

FREQUENCY OF METHICILLIN-RESISTANT STAPHYLOCOCCUS AUREUS (MRSA) BACTEREMIA AMONG CANCER PATIENTS

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Abstract

Objective: To examine the incidence of MRSA bacteremia in persons with cancer and characterize the demographic and clinical factors related to it.**Study Design:** Cross-sectional study.**Study Setting and Duration:** Shaukat Khanum Memorial Cancer Hospital and Research Centre, Lahore, from May 2025 to July 2025**Methodology:** This study recruited a sample of 179 adult patients by non-probability consecutive sampling. Data included demographic and clinical characteristics. Continuous variables were expressed as medians (IQR), and categorical variables as n(%). The associations associated with MRSA bacteremia were examined using chi-square and Mann-Whitney U tests and determined to be statistically significant if $p \leq 0.05$.**Results:** Median participant age was 48 years (IQR 25), body mass index (BMI) was 23.9 kg/m² (IQR 7.3), and median duration of cancer was 57 months (IQR 58). 92 (51.4%) were females; 101 (56.4%) were receiving active treatment for cancer. (MRSA) Bacteremia was documented in 45 (25.1%) individuals. MRSA-positive patients were significantly more likely than MRSA-negative to be male (75.6% vs 39.6%, $p < 0.001$), be receiving active treatment for cancer (95.6% vs 43.3%, $p < 0.001$), and have a diagnosis of leukemia and lymphoma ($p = 0.011$). People diagnosed with MRSA bacteremia were significantly older than those diagnosed without MRSA bacteremia ($p\text{-value} < 0.001$) and had significantly lower BMI ($p\text{-value} = 0.043$).**Conclusion:** MRSA bacteremia in cancer patients occurred at a rate of approximately 25% in this population. In addition, patients who were male, received active treatment, had disease classified as hematologic malignancy, were older than 40 years, and/or had low BMI had increased odds of developing MRSA bacteremia.

INTRODUCTION:

Bacteremia from methicillin-resistant Staphylococcus aureus (MRSA) is an important complication for cancer patients, as their immunosuppression, central venous access, injury to mucosal barriers, and frequent exposure to healthcare facilities make them less able to fight off infection, leading to adverse outcomes(1). A

systematic review and meta-analysis conducted in 2021 revealed that the pooled prevalence of MRSA was 3% of all bloodstream infections in cancer patients, and 44% of patients with S. aureus bacteremia had methicillin-resistant strains(2,3). Once a patient develops an S. aureus bloodstream infection, the frequency of developing a methicillin-resistant strain is high.

Recent global surveillance data from 2025 also confirm that MRSA continues to be an important cause of bloodstream infection globally, with continuing regional variability and burden seen in hospital systems(4,5).

A 2025 study focused on cancer patients in Egypt demonstrated that 97 out of 120 *Staphylococcus aureus* (*S. aureus*) isolates were *mecA*-positive, indicating the presence of Methicillin-resistant *Staphylococcus aureus* (MRSA)(6). The study also found that 26.8% of MRSA isolates were positive for Panton-Valentine leukocidin (PVL). Researchers reported persistent challenges in treating MRSA bacteremia, despite malignancy being a significant comorbidity factor in determining outcomes. In Pakistan, MRSA remains prevalent, and estimates from a 2025 national meta-analysis indicated an overall pooled MRSA prevalence of 50%, with an annual range of 61% in 2024; therefore, conducting local cancer surveillance is essential(7).

Given the considerable amount of MRSA burden within Pakistan, very little data exists to support the level of MRSA bacteremia specifically with oncology patients; accordingly, this study is reasonable to conduct due to the lack of epidemiologic data for MRSA bacteremia in this patient population and to help make evidence-based decisions regarding the appropriate initial empirical antibiotic therapy for this vulnerable population of oncology patients. Thus, this study will provide the necessary frequency of MRSA bacteremia in oncology patients and will improve the quality of empiric antibiotic treatment and infection control interventions through increased knowledge regarding incidence rates of bacteremia in patients undergoing treatment.

