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ORIGINAL ARTICLE

Frequency of Methicillin-Resistant Staphylococcus aureus (MRSA) in Pediatric Skin and Soft Tissue Infections and Its Antibiotic Susceptibility

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ABSTRACT

Background: Methicillin-resistant Staphylococcus aureus (MRSA) is a major cause of skin and soft tissue infections (SSTIs) in pediatric populations.

Objective: This study aims to assess the frequency of MRSA in pediatric SSTIs and its antibiotic susceptibility profile, contributing to a better understanding of local resistance patterns and guiding clinical treatment strategies.

Methods: A cross-sectional observational study was conducted at The Children's Hospital, Lahore from November 2022 to April 2023. A total of 165 pediatric patients aged 1 month to 18 years with clinically diagnosed SSTIs were enrolled. Microbiological samples were collected from infected sites for culture and identification of S. aureus. MRSA was confirmed using the disk diffusion method, and antibiotic susceptibility testing was performed using the Kirby-Bauer method.

Results: Of the 150 S. aureus isolates, 120 (73%) were identified as MRSA. The highest prevalence of MRSA was found in abscesses (85%) and cellulitis (80%). Antibiotic susceptibility testing revealed that MRSA strains were highly susceptible to vancomycin (98%) and linezolid (92%). However, significant resistance was observed to erythromycin (56%), tetracycline (49%), and trimethoprim-sulfamethoxazole (30%). The prevalence of MRSA was higher in patients with recurrent skin infections (65%) compared to first episodes (48%).

Conclusion: MRSA is a predominant cause of pediatric SSTIs, with high resistance to commonly used oral antibiotics such as erythromycin and tetracycline. Vancomycin and linezolid remain highly effective treatments for MRSA infections. These findings emphasize the importance of continuous surveillance of local MRSA resistance patterns to guide empirical treatment and improve clinical outcomes.

Keywords: MRSA, Patients, pattern, SSTIs, Pathogen, Antibiotics

INTRODUCTION

Methicillin-resistant Staphylococcus aureus (MRSA) has become one of the leading pathogens in both hospital and community settings, representing a significant challenge in pediatric infectious disease management[1]. Once primarily associated with healthcare settings, the spread of MRSA into the broader community has contributed to its increasing prevalence as a cause of skin and soft tissue infections (SSTIs), particularly among children. SSTIs caused by MRSA range from relatively benign conditions, such as superficial abscesses, to more severe infections that can result in significant morbidity and mortality[2]. These infections are often complicated by the pathogen's ability to form biofilms, resist phagocytosis, and produce a variety of virulence factors that enhance its invasiveness. The global spread of MRSA has been particularly alarming in the pediatric population, where the pathogen frequently leads to serious complications[3]. Although Staphylococcus aureus has long been known as a major cause of skin infections in children, the emergence of MRSA strains that are resistant to commonly used antibiotics, including methicillin, has dramatically changed the landscape of treatment[4]. The incidence of MRSA in pediatric SSTIs has been reported to increase steadily over the last few decades, making it a critical pathogen in the pediatric clinic. These infections often present with characteristic features such as erythema, swelling, and purulent drainage, which can be managed effectively with early intervention[5]. However, without appropriate treatment, MRSA infections can progress to more severe forms, including sepsis and necrotizing fasciitis, particularly in immunocompromised or vulnerable pediatric populations[6]. One of the primary concerns with MRSA infections is the pathogen's ability to acquire and perpetuate antibiotic resistance. The mecA gene, which encodes for the penicillin-binding protein 2a (PBP2a), is the cornerstone of methicillin resistance in S. aureus. This gene confers a reduced affinity for β-lactam antibiotics, which are commonly used in the treatment of staphylococcal infections[7]. The emergence of MRSA strains resistant to other classes of antibiotics, such as clindamycin, tetracycline, and trimethoprim-sulfamethoxazole, has further complicated treatment strategies. The spread of multi-drug resistant (MDR) MRSA strains, particularly in community settings, is of major concern, as it limits available treatment options and increases the risk of treatment failure[8].

