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MICROBIAL PROFILE OF LOWER RESPIRATORY TRACT INFECTIONS IN INTENSIVE CARE UNITS OF A TERTIARY CARE CENTRE, CENTRAL INDIA.

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ABSTRACT **Introduction:** Lower respiratory tract infections (LRTIs) are a leading cause of morbidity and mortality among patients in intensive care units. The consequences of increased drug resistance are far reaching since bacterial infection of the lower respiratory tract is a major cause of death from infectious disease. **Objective:** The study was conducted with the aim of determining the bacterial aetiology of LRTI in the intensive care unit (ICU) as well as to update the clinicians with the various antimicrobial alternatives available in the treatment of LRTI. **Materials And Methods:** Sputum, endotracheal and tracheostomy tube aspirate, pleural fluid of patients of LRT infections from medical and surgical ICUs were collected and processed by standard microbiological techniques. Routine antibiotic susceptibility with multi drug resistance were tested. **Results:** Total 430 patients were clinically suspected of LRTI, out of which significant pathogens were isolated from 187 (43. 48%). *Klebsiella pneumoniae* (33. 7%) was the most dominant pathogen followed by Acinetobacter baumannii(31. 6%). Alarmingly high percentage of extended spectrum beta-lactamase and methicillin resistant Staphylococcus aureus isolates were detected. The resistance to cephalosporins, aminoglycosides and carbapenem were remarkable. **Conclusions:** For the effective management of LRTI's, an ultimate and detailed bacteriological diagnosis and susceptible testing is required to overcome global problem of antibiotic resistance.

KEYWORDS : Intensive care units, lower respiratory tract infections, multidrug resistance

INTRODUCTION

Lower respiratory tract infections (LRTIs) are among the most prevalent bacterial infections affecting patients in intensive care units (ICUs), with an incidence ranging from 10% to 25%. These infections are associated with high mortality rates, which may reach up to 71%.[1] The growing burden of infection and the rise in antibiotic resistance have become major public health concerns globally. One of the most critical challenges is the increasing prevalence of antibiotic-resistant bacterial strains, particularly in hospital settings and increasingly within the community. Controlling these resistant infections often demands significant resources and investment. [2]

Several factors influence the incidence and outcomes of LRTIs, including patient demographics, healthcare infrastructure, the use of immunosuppressive therapies, inappropriate empirical antibiotic use, the types of causative organisms, and the local prevalence of antimicrobial resistance. Gram-negative bacilli (GNB), especially highly resistant strains, continue to pose a significant threat in hospitals, particularly in developing countries where infection control and isolation measures are often insufficient. [3] In these settings, acute respiratory infections remain a leading cause of morbidity and mortality in critically ill patients. Early initiation of antimicrobial therapy—often before culture results are available—is crucial for effective treatment. However, the increasing rate of antibiotic resistance in recent years has made empirical treatment more complex and less effective. [4]

Despite the high burden of LRTIs in ICUs, there remains a lack of comprehensive data on the bacterial pathogens involved and their resistance patterns, especially in our country. This study aims to address this gap by identifying the antimicrobial resistance profiles of microorganisms isolated from ICU-acquired respiratory infections, with the goal of informing the development of more effective, evidence-based antibiotic policies in collaboration with clinicians.

MATERIALS AND METHODS

The present study was conducted in the Microbiology Department of a Tertiary Care Hospital during Jan 2025 to July 2025. The LRT samples (sputum, endotracheal &tracheostomy tube aspirate, pleural fluid) were obtained from the patients revealing acute respiratory symptoms, admitted in the ICU of the same hospital. The samples were collected aseptically and processed immediately following collection.

