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Prevalence of Amoxicillin and Ciprofloxacin Sensitive *Staphylococcus* sp in Allergic Rhinitis Patients

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A R T I C L E I N F O

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A B S T R A C T

Allergens cause persistent irritation of the nasal and sinus mucosa in allergic rhinitis. Allergic rhinitis increases the risk of respiratory and ear infections. Antibiotics such as Amoxicillin and Ciprofloxacin are used to treat respiratory tract infections. Staphylococcus colonization increases the risk of allergic rhinitis and respiratory diseases. This study examined the sensitivity of Staphylococcus bacteria to amoxicillin and ciprofloxacin. This study was cross-sectional. The Microbiology and Research Laboratory at the School of Medicine, Universitas Muhammadiyah Yogyakarta, conducted the study. Based on historical records, 42 medical students at Universitas Muhammadiyah Yogyakarta suspect they have allergic rhinitis. Nasal samples were obtained from volunteers with allergic rhinitis. A sample was injected into the blood media to determine the presence of gram-positive bacteria. Gram stain and catalase tests indicated the presence of growing colonies. Kirby-Bauer sensitivity assays determine the sensitivity patterns of amoxicillin and ciprofloxacin in bacterial nasal swabs. Amoxicillin (62%) and ciprofloxacin (81%) were effective against Staphylococcus. These studies found that patients with allergic rhinitis have Staphylococcus nasal swabs that are sensitive to amoxicillin and ciprofloxacin

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INTRODUCTION

Allergic rhinitis is an inflammatory condition of the respiratory tract that is increasingly prevalent. This condition is associated with bacterial colonization of the nasal mucosa, particularly *Staphylococcus aureus*. Various studies have shown that the presence of *Staphylococcus aureus*, which produces toxins and superantigens, exacerbates the inflammatory reaction and clinical manifestations of allergic rhinitis. According to Zhang and Zhang (2019), the global prevalence of allergic rhinitis in adults is approximately 10-40%. Allergic rhinitis is a respiratory disease associated with allergies (Brozek et al., 2017). Allergic rhinitis is an IgE-mediated response. Ecological dysbiosis of the airway microbiota causes respiratory distress. Asthma and allergic rhinitis are associated with gut microbiota (Sozanska, 2019).

O'Neil and Mims (2014) reported that the prevalence of allergic rhinitis in Indonesia is 40% in children and between 10 and 30% in adults. Sur and Scandale (2010) reported that 50% of adults reported experiencing rhinitis symptoms. The prevalence of allergic rhinitis in the Philippines is 28.3%. Allergic rhinitis reduces productivity and quality of life for sufferers (Widuri et al, 2021). Side effects of allergic rhinitis include fatigue, disturbed sleep, and cognitive impairment (Zhang & Zhang, 2014). Fauzi et al. (2015) reported a 38.2% prevalence of allergic rhinitis among students at Padjajaran University, and Alotaibi (2018) reported a 51% prevalence of allergic rhinitis among students at University of Hail Saudi Arabia.

Amoxicillin and ciprofloxacin is one of the most widely used antibiotics in the treatment of infectious diseases due to its effectiveness, availability, and affordability. However, the widespread and irrational use of amoxicillin and ciprofloxacin has led to increased antibiotic resistance among pathogenic bacteria. In populations with a history of allergic rhinitis, colonization with amoxicillin and ciprofloxacin resistant *Staphylococcus aureus* has the potential to prolong inflammation, exacerbate symptoms, and increase the incidence of secondary infections.

Research on antibiotic resistance in Staphylococcus bacteria isolated from nasal swabs in patients with allergic rhinitis is limited. This local limitation makes it difficult to formulate evidence-based antibiotic use policies, especially in cases of allergic rhinitis, which are frequently treated by paramedics in primary healthcare facilities. The purpose of this study was to analyze the sensitive patterns of *Staphylococcus* sp. to amoxicillin and ciprofloxacin in patients with allergic rhinitis. The findings are expected to provide the latest empirical data on amoxicillin antibiotic resistance in the population. The results of this study can also serve as a basis for developing recommendations for more rational antibiotic use, increasing public and paramedic awareness of antimicrobial resistance trends in allergic rhinitis cases.

