ORIGINAL ARTICLE

Respiratory tract infection: Current pattern of pathogens involved and related antibiotic resistance observed at a tertiary health care institute of Rajasthan

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CITATION
Mathur N, Verma YN, Mathur M. Respiratory tract infection: Current pattern of pathogens involved and related antibiotic resistance observed at a tertiary health care institute of Rajasthan. Indian J Comm Health. 2025;37(1):114-118. https://doi.org/10.47203/IJCH.2025.v37i01.019

ARTICLE CYCLE
Received: 02/09/2024; Accepted: 14/02/2025; Published: 28/02/2025

Abstract

Background: Antibiotic resistance is one of the contributing factors responsible for increased morbidity and mortality. **Objectives:** The study was designed to assess the current pattern of involved pathogens in respiratory tract infections with relevant antibiotic sensitivity and resistance to improve patient outcomes. **Methodology**: The study was conducted for 6 months and positive cultured sample reports of respiratory secretions in the form of sputum, tracheal secretion, bronchial aspirate, and pus were included in the study. Pathogens involved and antibiotic sensitivity, resistance were observed for respiratory secretion and pus separately. **Results**: A total 129 samples including 83 respiratory secretion samples and 46 pus samples cultures were found positive for organisms and included in the study. Among respiratory secretion cultures, Pseudomonas were most common organism (60%) followed by E. Coli, Klebsiella, Acinetobacter, Staphylococcus aureus, Citrobector, and Candida. Among pus cultures, Staphylococcus was the most common organism (23.90%) followed by E.Coli, Klebsiella, Pseudomonas, Citrobactor, Coagulase negative staphylococcus, Proteus. These pathogens were resistant to many first-line antibiotics. **Conclusion**: Antibiotic resistance to first-line antibiotics has emerged as alarming situation and contributes to morbidity and mortality. The current pattern of involved pathogen and antibiogram may help to decide appropriate empirical treatment.

Keywords

Antibiotic; Culture; Infection; Resistance; Respiratory; Sensitivity

Introduction

Respiratory infection is a common entity and it may complicate into dreadful complications such as septicemia, acute respiratory distress syndrome, septicemic shock thus contributing significantly to overall morbidity and mortality. Antibiotics are the biggest tool to overcome infections and related complications. Currently, antibiotic resistance is an alarming situation. The O'Neill Report by the United Kingdom government estimated that deaths because of antimicrobial resistance could rise from approximately 700,000 deaths a year to close to 10 million deaths per year by 2050.(1) It is important to know commonly involved pathogens and current antibiotic sensitivity patterns to treat respiratory infections. It is especially useful in post COVID 19 era, as previously damaged lungs by COVID19 are predisposed to pulmonary infections. Secondary respiratory infections in the already compromised lung may have high impact on morbidity and mortality. Knowledge of current patterns of pathogens involved in respiratory infection and

antibiotic sensitivity patterns may help greatly in treating infections, avoiding complications, and reducing mortality as well as in making antibiotic policy at departmental, institutional, or regional level.

Objectives: This study was conducted to assess the current pattern of involved pathogens in respiratory tract infections with relevant antibiotic sensitivity and resistance to improve patient outcomes.

Material & Methods

Study types and design: The current study was a retrograde observational study. **Study setting**: The study was conducted at the general medicine department of a tertiary healthcare institute in Rajasthan. The study was conducted by observation of previous culture and sensitivity reports sent to microbiology lab, no patient is directly involved. **Study duration:** The study was conducted for 6 months (July to December 2023) after ethical clearance. Culture and sensitivity reports of respiratory secretions in the form of sputum, tracheal secretion, bronchial aspirate, and pus were reviewed which were sent within previous 6 month duration. **Study sample:** Only positively cultured sample reports of respiratory secretions and pus samples were included in the study. **Inclusion and exclusion criteria:** Positive samples of respiratory secretions in the form of sputum, tracheal secretion, bronchial aspirate and pus were included. Negative culture samples were excluded. **Data collection:** Pathogens involved and antibiotic sensitivity, resistance for commonly involved pathogens were observed. **Data analysis:** Statistical analysis was done in the form of descriptive statistics as percentages and tabulations.