Single or mixed growth (two or more than two isolates per specimen) isolated from all the eligible consecutive samples were identified by observing the colony characteristics on the blood agar, MacConkey agar plates and biochemical reactions using standard microbiological methods. [5,6]Isolates from repeat culture of previously recruited patients and isolates identified as commensals or contaminants were excluded. The bacterial isolates were subjected to susceptibility testing by standard Kirby Bauer disk diffusion methods. The susceptibility patterns of the bacterial pathogens were determined following the panel of antimicrobial agents as recommended by Clinical Laboratory Standard Institute (CLSI) -2024. [7]

RESULTS

During the study period, LRT specimens of 430 patients who were admitted in various ICU were evaluated ;187(43. 48%) were culture positive, whereas 243 (56. 52 %) specimens showed no growth.

A single pathogen was demonstrated in 169 (90. 37%) patients and 18 (9. 63%) had mixed bacterial etiology. A total of 187 isolates were recovered from 430 patients. Out of 187 bacterial pathogens recovered, 180 (96%) were Gram-negative and 7 (4 %) were Gram-positive bacteria. The most prevalent Gram-negative pathogen isolated was Klebsiella pneumoniae (34. 62%) followed by Acinetobacter baumannii (31. 86%) while the most prevalent Gram-positive pathogen was Staphylococcus aureus (n = 6; 3. 2%) followed by Enterococcus faecalis (n = 1; 0. 5%). (Table. 1)

Table. 1. Distribution Of Isolates From Various ICUs.

Organism	MICU	PICU	NICU	TICU	SICU	TOTAL	%
S .aureus	2	1	0	2	1	6	3.2
Enterococcus	1	0	0	0	0	1	0.5
K. pneumoniae	19	15	8	16	5	63	33.7
Acinetobacter baumaannii	22	10	6	18	3	59	31.6
P. aeruginosa	20	2	4	7	3	36	19.2
E.coli	8	5	2	0	1	16	8.6
Citrobacter spp.	1	2	0	2	0	5	2.7
Proteus spp.	0	0	0	0	1	1	0.5
Total	**73**	**35**	**20**	**45**	**14**	**187**	**100**

Respiratory infection caused by Staphylococcus aureus from surgical ICUs showed high resistance to Erythromycin and Levofloxacin while susceptible to Linezolid and Gentamicin. Enterococcus were highly resistant to Erythromycin and susceptible to Teicoplanin, Vancomycin,

Trimethoprim-sulphadiazine and Levofloxacin. (Chart. 1))

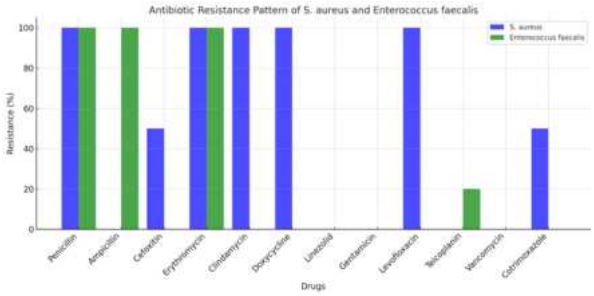


Chart. 1. Resistance pattern of Gram positive isolates(n=7)

Out of 85 isolates of Enterobacterales, highest resistance observed for Cefazolin, Cefuroxime, and Levofloxacin.

Meropenem and Piperacillin-tazobactam showed relatively lower resistance in medical ICU. (Table. 2)

Table. 2. Resistance Pattern Of Enterobacterales (n=85)

Drugs	K.pneumoniae (63)		E.coli (16)		Citrobacter (5)		Proteus (1)	
	Medical ICU	Surgical ICU	Medical ICU	Surgical ICU	Medical ICU	Surgical ICU	Medical ICU	Surgical ICU
Ampicillin	--	--	50	100	66	100	--	50
Cefazolin	62	70	72	100	62	100	--	50
Amoxicillin-clavulanate	72	86	73	100	66	100	--	50
Gentamicin	62	90	88	100	33	100	--	00
Tobramycin	82	100	83	100	66	100	--	50
Cefuroxime	76	100	90	100	66	100	--	50
Cefepime	47	83	43	00	66	100	--	00
Levofloxacin	77	96	83	100	66	100	--	50
Meropenem	61	90	57	100	66	100	--	00
Amikacin	97	100	100	100	33	100	--	50
Cefoxitin	72	86	80	100	66	100	--	00
Cefotaxime	60	100	73	00	66	100	--	50
Piperacillin-tazobactam	57	86	46	100	33	100	--	00

Acinetobacter spp. showed high resistance to Ampicillin-sulbactam, Ceftazidime, and Gentamicin. Minocycline and Piperacillin-tazobactam showed better effectiveness, but resistance patterns varied between medical and surgical ICUs.

