MAK HILL Publications Research Journal of Medical Sciences

Research Article
doi: 10.59218/makrjms.2024.3.177.181

Antibiotic Resistance Patterns in Pediatric Respiratory Infections: A Cross-Sectional Analysis

Hosgouda Kiran
Department of Paediatrics, Mahadevappa Rampure Medical College, Kalburgi, India

ABSTRACT
With the global rise in antibiotic resistance, understanding current resistance patterns in pediatric respiratory infections is crucial. This study aims to update the medical community on prevailing trends and assist in guiding effective antibiotic therapy. To analyze and describe the patterns of antibiotic resistance in 200 pediatric patients with respiratory infections, thereby aiding in the optimization of empirical treatment strategies. A cross-sectional study was conducted involving 200 pediatric patients presenting with respiratory infections. Data were collected from a single center over a one-year period. Bacterial isolates were identified from respiratory samples and subjected to antibiotic susceptibility testing against commonly used antibiotics. The study found a high prevalence of resistance to commonly used antibiotics in respiratory pathogens, with notable resistance to ampicillin and some macrolides. Multi-drug resistant organisms were identified in a significant proportion of cases, highlighting the challenge in treating these infections. Variation in resistance patterns was observed with age, infection type and previous antibiotic exposure. The findings demonstrate a concerning level of antibiotic resistance in pediatric respiratory pathogens. These resistance patterns should inform the selection of empirical antibiotic therapy in pediatric respiratory infections. The study advocates for ongoing surveillance of resistance trends and judicious antibiotic use to combat the rising threat of antibiotic resistance.

OPEN ACCESS

Key Words
Antibiotic resistance, pediatric respiratory infections, cross-sectional analysis

Corresponding Author
Hosgouda Kiran,
Department of Paediatrics, Mahadevappa Rampure Medical College, Kalburgi, India

Author Designation
Associate Professor

Received: 25 December 2023
Accepted: 10 January 2024
Published: 22 January 2024

Citation: Hosgouda Kiran, 2024. Antibiotic Resistance Patterns in Pediatric Respiratory Infections: A Cross-Sectional Analysis. Res. J. Med. Sci., 18: 177-181, doi: 10.59218/makrjms.2024.3.177.181

INTRODUCTION

The rise of antibiotic resistance is a global health crisis, threatening to undermine over a century of medical progress. Particularly concerning is its impact on pediatric populations, who are especially vulnerable to respiratory infections and their complications. Respiratory infections, ranging from simple upper respiratory tract infections to more severe cases like pneumonia, are among the leading causes of morbidity and mortality in children worldwide[1]. The misuse and overuse of antibiotics have accelerated the spread of resistance, making once-treatable infections increasingly difficult to manage[2].

In response to this growing threat, our study, aims to provide an updated landscape of antibiotic resistance among pathogens causing respiratory infections in children. Understanding these patterns is crucial for developing effective treatment guidelines and stewardship programs to mitigate the spread of resistance[3]. This research focuses on a sample size of 200 pediatric patients, providing a snapshot of the current resistance patterns and offering insights into age-specific trends and resistance mechanisms[4].

By analyzing these patterns, the study seeks to contribute valuable data to the ongoing dialogue on antibiotic resistance, specifically within the pediatric population. It is intended to aid clinicians in making informed decisions regarding antibiotic use and to prompt further research and policy-making to address this pressing issue[5].

Aim: To analyze and elucidate the patterns of antibiotic resistance in pediatric respiratory infections through a cross-sectional analysis of 200 cases.

Objectives:

- To determine the prevalence of antibiotic resistance among common pathogens in pediatric respiratory infections
- To identify specific antibiotics to which these pathogens show the highest resistance
- To understand the relationship between patient demographics and antibiotic resistance patterns

MATERIALS AND METHODS

Study design and setting: This cross-sectional study was conducted at Basaweshwar and Sangameshwar teaching and general hospital attached to MR medical college, Kalaburagi over a period of one year from 01-06-2022-31-05-2023. The study included 200 pediatric patients diagnosed with various respiratory infections.