METHODS

This study used a cross-sectional design. Research conducted in Microbiology laboratory, School of Medicine, Universitas Muhammadiyah Yogyakarta. The respondents were medical students at Universitas Muhammadiyah Yogyakarta with a history of allergic rhinitis. Respondents were asked to complete an informed consent form. This study has obtained research permission from the ethics committee of the Faculty of Medicine and Health Sciences, Universitas Muhammadiyah Yogyakarta. Data collected in this study were 42 medical students at Universitas Muhammadiyah Yogyakarta with a history of allergic rhinitis. They were asked to complete a questionnaire containing several statements, to determine the inclusion and exclusion criteria. Respondents who met the requirements for allergic rhinitis/atopy, nasal swabs were taken using sterile cotton to examine the type of bacteria. Nasal swabs were planted on blood agar media, then incubated at 37 °C, for 24 hours. Colonies that grew were identified using Gram staining. Colonies that had microscopic characteristics of cocci, Gram-positive, and clustered were tested with a catalase test. Furthermore, bacterial colonies that showed properties as Staphylococcus were tested for sensitivity to amoxicillin and ciprofloxacin using the Kirby Bauer method.

RESULTS

The subject of this research are 42 students of school medicine, Universitas Muhammadiyah Yogyakarta. Selection of subjects based on history checks to make sure the subjects suspect from allergic rhinitis. After identification and sensitivity test, the results were reported following term. Figure 1 shows the results of the pattern sensitivity bacteria to antibiotics amoxicillin and ciprofloxacin.

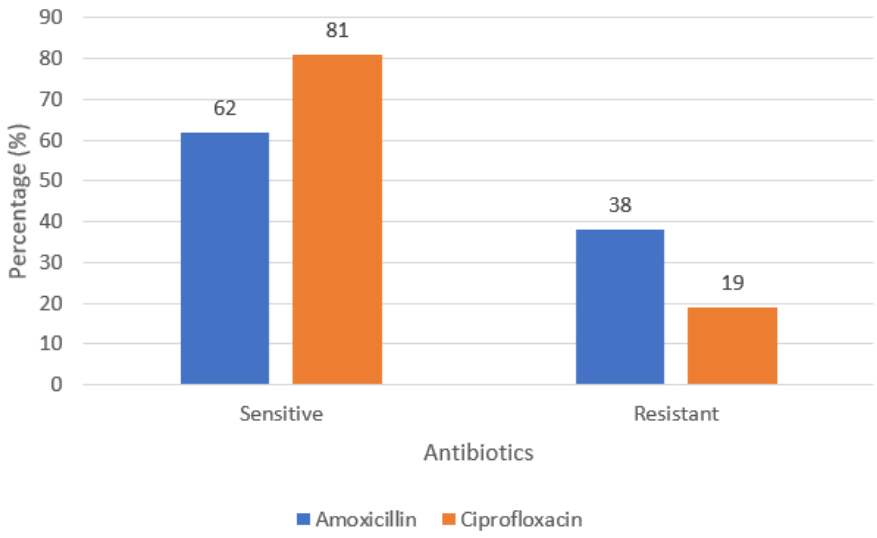

Figure 1. Sensitivity Patterns of Staphylococcus Nasal Isolates from Allergic Rhinitis Patients to Amoxicillin and Ciprofloxacin

DISCUSSION

While most Staphylococcus isolates were responsive to both medicines, amoxicillin sensitivity was 62%. Staphylococcus may become amoxicillin resistant. The 38% amoxicillin resistance rate suggests that clinical antibiotic selection pressure is present. The widespread and frequently uncontrolled antibiotic resistance indicates the need to select drugs more effectively. Ciprofloxacin's 81% sensitivity suggests that it can effectively treat Staphylococcus infections. However, 20% resistant isolates remain a concern. Ciprofloxacin resistance is typically associated with mutations in the antibiotic's primary target genes, gyrA and parC. Ciprofloxacin was more effective than amoxicillin in this experiment; however, overuse can quickly lead to the development of fluoroquinolone resistance (Shariati et al., 2022). Our data suggest that amoxicillin is no longer a reliable empirical treatment for staphylococcal infections in patients with allergic rhinitis due to its high rate of resistance. Ciprofloxacin may be more effective, but it must be used cautiously and monitored for the development of resistance. To prevent resistance increases, antibiotic usage strategies must include antimicrobial stewardship and resistance monitoring. Amoxicillin, a β-lactam antibiotic, treats infections caused by Gram-positive bacteria, such as Staphylococcus aureus. Penicillin-binding proteins (PBPs), enzymes that transpeptidase and cross-link peptidoglycan, enable amoxicillin to suppress bacterial cell wall production (Bush & Bradford, 2016).

