RESEARCH PAPER

Microbiological Profile and Antibiotic Sensitivity Pattern of Lower Respiratory Tract Infections in a Tertiary Care Teaching Hospital of Western Maharashtra

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ABSTRACT

Introduction: Lower respiratory tract infections (LRTIs) are among the leading causes of morbidity and mortality worldwide, particularly among elderly, hospitalized, and critically ill patients. Increasing antimicrobial resistance among respiratory pathogens has emerged as a major challenge in the effective management of these infections. The present study was conducted to evaluate the microbiological profile and antibiotic sensitivity pattern of organisms isolated from patients with respiratory infections in a tertiary care teaching hospital.

Materials and Methods: A hospital-based observational cross-sectional study was conducted in the Departments of Pharmacology and Microbiology of a tertiary care teaching hospital in Maharashtra, India, over 24 months. A total of 596 patients with respiratory infections were included. Clinical samples were processed using standard microbiological methods, and antibiotic susceptibility testing was performed by the Kirby–Bauer disc diffusion method according to CLSI guidelines. Data were analyzed using SPSS software and Chi-square test.

Results: Patients aged >60 years constituted the largest age group (39.6%), and males slightly outnumbered females (51.5%). General Medicine accounted for the highest proportion of cases (52.5%). Non-sterile samples predominated (87.6%), while blood and sputum were the most common clinical specimens processed. Microbiological analysis revealed predominance of Gram-negative organisms, particularly Pseudomonas spp. (90), Escherichia coli (82), Klebsiella spp. (66), and Acinetobacter spp. (48). Among Gram-positive isolates, CoNS and Staphylococcus aureus were commonly isolated. Gram-negative organisms demonstrated high sensitivity to carbapenems, piperacillin–tazobactam, cefoperazone–sulbactam, and colistin, whereas Gram-positive organisms showed high sensitivity to vancomycin, linezolid, and teicoplanin. Most comparisons in the study were found to be statistically significant ($p < 0.001$).

Conclusions: The study demonstrated a predominance of Gram-negative bacterial pathogens in lower respiratory tract infections, particularly among elderly and hospitalized patients. Carbapenems and colistin retained good efficacy against Gram-negative isolates, while vancomycin and linezolid remained effective against Gram-positive organisms. Continuous microbiological surveillance, regular antibiogram monitoring, rational antibiotic prescribing, and antimicrobial stewardship

programs are essential for effective management of respiratory infections and prevention of antimicrobial resistance.

Keywords: Lower respiratory tract infections; Antimicrobial resistance; Antibiotic sensitivity; Gram-negative bacteria; Respiratory pathogens.

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Introduction

Lower respiratory tract infections (LRTIs) remain one of the leading causes of morbidity and mortality worldwide, particularly among elderly individuals, immunocompromised patients, and critically ill hospitalized patients. LRTIs include pneumonia, bronchitis, bronchiolitis, and other infections involving the lower respiratory tract and lung parenchyma. Despite advances in antimicrobial therapy and supportive care, respiratory infections continue to impose a substantial burden on healthcare systems globally. (1,2)

The increasing prevalence of antimicrobial resistance among respiratory pathogens has become a major public health concern in recent years. Inappropriate antibiotic use, prolonged hospitalization, invasive procedures, intensive care unit admissions, and widespread empirical therapy have contributed significantly to the emergence of multidrug-resistant organisms. Gram-negative bacteria such as Pseudomonas spp., Klebsiella spp., and Acinetobacter spp. are increasingly implicated in hospital-acquired respiratory infections and ventilator-associated pneumonia. (3,4)

Several studies conducted in tertiary care hospitals have reported a predominance of Gram-negative organisms in lower respiratory tract infections, especially among critically ill and elderly patients. These pathogens are frequently associated with increased disease severity, prolonged hospital stay, treatment failure, and higher mortality rates. Gram-positive organisms including Staphylococcus aureus, coagulase-negative staphylococci (CoNS), and Streptococcus spp. also contribute significantly to respiratory tract infections. (5,6)

The emergence of multidrug-resistant respiratory pathogens has complicated empirical antibiotic therapy and necessitated regular surveillance of local microbiological patterns and antibiotic susceptibility profiles. Periodic antibiogram analysis plays an important role in guiding clinicians for rational antibiotic selection, reducing unnecessary antimicrobial use, and implementing effective antimicrobial stewardship programs. (7,8)

Knowledge of institution-specific microbial profiles and antimicrobial susceptibility patterns is essential for early diagnosis, appropriate treatment, and prevention of complications associated with respiratory infections. Monitoring the distribution of respiratory pathogens and their resistance trends also assists in formulating hospital antibiotic policies and infection control strategies. (9,10)

Therefore, the present study was undertaken to evaluate the microbiological profile and antibiotic sensitivity pattern of organisms isolated from patients with lower respiratory tract infections in a tertiary care teaching hospital.

