RESEARCH PAPER

Evaluation Of Antibiotic Resistance For Respiratory Tract Infections In Community Care Center: A Retrospective Study

Tangulla Leena Sivaani[1], Guttapalem Pavan Kalyan[2], Mopuru Priyanka[3], Koduru Nowshiya[4], Dr. J. Thipperudra[5]

[1] Email: leenasivaani@gmail.com
[2] Email: kalyankarthik797@gmail.com
[3] Email: mpriyankapriyankam4@gmail.com
[4] Email: nowshiyaa35@gmail.com
[5] Email: rudra@balajipharmacy.ac.in

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Abstract

Background: Antibiotic resistance is becoming a major health concern because of increasing resistance of antibiotics. Respiratory tract infections are one of the most frequent reasons for causing antibiotic resistance as the antibiotics are used irrationally. This needs regular resistance checking for an effective treatment.

Objective: The aim of the study is to understand the antibiotic resistance patterns found majorly in respiratory tract infection isolates and to evaluate the antimicrobial sensitivity based on the patient's demographic and laboratory data.

Methods used: A retrospective observational study was performed using several microbiology laboratory reports which were gathered between the time period from january 2023 to january 2025 from the government general hospital and also in sri rayalaseema diagnostic services, ananthapuramu. Around 289 patient laboratory reports were evaluated and the antibiotic susceptibility was conducted using kirby-bauer disk diffusion method and followed the clsi guidelines. In this study, the statistical analysis included descriptive statistics and chi-square testing.

Results: The rtis were most common among younger adults. The bacterial infections were slightly more common in males than females, with frequent gram-positives. Most samples were sputum, which is commonly used to test for respiratory infections. The most isolated bacteria were streptococcus pneumoniae, klebsiella pneumoniae, pseudomonas aeruginosa, staphylococcus aureus, escherichia coli. Meropenem and piperacillin + tazobactam displayed sensitivity to klebsiella pneumoniae, pseudomonas aeruginosa, staphylococcus aureus, escherichia coli. Moxifloxacin has exhibited effectiveness and resistance in the isolated bacteria such as streptococcus pneumonia and pseudomonas aeruginosa. Streptococcus pneumoniae, pseudomonas aeruginosa expressed resistance for both azithromycin and amoxicillin antibiotics.

Conclusion: Regular surveillance of the antibiotic resistance and rational antibiotic use are important in order to control the resistance development and to increase the treatment efficiency.

Keywords: Respiratory Tract Infections, Antibiotic Resistance, Antimicrobial Susceptibility, Bacterial Pathogens, Streptococcus Pneumoniae, Klebsiella Pneumoniae, Pseudomonas Aeruginosa, Staphylococcus Aureus.

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1. Introduction

Respiratory tract infections (RTI) are the most commonly seen infections in people of every age group (Hak et al., 2006). These infections affect the upper respiratory tract like nose, throat and sinuses and can cause cellular damage to the lower respiratory tract which includes lungs, bronchi and alveoli. Some commonly seen RTIs are common cold, bronchitis, pneumonia and sinus infections (Jain et al., 2001). Respiratory tract infections can be the primary reason for constant visiting of patients to the community care centers as they can spread easily mainly in crowded places (Muriithi, 2023). Antibiotics are the most common medications used to treat bacterial respiratory infections. And the

antibiotics are used irrationally and excessive use of antibiotics can lead to serious complications like antibiotic resistance (Hossain et al., 2023).

There are many reasons for the development of antibiotic resistance. Primarily, the overuse of antibiotics as many people take antibiotics without prescription and they use them even in viral infections like cold,flu(Otia,2024).Becauseofthese,antibioticsdonotworkeffectively.Along with that, people do not complete the full course of antibiotics, they discontinue the treatment when they feel healthier. This allows some bacteria to survive in the body and they become resistant. Incorrect dosing, self medication and frequent use of almost every broad spectrum antibiotic can lead to resistance (Bharadwajetal. 2022).Some of the reasons like poor infection management and lack of hygiene can contribute to antibiotic resistance as they play a major role in spreading the resistant bacteria from one person to another.

