United Academy of Pulmonary Medicine
Journal of Respiratory Diseases
and Allied Sciences

Research Article

# Pattern of Infection in Patient Admitted in Respiratory High Dependency Unit at Tertiary Care Hospital

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## Abstract

**Introduction:** Respiratory infections remain a leading cause of morbidity in hospital settings, particularly in respiratory high-dependency care units (RHDCUs). Patients admitted to RHDCUs are highly vulnerable to bacterial and fungal infections due to weakened immune systems and co-existing respiratory conditions. This study focuses on identifying infection patterns and antibiotic resistance in RHDCUs.

**Objective:** The study aimed to evaluate the pattern of infections in patients admitted to a tertiary care hospital's RHDCU and assess the antibiotic sensitivity of isolated organisms.

**Methods:** A prospective study was conducted on 180 patients admitted to the RHDCU with respiratory symptoms indicative of infection. Biological samples, including sputum and blood, were analyzed for bacterial and fungal infections. Bacterial culture, gram staining, and antibiotic sensitivity tests were obtained. Data on patient demographics, clinical presentation, and infection profiles were collected and analyzed using descriptive statistics.

**Results:** Of the 180 patients, Bacterial cultures showed 35.6% of samples to be sterile. Among the rest, the most common organisms isolated were *Pseudomonas aeruginosa* (24.4%), *Klebsiella oxytoca* (12.2%), and *Escherichia coli* (10%). Gram-negative bacilli were present in 64.4% of cases. Antibiotic sensitivity results revealed high resistance to ceftazidime (39.4%) and doxycycline (36.1%), while gentamicin showed the lowest resistance (22.2%).

**Conclusion:** The findings highlight the prevalence of gram-negative bacterial infections in RHDCUs, with *P. aeruginosa* being the most frequent pathogen. The large-scale antibiotic resistance observed emphasizes the need for tailored antimicrobial therapy and stringent infection control practices to improve patient outcomes.

**Keywords:** Respiratory infections, RHDCU, Antibiotic resistance, *Pseudomonas aeruginosa*, Gram-negative bacilli, Ceftazidime, Gentamicin.

## Introduction

Infectious diseases have historically been a significant cause of illness and suffering worldwide. Despite advances in medicine, they remain a major concern, especially in vulnerable populations. The respiratory system has built-in defense mechanisms that help prevent infections. The nasal mucosa acts as a first line of defense, trapping particles and microorganisms before they can enter the lower respiratory tract. The mucociliary clearance system plays a critical role in this process. When this defense is compromised, either by infections or other factors, the likelihood of developing respiratory infections increases.[1]

Patients in RHDCUs are particularly susceptible to infections due to weakened immune systems, making them more prone to upper and lower respiratory tract infections. Upper respiratory tract infections (URTIs) typically affect the

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**How to cite this article:** Garima, Gupta PP, Gill PS. Pattern of Infection in Patient Admitted in Respiratory High Dependency Unit at Tertiary Care Hospital. United Academy of Pulmonary Medicine J. Respiratory Diseases Allied Sci. 2024;1(1):1-5.

**Received:** 22-04-2024, **Accepted:** 09-06-2024, **Published:** 25-08-2024

nose, sinuses, throat, and larynx and are often associated with increased mucus production. While most URTIs are viral, bacterial and fungal infections can also occur.[2]

Lower respiratory tract infections (LRTIs), on the other hand, tend to be more severe and include conditions like pneumonia, lung abscesses, chronic obstructive pulmonary disease (COPD), and asthma. Symptoms of LRTIs typically include shortness of breath, fever, coughing, weakness, and fatigue. These infections can have serious consequences, especially for patients with compromised immunity or pre-existing conditions, making early diagnosis and treatment essential to prevent further deterioration.[3]

The aim of present study was to evaluate the pattern of infections in patients admitted to the respiratory high-dependency unit at a tertiary care hospital. The primary objective was to assess the presence of bacterial or fungal infections in various biological samples from these patients. Additionally, the study aimed to analyze the bacterial flora and antibiotic sensitivity of the microorganisms found in patients admitted to the high-dependency unit, providing insights into infection patterns and resistance profiles to improve patient care and treatment outcomes.