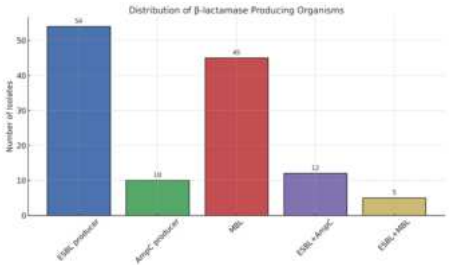
Among 36 isolates of Pseudomonas aeruginosa, high resistance was shown to Ceftazidime, Piperacillin-tazobactam, and Cefepime. Lower resistance was observed with Aminoglycosides.

SICU isolates tend to have higher resistance across most antibiotics compared to medical isolates, suggesting more extensive antibiotic use in SICUs. (Table. 3)

Table. 3. Resistance Pattern Of Non-fermenters (n=95)

Drugs	Acinetobacter (59)		Pseudomonas (36)	
	Medical ICU	Surgical ICU	Medical ICU	Surgical ICU
Ampicillin-sulbactum	78	86	--	--
Ceftazidime	69	61	63	86
Gentamicin	66	61	44	69
Tobramycin	61	59	41	69
Meropenem	67	61	54	78
Levofloxacin	55	59	57	69
Cefepime	68	61	52	86
Piperacillin-tazobactam	54	59	52	86
Amikacin	64	61	41	69
Aztreonam	--	--	44	69
Cefotaxime	45	25	--	--
Minocycline	57	54	--	--

Among 180 Gram-negative bacteria, 54 (30%) were extended spectrum beta-lactamase (ESBL) producers, 25% MBL producers and 5 % AmpC producers while out of six S. aureus, 3 (50%) methicillin resistant S. aureus (MRSA) isolates were recovered. (Chart 2)



DISCUSSION

The main objective of this study was to identify isolates from ICU patients suffering from lower respiratory tract infections and to determine the antimicrobial resistance pattern.

The present study showing Ventilator associated pneumonia(VAP) rate 12.78 (47confirmed cases/3675 device days). Ventilator associated respiratory infections continue to be a frequent and fatal complication in critically ill patients with mortality ranging from 40% to 80%. [8]

The study found Gram negative bacilli to be the predominant organisms (96%) compared to Gram positive organisms. These results were similar to those obtained by Wani et al. (2021) and Goel et al. (2009) who found that GNB isolated was 92.2% and 97.4% respectively. [9,1]

Among GNB, Klebsiella pneumoniae (33. 7%) was the most common isolate identical to the study made by quoted by Regha et al. (2018)was 31%. [10] There was an overall preponderance of GNB among the LRT infection isolates with Acinetobacter baumannii, P. aeruginosa as the common isolates as also confirmed from the studies made by Veena Kumari et al. (2007). [11]

Pneumonia is one of the most frequent complications among ICU patients and is often polymicrobial, predominantly caused by multi-drug resistant Gram-negative bacilli (GNB) such as Klebsiella pneumoniae, Acinetobacter baumannii, and Pseudomonas aeruginosa. In our study, the incidence of mixed bacterial infections was 9. 63%, which is consistent with other series where polymicrobial infections rarely exceed 30% (de Roux et al. , 2006). [12] The early identification of such infections is crucial for selecting appropriate treatment strategies and avoiding a false impression of extensively resistant strains.

Antibiotic resistance remains a major challenge in ICUs. The study observed a high rate of resistance to cephalosporins among various Gram-negative isolates, in concordance with the studies of Sofianou et al. (2000). [13]The high rates at our centre may be attributed to selective pressure from extensive use of third-generation cephalosporins, a trend documented in many ICUs worldwide.