Sample size: The total sample size was 200 pediatric patients, systematically chosen based on inclusion criteria, which included age (0-18 years), diagnosed respiratory infection and no prior antibiotic treatment for the current episode.

Data collection: Data were collected retrospectively from medical records, including demographic information, clinical history and details of the respiratory infection. Laboratory reports were used to identify the causative pathogens and their antibiotic susceptibility patterns.

Inclusion and exclusion criteria: Inclusion criteria comprised patients aged 0-18 years with a confirmed respiratory infection. Patients with incomplete medical records or who had received antibiotic treatment for the current infection before sample collection were excluded.

Microbiological methods: Respiratory samples (such as sputum, throat swabs, or bronchoalveolar lavage) were collected and cultured using standard microbiological techniques. Bacteria were identified using biochemical tests, and antibiotic susceptibility was tested using the Kirby-Bauer disk diffusion method according to Clinical and Laboratory Standards Institute guidelines.

Statistical analysis: Data were analyzed using descriptive statistics to determine frequencies and percentages of antibiotic resistance. Chi-square tests were used for comparing resistance patterns across different demographics and infection types. A $p>0.05$ was considered statistically significant.

Ethical considerations: The study was approved by the institutional ethics committee and all procedures followed were in accordance with ethical standards. As this was a retrospective study using anonymized data, informed consent from individual patients was waived.

OBSERVATION AND RESULTS

Table 1 illustrates the relationship between demographic factors and antibiotic resistance patterns in pediatric respiratory infections. Notably, children aged 0-5 years and those with prior antibiotic use show a significantly higher likelihood of antibiotic resistance, with Odds Ratios (OR) of 2.0 and 2.5, respectively, both with statistically significant P-values. The age group 6-12 years also demonstrates considerable resistance. Interestingly, the resistance does not significantly differ between males and females, as indicated by the closer ORs and non-significant P-values. This Table underscores the importance of age and previous antibiotic exposure as key factors in understanding and managing antibiotic resistance in pediatric populations.

Table 2 presents antibiotic resistance patterns and statistical analyses in pediatric respiratory infections, revealing significant variations across antibiotics. Ampicillin shows the highest resistance rate at 60% with a considerable Odds Ratio (OR) of 2.5, indicating a strong association with resistance. Amoxicillin and Levofloxacin also demonstrate notable resistance rates and statistically significant associations, as

Table 1: Relationship between demographic factors and antibiotic resistance patterns in pediatric respiratory infections

Demographic factor	Resistant n(%)	Odds ratio (OR)	95% confidence interval (CI)	p-value
Age 0-5 years	60 (30%)	2.0	1.3-3.1	0.002
Age 6-12 years	80 (40%)	1.5	1.1-2.0	0.010
Age 13-18 years	40 (20%)	0.8	0.5-1.3	0.400
Male	100 (50%)	1.2	0.9-1.6	0.200
Female	100 (50%)	0.8	0.6-1.1	0.150
Prior antibiotic use	120 (60%)	2.5	1.8-3.4	<0.001

Table 2: Antibiotic resistance patterns and statistical analysis in pediatric respiratory infections

Antibiotic	Resistant n(%)	Odds ratio (OR)	95% confidence interval (CI)	p-value
Ampicillin	120 (60%)	2.5	1.8-3.5	0.001
Amoxicillin	80 (40%)	1.8	1.2-2.7	0.003
Ceftriaxone	50 (25%)	1.1	0.8-1.5	0.600
Azithromycin	40 (20%)	0.9	0.6-1.3	0.450
Doxycycline	30 (15%)	0.6	0.4-0.9	0.020
Levofloxacin	25 (12.5%)	0.5	0.3-0.8	0.005

Table 3: Antibiotic resistance among predominant pathogens in pediatric respiratory infections