## Materials And Methods

This prospective study was conducted on 180 patients admitted to the High Dependency Unit (HDU) in the Respiratory Medicine Department of our Institute. A sample size of 180 was determined using a 95% confidence level, assuming 37% of the population has the factor of interest. The study was conducted from August 2022 to April 2023. Information on demographic data, patterns of respiratory infection among admitted patients, and comorbidities were retrieved. Informed consent was obtained from all participants. Inclusion criteria required the ability to collect samples of sputum on day 0 and all samples were collected within 6 hours of admission and the samples were subjected to the following investigation:

- Gram stain
- AFB Fluorescence microscopy stain
- Cartridge-based nucleic acid amplification test (CBNAAT)
- Bacterial culture
- Antibiotic sensitivity

All participants had to be over 18 years old.

Patients were asked to gargle with plain water and after that, sputum samples were taken after coughing. If the patient does not expectorate, induction of sputum was done by inhalation of 3% hypertonic saline for 15 minutes with an ultrasonic nebulizer. 3-5 ml sputum and induced sputum samples were collected in a sterile leakproof container. Adequacy of Sample- the quality of the expectorated sputum was assessed both by macroscopic and microscopic examination. Bartlett's scoring[4] method was used for microscopic evaluation of the expectorated sputum. Sputum will be considered unsuitable if it has a final score of 0 or less. All unsuitable specimens were discarded and a repeat specimen was collected. If gram staining shows > 25 pus cells and <10 epithelial cells/low power field, the sample was considered adequate for culture.

### Sample Packaging

The basic packaging system for local surface transport of all specimens consists of three layers that are primary receptacle (the specimen container packaged with enough absorbent material to absorb all fluid in case of breakage), secondary packaging (a second durable, watertight, leakproof packaging to enclose and protect the primary receptacle), outer packaging (to protect their contents from external influences during transit).

### Analysis

The sputum gram stain test distinguishes and classifies bacterial species into two large groups: gram-positive bacteria and gram-negative bacteria. For bacteria growth blood agar plate and MacConkey agar palate will be used. Samples were incubated at room temperature and were examined growth at 72-hour intervals.[5]

## Results

The study included 180 study subjects, out of which 64.4% of participants were male, while females comprised 35.6%. In terms of age distribution, the majority of participants were in the 60 to 69 and 50 to 59 age groups, representing 20.6 and 20%, respectively. This was followed by 15.6% in the 40 to 49 age group, 13.9% in the 70 to 79 group, and 12.2% in the 20 to 29 age group. The 30 to 39 age group accounted for 9.4% of participants, with only one participant (0.6%) over 90 years old.

The most common presenting symptom among study participants was shortness of breath, observed in 88.9%, followed by cough (86.7%) and sputum production (85.6%). Fever was present in 70.6% of participants. This highlights shortness of breath as the predominant symptom in the study group.

On general physical examination, edema (30.6%) and pallor (30%) were the most common findings, followed by clubbing (26.1%) and cyanosis (25.6%). Icterus was the least common, observed in only 2.2% of participants. These results highlight edema and pallor as the predominant physical findings among study participants.

Gram staining results showed that 64.4% of the isolated organisms were gram-negative bacilli. Additionally, no organisms (cocci or bacilli) were found in a portion of the samples, while 5% of the isolates were gram-positive cocci.

AFB fluorescence microscopy staining results showed that 84.4% of samples were negative for fluorescent AFB bacilli, while 15.6% tested positive. All positive samples underwent CBNAAT testing to determine if drug resistance was present. This indicates that the majority of samples did not exhibit bacilli under microscopy, with a smaller portion showing positive results.