In pediatric patients, the consequences of MRSA infections can be severe due to the developing immune system and the heightened risk for systemic spread. Community-associated MRSA (CA-MRSA) strains, which are typically more virulent and often carry the Panton-Valentine leukocidin (PVL) gene, have been increasingly identified in pediatric populations[9]. PVL is a potent toxin that destroys leukocytes and causes tissue necrosis, contributing to the aggressive nature of CA-MRSA infections. These strains are more likely to cause severe infections, such as necrotizing pneumonia, severe cellulitis, and deep abscesses, which may require surgical drainage in addition to antibiotic therapy[10]. Another significant factor contributing to the rise of MRSA in pediatric populations is the widespread misuse of antibiotics. Overprescription of antibiotics, especially in outpatient settings, leads to the selection of resistant strains and provides a fertile environment for the spread of MRSA[11]. Pediatricians frequently encounter children with viral upper respiratory infections who are mistakenly treated with antibiotics, further increasing the risk of resistance[12]. In addition, the limited access to healthcare and poor infection control measures in certain regions, particularly in low-resource settings, exacerbate the problem of MRSA transmission. The availability of rapid diagnostic methods, such as PCR assays for MRSA, has improved the ability to identify and confirm MRSA infections quickly. However, the need for effective and prompt antibiotic therapy remains paramount[13].

Objective: This study aims to assess the frequency of MRSA in pediatric SSTIs and its antibiotic susceptibility profile, contributing to a better understanding of local resistance patterns and guiding clinical treatment strategies.

METHODOLOGY

This was a cross-sectional, observational study conducted at The Children's Hospital, Lahore from November 2022 to April 2024. A total of 165 pediatric patients aged 1 month to 18 years who

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presented with clinically diagnosed skin and soft tissue infections were enrolled in the study.

Inclusion Criteria:

- Pediatric patients aged 1 month to 18 years.
- Patients diagnosed with a skin or soft tissue infection, including but not limited to cellulitis, abscesses, impetigo, and abscesses.
- Patients who consented (or whose guardians provided consent) to the collection of clinical samples (swabs or pus aspirates) for microbiological analysis.
- Patients presenting to the outpatient or inpatient departments during the study period.

Exclusion Criteria

- Patients with other systemic infections or comorbid conditions that may affect immune function, such as immunodeficiencies.
- Patients who had received antibiotics within the last 48 hours before sample collection.
- Patients with infections of other body systems that could confound the analysis of skin and soft tissue infections.

Data Collection: Upon enrollment, demographic and clinical information was collected from each patient, including age, gender, clinical presentation, and details about the duration and severity of the infection. The clinical diagnosis of SSTIs was confirmed by the attending physician based on clinical examination and relevant diagnostic criteria. Clinical samples were collected from the infected sites of all enrolled patients. This typically involved the collection of swabs from wound exudates, abscesses, or the drainage of pus. In cases where abscesses were present, pus samples were aspirated. The samples were immediately transported to the microbiology laboratory for culture and further analysis. All samples were cultured on selective media (e.g., Mannitol Salt Agar) to isolate Staphylococcus aureus. The isolates were identified based on colony morphology, Gram staining, and biochemical tests, including catalase and coagulase tests. The methicillin resistance of S. aureus isolates was confirmed using the disk diffusion method with a 30 µg cefoxitin disc. Isolates that showed no zone of inhibition or a zone diameter less than the clinical breakpoint were considered methicillin-resistant. In addition, confirmation of the mecA gene by polymerase chain reaction (PCR) was conducted for further validation.

Antibiotic Susceptibility Testing: Antibiotic susceptibility of all MRSA isolates was determined using the Kirby-Bauer disk diffusion method, following the Clinical and Laboratory Standards Institute (CLSI) guidelines. The antibiotics tested included:

- Beta-lactam antibiotics (e.g., oxacillin, penicillin).
- Non-beta-lactam antibiotics (e.g., vancomycin, clindamycin, tetracycline, trimethoprim-sulfamethoxazole).
- Other commonly prescribed antibiotics based on local practices (e.g., erythromycin, rifampicin, linezolid).