Materials and Methods

Study Design and Setting

A hospital-based observational cross-sectional study was conducted in the Department of Pharmacology and Microbiology of a tertiary care teaching hospital in Maharashtra, India.The study was carried out in collaboration with the Departments of General Medicine, General Surgery, Intensive Care Units (ICUs), and other clinical specialties.

Study Duration

The study was conducted over a period of 24 months from _to _.

Study Population

The study included patients clinically diagnosed with respiratory tract infections and admitted to various departments of the hospital during the study period.

Sample Size

A total of 596 patients with respiratory illness were included in the study.

Inclusion Criteria

- Patients of all age groups and both genders clinically suspected or diagnosed with lower respiratory tract infections.
- Patients whose respiratory or related clinical samples were sent for microbiological culture and sensitivity testing.
- Hospitalized patients from General Medicine, Surgery, ICUs, and other departments.

Exclusion Criteria

- Inadequately collected, leaking, or contaminated samples.
- Duplicate samples from the same patient.
- Patients receiving prolonged antibiotic therapy prior to sample collection.
- Samples with incomplete demographic or clinical details.

Data Collection

Demographic details including age, gender, department of admission, type of clinical sample, microbiological findings, and antibiotic susceptibility reports were collected from microbiology laboratory records and hospital case files using a structured data collection form.

Sample Collection and Processing

Clinical specimens including blood, sputum, urine, pus, and miscellaneous respiratory-related samples were collected under strict aseptic precautions and transported immediately to the microbiology laboratory for processing.
Blood samples were processed using standard blood culture techniques. Sputum samples were assessed for adequacy and cultured on appropriate bacteriological media. Urine, pus, and other specimens were processed according to standard microbiological procedures.

The collected samples were inoculated onto Blood agar and MacConkey agar and incubated aerobically at 37°C for 18–24 hours. Organisms were identified based on colony morphology, Gram staining characteristics, and standard biochemical tests. (11,12)

Antibiotic Susceptibility Testing

Antimicrobial susceptibility testing was performed using the Kirby–Bauer disc diffusion method on Mueller–Hinton agar according to Clinical and Laboratory Standards Institute (CLSI) guidelines. Antibiotics tested included carbapenems, piperacillin–tazobactam, cefoperazone–sulbactam, aminoglycosides, fluoroquinolones, glycopeptides, oxazolidinones, tetracyclines, and colistin depending on the organism isolated. Results were interpreted as sensitive or resistant according to CLSI criteria. (13)

Statistical Analysis

Data were entered into Microsoft Excel and analyzed using Statistical Package for the Social Sciences (SPSS) software. Categorical variables were expressed as frequencies and percentages. The Chi-square test was applied to determine statistical significance between categorical variables. A p-value <0.05 was considered statistically significant.

Ethical Considerations

The study was conducted after obtaining approval from the Institutional Ethics Committee of the tertiary care teaching hospital. Patient confidentiality and anonymity were strictly maintained throughout the study.

RESULTS

Table 1: Age-wise Distribution of Patients with Respiratory Infections (n = 596)

Age Group (years)	Frequency (n)	Percentage (%)
≤ 40	199	33.4
41–60	161	27.0
> 60	236	39.6

Table 1 shows that Patients aged >60 years constituted the largest group (236; 39.6%), followed by those ≤40 years (199; 33.4%), while the 41–60 years age group accounted for 161 patients (27.0%). The age-wise distribution of patients with Respiratory infections demonstrated a statistically significant variation across the different age groups. The Chi-square test revealed a **p-value < 0.001**, indicating that the observed distribution is not due to chance and is highly significant.