**Table 1:** Distribution of organisms isolated on bacterial culture (N = 180)

| *Bacterial culture* | *Frequency* | *Percentage* |
|---|---|---|
| *Acinetobacter baumanii* | 16 | 8.9 |
| *Citrobacter* | 6 | 3.3 |
| *Enterobacter aerogens* | 1 | 0.6 |
| *Escherichia coli* | 18 | 10 |
| *Klebsiella oxytoca* | 22 | 12.2 |
| *K. pneumonia* | 4 | 2.2 |
| *Pseudomonas aeruginosa* | 44 | 24.4 |
| *Staphylococcus aureus* | 2 | 1.1 |
| *Streptococci pneumoniae* | 3 | 1.7 |
| No pathogenic organism | 64 | 35.6 |

**Table 2:** Sensitivity profile of antibiotics

| *Antibiotic* | *Sensitive* | *Resistant* |
|---|---|---|
| Ceftazidime | 63 (35%) | 71 (39.4%) |
| Ciprofloxacin | 71 (39.4%) | 63 (35%) |
| Levofloxacin | 84 (46.7%) | 50 (27.8%) |
| Imipenem | 71 (39.4%) | 61 (33.9%) |
| Meropenem | 81 (45%) | 53 (29.4%) |
| Gentamicin | 94 (52.2%) | 40 (22.2%) |
| Amikacin | 81 (45%) | 53 (29.4%) |
| Piperacilin tazobactam | 81 (45%) | 53 (29.4%) |
| Cefepime | 80 (44.4%) | 54 (30%) |
| Doxycycline | 69 (38.3%) | 65 (36.1%) |
| Aztrenam | 80 (44.4%) | 54 (30%) |

**Table 3:** Antibiotics sensitivity profile of *P. aeruginosa* isolated on bacterial culture

| *Organism* | *Antibiotic* | *Sensitive isolates* | *Resistant isolates* |
|---|---|---|---|
| *P. aeruginosa* (Total isolates = 44) | Ceftazidime | 23 (52.3) | 21 (47.7) |
| | Ciprofloxacin | 27 (61.4) | 17 (38.6) |
| | Levofloxacin | 32 (72.7) | 12 (27.3) |
| | Imipenem | 17 (38.6) | 27 (61.4) |
| | Meropenem | 25 (56.8) | 19 (43.2) |
| | Gentamicin | 24 (54.5) | 20 (45.5) |
| | Amikacin | 26 (59.1) | 18 (40.9) |
| | Piperacilin tazobactam | 28 (63.6) | 16 (36.4) |
| | Cefepime | 24 (54.5) | 20 (45.5) |
| | Doxycycline | 24 (54.5) | 20 (45.5) |
| | Aztrenam | 25 (56.8) | 19 (43.2) |

**Table 4:** Antibiotics sensitivity profile of *K. oxytoca* isolated on bacterial culture

| *Organism* | *Antibiotic* | *Sensitive isolates* | *Resistant isolates* |
|---|---|---|---|
| *K. oxytoca* (Total isolates = 22) | Ceftazidime | 6 (27.3) | 16 (72.7) |
| | Ciprofloxacin | 5 (22.7) | 17 (77.3) |
| | Levofloxacin | 10 (45.5) | 12 (54.5) |
| | Imipenem | 17 (77.3) | 5 (22.7) |
| | Meropenem | 8 (36.4) | 14 (63.6) |
| | Gentamicin | 19 (86.4) | 3 (13.6) |
| | Amikacin | 19 (86.4) | 3 (13.6) |
| | Piperacilin tazobactam | 8 (36.4) | 14 (63.6) |
| | Cefepime | 9 (40.9) | 13 (59.1) |
| | Doxycycline | 10 (45.5) | 12 (54.5) |
| | Aztrenam | 12 (54.5) | 10 (45.5) |

The bacterial culture showed 35.6% sterile samples with no organisms isolated. Among positive cultures, 24.4% had *P. aeruginosa*, followed by *K. oxytoca* (12.2%), *E. coli* (10%), and *A. baumannii* (8.9%) (Table 1).