Methodology:

The study was carried out in Department of Medicine at Shaukat Khanum Memorial Cancer Hospital and Research Centre, Lahore, from May 2025 to July 2025. The sample size was derived from 179 patients identified using the WHO sample size calculator based upon an expected prevalence of MRSA bacteremia in cancer patients of 3%, a margin of error of 2%, and a confidence

level of 95%(7). Non-probability consecutive sampling was used when selecting subjects.

Inclusion criteria: Patients who had been diagnosed with histologically confirmed malignancies and tested positive for blood culture were included in the study. A histologically confirmed malignancy would mean that there is a malignant tumor diagnosed microscopically, showing the general character of a cancer.

Exclusion criteria: Patients who had any type of fungal infection, culture results that were contaminated with other organisms, growth in the culture of more than two organisms, non-cancer patients, patients aged <18 or >75 were excluded from the study.

Eligible patients were recruited into the study with the approval of the College of Physicians and Surgeons Pakistan (CPSP) and an institutional ethical review committee. Data concerning patient demographics and clinical characteristics were retrieved from the Hospital Information System via the unique Medical Record Numbers associated with patients. This included data about age, sex, BMI, duration of diagnosis, and malignancy type, as well as active treatment of cancer history. All patient identifiers have been removed to protect the anonymity and confidentiality of those involved with this study. Data for this research have been recorded on a form developed specifically for this study.

MRSA bacteremia was defined in accordance with operationalization as described. *Staphylococcus aureus*, isolated from blood cultures that showed resistance to cefoxitin or oxacillin as evidenced by Minimum Inhibitory Concentration (MIC) values which exceeded the established breakpoint levels for these drugs (e.g., cefoxitin >4 µg/mL, oxacillin >2 µg/mL), were classified as MRSA.

The Statistical Package for Social Sciences (SPSS) (version 26) was utilized to conduct an analysis of the gathered data [insert citation here]. The normality of each continuous variable was assessed using Shapiro-Wilk's test; therefore, variables age, BMI (Body Mass Index), and the length of time since the individual was diagnosed with cancer did not have a true normal distribution, thus the three variables were determined to be median with

interquartile range (IQR). Categorical data such as gender, type of cancer, currently receiving cancer treatment, had MRSA Bacteremia were reported in frequency (n) and percentage (%). Chi-square test was conducted to evaluate the association between MRSA Bacteremia and categorical variables. The Mann-Whitney U Test was used to compare continuous data between two groups.

Statistical significance was defined as a p-value of ≤ 0.05 .

Results:

In this study, there were 179 cancer patients included, with a median age of 48 years (IQR=25), median BMI of 23.9 kg/m² (IQR=7.3), and mean time from cancer diagnosis of 57 months (IQR=58).

Table I: Baseline demographic and clinical characteristics of the study participants (n=179)

Variable	Median (IQR)
Age (years)	48 (25)
BMI (kg/m ²)	23.9 (7.3)
Duration of diagnosis of cancer (months)	57 (58)

Of these 179 patients, 92 (51.4%) were female, and 87 (48.6%) were male, and most patients were undergoing active treatment and had an MRSA-positive culture (45 patients or 25.1%).

Table II: Distribution of demographic and clinical characteristics among study participants (n=179)

Variable	Category	n (%)
Gender	Female	92 (51.4)
	Male	87 (48.6)
Undergoing Active Cancer Treatment	No	78 (43.6)
	Yes	101 (56.4)
Type of Cancer	Carcinomas	24 (13.4)
	Central Nervous System (CNS) tumors	36 (20.1)
	Leukemias	30 (16.8)
	Lymphomas	33 (18.4)
	Others	34 (19.0)
	Sarcomas	22 (12.3)
MRSA	No	134 (74.9)
	Yes	45 (25.1)

Gender was significantly associated with MRSA-positive cultures. In the MRSA-positive group, there was a larger proportion of men than women (75.6% vs. 39.6%, $p < 0.001$). Active treatment was also significantly associated with MRSA-positive cultures, as 95.6% of MRSA-positive patients

compared to 43.3% of MRSA-negative patients were receiving active cancer treatment ($p < 0.001$). Certain cancer types were also significantly associated with MRSA-positive cultures ($p = 0.011$), with higher MRSA frequencies in patients with lymphoma and leukemia.