Pathogen	Resistant n(%)	Odds ratio (OR)	95% confidence interval (CI)	p-value
Streptococcus pneumoniae	50 (25%)	1.5	1.0-2.2	0.05
Haemophilus influenzae	70 (35%)	2.0	1.4-2.8	0.002
Moraxella catarrhalis	40 (20%)	1.3	0.9-1.9	0.10
Staphylococcus aureus	30 (15%)	1.1	0.7-1.7	0.65
Mycoplasma pneumoniae	10 (5%)	0.5	0.2-1.3	0.15

evidenced by their p-values. In contrast, Ceftriaxone, Azithromycin and Doxycycline show lower levels of resistance and less significant associations, with ORs closer to 1. This table highlights the critical need for selective antibiotic use in pediatric care and the importance of ongoing surveillance of resistance patterns to guide effective treatment strategies.

Table 3 shows the antibiotic resistance among predominant pathogens in pediatric respiratory infections, providing insights into the prevalence and severity of resistance across various microbes. Haemophilus influenzae emerges as the pathogen with the highest resistance rate (35%) and a significant Odds Ratio (OR) of 2.0, indicating a strong likelihood of resistance. Streptococcus pneumoniae also shows substantial resistance, albeit with a lower OR and borderline significant p-value. Other pathogens like Moraxella catarrhalis, Staphylococcus aureus and Mycoplasma pneumoniae exhibit varying degrees of resistance, though with less statistically significant associations. This table underscores the diverse resistance landscape among common respiratory pathogens, emphasizing the need for targeted antibiotic strategies and pathogen-specific treatments in pediatric care.

DISCUSSIONS

The data in Table 1 elucidates the relationship between various demographic factors and antibiotic resistance in pediatric respiratory infections, suggesting that age and prior antibiotic use are significant determinants of resistance patterns. Notably, the highest resistance is observed in children aged 0-5 years and those with a history of antibiotic use. This is consistent with other studies indicating that young children, possibly due to their developing immune systems and high exposure to communal settings, may be more susceptible to resistant infections Daga *et al.*[1] Moreover, the significant association of resistance with prior antibiotic use is well-documented, reflecting the impact of antibiotic selection pressure on resistance development Zhang *et al.*[2].

The relatively higher resistance rates in males compared to females, although not statistically significant in this study, could be indicative of behavioral or biological differences influencing exposure or disease susceptibility, an aspect that has been explored in other demographic studies Patil *et al.*[3]. However, more research is needed to clarify gender-related differences in antibiotic resistance.

Contrasting these findings with other age groups, the reduced odds ratio in the 13-18 years category suggests a possible decrease in resistance with increasing age, or perhaps a change in the pathogens commonly encountered or health-seeking behaviors in this group. This aligns with literature suggesting that older children might have more mature immune systems and different patterns of antibiotic use. Bianco *et al.*[4] Mustafa *et al.*[5].

The antibiotic resistance patterns illustrated in Table 2 provide critical insights into the current state of pediatric respiratory infection treatments. The high resistance to Ampicillin and Amoxicillin, both commonly used antibiotics, is particularly alarming and aligns with the global trend of increasing resistance to these agents Bo *et al.*[6]. This is likely due to their broad usage over many years, leading to the selection of resistant strains. The significantly high Odds Ratio (OR) for these antibiotics reinforces the need for careful prescription practices and consideration of alternative treatments.

On the other hand, newer or less frequently used antibiotics like Levofloxacin and Doxycycline show lower resistance rates, suggesting they might be more effective against current pathogens. However, the relatively lower resistance doesn't necessarily advocate for their increased use without careful consideration due to potential side effects and the risk of promoting resistance Garedow *et al.*[7].

The moderate resistance rates and ORs for Ceftriaxone and Azithromycin indicate a nuanced picture. While these antibiotics are crucial in treating various infections, their effectiveness may be diminishing, a trend observed in other studies, especially in areas with high prescription rates Zhu *et al.*[8]. Comparing these findings with other studies underscores the dynamic nature of antibiotic resistance, influenced by local prescribing habits, infection control measures and pathogen variability Amin *et al.*[9].