Fig 1: Gender Distribution of Patients with Respiratory Infections (n = 596)

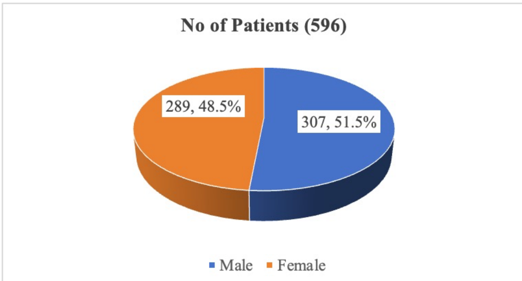

Fig 1 shows that the gender-wise distribution showed that males (51.5%) slightly outnumbered females (48.5%) among patients with infective illnesses.

Fig 2 Department-wise Distribution of Patients with Respiratory Infections (n = 596)

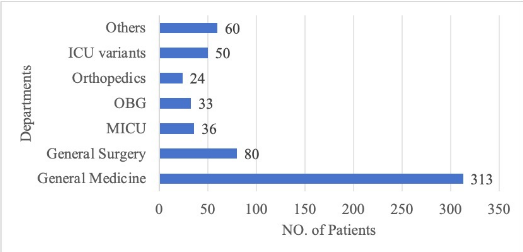

Fig 2 shows that the department-wise distribution revealed that General Medicine accounted for the highest proportion of cases (52.5%), followed by General Surgery (13.4%) and ICU-related admissions (~14 %).

Fig 3 Distribution of Clinical Samples in Respiratory Infections Based on Sterility

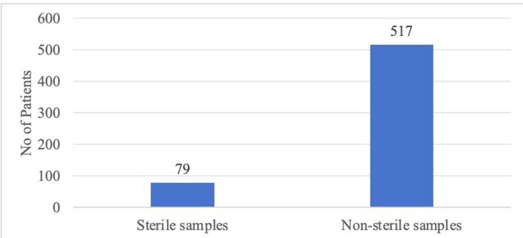

Fig 3 shows that the Non-sterile samples predominated (87.6%) compared to sterile samples (13.3%). The difference was statistically highly significant **(p < 0.001).**

Table 2 Organism Distribution: Sample-wise in Respiratory Infections

Organism	Blood (n =390)	Urine (n =80)	Pus (n = 40)	Sputum (n=49)	Miscellaneous (n=37)
Pseudomonas spp.	74	6	4	16	5
Escherichia coli	62	18	3	4	2
CoNS	68	2	1	10	4
Staphylococcus aureus	40	3	7	8	2
Klebsiella spp.	48	10	4	14	3
Acinetobacter spp.	34	4	3	10	4
Enterococcus spp.	20	10	1	3	2
Streptococcus spp.	12	2	1	6	2
Streptococcus pneumoniae	4	–	–	5	–
Enterobacter spp.	10	2	1	3	1
Burkholderia cepacia	4	–	–	5	2
Serratia spp.	5	–	–	4	1
Brevundimonas Diminuta	5	–	–	3	1
Citrobacter spp.	3	2	1	–	–
Proteus mirabilis	2	1	–	–	–
Providencia spp.	–	1	–	–	–
Candida spp.	–	5	1	4	1
Non-albicans Candid	2	3	–	3	1

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Trichosporon asahii	2	–	–	3	1
Stenotrophomonas maltophilia	1	–	–	3	–
Sphingomonas paucimobilis	1	–	–	1	–
Gram-positive others	–	–	–	4	–

Table 2 Shows that the Organism distribution showed that Pseudomonas spp., CoNS, Escherichia coli, and Klebsiella spp. were the predominant isolates among respiratory illness samples. Sputum samples commonly yielded respiratory pathogens such as Pseudomonas spp., Klebsiella spp., and Acinetobacter spp., indicating their important role in lower respiratory tract infections.

Table 3 Distribution of Microorganisms Isolated from Lower Respiratory Tract Infection (LRTI) Samples

Organism	LRTI (n)
CoNS	85
Escherichia coli	82
Pseudomonas spp.	90
Pseudomonas aeruginosa	–
Klebsiella spp.	66
Klebsiella pneumoniae	–
Acinetobacter spp.	48
Staphylococcus aureus	54
Enterococcus spp.	36
Streptococcus spp.	23
Streptococcus pneumoniae	–
Enterobacter spp.	18
Citrobacter spp.	–
Proteus mirabilis	–
Proteus vulgaris	–
Burkholderia cepacian	17
Serratia spp.	17
Brevundimonas diminuta	18
Candida spp.	16
Candida albicans	–
Non-albicans Candida	15
Trichosporon asahii	14
Stenotrophomonas maltophilia	–
Sphingomonas paucimobilis	–
Ewingella americana	–
Pseudomonas alcaligenes	–
Staphylococcus spp. (unspecified)	–
Myroides spp.	–
Providencia spp.	–
Alcaligenes faecalis	–
Salmonella spp.	–
Vibrio cholerae	–
Salmonella typhi	–