Peptidoglycan provides Gram-positive bacteria, such as Staphylococcus, with mechanical strength and cellular stability. Amoxicillin binds to penicillin-binding proteins (PBPs), disrupting cell wall production and creating an unstable peptidoglycan structure that cannot tolerate intracellular osmotic pressure (Garde et al., 2021). Amoxicillin inhibits the action of penicillin-binding proteins, which are responsible for breaking down cell walls and activating autolysins. Autolysin activation degrades cell wall components, thereby accelerating bacterial cell lysis and enhancing the bactericidal effects of amoxicillin (Kushwana and Gupta, 2023). Since PBP activity peaks during growth, amoxicillin is highly efficient against actively dividing bacteria. Although amoxicillin has a strong mechanism of action, its effectiveness against *Staphylococcus aureus* is decreasing due to the rise of β-lactamase-producing bacteria. These enzymes break down the β-lactam ring of amoxicillin before it interacts with its target, penicillin-binding proteins (PBPs), rendering the antibiotic inactive (Baran et al., 2023). In bacteria such as *Staphylococcus aureus*, the blaZ gene leads to the production of β-lactamase, the primary mechanism of resistance (Rajput et al, 2024). MRSA contains a mutant penicillin-binding protein 2a (PBP2a) encoded by the mecA gene. PBP2a's low affinity for β-lactam

antibiotics, such as amoxicillin, allows bacteria to produce cell walls despite the presence of the drug (Hiramatsu et al., 2014).

Staphylococcus dies due to amoxicillin's disruption of the cell wall and activation of the autolysin. Resistance from β-lactamase production and PBP alterations significantly impacts the therapeutic effectiveness of this antibiotic. Monitor bacterial susceptibility and use antibiotics appropriately to prevent the development of antimicrobial resistance. Ciprofloxacin inhibits *Staphylococcus aureus* DNA replication. They block DNA gyrase (topoisomerase II) and IV, which are needed for supercoiling, DNA strand separation, and bacterial chromosomal segregation during cell division (Hooper & Jacoby, 2016). Ciprofloxacin's interaction with the DNA-enzyme complex produces permanent double-strand breaks, thereby limiting replication and transcription (Aldred, Kerns, & Berger, 2014). This DNA damage triggers the cellular stress response, which kills bacteria and renders ciprofloxacin a potent antibiotic. Ciprofloxacin works against Staphylococcus because it binds to topoisomerase IV, the principal target of fluoroquinolones in Gram-positive bacteria (Lambert, 2012). The prevalence of fluoroquinolone-resistant *Staphylococcus aureus* isolates is increasing globally. The affinity of ciprofloxacin for the target enzyme diminishes because of mutations in the gyrA and parC loci (Shariati et al, 2022). Elevated expression of efflux pumps, such as NorA, may reduce intracellular antibiotic concentrations and compromise therapeutic effectiveness (Foster, 2017). Administration of ciprofloxacin should consider local susceptibility patterns, as target mutations and efflux mechanisms contribute to resistance. 81% of the study Staphylococcus isolates were ciprofloxacine-sensitive. The 19% resistant isolates suggest that fluoroquinolone resistance is rising. To avoid the development of resistant strains, empirical ciprofloxacin treatment must incorporate clinical considerations, susceptibility test results, and antimicrobial stewardship requirements. Fluoroquinolone resistance must be monitored to treat staphylococcal infections.

CONCLUSIONS AND RECOMMENDATIONS

This study found that the nasal Staphylococcus isolates of allergic rhinitis patients are sensitive to amoxicillin and ciprofloxacin differently. Eighty percent of nasal swab isolates were ciprofloxacin-sensitive, while 62 percent were amoxicillin-sensitive. Ciprofloxacin kills Staphylococcus isolates from allergic rhinitis nasal better than amoxicillin. This discrepancy may be due to the antibiotic's mechanism of suppressing the target cell. Monitoring antibiotic resistance patterns is crucial to preventing bacterial resistance from rising. The prudent use of antibiotics requires education for both the public and medical professionals.

FURTHER STUDY

Several study limitations must be addressed to avoid misinterpretation of the results. The modest number of Staphylococcus isolates does not reflect community resistance tendencies. Only two medications were tested; therefore, the study does not provide a complete picture of antibiotic resistance for Staphylococcus infections. Most antibiotic resistance testing utilizes phenotypic tests, which do not reveal the molecular pathways of bacterial drug resistance. Staphylococcus isolates from other sources, as well as larger samples, are needed for further research. Researching resistance patterns, epidemiological factors, and patient clinical characteristics will yield more comprehensive information that can be used to develop effective plans for controlling antibiotic resistance.

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