Section: Pediatrics

Original Research Article

COMMUNITY-ACQUIRED METHICILLIN-RESISTANT STAPHYLOCOCCUS AUREUS (CA-MRSA) AS AN EMERGING CAUSE OF SUBCUTANEOUS ABSCESSES IN CHILDREN

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Received *: 07/05/2026*
Received in revised form *: 22/06/2026*
Accepted *: 11/07/2026*

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DOI: 10.70034/ijmedph.2026.3.143

Source of Support: Nil,
Conflict of Interest: None declared

Int J Med Pub Health
2026; 16 (3); 881-885

ABSTRACT

Background: The objective is to assess the prevalence, clinical features, and microbiological profile of community-acquired methicillin-resistant Staphylococcus aureus (CA-MRSA) in children with subcutaneous abscesses. Study design is prospective cross-sectional study. This research was undertaken at Department of Peadiatrcs Pir Abdul Qadir Shah Jillaani Intitute of Medical Sciences Gambat khairpur from September 2024 to Sepember 2025.

Materials and Methods: A total of 168 children aged 7 days to 14 years were included who required incision and drainage of clinically diagnosed subcutaneous abscesses. Pus samples were aseptically collected and cultured for culture and sensitivity testing. Standard microbiological methods were used to identify Staphylococcus aureus, with confirmation of methicillin resistance by cefoxitin disc diffusion. Demographic and clinical information was collected, and statistical analysis was conducted using SPSS version 25. Data were analyzed with the chi-square test ($p<0.05$).

Results: In 78 cases (46.4%), CA-MRSA was found, and in 90 cases (53.6%), non-MRSA growth was observed. The highest proportion of CA-MRSA was seen in neonates (<1 month; 100%), followed by 1–12 months (58.8%), 1–5 years (41.2%), and 5–10 years (33.3%), showing a decreasing trend with age ($p < 0.001$). The highest CA-MRSA positivity was seen in lower limb abscesses (53.6%), and the lowest was seen in abdominal wall (33.3%) ($p = 0.041$). An elevated leukocyte count was significantly associated with CA-MRSA infection (76.9% versus 48.9%, $p < 0.001$).

Conclusion: CA-MRSA is frequently associated with subacute pediatric subcutaneous abscesses, occurs more often in younger age groups, and is significantly correlated with leukocytosis and limb involvement. Early empirical coverage is crucial for better results.

Keywords: CA-MRSA, Subcutaneous abscess, pediatric, S. aureus.

INTRODUCTION

Community-acquired methicillin-resistant Staphylococcus aureus (CA-MRSA) has become an important pathogen in skin and soft tissue infections (SSTIs), especially in subcutaneous abscesses in children, owing to the worldwide spread of virulent clones such as USA300 and regional strains with increased toxin production, including Panton-Valentine leukocidin (PVL).[1] These isolates may exhibit unique molecular epidemiology; generally, the most common are SCCmec types IV and V and

may result in community transmission without typical healthcare-associated risk factors.[2] In children, CA-MRSA often presents as purulent lesions, such as those on the head and neck or extremities, and is more likely to become deeper, cause bacteremia, and involve the osteoarticular system than methicillin-susceptible CA-MRSA.[3]

The prevalence of CA-MRSA worldwide varies by geographic region and among community S. aureus populations, with reported rates ranging from about 10% to 46% among pediatric isolates across settings.[4] In high-burden areas, CA-MRSA is responsible for almost one-half of community S. aureus infections and is increasingly becoming resistant to multiple antibiotics and rapidly spreading across the community.[4] Local studies in Pakistan and neighboring areas indicate that S. aureus is well established in community settings, with methicillin resistance rates of S. aureus from community SSTIs and pediatric abscesses often exceeding 85%.[5] Environmental and public health determinants significantly influence the incidence and transmission of infectious diseases among pediatric populations in Pakistan, particularly within resource-constrained environments.[6]

From a clinical standpoint, CA-MRSA is closely linked to purulent SSTIs, and in children, the most frequent clinical presentation is an abscess. Typically, the infections present with a sudden onset of swelling, erythema, and fluctuant masses, often requiring incisional drainage, and beta-lactam antibiotics are generally ineffective.[7] CA-MRSA can be multidrug-resistant, meaning it is resistant to more than one currently available antimicrobial agent, which may limit options for empirical therapy and ultimately result in treatment failure.[3,7]

What is important, however, is that CA-MRSA is not limited to “local” disease. Infections can be invasive and can involve osteomyelitis, septic arthritis, pyomyositis, necrotizing pneumonia, and bloodstream infection, particularly with PVL-positive and other exotoxin-positive strains. Such complications are associated with high morbidity in children, including long hospitalization, re-infection, and, at the extreme end, systemic inflammatory response and septic shock.[8,9] CA-MRSA has been shown to have significant transmission potential within families and close-contact environments, and both skin and nasal colonization are reservoirs for recurrent infection and community transmission.[9]

There is increasing international evidence but limited regional information regarding the microbiological profile, virulence properties, and clinical outcomes in children with subcutaneous abscesses associated with CA-MRSA. This gap can contribute to inappropriate antibiotic use and the rise of antimicrobial resistance. Therefore, this study aims to determine the prevalence and microbiological characteristics of CA-MRSA among children with subcutaneous abscesses.