Bacteria develop resistance through many mechanisms like production of enzymes as they make the antibiotic inefficient before they show its activity (Urban-Chmiel et al., 2022). On the other hand, the target site of the bacteria can be changed and the internal structure of the bacteria will be modified due to which the drug can not bind in a proper way (Osman et al., 2022). Some types of bacteria remove the antibiotic from the cell using efflux pumps which lead to resistance (Zhang et al., 2024). Some of the other reasons like the bacteria's can transform their cell wall structure which stops the bacteria entering the bacterial cell. Bacteria can form bio films which serve as protective barriers against antibiotics (Singh et al., 2022). The resistance can develop through genetic mutations or resistance genes are transferred between bacteria. Knowing all the reasons and mechanisms of antibioticresistanceissignificantforselectingtherational antibiotics which help in increasing the treatment outcomes (Maeda and Furusawa, 2024).Along with this, constant monitoring of the resistance patterns can minimize the treatment failure and can control the spread of resistant bacteria.

2. Methodology

Study Design: The research was conducted as a retrospective observational study to determine the antibiotic resistance patterns in the patients having respiratory tract infections (RTIs). The study was carried out using the data collected from two community healthcare centers in Ananthapuramu, Andhra Pradesh: Government General Hospital (GGH) and Sri Rayalaseema Diagnostic Services. These healthcare centers were selected because they provide microbiological diagnosing services for both the inpatients and outpatients from different backgrounds.

Study Period: The study evaluated laboratory reports gathered during a time period of two years which was from January 2023 to January 2025.During this period, culture and sensitivity reports of the respiratory samples were tested and evaluated to understand the prevalence and antibiotic resistance among respiratory pathogens.

Ethical Approval: Ethical clearance was obtained from the Institutional Review Board(IRB)of Government General Hospital, Ananthapuramu (Approval No: IRB/2024/GGH/PD/02). Patient confidentiality and the ethical research standards were maintained in the study.

Table-01 showing Inclusion and Exclusion Criteria:

Inclusion Criteria	Exclusion Criteria
Patients aged between 18-75 years	Patients who were below18years or above75 years
Patients with RTI symptoms like fever, cough, SOB	Patients with viral infections
Positive bacterial culture reports	Negative cultural reports
Patient treated in outpatient or inpatient departments	Patients with duplicate records
Specimens like sputum, blood or throat swab	Follow-up samples from the same infection episode

Sample Size Calculation: The required sample size was calculated using the formula:

$$n = Z^2 \times p \times (1 - p) / d^2$$

Where:

Z = 1.96 (standard value for 95% confidence interval)

p=0.25(estimated prevalence of ciprofloxacin resistance in E.coli based on prior literature) d = 0.05 (desired precision level)
This yielded a sample size of 289 patients, which was met and used in the analysis.

Data Collection: Data was gathered from laboratory registers and electronic databases.

- Age and gender
- Type of respiratory specimen
- Identified bacterial isolates
- Antibiotic susceptibility results
- Patient category (outpatient/inpatient)

All the data was categorized before evaluation and the repeat samples from the same infection were not included in order to avoid duplication.
Microbiological Evaluation: Respiratory samples were processed using the standard microbiological evaluation techniques. Antibiotic susceptibility was tested using Kirby-Bauer disk diffusion method and followed clinical and laboratory standards institute (CLSI)guidelines. The commonly used antibiotics were

- Meropenem
- Piperacillin-Tazobactam
- Amoxicillin
- Azithromycin
- Moxifloxacin

The isolates were categorized as sensitive, intermediate or resistant based on the zone of inhibition diameters. The sensitive and resistant results were considered for statistical comparison.
Statistical methods: The statistical analysis was conducted using Graph Pad Instat software and the descriptive statistics like frequencies and percentages were used to summarize the data. The Chi-square test was used to evaluate the association between antibiotic resistance and variables
Like age, gender, sample type and study site. A p-valueless than 0.05was considered as statistically significant.

3. Results

Table-02showingpercentageofRTIshowinginpeoplewithdifferentage group

Age (years)	Frequency of patients having RTI	% of having RTI	P value
18-35	102	35.294%	<0.0001
36-45	70	24.221%	<0.0001
46-60	71	24.567%	<0.0001
61-75	46	15.916%	<0.0001
Total	289	100%	

The above table explains about the distribution of respiratory tract infection cases in different age groups. A total of 289 patients were included in the study. In the18-35yearsagegrouppatients had a high number of RTI cases which is 102 patients which indicates that the RTIs are seen more commonly in younger adults. The 36-45 years and 46-60 years age groups had almost same average values indicating moderate occurrence of the infections in this middle aged people. On the other hand, 61-75 years old showed very less number of cases which was only 46 patients indicating very lower exposure and better preventive therapy in the study population.The p-value was <0.0001in all the age groups indicating the difference in RTI cases between the age groups is highly significant statistically explaining the variation is not random.