The antibiotic sensitivity profile revealed that ceftazidime had the highest resistance, with 39.4% of isolates resistant, followed by doxycycline at 36.1%, ciprofloxacin at 35%, and imipenem at 33.9%. Amikacin, meropenem, and piperacillin-tazobactam each showed resistance in 29.4% of isolates. Gentamicin demonstrated the lesser resistance, with only 22.2% of isolates resistant. These findings highlight varying degrees of antibiotic resistance among the organisms, with ceftazidime and doxycycline showing the highest resistance rates and gentamicin the lowest (Table 2).

Table 3 describes the antibiotic sensitivity profile of *P. aeruginosa* isolated on bacterial culture. It was observed that isolates were highly sensitive to levofloxacin (72.7%), followed by piperacillin tazoactam (63.6%), and ciprofloxacin (61.4%). The isolates were least sensitive for imipenem (38.6%).

Table 4 describes the antibiotic sensitivity profile of *K. oxytoca* isolated on bacterial culture. It was observed that the organism isolated was highly sensitive to gentamicin and amikacin, i.e., 86.4% sensitivity each, followed by imipenem (77.3%), and aztrenam (54.5%). The organisms were found to be least sensitive to ciprofloxacin (22.2%).

Table 5 describes the antibiotic sensitivity profile of *E. coli* isolated on bacterial culture. It was observed that maximum antibiotic sensitivity was observed with meropenem (83.3%), followed by gentamicin (77.8%), ciprofloxacin (72.2%), aztrenam (72.2%), piperacillin-tazobactam (66.7%). The organisms were found to be least sensitive to ceftazidime (22.2%).

Table 6 reflects the antibiotic sensitivity profile of *A. baumanii* isolated on bacterial culture. It was observed that

**Table 5:** Antibiotics sensitivity profile of *E. coli* isolated on bacterial culture

| *Organism* | *Antibiotic* | *Sensitive isolates* | *Resistant isolates* |
|---|---|---|---|
| *E. coli* (Total isolates = 18) | Ceftazidime | 4 (22.2) | 14 (77.8) |
| | Ciprofloxacin | 13 (72.2) | 5 (27.8) |
| | Levofloxacin | 11 (61.1) | 7 (38.9) |
| | Imipenem | 8 (44.4) | 10 (55.6) |
| | Meropenem | 15 (83.3) | 3 (16.7) |
| | Gentamicin | 14 (77.8) | 4 (22.2) |
| | Amikacin | 10 (55.6) | 8 (44.4) |
| | Piperacilin tazobactam | 12 (66.7) | 6 (33.3) |
| | Cefepime | 9 (50) | 9 (50) |
| | Doxycycline | 6 (33.3) | 12 (66.7) |
| | Aztrenam | 13 (72.2) | 5 (27.8) |

**Table 6:** Antibiotics sensitivity profile of *A. baumanii* isolated on bacterial culture

| *Organism* | *Antibiotic* | *Sensitive isolates* | *Resistant isolates* |
|---|---|---|---|
| *A. baumanii* (Total isolates = 16) | Ceftazidime | 8 (50) | 8 (50) |
| | Ciprofloxacin | 10 (62.5) | 6 (37.5) |
| | Levofloxacin | 12 (75) | 4 (25) |
| | Imipenem | 8 (50) | 8 (50) |
| | Meropenem | 10 (62.5) | 6 (37.5) |
| | Gentamicin | 13 (81.3) | 3 (18.7) |
| | Amikacin | 7 (43.8) | 9 (56.3) |
| | Piperacilin tazobactam | 11 (68.8) | 5 (31.2) |
| | Cefepime | 11 (68.8) | 5 (31.2) |
| | Doxycycline | 8 (50) | 8 (50) |
| | Aztrenam | 10 (62.5) | 6 (37.5) |

a maximum (81.3%) of isolates were sensitive to gentamicin, followed by 75% to levofloxacin, 68.8% to piperacillin, tazobactam and cefepime. The organisms were found to be least sensitive to amikacin (43.8%).

## Discussion

This study was conducted in the Department of Respiratory Medicine in collaboration with the Department of Microbiology and analyzed 180 cases. The observations were compared with other studies to draw objective comparisons and enhance the understanding of the findings in a broader context.