MATERIALS AND METHODS

This was a prospective, cross-sectional study to determine the prevalence of CA-MRSA in children with subcutaneous abscesses, along with the antibiotic susceptibility patterns of the bacteria and their clinical characteristics. During the study period, 168 children were selected from the pediatric outpatient department, surgical outpatient department, and emergency department using the consecutive non-probability sampling method.

Children under 14 years of age, both sexes, who had a clinically diagnosed subcutaneous abscess and who required surgical intervention, were included. Patients were divided into four age groups: neonates (<1 month), infants (1–12 months), toddlers and preschoolers (1–5 years), and school-age children (>5 years). Neonates admitted to the hospital following birth for >24 hours, those with previous surgery or trauma, those who were previously hospitalized within the previous month, and those with underlying chronic diseases or immunosuppression were excluded.

Detailed demographic (age, gender, residence) and clinical (duration of symptoms, abscess location, previous antibiotic therapy, family history of the same type of abscess) data were recorded using a structured proforma at presentation. The pus samples were aspirated or obtained on incision and drainage and sent for aerobic culture and sensitivity under aseptic precautions. All were immediately sent to the microbiology laboratory for culture and biochemical testing in standard conditions, and oxacillin MIC testing or cefoxitin disk diffusion was added to confirm methicillin resistance. The cefoxitin disc diffusion test was used to confirm methicillin resistance. The antibiotic susceptibility test was conducted to determine sensitivity to commonly used antimicrobial agents.

The results were analyzed and presented using SPSS 25.0. Association of categorical variables (age group, gender, prior antibiotic use) and CA-MRSA positivity was determined using the chi-square test. A p-value < 0.05 was considered significant.

RESULTS

A total of 168 children were included in the study. The majority belonged to the 1–5 years age group (n=68, 40.5%), followed by 5–10 years (n=54, 32.1%), 1–12 months (n=34, 20.2%), and <1 month (n=12, 7.1%). Males were more commonly affected (n=98, 58.3%) compared to females (n=70, 41.7%). Most children (n=142, 84.5%) were presented with only one abscess, and multiple abscesses were less common (n=26, 15.5%). Duration of symptoms was ≤5 days in 74 cases (44.0%), >5–10 days in 66 cases (39.3%), and >10 days in 28 cases (16.7%). Prior antibiotic use was reported in 63 patients (37.5%) and a history of recurrent abscesses in 29 patients (17.3%) [Table 1].

Table 1: Demographic and Clinical Characteristics of Study Participants

Variable	Category	Frequency (n)	Percentage (%)
Age Groups	<1 month	12	7.1
	1–12 months	34	20.2
	1–5 years	68	40.5
	5–10 years	54	32.1
Gender	Male	98	58.3
	Female	70	41.7
Number of lesions	Single abscess	142	84.5
	Multiple abscesses	26	15.5
Duration of symptoms	≤5 days	74	44.0
	>5–10 days	66	39.3
	>10 days	28	16.7
Prior antibiotic use	Yes	63	37.5
	No	105	62.5
Recurrent abscess history	Yes	29	17.3
	No	139	82.7

The most common site of subcutaneous abscess was the lower limb (n=56, 33.3%), followed by the upper limb (n=44, 26.2%). Truncal involvement was also observed, with back abscesses in 20 cases (n=20, 11.9%), chest wall abscesses in 18 cases (n=18, 10.7%), and abdominal wall abscesses in 12 cases (n=12, 7.1%). Head and neck involvement was noted in 18 cases (n=18, 10.7%). Overall, extremity involvement (upper and lower limbs combined) was predominant, accounting for 58.3% of cases (n=100, 59.5%), while trunk-related sites collectively contributed 29.7% (n=50, 29.8%) [Table 2].

Table 2: Distribution of Abscess Sites in Study Participants

Abscess Site	Frequency (n)	Percentage (%)
Upper limb	46	27.4
Lower limb	52	31.0
Head/neck	18	10.7
Chest wall	20	11.9
Abdominal wall	12	7.1
Back	20	11.9
Total	168	100%

CA-MRSA was isolated in 78 cases (n=78, 46.4%), while non-MRSA growth was seen in 90 cases (n=90, 53.6%). The highest proportion of CA-MRSA was observed in the <1 month age group (n=12, 100%), followed by 1–12 months (n=20, 58.8%), 1–5 years (n=28, 41.2%), and 5–10 years (n=18, 33.3%), showing a decreasing trend with increasing age. Lower limb abscesses demonstrated the highest CA-MRSA positivity (n=30, 53.6%), whereas abdominal wall infections showed the lowest (n=4, 33.3%). Elevated leukocyte counts were more frequent in CA-MRSA cases (n=60, 76.9%) compared to non-MRSA growth (n=44, 48.9%), indicating a stronger inflammatory response associated with MRSA infection. Statistically significant associations were observed for age group ($p < 0.001$) and leukocyte count ($p < 0.001$), while abscess site also showed a significant but weaker association ($p = 0.041$) [Table 3].