Carbapenems, often regarded as the last line of defence against multidrug-resistant organisms, were also frequently used in our setting. Alarmingly, we noticed resistance of GNB to aminoglycosides, particularly higher resistance to gentamicin than to amikacin, which echoes findings from several hospitals (Aloush et al. , 2006). [14] This highlights the urgent need for prudent antibiotic use policies and antimicrobial stewardship, especially for aminoglycosides, where poor tissue penetration may foster resistant strains.

Among Gram-positive organisms, S. aureus remains a significant cause of nosocomial lung infections. In our study, MRSA accounted for 50% of infections, comparable to National Nosocomial Infections Surveillance (NNIS) data (52. 3%). [15] The rising proportion of ESBL producers (30%) and MRSA (50%) is particularly alarming and calls for stringent infection control measures.

In our study, among 180 Gram-negative bacterial isolates, 30% were extended-spectrum β-lactamase (ESBL) producers, 25% were metallo-β-lactamase (MBL) producers, and 5% were AmpC β-lactamase producers. These findings indicate a high prevalence of multidrug-resistant (MDR) Gram-negative pathogens in ICU settings, comparable to previous reports from tertiary care centres in India and globally (Pitout et al., 2008; Nordmann et al., 2011).[16,17] The predominance of ESBL-producing Enterobacterales, particularly

Klebsiella pneumoniae and Escherichia coli, has been consistently reported in ICU patients and is associated with increased morbidity, mortality, and prolonged hospital stays (Kumar et al. , 2017). [18] The MBL production rate (25%) in our study is concerning, as MBLs confer resistance to carbapenems often considered the last-line therapy for severe infections and have been linked to outbreaks in critical care settings (Rodríguez-Baño et al. , 2018). [19]

In conclusion, multidrug-resistant K. pneumoniae, A. baumannii, and P. aeruginosa are the most common etiological agents of lower respiratory tract infections (LRTIs) in ICU settings. We report an alarmingly high rate of resistance to cephalosporins, beta-lactam/beta-lactamase inhibitors, and carbapenems. Increasing resistance among respiratory pathogens has complicated the use of empirical treatments with traditional agents (Weinstein et al., 2016). [20] Therefore, a definitive bacteriological diagnosis and susceptibility testing are indispensable for the effective management of LRTIs (Magill et al. , 2018). [21]

It is well established that critically ill and elderly patients are at greater risk of contracting GNB-LRT infections. Ongoing antimicrobial resistance surveillance in ICUs is essential to optimize therapy and guide empirical treatment, especially in high-consumption settings.

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REFERENCES :