Results

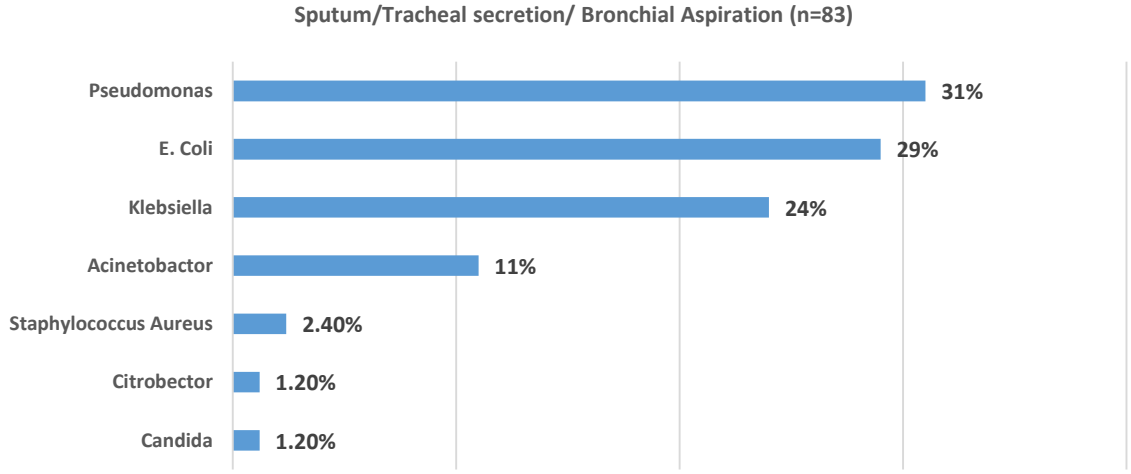
Total of 129 positive cultures and sensitivity reports were observed including 83 samples of respiratory secretions in the form of sputum, tracheal secretion, bronchial aspirate, and 46 samples of pus (Table 1).

Table 1. Showing distribution of samples included in the study.

Type of positive cultured Samples	Sample size
Sputum, tracheal secretion, bronchial aspirate	83
Pus	46
Total	129

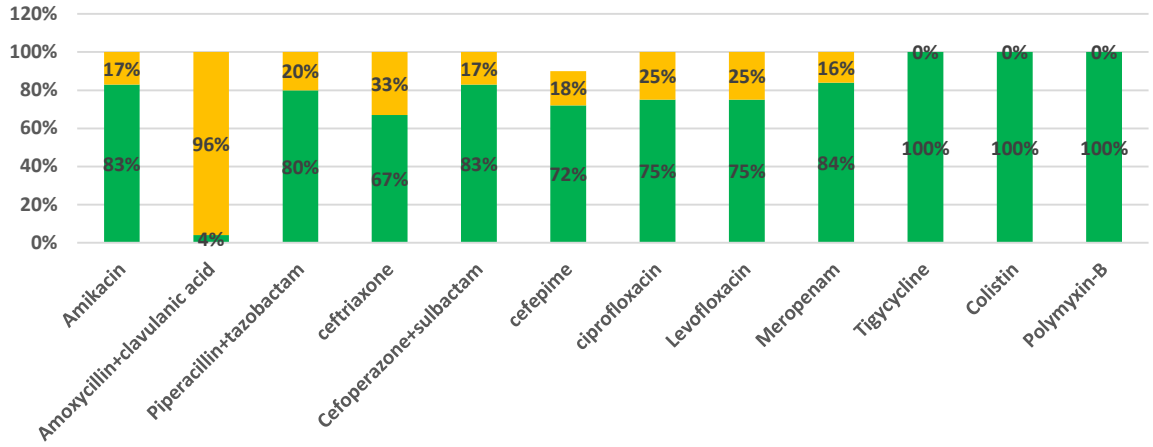
Among 83 respiratory secretion samples, Pseudomonas was the most common organism (31%) followed by E.Coli (29%), Klebsiella (24%), Acinetobacter (11%), Staphylococcus aureus (2.4%), Citrobactor (1.2%), Candida (1.2%). (Figure 1)

Figure 1. Distribution of organisms found in positive respiratory secretion culture and sensitivity report.