Table 3: Comparison of CA-MRSA with Patient Characteristics

Variable	Category	CA-MRSA (n=78)	Non-MRSA (n=90)	Total (n)	p-value
Age group	<1 month	12	0	12	<0.001
	1–12 months	20	14	34	
	1–5 years	28	40	68	
	5–10 years	18	36	54	
Abscess site	Upper limb	20	24	44	0.041
	Lower limb	30	26	56	
	Head/neck	10	8	18	
	Chest wall	8	10	18	
	Abdominal wall	4	8	12	
	Back	6	14	20	
Leukocyte count	Normal	18	46	64	<0.001
	Elevated	60	44	104	

DISCUSSION

CA-MRSA is a highly virulent pathogen that can cause aggressive SSTIs, such as subcutaneous abscesses, that can quickly lead to invasive disease. Some of the major risk factors are prior exposure to antibiotics, overcrowding, close contact environments (such as daycare or sporting events),

impaired skin barriers, and poor access to health care, all of which create conditions for the spread of antibiotic-resistant clones with toxin genes such as PVL.[4,10] Children may experience significant morbidity and higher hospitalization rates due to additional complications of these infections, including bacteremia, osteomyelitis, septic arthritis, necrotizing pneumonia, and re-infection. These complications should be avoided to limit the health care burden, reduce the risk of long-term complications in children, and prevent the spread of antimicrobial resistance in resource-poor settings.[11,12] This study was designed to assess the prevalence, clinical features, and epidemiology of CA-MRSA in pediatric subcutaneous abscesses.

Most children in the present study were in the age groups 1–5 years and 5–10 years, but there were fewer infants and neonates. This age distribution is consistent with recent evidence showing that CA-MRSA SSTIs are most frequent in the first five years of life, with exposure to minor skin trauma, immature immune responses, and close interpersonal contact in day care and household environments being most common in this age group.[13] Anatomically, lower-limb involvement was the most common, followed by upper-limb and trunk sites. This is similar to Bustamante et al., who showed that the extremities are the most common sites of CA-MRSA SSTIs due to greater exposure to trauma, insect bites, and environmental contamination.[14] The same has been observed by Linz et al., who also reported that limb-dominant infection is ubiquitous in CA-MRSA disease worldwide.[2]

In the present study, 46.4% of cases were positive for CA-MRSA, and an interesting age-dependent pattern was observed, with 100% positivity in neonates (aged <1 month), followed by a progressive decline to 33.3% in the 5–10-year group. This is consistent with other studies that have reported increased susceptibility in younger infants due to less mature immunity and colonization.[15,16] In terms of abscess sites, the highest positivity for CA-MRSA was seen in the lower limbs, and the lowest in the abdominal wall; however, this was not a strong association. This extreme predominance, especially on the lower limbs, is consistent with the results of Wang et al. and Aaron et al., who found that trauma-prone sites are the cause of infection resulting from environmental exposure and low levels of skin penetration.[17,18]

Leukocyte counts were significantly higher among cases with CA-MRSA, suggesting increased systemic inflammatory response. This is corroborated by Goemanne et al., who found that PVL-positive, or virulent, CA-MRSA was associated with higher inflammatory marker levels and stronger host responses in pediatric invasive and soft-tissue infections.[19] It suggests that simple hematological parameters may be useful for early decision-making in empirical therapy, especially when culture results are unavailable in a timely manner. The results highlight the need for prompt empirical MRSA treatment of neonates and young children with abscesses, particularly if leukocytosis is present and the limbs are involved. Incision and drainage is recommended for high-risk children, as well as active MRSA antibiotics for purulent SSTIs.[18,19]

One limitation of the study is its single-center design, which may affect generalizability. Molecular typing (PVL and SCCmec characterization) was not performed, and the long-term recurrence outcome was not evaluated.

CONCLUSION

CA-MRSA is a significant pathogen in pediatric subcutaneous abscesses, and a significant number of cases in this study. A high prevalence was seen among younger children and declined with age in older children. Leukocytosis was significantly correlated with the presence of CA-MRSA, and the lower limbs appeared to be the most common site of involvement. The study emphasizes the role of early diagnosis and appropriate empirical antibiotic treatment for CA-MRSA in children with abscesses.

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