Table III: Association of demographic and clinical characteristics with Methicillin-resistant Staphylococcus aureus (MRSA) bacteremia among cancer patients (n=179)

Variable	Study Groups		p-value
	MRSA Absent n (%) (n=134)	MRSA Present n (%) (n=45)	
Gender			<0.001
Female	81 (60.4)	11 (24.4)	
Male	53 (39.6)	34 (75.6)	
Undergoing Active Cancer Treatment			<0.001
No	76 (56.7)	2 (4.4)	
Yes	58 (43.3)	43 (95.6)	
Type of Cancer			0.011
Carcinomas	20 (14.9)	4 (8.9)	
Central Nervous System (CNS) tumors	29 (21.6)	7 (15.6)	
Leukemias	21 (15.7)	9 (20.0)	
Lymphomas	17 (12.7)	16 (35.6)	
Others	30 (22.4)	4 (8.9)	
Sarcomas	17 (12.7)	5 (11.1)	

Chi-square test was applied. *p*-value < 0.05 is considered significant

Patients with MRSA positive cultures were older [median 63 years (IQR=13) compared to 41 years (IQR=20), *p*<0.001] and had lower BMI [median 18.0 kg/m² (IQR=14.8), compared to 24.4 kg/m² (IQR=5.1), *p*=0.043] than patients with MRSA negative cultures.

Table IV: Comparison of continuous variables between patients with and without Methicillin-resistant Staphylococcus aureus (MRSA) bacteremia (n=179)

Variables	Study Groups		p-value
	MRSA Absent (n=134) Median (IQR)	MRSA Present (n=45) Median (IQR)	
Age (years)	41 (20)	63 (13)	<0.001
BMI (kg/m ²)	24.4 (5.1)	18.0 (14.8)	0.043

Mann-Whitney U test was applied. *p*-value < 0.05 is considered significant

Discussion:

This study involved 179 cancer patients who had blood cultures that tested positive for bacteria, including 25.1% being infected with methicillin-resistant Staphylococcus aureus (MRSA) bacteremia. The median age of patients in our study was 48 years, with 51.4% of patients being females and 56.4% actively treated for cancer. Central nervous system (CNS) tumors were most common (20.1%) in our patients, compared to other cancers such as lymphoma (18.4%) and leukemia (16.8%).

This study reported that (75.6% of MRSA-infected patients were male, compared to 39.6% of non-MRSA infected patients, *p*<0.001), receiving active therapy for your cancer (95.6% of MRSA patients versus 43.3% of non-MRSA patients, *p*<0.001) and having a hematological malignancy (35.6% were lymphomas and 20.0% were leukemias, *p*=0.011) were all significantly related to having MRSA bacteremia. In addition to the above, MRSA-positive patients were also typically older (MRSA-positive median age 63 years compared to median age 41 years, *p*<0.001) and had lower body mass indexes (MRSA-positive

mean BMI 18.0 kg/m² compared to non-MRSA mean BMI 24.4 kg/m², $p=0.043$).

The rate of MRSA at our institution of 25.1% is significantly higher than the global pooled prevalence of MRSA at 3% (95% CI 2-5%) from a systematic review published by Prentzas et al. (2019) that included all bloodstream infections in patients with cancer(8). This difference could be attributed to our eligibility criteria, whereby patients must have a positive blood culture to be included, whereas included all patients with bloodstream infection due to any organism, which is much broader than blood culture-positive patients. Likewise, studies also found that 26.8% of *S. aureus* isolates from pediatric cancer patients in Egypt were MRSA, and these results are similar to ours(6,9). Nevertheless, the overall prevalence of MRSA among cancer patients in Pakistan (50%), as reported by Toori et al. (2025), was higher than ours, as included all clinical specimens, while our analysis was restricted to positive blood cultures(10).