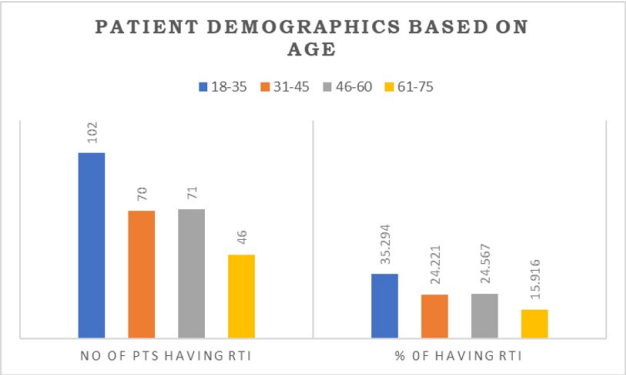


Figure-01:Patient demographics based on age

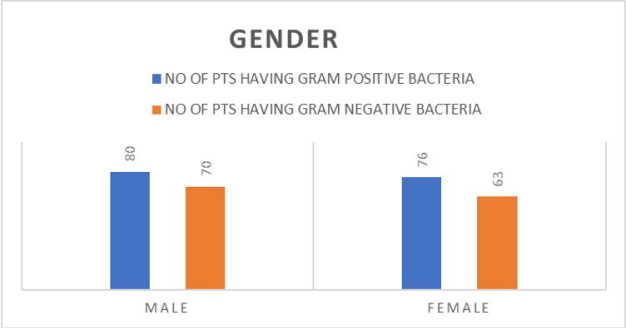


Figure-02: Distribution of strains in male and female patients

Table-02 showing the % of male and female patients having different gram stains

Gender	No of Patients with +ve gram bacteria	No of Patients with -ve gram bacteria	Percentage	P value
Male	80	70	51.903%	<0.0001
Female	76	63	48.096	<0.0001
Total	156 (53.979%)	133 (46.020%)	100%	

The above table explains the distribution of gram-positive and negative bacterial infections in male and female patients. In the 289 patients, male patients showed more infections which were 51.9% compared to female patients (48%). In the male patients, 80 patients had gram positive bacteriaand70patientshadgramnegativebacteria.Wher e as, in female patients, 76 showed gram positive and 63 showed gram negative strains. The positive strains were more common than the negative strains in this study. The p-value was also < 0.0001 indicating the significant differences.

Table-03 showing percentage of different samples

Type of sample	No. of samples	Percentage	P value
Sputum	235	81.314%	<0.0001
Blood	43	14.879%	<0.0001
Swab	11	3.806%	<0.0001
Total	289	100%	

The table shows the different types of samples collected in order to test the RTI. The total samples were 289 in which the highest samples collected were sputum samples indicating the Sputum is the most commonly used sample for RTI diagnosis. The blood samples were 43 samples and the least samples collected were swab samples. Most of the RTI tests were diagnosed using sputum samples.

Figure-03:Pie chart showing Frequency of samples used

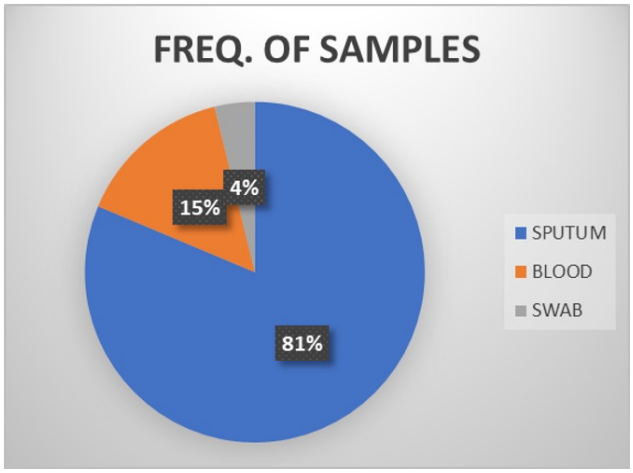
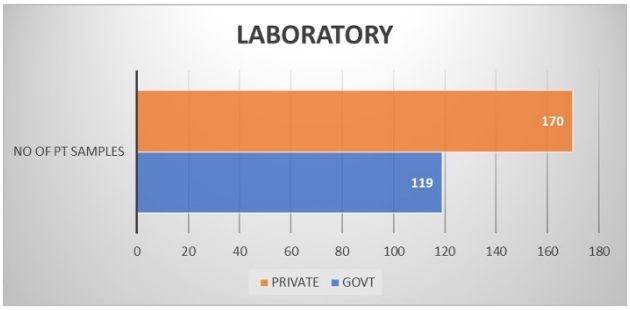