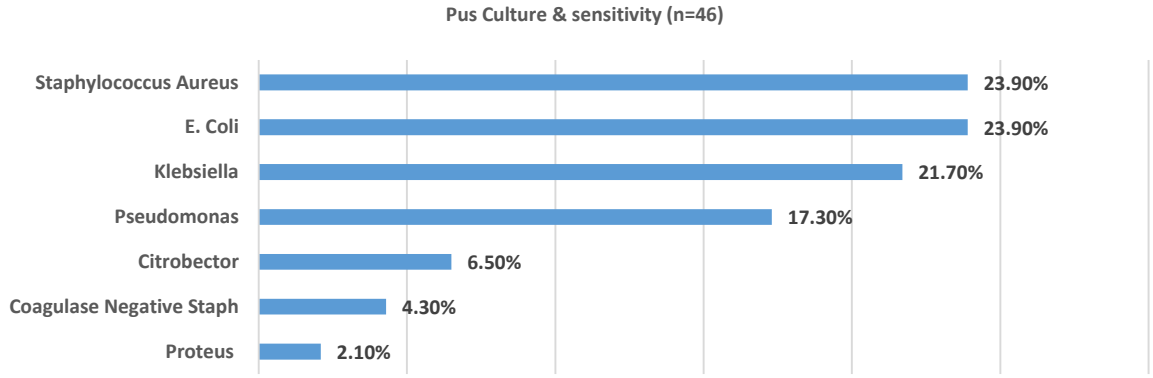
Antibiotic sensitivity and resistance were observed for Pseudomonas, as it was the most common organism found in the culture of respiratory secretions. Pseudomonas was found resistant to many known first-line antibiotics like - piperacillin + tazobactam resistance was found in 20% samples, meropenam resistance was in16% samples, amikacin resistance in 17% samples, ciprofloxacin and levofloxacin resistance in 25% samples, cefepime resistance in 18% samples. Maximum 100 % sensitivity was found to colistin and polymyxin B. Interestingly one sample was also tested for tigecycline and found sensitive to it. (Figure 2)

Figure 2. Showing distribution of antibiotic sensitivity and resistance in pseudomonas.



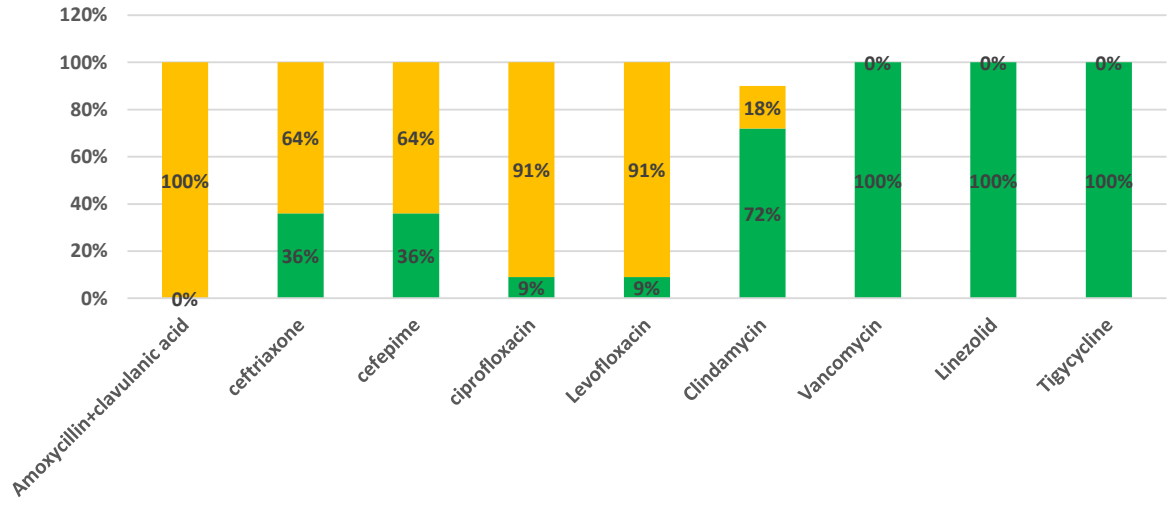
Among 46 pus samples most common organism was Staphylococcus aureus (23.9%) followed by E.Coli (23.9%), Klebsiella (21.7%), Pseudomonas (17.3%), Citrobactor (6.5%), Coagulase negative staphylococcus (4.3%), Proteus (2.1%). (Figure 3)

Figure 3. Showing distribution of organisms found in positive pus culture and sensitivity reports.