The strong association found in our study (75.6% compared to 39.6% for females, $p<0.001$) for male gender correlates with new findings. For instance, a 2025 study showed that being male is a major risk factor for having an MDRO; their blood cultures were statistically significant ($p<0.001$). Furthermore, a very large cohort study showed that being male is a predictor of having MRSA bacteremia (OR=2.33; 95% CI=1.34-4.05; $P=0.003$), which is supported by the predominance of males (75.6%) in our study(11). However, the percentage of males in our study (75.6%) is higher than the percentage of males that were found in cancer patients with bacteremia, as reported by Sharma et al. (2021), and was reported at 54.4% in those patients; this may indicate that either regional genetic predisposition or environmental factors are influencing these results(12).

Research by Kim et al. found that a total of 61.5% of patients diagnosed with bacteremia due to a cancer diagnosis were treated with chemotherapy before having an identified infection(13). The treatment with chemotherapy also correlated with lower survival rates for patients with concomitant

bacteremia due to *S. aureus* ($r = -0.15$, $P = 0.03$)(14). The immunosuppressive effects of chemotherapy on previously treated patients would naturally lead to a higher risk of developing infections and a higher incidence rate for patients receiving chemotherapy. Infection rates in patients with hematological malignancies receiving chemotherapy (74%) versus patients with solid tumors receiving chemotherapy (53.2%) demonstrate the immunocompromised state of hematological patients(15-17). The predominance of MRSA in our study population was significantly higher (lymphoma = 35.6% and leukemia = 20.0%) than the 6% for patients with *S. aureus* bacteremia historically documented in hematological malignancies.

The difference in the ages of participants in this study is [63 vs. 41, ($p<0.001$)] and differs from some existing literature. Previous studies demonstrate that older participants have higher mortality rates for MRSA compared to younger participants (6.9% mortality <65 years of age; 33.2% mortality >80 years of age) indicating that the younger median age of line participants in our study reflects that they are much younger than the cohort participants in the study by Macedo et al. who had a median age of 66 years, demonstrating a significant regional difference in the ages of onset for CNS tumors and hematological malignancies(18).

Our new and clinically meaningful findings for BMI (18.0 vs 24.4 kg/m²) demonstrate that a lower amount of ASM/BMI reflects an increased risk of nasal MRSA colonization (i.e., with increasing dose dependent on $p<0.05$), giving a 64% reduction in risks by increasing BMI by 1 unit. Furthermore, being underweight will increase the likelihood of 90-day mortality after infection by 1.75 times (95% confidence interval [12.58 to 14.94]), again demonstrating the prediction of low BMI for MRSA bacteremia found earlier; however, studies exist that demonstrate an increase in survival in patients with metastatic renal cancer based upon increasing amounts of BMI(19,20).

Limitations of Study: The design is cross-sectional and therefore does not allow us to make causal inferences about active treatment and MRSA. The

intervention was performed at one site only and therefore, cannot be applied to other hospitals or groups of people; whereas, the BALANCE study included data across 74 hospitals. Additionally, we excluded participants who were culture-negative; thus, our estimate of the prevalence of BSI in this group may be inflated compared to the systematic reviews, which included all BSI. The interquartile ranges (age IQR=25, BMI IQR=7.3) demonstrate that we had a very heterogeneous sample as opposed to the tightly controlled conditions associated with typical randomized trials.

Conclusion:

In this study, MRSA bacteremia was found to occur in a large number (25%) of the cancer patient population. This study also reported the following statistically significant associations with MRSA bacteremia: male gender, currently receiving cancer treatment, having a hematological malignancy, age, and lower BMI. Patients undergoing cancer treatment and individuals with lymphoma or leukemia were found to be at much higher risk for MRSA infection than the study population as a whole. The findings from this study emphasize the need for improved surveillance for infection, timely microbiological diagnosis of infection, and appropriate empirical antibiotic selection in the cancer care setting. Early identification of high-risk patients may allow for targeted strategies to prevent MRSA infections and improve clinical outcomes, as well as reduce the incidence of morbidity due to MRSA among cancer patients.

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