Table-04 showing the percentage of patient samples based on the laboratory

Laboratory type	No. of patient samples	Percentage	P value
Government	119	41.176%	<0.0001
Private	170	58.823%	<0.0001
Total	289	100%	

The above table 4 showed the patient samples were collected more from the private laboratories which were 170 samples whereas, only 119 samples were collected from the government laboratories. This explained that patients preferred more private diagnostic centers or the private labs received more RTI cases in the study period.

Figure-04:Patientsamplesbasedonthelaboratory



Sensitivity to the Isolated Organisms:

The antibiotic sensitivity pattern showed different organisms exhibited different responses to the various antibiotics. *Streptococcus pneumoniae* (N=109) had highest sensitivity to the antibiotics like moxifloxacin, meropenem, doxycycline and piperacillin-tazobactam with percentages around 70.6%, 69.7%, 66.0% and 58.7% respectively. *Klebsiella pneumoniae* (N=70) showed proper sensitivity to meropenem with 68.5%, moxifloxacin with 62.8% and piperacillin tazobactam with 52.8%. *Pseudomonas aeruginosa* (N=36) showed better sensitivity to moxifloxacin and meropenem with percentages of 63.8% and 52.7% respectively. N=23, *Escherichia coli* showed good sensitivity to moxifloxacin and meropenem both showed 39.1%. On the other hand, *Candida albicans* (N=11) was seen with piperacillin-tazobactam around 45.85% and meropenem around 36.6%. The *Acinetobacter baumannii* (N=3) showed better sensitivity to moxifloxacin which was 100% and moderate action to ceftriaxone, doxycycline, levofloxacin, and piperacillin-tazobactam (33.3% to all the antibiotics). *Brucella melitensis* (N=1) showed sensitivity only to feropenem which was 100%. Meropenem, moxifloxacin and doxycycline showed better sensitivity compared to the other antibiotics and amoxicillin and ceftazidime showed less sensitivity.

Table-05 showing organisms showing sensitivity patternstotheisolated organisms

Antibioti c	A. bauman nii (N=3)	B. melitensi s (N=1)	C. albicans (N=11)	E.coli (N=23)	K. pneumo niae (N=70)	P. aerugino sa (N=36)	S.aureus (N=36)	S. pneumon iae (N=109)

Amoxicillin	0	0	1 (9.09%)	2 (8.6%)	2 (2.8%)	7 (19.4%)	4 (11.1%)	13 (11.9%)
Azithromycin	0	0	1 (9.09%)	0	4 (5.7%)	2 (5.5%)	5 (13.8%)	15 (13.7%)
Ceftriaxone	1 (33.3%)	0	3 (27.2%)	4 (17.3%)	17 (24.2%)	5 (13.8%)	9 (25%)	45 (41.2%)
Ceftazidime	0	0	0	1 (4.3%)	2 (2.8%)	0	0	0
Ciprofloxacin	0	0	1 (9.09%)	3 (13.0%)	3 (4.2%)	10 (27.7%)	5 (13.8%)	11 (10.0%)
Doxycycline	1 (33.3%)	0	3 (27.2%)	4 (17.3%)	29 (41.4%)	6 (16.6%)	11 (30.5%)	72 (66.0%)
Faropenem	0	1 (100%)	2 (18.1%)	3 (13.0%)	16 (22.8%)	1 (2.7%)	2 (5.5%)	6 (5.5%)
Levofloxacin	1 (33.3%)	0	0	2 (8.6%)	12 (17.1%)	4 (11.1%)	7 (19.4%)	5 (4.5%)