In this study, 48.8% of participants had diabetes, higher than the general population's 12.8%, likely due to diabetes being a risk factor for respiratory infections. Yalan Q *et al.* in China reported 60% comorbidity in the HDU group, higher than this study, as they included hypertension, diabetes, and CHD, while this study only considered diabetes.[6]

In this study, 38.8% of participants had hypertension, higher than the general population's 23.1%, likely due to its role as a risk factor for respiratory infections and HDU admissions. Yalan Q *et al.* in China reported 60% comorbidity in the HDU group, higher than this study, as they considered hypertension, diabetes, and CHD, while this study focused only on hypertension.[6]

In our study, 72.2% of participants had a smoking history, with shortness of breath (88.9%) being the most common symptom, followed by cough (86.7%) and sputum (85.6%). Oedema (30.6%) and pallor (30%) were frequent findings, while bilateral air entry (28.9%) and crept (26.6%) dominated chest exams, consistent with typical LRTI presentations.

In the present study, 64.4% of isolates were Gram-negative bacilli, aligning with findings by Javeri *et al.* (74.21%) and Sheth KV *et al.* (71%). Similarly, Sharma *et al.* in Shimla reported Gram-negative bacteria as the most common isolate. Additionally, 15.6% of samples were positive for bacilli, while 84.4% were negative on fluorescent microscopy.[7-9]

In this study, 86.1% of cultures were sterile, whereas in bacterial cultures, 35.6% were sterile, while 24.4% isolated *P. aeruginosa*, followed by *K. oxytoca* (12.2%) and *E. coli* (10%). These results align with studies by Jitendra *et al.*, Richard *et al.*, Radji *et al.*, Sheth *et al.*, Mahendra *et al.*, and Gebre *et al.*, although Klebsiella was less common here.[6-8,10,11]

In present study, *A. baumanii* showed 81.3% sensitivity to gentamicin and 75% to levofloxacin, similar to Sheth *et al.*, but higher than Duan *et al.*, citrobacter isolates were 100% sensitive to ciprofloxacin, meropenem, and piperacillin-tazobactam, consistent with Gebre *et al.*, but differed in ceftazidime sensitivity, whereas Gebre *et al.* reported 100% resistance. Study setting variations explain these differences.[6,10,11]

In our study, *Enterobacter aerogens* was 100% sensitive to ceftazidime, imipenem, meropenem, amikacin, and cefepime, similar to findings by Gebre *et al. E. coli* sensitivity was highest for meropenem (83.3%) and gentamicin (77.8%), aligning with Anvari MS *et al.* for gentamicin but differing in ciprofloxacin sensitivity. Gebre *et al.* reported higher sensitivity to ceftazidime and cefepime than this study.[11,12]

In this study, 75% of *K. pneumoniae* isolates were sensitive to ceftazidime, levofloxacin, and imipenem, while no sensitivity was noted for piperacillin-tazobactam. Anvari MS *et al.* and Sheth *et al.* reported higher sensitivity for ceftazidime and imipenem but lower for amikacin. Sensitivity to levofloxacin and ciprofloxacin was also higher in Sheth *et al.*'s study compared to this study's findings.[9,13]

In this study, isolates were 100% sensitive to ceftazidime, imipenem, meropenem, cefepime, and aztreonam, with 50% sensitivity to gentamicin and piperacillin-tazobactam. Mahendra M *et al.* found similar results for piperacillin-tazobactam, while Miriti *et al.* reported 92% sensitivity to ciprofloxacin, comparable to this study. Variations were noted in antibiotic sensitivity, particularly for ceftazidime and amikacin, across studies.[7,11]

## Conclusion

Our study highlights the significant burden of respiratory infections in patients admitted to the Respiratory High Dependency Unit, with a higher prevalence in males, smokers, diabetes and hypertension. Gram-negative bacteria, particularly *P. aeruginosa*, *K. pneumoniae,* and *A. baumanii*, were the most common pathogens. The varying antibiotic sensitivities underline the need for tailored treatment approaches. Vigilance in diagnosis, targeted antibiotic use, and public health interventions are crucial for managing these infections and reducing associated mortality.

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