentage of susceptibility for each organism-antibiotic combination.

Results: Three Gram positive and eleven Gram negative organisms were tested. Enterococcus faecalis remained entirely sensitive to Penicillin, Linezolid, Tigecycline, Vancomycin and Teicoplanin while Staphylococcus aureus exhibited considerable resistance to Penicillin (16.7 percent susceptible) but remained fully susceptible to Linezolid, Levofloxacin and Teicoplanin. Klebsiella aerogenes showed a pan-resistant profile among Gram-negative isolates, whereas Pseudomonas aeruginosa remained vulnerable to most anti-pseudomonal drugs. Elizabethkingia meningoseptica was sensitive to only Cotrimoxazole and Cefoperazone-Sulbactam.

Conclusion: Significant resistance was reported to several routinely used antibiotics among the ICU isolates in this institution. These findings underscore the necessity of local antibiogram surveillance and formalized antimicrobial stewardship to guide empirical prescribing and sustain the utility of last-resort medicines.

Keywords: Antibiogram, Intensive Care Unit, Antimicrobial Resistance, Antibiotic Susceptibility, Gram-Positive Organisms, Gram-Negative Organisms, Antimicrobial Stewardship Program

1. Introduction

Antimicrobial resistance is now considered as one of the greatest risks to global public health and antibiotic-resistant diseases are expected to cause significant morbidity and mortality worldwide in the next decades. Patients in intensive care units are especially vulnerable due to severe illness, invasive operations, lengthy hospital stay and repeated antibiotic exposure, all of which generate conditions favourable for the establishment and spread of resistance microbes.

In critically sick patients, empirical antibiotic therapy is typically begun before the availability of culture and sensitivity reports, making it crucial for clinicians to be led by locally generated resistance data, rather than relying on general prescribing patterns. A hospital specific antibiogram is a summary of the in vitro susceptibility of commonly identified organisms to the antibiotics tested against them. Such a tool is useful in rational empirical prescribing and in supporting antimicrobial stewardship programs.

This antibiogram was generated as part of a larger prospective observational study conducted in the intensive care unit of ESIC MC-PGIMSR and Model Hospital, Rajajinagar, Bengaluru that studied the neutrophil to lymphocyte ratio as a biomarker of antibiotic therapeutic efficacy and clinical outcomes among patients with infectious diseases. Antibiotic choice and clinical response in that study were directly related to the underlying microbiological profile of the recruited patients and, thus, a specific examination of the antibiotic susceptibility patterns of isolates collected from these patients was performed. The current paper summarizes an antibiogram, including Gram-positive and Gram-negative organisms isolated over the study period, with the goal of promoting evidence-based empirical antibiotic selection and stewardship initiatives at this institution.

2. Materials and Methods

2.1 Study Design and Location

This antibiogram analysis was derived from a prospective observational study conducted over a period of six months in the in-patient intensive care unit of ESIC MC-PGIMSR and Model Hospital, Rajajinagar, Bengaluru, in affiliation with Department of Pharmacy Practice, Acharya and B M Reddy College of Pharmacy, Bengaluru. The primary study included patients admitted to the intensive care unit with infectious illnesses who were taking antibiotics. Of the 114 patients initially screened, 12 were eliminated after application of the predefined eligibility criteria, resulting in 102 patients qualified for final analysis, based on a determined minimum requirement of 92 individuals. The study was initiated after clearance from the Institutional Ethics Committee and signed informed consent was obtained from each patient or legally authorised representative prior to enrolment.

2.2 Isolates Identification and Susceptibility Testing

Bacterial isolates obtained from clinical specimens of enrolled patients such as blood, urine, wound swabs, respiratory secretions and other relevant sites were identified using standard microbiological techniques

of colony morphology, Gram staining and biochemical characterisation. Antibiotic susceptibility testing was performed by the Kirby-Bauer disc diffusion method or by automated methods based on minimum inhibitory concentration, according to the Clinical and Laboratory Standards Institute standards. The results were classified as susceptible, intermediate or resistant and reported as percentage susceptibility for each organism antibiotic combination in this research.