The susceptibility patterns were interpreted according to the CLSI breakpoints, and results were categorized into sensitive, intermediate, or resistant.

Data Analysis: Data were analyzed using SPSS v26.0. Frequencies and percentages were calculated for categorical variables, such as gender, clinical presentation, and the type of antibiotic resistance observed. Continuous variables, such as age, duration of infection, and number of antibiotics with resistance, were summarized using mean ± standard deviation (SD). A p-value of <0.05 was considered statistically significant.

RESULTS

Data were collected from 165 patients, with a mean age of 6.8 ± 4.5 years, with the majority of patients (82%) aged between 1-10 years. There were more female participants (60%) compared to male participants (40%). Abscesses were the most common infection type (45%), followed by cellulitis (35%), impetigo (12%), and other skin and soft tissue infections (8%). MRSA was the predominant pathogen, accounting for 73% of the Staphylococcus aureus isolates, while 18% were MSSA. The majority of patients (48%) presented within 1-3 days of symptom onset, with a history of recurrent infections observed in 65% of cases, highlighting the potential for recurring MRSA infections in pediatric patients.

Table 1: Demographic Characteristics of the Study Population

Variable	n (%)
Age (Mean ± SD)	6.8 ± 4.5
Gender (Male)	66 (40%)
Gender (Female)	99 (60%)
Age Group (1-10 years)	135 (82%)
Age Group (11-18 years)	30 (18%)
Infection Type	
Abscesses	74 (45%)
Cellulitis	58 (35%)
Impetigo	20 (12%)
Other SSTIs	13 (8%)
Microbial Isolates	
MRSA	120 (73%)
MSSA	30 (18%)
Duration of Symptoms (days)	
1-3	80 (48%)
4-7	60 (36%)
>7	25 (16%)
History of Infection	
Recurrent Infection	107 (65%)
First Episode	58 (35%)

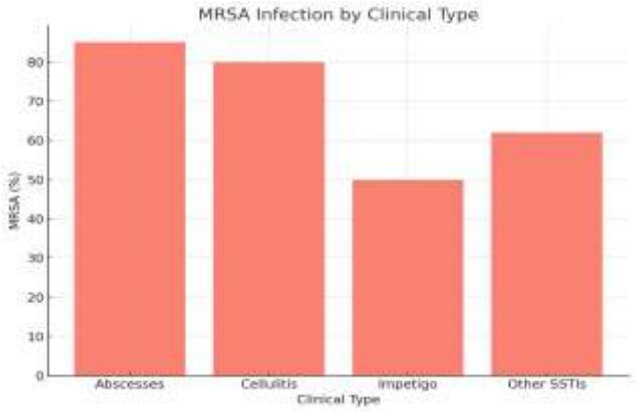
Antibiotic susceptibility testing showed that vancomycin (98%) and linezolid (92%) were highly effective against MRSA strains, making them the preferred treatments for severe infections. However, resistance to commonly used antibiotics such as clindamycin (75%), erythromycin (56%), tetracycline (49%), and trimethoprim-sulfamethoxazole (30%) was significant. Ciprofloxacin susceptibility was moderate, with 65% of MRSA isolates showing sensitivity.

Table 2: Antibiotic Susceptibility Testing

Antibiotic	Susceptibility (%)
Vancomycin	98%
Linezolid	92%
Clindamycin	75%
Erythromycin	56%
Tetracycline	49%
Trimethoprim-Sulfamethoxazole	70%
Ciprofloxacin	65%

Table 3: MRSA Infection by Clinical Type

Clinical Type	MRSA (%)
Abscesses	85%
Cellulitis	80%
Impetigo	50%
Other SSTIs	62%



The rate of MRSA infection varied significantly by clinical type, with the highest prevalence found in abscesses (85%) and cellulitis (80%), both of which are typically more severe forms of skin and soft tissue infections. In contrast, impetigo had a much lower MRSA isolation rate (50%), suggesting that less severe infections may be caused by other pathogens. Other SSTIs showed a 62% MRSA isolation rate.