Antibiotic sensitivity and resistance were observed for staphylococcus as it was the most common organism found in pus culture. Not all samples were tested for vancomycin, linezolid and tigecycline but the samples tested, were found sensitive to these 3 antibiotics. Other antibiotics showed significant resistance like- clindamycin resistance in 18% of samples, ceftriaxone and cefepime resistance in 64% of samples, ciprofloxacin and levofloxacin resistance in 91% of samples. Interestingly amoxycillin+ clavulinic acid resistance was found in 100% samples. (Figure 4)

Figure 4. Showing distribution of antibiotic sensitivity and resistance in staphylococcus aureus



Discussion

The current study included 89 respiratory secretions culture and sensitivity reports. Pathogens involved in decreasing order were Pseudomonas (31%), E.Coli (29%), Klebsiella (24%), Acinetobacter (11%), Staphylococcus aureus (2.4%), Citrobactor (1.2%), Candida (1.2%). Pseudomonas showed significant resistance to many known first-line antibiotics like piperacillin + tazobactam (20%), meropenam (16%), amikacin (17%), ciprofloxacin and levofloxacin (25%), cefepime in (18%). Maximum 100 % sensitivity was found to colistin and polymyxin B.

In a study by Ahmed SMA et al the common organisms cultured among respiratory secretion samples were Klebsiella (25.20%), Mycobacterium tuberculosis (25.20%), Staphylococcus aureus (19.89%), Pseudomonas (8.49%).2 A high rate of resistance was observed to co-trimoxazole, ampicillin-sulbactam, cefotaxime, and tetracycline in 80%, 72.3%, 68.8%, and 66.9% samples respectively. A very low resistance rate was found to amikacin (AK) and levofloxacin (LE), being 4.6% and 8.5%, respectively. This study also recommended the 'use of antibiotic cycling policy, as the rotation of antibiotic classes, reduces the emergence of resistant organisms'. (2)

In study by Atia A et al involved pathogens among respiratory secretions were Streptococcus pneumonia (43.3%), Pseudomonas (22.8%), Staphylococcus aureus (13.8%), Escherichia Coli (6.9%), Enterobacter spp (6.2%), Citrobacter (4.5%), and Klebsiella (2.2%). Pseudomonas was resistant significantly to amoxyclav (71%), amoxicillin (44%), ceftriaxone(29%), clarithromycin (37%), ciprofloxacin (24%), gentamicin (24%)and amikacin (23%). (3) The difference in results in various studies may be due to different level of institutional hygiene practices and related policies implementation. The difference in results also signifies the need of antibiogram policy at regional and institute level.

Whereas Mishra S et al found Haemophilus influenzae (21%) as the most predominant pathogen followed by Klebsiella (19.1%), Pseudomonas (17.1%), Acinetobacter (10.9%), Streptococcus pneumoniae (8.6%), Escherichia coli (6.9%).(4)

In the study by Sharma P et al sputum culture revealed the growth of bacterial organisms in patterns of Streptococcus pneumoniae (13%), E. coli (9.4%), Acinetobacter (8.1%), P. aeruginosa (7.5%), Klebsiella (6.3%), H. influenzae (2%) and M. catarrhalis (2%). Similar to the current study, only colistin and polymyxin B were effective antibiotics against all the isolated organisms. (5)

Different studies showed similar results in view of significantly emerging antibiotic resistance. Variations in involved pathogens and sensitivity patterns in different studies indicate that there is need to observe, region wise specific sensitivity, and resistance patterns. In the current study, one positive sample for Pseudomonas was also tested against tigycycline and found sensitive to it. So far tigycycline is not known to be much effective against Pseudomonas. Further studies are needed to clarify the fact.