Table 3 shows that the distribution of microorganisms isolated from LRTI samples was predominantly represented by Pseudomonas spp. (90), CoNS (85), and Escherichia coli (82), followed by Klebsiella spp. and Staphylococcus aureus. The findings indicate a predominance of Gram-negative bacterial pathogens in respiratory tract infections, particularly among hospitalized and critically ill patients.

Table 4 Respiratory Infections-Antibiotic sensitivity pattern

Antibiotic	Klebsiella spp. S/R (%)	E. coli S/R (%)	Pseudomonas spp. S/R (%)	Acinetobacter spp. S/R (%)	Staphylococcus aureus S/R (%)	CoNS S/R (%)	Enterococcus spp. S/R (%)	Streptococcus spp. S/R (%)	Burkholderia cepacia S/R (%)
Imipenem/Meropenem	94/6	92/8	91/9	60/40	NA	NA	NA	NA	NA
Piperacillin–Tazobactam	85/15	88/12	87/13	55/45	NA	NA	NA	NA	NA
Cefoperazone–Sulbactam	82/18	85/15	80/20	65/35	NA	NA	NA	NA	NA
Amikacin	78/22	80/20	82/18	50/50	NA	NA	NA	NA	NA
Cefepime	65/35	70/30	71/29	45/55	NA	NA	NA	NA	NA
Ceftazidime	60/40	65/35	75/25	40/60	NA	NA	NA	NA	NA
Ciprofloxacin	59/41	55/45	63/37	30/70	NA	NA	NA	NA	NA
Cotri	45/	40	20/	25/7	NA	NA	NA	NA	30/

moxazole	55	/60	80	5					70
Tigecycline	75 / 25	78 / 22	NA	70 / 30	NA	NA	NA	NA	NA
Colistin	90 / 10	92 / 8	88 / 12	80 / 20	NA	NA	NA	NA	NA
Vancomycin	NA	NA	NA	NA	94 / 6	92 / 8	95 / 5	NA	NA
Linezolid	NA	NA	NA	NA	95 / 5	94 / 6	96 / 4	90 / 10	NA
Teicoplanin	NA	NA	NA	NA	93 / 7	91 / 9	94 / 6	NA	NA
Clindamycin	NA	NA	NA	NA	65 / 35	60 / 40	NA	NA	NA
Erythromycin	NA	NA	NA	NA	54 / 46	50 / 50	NA	NA	NA
Doxycycline	NA	NA	NA	NA	72 / 28	70 / 30	NA	85 / 15	NA
Minocycline	NA	NA	NA	NA	NA	NA	NA	NA	80 / 20

Table 4 shows the antibiotic sensitivity pattern of organisms isolated from respiratory infections. Among Gram-negative isolates, Klebsiella spp., Escherichia coli, and Pseudomonas spp. demonstrated high sensitivity to carbapenems (Imipenem/Meropenem: 94%, 92%, and 91% respectively), followed by piperacillin–tazobactam and cefoperazone–sulbactam. Moderate sensitivity was observed with amikacin, cefepime, and ceftazidime, whereas lower sensitivity was noted with ciprofloxacin and cotrimoxazole, particularly in Pseudomonas spp.. Acinetobacter spp. showed comparatively lower susceptibility to most antibiotics but retained higher sensitivity to colistin (80%). Among Gram-positive isolates, Staphylococcus aureus, CoNS, and Enterococcus spp. exhibited high susceptibility to vancomycin, linezolid, and teicoplanin. Moderate susceptibility was observed with doxycycline and clindamycin, while erythromycin showed comparatively lower activity.

Burkholderia cepacia demonstrated good sensitivity to minocycline (80%).

Discussion

Lower respiratory tract infections (LRTIs) continue to be a major cause of morbidity and hospitalization worldwide, particularly among elderly and critically ill patients. The present study evaluated the microbiological profile and antibiotic sensitivity pattern of respiratory pathogens isolated from patients admitted to a tertiary care teaching hospital.