2.3 Antibiotic Test Panel

The gram-positive isolates were tested against a panel of 14 antimicrobial agents including Penicillin, Amoxicillin, Ampicillin, Tetracycline, Levofloxacin, Linezolid, Tigecycline, Clindamycin, Vancomycin, Gentamycin, Erythromycin, Ciprofloxacin, Nitrofurantoin, Teicoplanin and Cotrimoxazole. The gram-negative isolates were screened for 15 different antimicrobial drugs such as Ampicillin, Piperacillin-Tazobactam, Tetracycline, Tigecycline, Gentamycin, Ciprofloxacin, Nitrofurantoin, Cotrimoxazole, Cefoperazone-Sulbactam, Meropenem, Imipenem, Amikacin, Cefepime, Cefotaxime and Ceftazidime.

2.4 Analysis of data

Susceptibility data were aggregated for each organism antibiotic combination and reported as percentage susceptibility. In the tables a dash symbol indicated susceptibility data not available or not tested. Descriptive analysis was used to summarize the antibiogram. No inferential statistical testing was done for this part of the study.

3. Results

During the study period, three Gram-positive and eleven Gram-negative bacterial species were isolated and examined from the clinical specimens of the enrolled critical care unit patients.

3.1 Gram-positive bacteria

Table 1 summaries the susceptibility profiles of the three Gram-positive pathogens discovered, Enterococcus faecalis, other Enterococcus species and Staphylococcus aureus.

Table 1: In Vitro Antibiotic Susceptibility Patterns Of Gram-Positive Organisms Isolated (%)

Organism	Pen	Amox	Amp	Tet	Levo	Line	Tige	Clinda	Vanco	Gent	Eryth	Cipro	Nitro	Teico	Cotri
E. faecalis	100	–	–	100	0	100	100	–	100	–	0	0	–	100	–
Enterococcus spp.	50	100	33.3	–	–	100	–	–	100	100	–	25	100	–	–
S. aureus	16.7	–	–	100	0	100	–	83.3	100	100	66.7	0	–	100	83.3

Pen=Penicillin, Amox=Amoxicillin, Amp=Ampicillin, Tet=Tetracycline, Levo=Levofloxacin, Line=Linezolid, Tige=Tigecycline, Clinda=Clindamycin, Vanco=Vancomycin, Gent=Gentamycin, Eryth=Erythromycin, Cipro=Ciprofloxacin, Nitro=Nitrofurantoin, Teico=Teicoplanin, Cotri=Cotrimoxazole; dash = data not available

Enterococcus faecalis was totally susceptible to Penicillin, Tetracycline, Linezolid, Tigecycline, Vancomycin and Teicoplanin yet completely resistant to Erythromycin and Ciprofloxacin. Other

Enterococcus species were entirely susceptible to Amoxicillin, Linezolid, Vancomycin, Gentamycin and Nitrofurantoin with less susceptibility to Penicillin (50 percent), Ampicillin (33.3 percent) and Ciprofloxacin (25 percent). Staphylococcus aureus showed strong resistance to Penicillin (16.7 percent sensitive) but complete susceptibility to Levofloxacin, Linezolid and Teicoplanin and high susceptibility to Vancomycin (83.3 percent) and Cotrimoxazole (83.3 percent). This isolate proved fully resistant to Nitrofurantoin and Ciprofloxacin.

3.2 Bacteria of the Gram Negative Category

The 15-antibiotic panel was tested against 11 species of Gram-negative bacteria and the results are reported in Table 2.

Table 2: In Vitro Antibiotic Susceptibility Profiles of Isolated Gram-Negative Microorganisms (% Susceptibility)

Organism	Amp	Pip/Tazo	Tet	Tige	Gent	Cipro	Nitro	Cotri	Cefo/Sulb	Mero	Imi	Amik	Cefep	Cefotax	Ceftaz
E. meningoseptica	–	0	–	–	0	0	–	100	100	0	0	0	0	–	0
E. coli	25	40	37.5	100	63.6	0	83.3	40	0	60	60	81.8	0	12.5	12.5
K. aerogenes	0	0	–	–	0	0	–	0	–	0	0	0	–	0	0
K. oxytoca	–	0	100	–	100	0	–	100	–	100	100	100	–	0	0
K. pneumoniae	0	27.3	66.7	100	40	40	0	27.3	50	60	60	50	66.7	20	37.5
M. morganii	0	0	0	–	100	0	0	100	–	0	0	–	–	0	0
P. mirabilis	0	75	0	0	50	66.7	0	50	–	66.7	66.7	75	100	75	75
P. aeruginosa	–	75	0	–	100	100	–	50	100	100	100	100	100	–	100
S. paucimobilis	–	0	–	–	0	0	–	0	0	0	100	0	–	–	0
S. maltophilia	–	–	–	–	–	–	–	100	–	–	–	–	–	–	–