Moxifloxacin	3 (100%)	0	3 (27.2%)	9 (39.1%)	44 (62.8%)	23 (63.8%)	4 (11.1%)	77 (70.6%)
Meropenem	0	0	4 (36.6%)	9 (39.1%)	48 (68.5%)	19 (52.7%)	17 (47.2%)	76 (69.7%)
Piperacillin + Tazobactam	1 (33.3%)	0	5 (45.4%)	8 (34.7%)	37 (52.8%)	20 (55.5%)	11 (30.5%)	64 (58.7%)

Resistance to the Isolated Organisms:

The antibiotic resistance pattern was presented in the table-05 in which some bacteria were highly resistant to the most commonly used antibiotics. *Streptococcus pneumoniae* (N=109) showed higher resistance patterns to azithromycin (33.9%), moxifloxacin (28.4%) and amoxicillin (22.0%). Similarly, the resistance patterns seen in the *Staphylococcus aureus* (N=36)had higher resistance to antibiotics like amoxicillin which was around 94.4%, ceftazidime was 86.1% and moxifloxacin was 75%. On the other hand, *Klebsiella pneumoniae* (N=70) showed resistance to ceftazidime and azithromycin(21.4%and15.7%respectively).*Pseudomonasaeruginosa*(N=36) exhibited resistance to ceftazidime (30.5%), amoxicillin (16.6%) and moxifloxacin (16.6%). *Escherichia coli* (N=23) showed very less resistance to ceftazidime and doxycycline which was only around 8.6% and4.3%respectively.*Candidaalbicans* (N=1) showed very less resistance to ciprofloxacin, faropenem and meropenem with 9.09% for all the antibiotics. *Acinetobacter baumannii* (N=3) showed patterns to azithromycin which was around 66.6% and moderate resistance to ceftriaxone, ceftazidime, ciprofloxacin, doxycycline and faropenem. *Brucella melitensis* (N=1) showed resistance to ciprofloxacin and meropenem which was 100%. Higher resistance was seen with amoxicillin, ceftazidime and azithromycin and less was with doxycycline, meropenem and piperacillin-tazobactam.

Table-06 showing organisms showing resistance patterns to the isolated organisms

Antibiotic	**A. baumannii (N=3)**	**B. melitensis (N=1)**	**C. albicans (N=11)**	**E.coli (N=23)**	**K. pneumoniae (N=70)**	**P. aeruginosa (N=36)**	**S.aureus (N=36)**	**S. pneumoniae (N=109)**
Amoxicillin	0	0	0	0	0	6 (16.6%)	34 (94.4%)	24 (22.0%)
Azithromycin	2 (66.6%)	0	0	0	11 (15.7%)	2 (5.5%)	5 (13.8%)	37 (33.9%)

Ceftriaxo ne	1 (33.3%)	0	0	0	6 (8.5%)	6 (16.6%)	16 (44.4%)	9 (8.25%)
Ceftazidi me	1 (33.3%)	0	0	2 (8.6%)	15 (21.4%)	11 (30.5%)	31 (86.1%)	0
Ciproflox acin	1 (33.3%)	1 (100%)	1 (9.09%)	0	2 (2.8%)	0	22 (61.1%)	13 (11.9%)
Doxycycl ine	1 (33.3%)	0	0	1 (4.3%)	1 (1.4%)	0	0	8 (7.3%)
Faropenem	1 (33.3%)	0	1 (9.09%)	0	2 (2.8%)	5 (13.8%)	14 (38.8%)	10 (9.17%)
Levoflox acin	0	0	0	0	8 (11.4%)	1 (2.7%)	18 (50%)	10 (9.17%)
Moxiflox acin	0	0	0	1 (4.3%)	0	6 (16.6%)	27 (75%)	31 (28.4%)
Meropen em	0	1 (100%)	1 (9.09%)	0	5 (7.1%)	5 (13.8%)	10 (27.7%)	9 (8.2%)
Piperacil lin + Tazobact am	0	1 (100%)	0	0	1 (1.4%)	1 (2.7%)	0	0

Overall Antibiotic Susceptibility Pattern of Bacterial Isolates:

The overall antibiotic sensitivity patterns showed that the moxifloxacin showed highest sensitivity as the sensitivity was 179% and the resistance was only 61.9%. After that, meropenem showed sensitivity around 173% and resistance around 59.8% and the piperacillin-tazobactam showed 145% sensitivity and 50.1% resistance. The susceptibility of the doxy cycline was 127% and the resistance was 43.9%. Moderate sensitivity patterns were seen by ceftriaxone with 84% as sensitivity and 29% as resistance. Ciprofloxacin, levofloxacin, amoxicillin and azithromycin showed lower sensitivity with 11.4%, 10.3%, 9.6% and 8.9% respectively. The ceftazidime had the least sensitivity with only 1.03%.

The higher resistance was seen with the amoxicillin (28.7%) followed by ceftazidime (26.2%), azithromycin (25.6%). Moxifloxacin and ceftriaxone with 13.8% and 11% showed moderate resistance. Lower resistance was seen with meropenem, levofloxacin, ciprofloxacin and faropenem with 8.9%, 9.6%, 9.3% and 7.9% respectively. The least resistance was seen with doxycycline (3.8%) and piperacillin-tazobactam (1.03%). Better effectiveness was seen with moxifloxacin, meropenem, doxycycline and piperacillin-tazobactam whereas amoxicillin, azithromycin and ceftazidime showed higher resistance.

Table-07 showing over all antibiotic susceptibility patterns of bacterial isolates

Antibiotic	**Sensitivity (Frequency)**	**Sensitivity (%)**	**Resistance (Frequency)**	**Resistance (%)**
Amoxicillin	28	9.60 %	83	28.70 %
Azithromycin	26	8.90%	74	25.60 %
Ceftriaxone	84	29.00%	32	11.00 %
Ceftazidime	3	1.03%	76	26.20 %
Ciprofloxacin	33	11.40%	27	9.30 %
Doxycycline	127	43.90%	11	3.80 %
Faropenem	18	6.20%	23	7.90 %
Levofloxacin	30	10.30%	28	9.60 %
Moxifloxacin	179	61.90%	40	13.80 %
Meropenem	173	59.80%	26	8.90 %
Piperacillin+ Tazobactam	145	50.10%	3	1.03 %

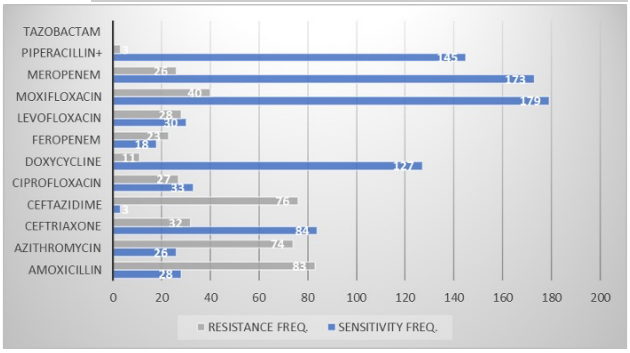


Figure-05:Distribution of antibiotic sensitivity and resistance

4. Discussion

Respiratory tract infections are the emerging concerns which causes morbidity and increasing antimicrobial resistance (Reynoldsetal.,2022). According to Muteebetal.(2023)The increasing emergence of the antimicrobial resistance in the respiratory pathogens became major therapeutic challenges mainly in developing countries in which the antibiotics are used as empirical therapy. However, continuous monitoring of the bacterial changes and factors along with the antibiotic susceptibility patterns help in providing rational therapeutic managing strategies

and also help in minimizing the development of resistance patterns (Basetti et al., 2022). The present study showed that organisms like *Streptococcus pneumoniae, Klebsiella pneumoniae, Pseudomonas aeruginosa* and *Staphylococcus aureus* were most commonly isolated organisms. Similar findings were found by Wajid et al. (2020) in which the *Streptococcus pneumoniae* and *Klebsiella pneumonia* were found as the predominant pathogens which are responsible for causing lower respiratory tract infections. These results suggest that these organisms always contribute to the major bacterial causes of RTIs in all the different healthcare settings. In the present study, the male population showed higher infections when compared to the female patients.