In the current study among 46 pus samples most common organism was Staphylococcus aureus (23.9%) followed by E.Coli (23.9%), Klebsiella (21.7%), Pseudomonas (17.3%), Citrobactor (6.5%), Coagulase negative staphylococcus (4.3%), Proteus (2.1%). Staphylococcus showed maximum sensitivity (100%) sensitivity to vancomycin, linezolid, and tigycycline. Significant resistance was shown against clindamycin (18%), ceftriaxone and cefepime (64%), ciprofloxacin and levofloxacin (91%), amoxycillin+ clavulinic acid (100%).

Like the current study, the study by Tiwari P et al also found the most common (35.5%) organism isolated as S. aureus among the positive pus culture, which was 100% sensitive to vancomycin, 87% to clindamycin, and 75% to oxacillin.(6)

In a study by Trojan R et al bacterial isolates from pus samples were E. coli (51.2%), Staphylococcus aureus (21%), Klebsiella (11.6%), Pseudomonas (5.8%), Citrobacter spp. (3.5%), Acinetobacter (2.3%), Proteus (2.3%), and Streptococcus spp. (2.3%). S. aureus and Streptococcus isolates were sensitive to cloxacillin, vancomycin and showed resistance to multiple antibiotics. (7)

The study by Khanam RA et al isolated Staphylococcus aureus (25.0%), Escherichia coli (16.5%), Pseudomonas (14.6%), Acinetobacter species (4.7%) and Klebsiella (0.9%) bacteria from pus culture. High antibiotic resistance was seen by S. aureus to penicillin (84.5%), ampicillin(63.6%), and erythromycin (41.7%). Like the current study, the highest sensitivity was shown to linezolid and vancomycin.(8)

Wadekar et al also found S. aureus (22.9%) as most common organism. Most gram-positive isolates were susceptible to vancomycin (100%) and linezolid (92.5%), like in current study.(9) Other studies also showed significant resistance to multiple antibiotics on pus culture.(10, 11)

Like current study most studies found staphylococcus aureus amongst the most common organisms cultured in pus samples having fair sensitivity to vancomycin, linezolid and having significant resistance to other antibiotics.

Conclusion

Considering comparison with other studies the current study results suggest the incorporation of linezolid and vancomycin in empirical therapy for infection producing pus, due to the common involvement of staphylococcus aureus and good sensitivity to these antibiotics. In the case of respiratory infections pseudomonas is fairly sensitive to colistin and polymyxin B but has significant antibiotic resistance to other antibiotics. Awareness and knowledge of the current pattern of pathogen involvement and antibiotic resistance may help significantly in reducing morbidity and mortality. Sensitization and awareness of clinicians about antibiotic resistance is needed. Unethical and irrational antibiotic practices should be inhibited legally. Promotion of health hygiene practices like hand washing should be promoted in the general population.

Recommendation

The study highlights the necessity of updated empirical antibiotic guidelines to combat rising antimicrobial resistance. Improved awareness among clinicians and the public can reduce morbidity and mortality from resistant infections. Strengthening infection control measures, including hand hygiene, is crucial in preventing the spread of resistant pathogens.

Limitation of the study

The study is limited by its sample size and single-centre design, which may affect the generalizability of the findings.

Antibiotic susceptibility patterns may change over time, requiring continuous surveillance for more accurate treatment recommendations.

Relevance of the study

This study provides updated insights into the antibiotic susceptibility patterns of common pathogens causing pus and respiratory infections. It emphasizes the need for incorporating linezolid, vancomycin, colistin, and polymyxin B in empirical therapy while highlighting the growing concern of antimicrobial resistance, reinforcing the urgency of antibiotic stewardship and infection control measures.

Authors Contribution

All authors have contributed equally.

Financial Support and Sponsorship

Nil

Conflict of Interest

There are no conflicts of interest.

Acknowledgement

None

Declaration of Generative AI and AI Assisted Technologies in the writing Process

The authors haven't used any generative AI/AI assisted technologies in the writing process.

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