Organism	Amp	Pip/Tazo	Tet	Tige	Gent	Cipro	Nitro	Cotri	Cefo/Sulb	Mero	Imi	Amik	Cefep	Cefotax	Ceftaz
GN bacilli	0	50	0	–	50	50	–	50	–	50	50	50	–	50	100

Amp=Ampicillin, Pip/Tazo=Piperacillin-Tazobactam, Tet=Tetracycline, Tige=Tigecycline, Gent=Gentamycin, Cipro=Ciprofloxacin, Nitro=Nitrofurantoin, Cotri=Cotrimoxazole, Cefo/Sulb=Cefoperazone-Sulbactam, Mero=Meropenem, Imi=Imipenem, Amik=Amikacin, Cefep=Cefepime, Cefotax=Cefotaxime, Ceftaz=Ceftazidime; dash = data not available

Elizabethkingia meningoseptica showed extensive resistance, being sensitive only to Cotrimoxazole and Cefoperazone-Sulbactam (both 100%). Escherichia coli was most susceptible to Tigecycline (100 percent), Nitrofurantoin (83.3 percent) and Amikacin (81.8 percent), but was very poorly susceptible to Ciprofloxacin, Cefepime and the third generation cephalosporins Cefotaxime and Ceftazidime (12.5 percent each), suggestive of extended-spectrum beta-lactamase production. Klebsiella aerogenes was pan-resistant in the whole panel. Klebsiella oxytoca remained very susceptible to Tetracycline, Gentamycin, Cotrimoxazole, the carbapenems and Amikacin (all 100 percent). Klebsiella pneumoniae demonstrated varied susceptibility with Tigecycline (100 percent) being the most active drug.

Morganella morganii was sensitive only to Gentamycin and Cotrimoxazole (100 percent). Proteus mirabilis had best sensitivity to Amikacin (100 percent) and good activity to Piperacillin-Tazobactam, Imipenem, Cefepime and Ceftazidime (75 percent each). Pseudomonas aeruginosa was very susceptible to most of the anti-pseudomonal drugs tested, including Gentamycin, Ciprofloxacin, Cefoperazone-Sulbactam, the carbapenems, Amikacin, Cefepime and Ceftazidime (all 100%). Imipenem (100 percent) was the sole drug to which Sphingomonas paucimobilis was susceptible. Stenotrophomonas maltophilia was tested exclusively against Cotrimoxazole and was 100 percent susceptible to this agent. The group of unspeciated Gram-negative bacilli showed the highest susceptibility to Ceftazidime (100 percent). Most other drugs examined had a consistent 50 percent susceptibility.

4. Discussion

The antibiogram obtained from this group of intensive care unit patients with infectious illnesses offers valuable institution-specific insights into local antimicrobial resistance trends, in addition to the biomarker-based findings of the parent study. It is reassuring to note that Vancomycin and Teicoplanin susceptibility was preserved among Gram-positive isolates. Vancomycin-resistant enterococci have not yet become an important problem at this institution. However, the complete resistance to Erythromycin and Ciprofloxacin indicates that these agents should be avoided for empirical enterococcal coverage. The low Penicillin susceptibility observed in Staphylococcus aureus is consistent with the well documented widespread production of penicillinase by this organism. The retained susceptibility to Linezolid, Vancomycin and Teicoplanin still offers reliable options for serious infections.

Gram-negative isolates are of particular clinical concern due to the pan-resistant profile of Klebsiella aerogenes and the very low susceptibility of Escherichia coli to third-generation cephalosporins and Ciprofloxacin. This is consistent with a high local burden of extended-spectrum beta-lactamase producing and fluoroquinolone-resistant Enterobacterales. The patterns observed suggest that the usual use of fluoroquinolones or third-generation cephalosporins alone for the empirical management of suspected Gram-negative sepsis in this intensive care unit is not appropriate. In contrast, the largely preserved

susceptibility of Pseudomonas aeruginosa to anti-pseudomonal agents, and the high susceptibility of Escherichia coli and Klebsiella pneumoniae to Tigecycline suggest that effective options are still available for many Gram-negative infections at this institution when chosen on the basis of culture and sensitivity data.