Ahmedetal.(2013)also showed that the Gram-negative bacteria like *Klebsiellapneumoniae* and *Pseudomonas aeruginosa* were mostly found to isolate organisms in most respiratory infections indicating that these organisms have an increasing resistance pattern. This is similar to our study in which the Gram-negative strains played an important role in contributing to the infections. In the same way, Chowdhury et al. (2023) performed a study in which the male patients had higher predominance in the respiratory tract infections and this can be because males are exposed to the environment more and have certain lifestyle habits. This observation helped the demographic findings of our study.

The different types of specimens used in our study were sputum, blood and swab. In which the sputum is the most common sample used in the diagnosis. In the same way, a study by Mishraet al. (2012) similarly showed that the sputum sample is the most common respiratory sample because of the highest value and routine use in microbiological investigations of Respiratory Tract Infections. This explains that the sputum examination is the standard diagnostic approach.

The present study showed better sensitivity towards meropenem, moxifloxacin and piperacillin-tazobactam. Gagneja et al. (2011) also explained that carbapenems and beta-lactam combination antibiotics showed good sensitivity whereas the most commonly used ones showed increasing resistance patterns. These findings helped in understanding that higher-generation antibiotics were more effective against the resistant pathogens. And the authors of the present study reported that the most commonly used antibiotics such as amoxicillin and azithromycin have higher resistance compared to other antibiotics. Amarasinghe et al. (2018) showed similar findings in their study which suggested that frequent and irrational use of these antibiotics can be the reason for the increasing resistance. This helps in understanding that overuse of common antibiotics decreases their therapeutic efficiency.

In the current study, another important finding was that carbapenem antibiotics like meropenem and faropenem showed higher susceptibility and better effectiveness when compared to other drugs. Tchatchouang et al. (2019) also showed the same findings in which the carbapenems were effective against the most resistant bacteria and this explains that these antibiotics are suitable for serious infections. According to our results and findings, the increase in antibiotic resistance can be because of improper antibiotic use which includes self medication, not being adherent to the therapy as patients often stop using the antibiotics early when they feel healthy. Lack of proper antibiotic control programs and awareness can also be a reason for increasing the resistance patterns.

A major strength of the study is it included the recent data collected within a time period of two years with proper sample size and standardized susceptibility testing like CLSI guidelines. Also the data from both Government and private laboratories were included in the present study which helps in providing a better understanding about resistance patterns in the community. Along with the strengths there are also some limitations, since the study has a retrospective timeline it majorly depends on the available records. The patient treatment out comes were not included and the molecular resistance was not performed like Domínguez et al (2023) performed in their study. In addition, the study was performed only in one region and the results in the different areas might differ. Future studies must include the different centers and advanced resistance techniques for obtaining accurate results. Conducting antibiotic stewardship programs can also be included in the further studies. However, the novelty of the present study is present in determining the antibiotic resistance patterns in a community health care setting as most of the previous studies were conducted in a tertiary care hospital. The

study also explains about the data regarding recent resistance which help in understanding the empirical antibiotic therapy in the local healthcare settings. Our study explained that the resistance of antibiotics in respiratory infections is increasing. To overcome this regular monitoring, rational antibiotic use and infection control can help in increasing the treatment effectiveness.

5. Conclusion

The present study explained about the increasing resistance patterns of antibiotics in respiratory tract infections in a community healthcare setting. The results showed that *Streptococcus pneumoniae*, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa* and *Staphylococcusaureus* were most commonly found isolated pathogens. The study also showed that higher antibiotics like meropenem, Moxifloxacin and piperacillin-tazobactam had better susceptibility and the commonly used antibiotics like amoxicillin and Azithromycin had higher resistance. These results indicate the increasing problem of the antimicrobial resistance between most commonly used antibiotics. The results also explained the importance of conducting culture and sensitivity testing before starting the antibiotic therapy. Proper use of antibiotics and avoiding misuse of the unnecessary prescriptions are important for minimizing the development of the resistance. Constant monitoring of antibiotic susceptibility patterns can help in selecting more effective empirical therapy.

The study used local resistance data from a community healthcare setting which helped in understanding the real-world resistance patterns as most of the previous studies conducted their study in tertiary care hospitals. This data was important for increasing the treatment guidelines locally. Further studies on inclusion of molecular resistance mechanisms and risk factor analysis help in obtaining more clear results. Rational use of drugs and constant monitoring help in increasing treatment strategies and enhance the effectiveness.

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