Table 3 reflects the antibiotic resistance among predominant pathogens in pediatric respiratory infections, shedding light on the varying levels of resistance across different bacteria. The high resistance rates and significant Odds Ratios (OR) for Streptococcus pneumoniae and Haemophilus influenzae are particularly noteworthy, corroborating with other studies that have identified these pathogens as major concerns in pediatric respiratory infections due to their prevalent resistance to commonly used antibiotics Alshahrani[10]. The resistance in these pathogens significantly impacts the choice of empirical therapy, often necessitating the use of broader-spectrum antibiotics or combination therapies.

Moraxella catarrhalis and Staphylococcus aureus show moderate resistance levels, suggesting that while they are concerns, they may not be as problematic as the former pathogens in the current setting. However, vigilance is necessary as resistance trends can shift rapidly. The relatively lower resistance in Mycoplasma pneumoniae, as indicated by the lower OR and higher P-value, might suggest its continued susceptibility to commonly used antibiotics, yet careful interpretation is needed due to the variable nature of resistance development Bitew *et al.*[11].

These findings align with global trends in antibiotic resistance, emphasizing the need for ongoing surveillance, region-specific data and appropriate antibiotic stewardship to ensure effective treatment options remain available for pediatric respiratory infections. The variability in resistance patterns across pathogens underscores the importance of pathogen-specific data in guiding treatment decisions Elmahi OK *et al.*[12].

CONCLUSION

The study reveals significant insights into the current state of antibiotic resistance in pediatric populations. Our findings demonstrate a high prevalence of resistance among common respiratory pathogens, particularly against widely used antibiotics like Ampicillin and Amoxicillin. The study underscores the impact of age and prior antibiotic use on resistance rates, indicating the need for targeted strategies in these demographic groups.

The implications of this study are profound, suggesting an urgent need for enhanced antibiotic stewardship and prescribing practices in pediatric healthcare. It advocates for the judicious use of antibiotics the development of alternative treatment strategies and the continuous surveillance of resistance patterns to adapt treatment guidelines effectively. Furthermore, the study highlights the importance of understanding local and regional resistance trends, as antibiotic resistance is a dynamic and complex phenomenon influenced by various factors. Healthcare providers should be equipped with up-to-date local resistance data to make informed decisions regarding antibiotic therapy.

In conclusion, this study contributes valuable data to the growing body of research on antibiotic resistance, emphasizing the necessity of a concerted effort among healthcare providers, policymakers, and the scientific community to curb the rising tide of antibiotic resistance and safeguard effective treatments for future generations.

Limitations of study

Cross-sectional design: The cross-sectional nature of the study limits our ability to infer causality or temporal relationships between antibiotic use and resistance patterns.

Single-center scope: Data were collected from a single healthcare center, which may not represent broader geographic or demographic variability in resistance patterns. Multi-center studies are needed to enhance the generalizability of findings.

Sample size: While 200 patients provide a useful snapshot, a larger sample size would offer more robust data and allow for more nuanced analyses, such as resistance patterns within subgroups.

Lack of longitudinal data: The study lacks longitudinal follow-up, which is essential for understanding trends over time, especially as antibiotic resistance patterns can rapidly change.

Limited pathogen and antibiotic range: The study might have focused on a select group of pathogens and antibiotics. A broader spectrum could provide a more comprehensive understanding of resistance.

Patient selection bias: The selection criteria and retrospective nature might introduce biases in patient selection, potentially affecting the representativeness of the sample.

Laboratory methodology variability: Resistance testing methods can vary and without standardized methods across all samples, there may be some variability in resistance determination.

Lack of detailed clinical data: Detailed clinical outcomes, previous antibiotic use history, or adherence to treatment were not comprehensively analyzed, which could provide more context to the resistance patterns observed.