The distinct, almost uniform resistance profiles seen with less commonly encountered organisms such as Elizabethkingia meningoseptica, Sphingomonas paucimobilis and Stenotrophomonas maltophilia underline the significance of culture-guided, rather than purely empirical, therapy when these organisms are suspected or identified. Together, these data support the routine, continued generation of unit-specific antibiograms and their integration into antimicrobial stewardship initiatives, including prospective audit and feedback of antibiotic selection, restriction of broad-spectrum agents when narrower options are sufficient, and education of clinicians on locally prevalent resistance patterns.

As this was an analysis of a single intensive care unit over a defined six month period and was part of a study primarily designed to examine the neutrophil to lymphocyte ratio, the number of isolates for a number of organisms was small and susceptibility data was not available for each antibiotic-organism combination. These limitations should be taken into account when generalising the findings beyond this specific clinical environment. Periodic update of the antibiogram with greater numbers of isolates is recommended.

5. Conclusion

This antibiogram is obtained from infectious illnesses patients attending intensive care units at ESIC MC-PGIMSR and Model Hospital, Rajajinagar, Bengaluru. The antibiogram shows significant antimicrobial resistance in some of the regularly prescribed antibiotics among the Gram positive and Gram negative isolates. Glycopeptides and oxazolidinones continued to exhibit reliable efficacy against Gram-positive pathogens. Tigecycline and Amikacin showed a broad spectrum of effectiveness against Gram-negative isolates, while carbapenems maintained moderate to good activity overall. The almost pan-resistant profile of Klebsiella aerogenes and limited treatment options identified for Elizabethkingia meningoseptica highlight pathogens of special concern at this hospital. Regular surveillance of local susceptibility trends in conjunction with structured antimicrobial stewardship are recommended to enable appropriate empirical prescribing and retain the effectiveness of currently active medicines.

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References

1. 1World Health Organization. Global Action Plan On Antimicrobial Resistance. Geneva; 2015.
2. Performance Standards For Antimicrobial Susceptibility Testing. 33rd Ed. CLSI Supplement M100. Wayne, PA: CLSI; 2023.
3. Prestinaci F, Pezzotti P, Pantosti A. Antimicrobial Resistance: A Global Multifaceted Phenomenon. Pathog Glob Health. 2015;109:309–18.

4. Magiorakos A-P, Srinivasan A, Carey RB, Carmeli Y, Falagas ME, Giske CG, et al. Multidrug-resistant, extensively drug-resistant and pandrug-resistant bacteria: an international expert proposal for interim standard definitions for acquired resistance. Clin Microbiol Infect [Internet]. 2012;18(3):268–81. Available from: http://dx.doi.org/10.1111/j.1469-0691.2011.03570.x
5. Morrill HJ, Pogue JM, Kaye KS, LaPlante KL. Treatment options for carbapenem-resistant Enterobacteriaceae infections. Open Forum Infect Dis [Internet]. 2015;2(2):ofv050. Available from: http://dx.doi.org/10.1093/ofid/ofv050
6. Paul M, Carmeli Y, Durante-Mangoni E, Al E. Combination Antibiotic Therapy For The Treatment Of Infective Endocarditis Due To Enterococcus Faecalis. J Infect. 2012;69(3):211–23.
7. Sievert DM, Ricks P, Edwards JR, Schneider A, Patel J, Srinivasan A, et al. Antimicrobial-resistant pathogens associated with healthcare-associated infections: summary of data reported to the National Healthcare Safety Network at the Centers for Disease Control and Prevention, 2009-2010. Infect Control Hosp Epidemiol [Internet]. 2013;34(1):1–14. Available from: http://dx.doi.org/10.1086/668770
8. Tamma PD, Cosgrove SE, Maragakis LL. Combination therapy for treatment of infections with gram-negative bacteria. Clin Microbiol Rev [Internet]. 2012;25(3):450–70. Available from: http://dx.doi.org/10.1128/CMR.05041-11
9. Indian Council Of Medical Research. Treatment Guidelines For Antimicrobial Use In Common Syndromes. New Delhi: ICMR; 2019.
10. Laxminarayan R, Duse A, Wattal C, Al E. Antibiotic Resistance: The Need For Global Solutions. Lancet. 2013;382(9912):1057–98.