In the present study, patients aged >60 years constituted the largest group (39.6%), indicating increased susceptibility of elderly individuals to respiratory infections. Advanced age is associated with reduced immunity, multiple comorbidities, impaired mucociliary clearance, and frequent hospital admissions, which increase the risk of respiratory tract infections. Similar findings were reported by Koul et al. and Joseph et al., who observed a higher prevalence of LRTIs among elderly hospitalized patients. (4,5)

Male predominance was observed in the present study, with males accounting for 51.5% of cases. Similar findings have been reported in previous studies where respiratory infections were more common among males due to higher exposure to smoking, occupational hazards, environmental pollution, and associated comorbidities. (14,15) However, the gender difference in the present study was not statistically significant.

Department-wise distribution revealed that the majority of cases belonged to the General Medicine department followed by ICU-related admissions. This finding is consistent with previous tertiary care hospital studies which reported higher rates of respiratory infections among medicine ward and ICU patients because of prolonged hospitalization, invasive procedures, mechanical ventilation, and underlying chronic illnesses. (9,10)

The present study demonstrated predominance of non-sterile clinical samples (87.6%), with blood and sputum being the most commonly processed specimens. Similar observations were reported in studies conducted by Golia et al. and Chawla et al., where sputum and blood cultures constituted the major samples evaluated for respiratory infections. (6,16)

Microbiological analysis in the present study showed predominance of Gram-negative organisms, particularly Pseudomonas spp., Escherichia coli, Klebsiella spp., and Acinetobacter spp.. These findings are comparable with studies conducted in tertiary care and ICU settings where Gram-negative bacilli were identified as the major etiological agents of lower respiratory tract infections. (4,9,17)

Pseudomonas spp. was the most common isolate in the present study. Similar findings were reported by Joseph et al. and Golia et al., who observed increased isolation of Pseudomonas spp. among hospitalized and mechanically ventilated patients. (4,6)

The high prevalence of Klebsiella spp. and Acinetobacter spp. observed in the present study is also consistent with previous Indian studies on hospital-acquired respiratory infections. (10,18) The present study also demonstrated the presence of

Gram-positive organisms such as Staphylococcus aureus, CoNS, and Streptococcus spp.. Similar findings have been reported in earlier studies where these organisms contributed significantly to respiratory tract infections, particularly among immunocompromised and ICU patients. (15,16)

Antibiotic susceptibility analysis revealed that Gram-negative isolates showed high sensitivity to carbapenems, piperacillin–tazobactam, cefoperazone–sulbactam, and colistin. Comparable susceptibility patterns have been reported in several Indian studies evaluating respiratory pathogens in tertiary care hospitals. (17,19) However, reduced susceptibility of Acinetobacter spp. to multiple antibiotics observed in the present study reflects the increasing burden of multidrug-resistant organisms in hospital settings.

Among Gram-positive isolates, high sensitivity to vancomycin, linezolid, and teicoplanin was observed, which is consistent with previous studies reporting preserved efficacy of these agents against resistant Gram-positive pathogens. (7,8) Moderate resistance to erythromycin and clindamycin observed in the present study is also comparable with earlier reports indicating increasing resistance among staphylococcal isolates.

The findings of the present study emphasize the importance of continuous microbiological surveillance, institution-specific antibiograms, rational antibiotic prescribing, and implementation of antimicrobial stewardship programs to reduce the emergence of antimicrobial resistance.

Conclusion

The present study demonstrated that lower respiratory tract infections were more common among elderly and hospitalized patients, with a predominance of cases in the General Medicine and ICU settings. Gram-negative organisms, particularly Pseudomonas spp., Escherichia coli, Klebsiella spp., and Acinetobacter spp., were the major pathogens isolated from respiratory samples, indicating their important role in hospital-associated respiratory infections.

Among Gram-negative isolates, carbapenems, piperacillin–tazobactam, cefoperazone–sulbactam, and colistin showed good antimicrobial activity, whereas Gram-positive organisms demonstrated high susceptibility to vancomycin, linezolid, and teicoplanin. However, reduced susceptibility among certain isolates, especially Acinetobacter spp., highlights the growing concern of antimicrobial resistance.

The study emphasizes the importance of early microbiological diagnosis, periodic surveillance of local antibiogram patterns, rational antibiotic use, and implementation of antimicrobial stewardship programs for effective management of lower respiratory tract infections and prevention of multidrug-resistant organisms.

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