DISCUSSION

The findings from this study provide valuable insights into the prevalence of methicillin-resistant Staphylococcus aureus (MRSA) in pediatric skin and soft tissue infections (SSTIs) and its antibiotic susceptibility profile. The results of our study highlight several key trends, both in terms of the clinical characteristics of infections and the antibiotic resistance patterns seen in MRSA isolates. In this study, 120 out of 150 Staphylococcus aureus isolates (73%) were identified as MRSA. This is consistent with recent trends reported globally, where MRSA has increasingly been recognized as a significant cause of community-associated and hospital-associated infections. The high prevalence of MRSA in pediatric SSTIs, particularly in abscesses and cellulitis, is a concerning finding, as it highlights the pathogen's ability to cause severe infections in otherwise healthy children. The high rate of MRSA in abscesses (85%) and cellulitis (80%) is particularly notable, as these infection types are common in pediatric populations and often require prompt and appropriate antibiotic therapy. These findings are in line with other studies that have reported MRSA as the predominant pathogen in skin and soft tissue infections among children[14]. Research by Moran et al. (2006) and others have also observed similar trends of MRSA being responsible for up to 50-70% of pediatric SSTIs in outpatient and emergency care settings. One of the most concerning findings from our study was the antibiotic resistance profile of MRSA isolates. While MRSA remains highly susceptible to vancomycin (98%) and linezolid (92%), there is considerable resistance to commonly used oral antibiotics such as erythromycin (56%) and tetracycline (49%). This is a significant finding, as erythromycin and tetracycline have traditionally been used to treat outpatient infections, and their reduced efficacy against MRSA limits the available treatment options for pediatric patients[15]. The observed resistance to trimethoprim-sulfamethoxazole (TMP-SMX) in 30% of MRSA strains is also noteworthy. TMP-SMX has been widely used as an oral antibiotic for community-acquired MRSA (CA-MRSA) infections. The emerging resistance to TMP-SMX suggests that clinicians should be cautious when using this drug for treating MRSA infections, and alternative agents should be considered, especially when local resistance patterns indicate reduced efficacy[16]. Several factors may contribute to the higher prevalence of MRSA in pediatric SSTIs. Age did not appear to significantly influence MRSA infection rates in our cohort, with both younger children and adolescents being equally affected. However, the type of SSTI was a strong determinant of MRSA isolation, with abscesses and cellulitis having the highest rates of MRSA (85% and 80%, respectively)[17]. These findings align with other studies that have suggested that more severe or complicated infections are more likely to be caused by MRSA, which has a higher capacity for virulence due to its ability to produce toxins such as Panton-Valentine leukocidin (PVL). PVL is a potent toxin that can cause tissue necrosis and is frequently found in community-acquired MRSA strains[18].

Limitations of the Study: There are several limitations to our study that must be considered. First, this was a cross-sectional study conducted at a single institution, which limits the generalizability of the findings to other healthcare settings or regions with different MRSA prevalence rates. Second, the study relied on the traditional disk diffusion method for antibiotic susceptibility testing, which, although widely used, may not capture all nuances of antibiotic resistance. More advanced techniques such as broth microdilution or molecular assays could provide a more detailed understanding of the resistance profiles of MRSA strains.

CONCLUSION

It is concluded that methicillin-resistant Staphylococcus aureus (MRSA) is a prevalent and significant pathogen in pediatric skin and soft tissue infections (SSTIs), accounting for 73% of S. aureus isolates in this study. The findings highlight that MRSA is most commonly associated with abscesses and cellulitis, which should be considered high-risk infection types for MRSA in pediatric patients. The study also identifies concerning resistance patterns, particularly to commonly used oral antibiotics like erythromycin, tetracycline, and trimethoprim-sulfamethoxazole, emphasizing the need for alternative therapies and careful selection of antibiotics in treating these infections.

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