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Study of Vancomycin Susceptibility in Methicillin-Resistant Staphylococcus aureus (MRSA)

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Abstract

Methicillin-resistant Staphylococcus aureus (MRSA) has emerged as a major cause of healthcare-associated infections, posing significant treatment challenges due to its resistance to multiple antibiotics. Vancomycin, a glycopeptide antibiotic, is often considered the drug of choice for treating MRSA infections. However, the emergence of reduced vancomycin susceptibility in MRSA strains has raised concerns regarding the efficacy of this treatment. This study aimed to investigate the vancomycin susceptibility of MRSA isolates obtained from clinical samples in a tertiary care hospital. A total of 100 MRSA isolates were collected from various clinical specimens, including blood, wound, and respiratory tract samples. Vancomycin susceptibility was determined using the disk diffusion method and the broth microdilution method to identify Minimum Inhibitory Concentration (MIC) values. Among the 100 MRSA isolates, 96% showed susceptibility to vancomycin, with only 4% exhibiting intermediate resistance. No isolates demonstrated complete resistance to vancomycin. The study highlights that while vancomycin remains effective against most MRSA strains, the emergence of intermediate resistance indicates the need for continuous surveillance and the prudent use of antibiotics to prevent further resistance development.

Keywords: Staphylococcus aureus, Methicillin-resistant Staphylococcus aureus (MRSA), Vancomycin susceptibility, Antimicrobial resistance, Hospital infections.

Introduction

Staphylococcus aureus is a common pathogen that can cause a wide range of infections, from mild skin conditions to severe systemic diseases such as pneumonia, septicemia, and endocarditis. Historically, S. aureus was treatable with a variety of antibiotics, including methicillin, a penicillin derivative. However, the emergence of methicillin-resistant Staphylococcus aureus (MRSA) in the 1960s marked a significant challenge in the management of S. aureus-related infections. MRSA strains are resistant to nearly all beta-lactam antibiotics, including penicillin and cephalosporins, making infections caused by these bacteria difficult to treat with conventional antibiotics (1).

Vancomycin, a glycopeptide antibiotic, has remained the cornerstone of therapy for MRSA infections, particularly in severe cases such as bacteremia, endocarditis, and pneumonia (2). However, the increasing emergence of vancomycin-intermediate Staphylococcus aureus (VISA) and vancomycin-resistant Staphylococcus aureus (VRSA) strains presents a growing concern (3). The clinical significance of intermediate resistance to vancomycin is still debated, as it may indicate an impending shift toward full vancomycin resistance, which would leave very limited treatment options available (4).

Vancomycin resistance in S. aureus is typically associated with a thickening of the bacterial cell wall, which reduces the effectiveness of the drug

(5). Furthermore, the use of vancomycin over extended periods has been implicated in the selection of these resistant strains. While the prevalence of VRSA is still relatively low, the development of intermediate resistance in MRSA has been increasingly reported (6). Surveillance of vancomycin susceptibility in MRSA isolates is essential for understanding the evolution of resistance patterns and for informing treatment decisions.

The present study aims to assess the vancomycin susceptibility of MRSA isolates from clinical samples in a tertiary care hospital, contributing to the understanding of resistance trends and the potential risks of treatment failure in the future.

Aim

To evaluate the vancomycin susceptibility of Staphylococcus aureus isolates in patients with methicillin-resistant Staphylococcus aureus (MRSA) infections in a tertiary care hospital.

Objectives

1. To determine the vancomycin susceptibility profile of MRSA isolates from various clinical specimens.
2. To assess the prevalence of intermediate vancomycin resistance among MRSA isolates.

Materials and Methods

This cross-sectional study was conducted at a tertiary care hospital over a six-month period. A total of 100 clinical isolates of MRSA were collected from different specimens, including blood, wound, and respiratory tract samples, from patients admitted to the hospital.

Inclusion criteria included all patients diagnosed with MRSA infections and who had cultures yielding MRSA from clinical specimens. Patients who received antibiotics, including vancomycin, within the previous 48 hours, were excluded to avoid the potential bias of antibiotic exposure on resistance development.

The identification of MRSA was performed using standard microbiological techniques, including Gram staining, catalase test, coagulase test, and oxacillin resistance confirmation by disk diffusion method (7). The vancomycin susceptibility of the MRSA isolates was determined using the disk diffusion method with vancomycin disks (30 µg) and the broth microdilution method to determine the Minimum Inhibitory Concentration (MIC). An MIC value of ≥4 µg/mL was considered indicative of vancomycin resistance, while an MIC between 2-4 µg/mL was categorized as intermediate resistance, and an MIC of ≤2 µg/mL was considered susceptible (8).

The results were analyzed to determine the proportion of MRSA strains with varying levels of vancomycin susceptibility.

Results

Table 1: Vancomycin Susceptibility Profile of MRSA Isolates

Vancomycin Susceptibility	Number of Isolates (%)
Susceptible (MIC ≤ 2 µg/mL)	96 (96%)
Intermediate Resistance (MIC 2-4 µg/mL)	4 (4%)
Resistant (MIC ≥ 4 µg/mL)	0 (0%)

Table 2: Resistance Pattern of MRSA Isolates to Other Antibiotics

Antibiotic	Resistant Isolates (%)
Methicillin	100 (100%)
Erythromycin (Macrolides)	40 (40%)
Tetracycline	30 (30%)
Clindamycin	25 (25%)

Discussion

The findings from this study indicate that the majority of MRSA isolates were susceptible to vancomycin (96%), which is consistent with studies conducted in other regions (9, 10). However, the identification of 4% of isolates exhibiting intermediate resistance to vancomycin is concerning and suggests that some MRSA strains may be evolving toward full vancomycin resistance. This trend mirrors the global rise in vancomycin-intermediate Staphylococcus aureus (VISA) and highlights the importance of continued surveillance for vancomycin susceptibility in clinical isolates of MRSA (11).

The complete absence of fully vancomycin-resistant S. aureus (VRSA) in this study is a positive finding, as VRSA remains relatively rare. However, the presence of intermediate resistance could indicate the emergence of this problematic resistance phenotype, which is typically associated with poor clinical outcomes and limited therapeutic options (12).

The high resistance rates to other antibiotics, such as erythromycin (40%), tetracycline (30%), and clindamycin (25%), are in line with previous reports of multi-drug resistance among MRSA strains (13). The presence of multi-drug resistance further complicates the treatment of MRSA infections, emphasizing the need for antibiotic stewardship programs to reduce the selective pressure for resistance.

Given the potential for vancomycin resistance to evolve and the limited treatment options available for resistant strains, ongoing surveillance and the prudent use of vancomycin are essential in managing MRSA infections.

Conclusion

This study underscores the importance of monitoring vancomycin susceptibility in MRSA isolates, as the emergence of intermediate resistance poses a potential threat to effective treatment. While vancomycin remains effective against the majority of MRSA strains, vigilance is required to prevent further resistance development. In addition, multi-drug resistance in MRSA isolates calls for enhanced infection control practices and antibiotic stewardship efforts in healthcare settings to combat the rising tide of antimicrobial resistance.

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