1. Goel N, Chaudhary U, Aggarwal R, Bala K. Antibiotic sensitivity pattern of gram negative bacilli isolated from the lower respiratory tract of ventilated patients in the intensive care unit. Indian J Crit Care Med. 2009;13:148–51. doi: 10. 4103/0972-5229. 58540.
2. Ayliffe GA, Fraise AP, Geddes AM, Mitchell K. 4th ed. London: Arnold; 2000. Control of Hospital Infection: A Practical Handbook; pp. 1–10.
3. Navaneeth BV, Belwadi MR. Antibiotic resistance among gram-negative bacteria of lower respiratory tract secretions in hospitalized patients. Indian J Chest Dis Allied Sci. 2002;44:173–6.
4. Pfaller MA, Korten V, Jones RN, Doern GV. Multicenter evaluation of the antimicrobial activity for seven broad-spectrum beta-lactams in Turkey using the Etest method. Turkish antimicrobial resistance study group. Diagn Microbiol Infect Dis. 1999;35:65–73. doi: 10. 1016/s0732-8893(99)00054-1
5. Koneman's, Gary W. Procop, Deivdre L. Church, Geraldine S. Hall, William M-janda, Elmec W. Koneman, Paul C. Schreckenberg, Gail L. Woods, colour ATLAS and Text book of Diagnostic Microbiology, 7th ed. Wolters Kluwer 2016, PP 60-62.
6. J. G. Collee, R. S. Miles, B. Watt, Tests For the identification of bacteria in J. G. Collee, R. S. Miles, B. Watt, A. Mackie and McCartney Practical Medical Microbiology, 14th edition, Edinburgh: Churchill 2006, 131-149.
7. CLSI. Performance Standards for Antimicrobial Susceptibility Testing. 34th ed. CLSI supplement M100. Clinical and Laboratory Standards Institute; 2024.
8. Rahimibashar F, Miller AC, Yaghoobi MH, Vahedian-Azimi A. A comparison of diagnostic algorithms and clinical parameters to diagnose ventilator-associated pneumonia: a prospective observational study. BMC Pulmonary Medicine. 2021 May 13;21(1):161
9. Wani FA, Bandy A, Alenzi MJ, Alzarea AI, Alanazi AS, Sayeed MU, Thirunavukkarasu A, Tantry B, Dar M. Resistance patterns of gram-negative bacteria recovered from clinical specimens of intensive care patients. Microorganisms. 2021 Oct 28;9(11):2246.
10. Regha I, Sulekha BJ. Bacteriological profile and antibiotic susceptibility patterns of lower respiratory tract infections in a tertiary care hospital, Central Kerala. Int J Med Microbiol Trop Dis. 2018 Oct;4(4):186-90.
11. Kumari HV, Nagarathna S, Chandramuki A. Antimicrobial resistance pattern among aerobic gram-negative bacilli of lower respiratory tract specimens of intensive care unit patients in a neurocentre.
12. De Roux A, Ewig S, Garcia E, Marcos MA, Mensa J, Lode H, Torres A. Mixed community-acquired pneumonia in hospitalised patients. European Respiratory Journal. 2006 Apr 1;27(4):795-800.
13. Sofianou DC, Constandinidis TC, Yannacou M, Anastasiou H, Sofianos E. Analysis of risk factors for ventilator-associated pneumonia in a multidisciplinary intensive care unit. European Journal of Clinical Microbiology and Infectious Diseases. 2000 Jul;19(6):460-3.
14. Gonlugur U, Bakici MZ, Ozdemir L, Akkurt I, Icagasioglu S, Gultekin F. Retrospective analysis of antibiotic susceptibility patterns of respiratory isolates of Pseudomonas aeruginosa in a Turkish University Hospital. Annals of Clinical Microbiology and Antimicrobials. 2003 Mar 7;2(1):5.
15. Centers for Disease Control and Prevention. National Nosocomial Infections Surveillance (NNIS) System report, data summary from January 1990-May 1999. Am J Infect Control. 1999;27:520-32.
16. Pitout JD, Laupland KB. Extended-spectrum β-lactamase-producing Enterobacteriaceae: An emerging public-health concern. Lancet Infect Dis. 2008;8 (3):159–66.
17. Nordmann P, Naas T, Poirel L. Global spread of carbapenemase-producing Enterobacteriaceae. Emerg Infect Dis. 2011;17(10):1791–8.
18. Kumar P. Bacteriological profile and antibiotic sensitivity pattern of hospital-acquired septicemia in a tertiary care hospital in North East India. Asian J Pharm Clin Res. 2017;10(11):1–4.
19. Rodríguez-Baño J, Gutiérrez-Gutiérrez B, Machuca I, Pascual A. Treatment of infections caused by multidrug-resistant Gram-negative bacteria. Lancet Infect Dis. 2018;18(11):e133–46.
20. Weinstein MP, Patel JB, Campeau S, Eliopoulos GM, Galas M, Humphries R, et al. M100 Performance standards for antimicrobial susceptibility testing. Clin Lab Standards Institute. 2016;36(3):1–256.
21. Magill SS, O'Leary E, Janelle SJ, Thompson DL, Dumyati G, Nadle J, et al. Changes in prevalence of health care–associated infections in U. S. hospitals. N Engl J Med. 2018;379(18):1732–44