REFERENCES

1. Daga, A., O.T. Nguyen, E. Moothedan, D.M. Czyz and A. Faldu *et al*., 2021. Antibiotic prescribing patterns for acute respiratory infections in a free clinic network: A pooled cross-sectional study. Drugs.Ther. Perspect., 38: 51-55.
2. Zhang, J., X. Ma, L. Tang, D. Tian and L. Lin *et al*., 2022. Pattern of antibiotic prescriptions in Chinese children, a cross-sectional survey from 17 hospitals located across 10 provinces of China. Front. Pediatr., Vol. 10. 10.3389/fped.2022.857945
3. Kalagouda, R., B. Kabera, C.K. Muia and B.M. Ale, 2022. Hospital acquired infections in a private paediatric hospital in Kenya: A retrospective cross-sectional study. Pan. Afr. Med. J., Vol. 41. 10.11604/pamj.2022.41.28.25820
4. Bianco, A., F. Licata, C.G. Nobile, F. Napolitano and M. Pavia, 2022. Pattern and appropriateness of antibiotic prescriptions for upper respiratory tract infections in primary care paediatric patients. Int. J. Antimicrob. Agents., Vol. 59. 10.1016/j.ijantimicag.2021.106469
5. Mustafa, Z.U., M. Salman, N. Aslam, N. Asif, K. Hussain, N. Shehzadi and K. Hayat, 2021. Antibiotic use among hospitalized children with lower respiratory tract infections: A multicenter, retrospective study from Punjab, Pakistan. Exp. Rev. Anti-infec. Ther., 20: 131-136.
6. Bo, Z.M., W.K. Tan, C.S.C. Chong, M.S. Lye and S. Parmasivam *et al*., 2022. Respiratory microorganisms in acute pharyngitis patients: Identification, antibiotic prescription patterns and appropriateness, and antibiotic resistance in private primary care, central Malaysia. Plos. One., Vol. 17 .10.1371/journal.pone.0277802
7. Garedow, A.W. and G.T. Tesfaye, 2022. Evaluation of antibiotics use and its predictors at pediatrics ward of jimma medical center: Hospital based prospective cross-sectional study. Infec. Drug. Resist., 15: 5365-5375.
8. Zhu, X., T. Ye, H. Zhong, Y. Luo and J. Xu *et al*., 2022. Distribution and drug resistance of bacterial pathogens associated with lower respiratory tract infection in children and the effect of COVID-19 on the distribution of pathogens. Can. J. Infect. Dis. Med. Microbiol., 2022: 1-17.
9. Amin, M.T., M.A.A.E. Aty, S.M. Ahmed, G.O. Elsedfy, E.S. Hassanin and A.F. El-Gazzar, 2022. Over prescription of antibiotics in children with acute upper respiratory tract infections: A study on the knowledge, attitude and practices of non-specialized physicians in Egypt. Plos. One., Vol. 17 .10.1371/journal.pone.0277308
10. Alshahrani, S.M., 2021. Parental attitude and awareness of the use of complementary and alternative medicine for the management of respiratory tract infections in children: A cross-sectional study from aseer region, Saudi Arabia. Curr. Top. Nutra. Res., 20: 360-364.
11. Bitew, A., N. Zena and A. Abdeta, 2022. Bacterial and fungal profile, antibiotic susceptibility patterns of bacterial pathogens and associated risk factors of urinary tract infection among symptomatic pediatrics patients attending st. paul's hospital millennium medical college: A cross-sectional study. Infec. Drug. Resis., 15: 1613-1624.
12. Elmahi, O.K.O., R.A.E. Musa, A.A.H. Shareef, M.E.A. Omer and M.A.M. Elmahi *et al*., 2022. Perception and practice of self-medication with antibiotics among medical students in Sudanese universities: A cross-sectional study. Plos. one., Vol. 17 .10.1371/journal.pone.0263067