

# Prevalence and Antibiotics Susceptibility of MRSA at Federal Burn Care Centre, Pakistan

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## ABSTRACT

**Objectives:** 1) To assess the prevalence of MRSA among patients with burn wounds. 2) To explore the susceptibility of MRSA to antibiotics in patients with burn wounds.

**Methodology:** An observational descriptive study was conducted in the Burn Care Centre (BCC), PIMS, SZAB Medical University, Islamabad, from July 2023 to April 2024. Patients of all age groups, genders, and burn varieties were included in our study.

**Results:** A total of 274 swab cultures were collected from patients who showed signs of infection. Out of the total, 122 (44.5%) were male patients and 152 (45.4%) were females. About 39.7% (109) patients were children younger than 12 years of age. Among 274 samples, 50 (18.2%) samples revealed no growth. The most common bacteria cultured was *Pseudomonas aeruginosa* with 113 (41.2%) swab cultures, followed by *Klebsiella pneumoniae* with 71 (25.9%) samples and MRSA with 40 (14.6%) cultures. MRSA showed 100% sensitivity to vancomycin and 92.5% sensitivity to linezolid. Chloramphenicol was 60% sensitive. Penicillin, ceftriaxone, ceftazidime, oxacillin, piperacillin, and tazobactam showed no sensitivity to MRSA.

**Conclusion:** Our study shows less prevalence of MRSA in the BCC unit with no vancomycin and almost no linezolid resistance as compared to other mentioned studies. We achieved low prevalence of MRSA and antibiotic resistance due to judicious use of antibiotics, maintenance of antibiograms, and following aseptic technique.

**Keywords:** Antibiotic susceptibility, Burn, Pakistan, Methicillin-resistant *Staphylococcus aureus*, Wound culture

### Authors' Contribution:

<sup>1,2</sup>Conception; Literature research; manuscript design and drafting; <sup>3,4</sup>Critical analysis and manuscript review; <sup>5,6</sup>Data analysis; Manuscript Editing.

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## Introduction

Globally, burn injuries are a major public health concern.<sup>1</sup> According to the World Health Organization (WHO), 180,000 deaths occur every year and the majority of the victims belong to low- and middle-income countries (LMIC).<sup>2</sup> Skin, which is the largest organ of the human body, acts as a natural barrier and prevents microbes from entering

into the body.<sup>3</sup> Due to the loss of this barrier in burn injury, patients become immunocompromised and are more prone to infections of burned areas. Infections are the leading cause of morbidity and mortality in burn patients worldwide. Methicillin resistant *Staphylococcus aureus* (MRSA) is a major cause of infection in hospitals worldwide and is also endemic in burn units.<sup>4</sup> Irrational use of antibiotics has caused pathogens to develop resistance over

time.<sup>5,6</sup> The antibiotic resistance properties of *Staphylococcus aureus* is actually a result of complex interplay among exposure to antibiotics, environmental factors and bacteria's genetic design. Some species of bacteria possess specific genes that fight stressors like antibiotic while others can undergo mutations that help them defend against antibiotics. Resistant cells in *Staphylococcus aureus* species can either undergo mutation or acquire new genes to better combat against antibiotics. For example, a mutation in "A subunit" of topoisomerase IV (an enzyme in DNA replication) can lead to fluoroquinolone resistance in *Staphylococcus aureus*. This mutation allows for the bacteria to change the structure of proteins which are the target of fluoroquinolones.<sup>7</sup> Another mechanism by which the *Staphylococcus aureus* resists antibiotics is by acquiring de novo genes via specific elements. These elements may vary, ranging from plasmids to transposons and insertion sequences to phage DNAs. These new DNA sequences may change the motility patterns or help bacteria form new proteins to evade antibiotics.<sup>8</sup> Antibiotic resistance is a major threat to infection treatment in modern day medicine. The improper, unjudicial and over-the-counter use of antibiotics has led to resistance of many antibiotics that were drug of choice not more than 15 years ago.<sup>9</sup> According to the World Health Organization, antibiotic resistance could cause 10 million deaths by 2050 if newer viable antibiotics are not developed. The most affected regions will be South Asia and Africa.<sup>9</sup> This would certainly lead to a substantial increase in load on the healthcare system in these regions, costing hundreds of millions of dollars on these low-and -middle-income countries. One of the important bacteria with widespread antibiotic resistance is MRSA. A systematic review and meta-analysis on studies of burn wound infections revealed a 50% greater risk of getting MRSA infection in case of burn wound when compared to other surgical site infections.<sup>10</sup> The prevalence of MRSA has been reported to be 25.22%

among other pathogens in burn wound infections, followed by *Klebsiella pneumoniae* (15.93%) and *Pseudomonas aeruginosa* (38.93%).<sup>11</sup> Although other gram-negative organisms like *Pseudomonas aeruginosa* and *Klebsiella pneumoniae* contribute significantly to the culture positive burn infections, MRSA remains clinically relevant in terms of multi-drug resistance.<sup>4</sup> It is important to address the resistance patterns of MRSA as it is the major cause of morbidity and mortality among patients with burn wounds.<sup>4</sup> The purpose of this study is to find the prevalence of MRSA and susceptibility to antibiotics in our setting.

## Methodology

An observational, descriptive study was conducted at Burn Care Centre (BCC), PIMS SZAB Medical University Islamabad from July 2023 to April 2024. The study population was all patients with burns admitted to the Burn Care Centre, Pakistan Institute of Medical Sciences (PIMS), Islamabad, Pakistan, from July 2023 to April 2024. Patients of all age groups, genders and burn types were included in our study. A total of 274 swab cultures were collected from patients who showed signs of infection. Since this was a time-bound study and involved a consecutive sampling technique, formal sample size calculation was not required. Samples were collected from admitted patients on weekly basis. Strict anti-septic techniques were applied while taking the swab culture and making sure there is no cross-infections. Disposable gloves were worn by the medical professionals and patients were placed on clean disposable sheets to prevent cross infections. Samples were taken before the wound was washed and a new dressing was applied. Cultures were taken by rubbing the swab over the burn area which was deep, infected and had clear or cloudy discharge. Swab sticks were sent immediately to laboratory for growth and antibiotic susceptibility of microorganisms. Cultures were incubated for 24 hours in blood agar and MacConkey agar. Gram

staining was done on plates showing microbial growth. The disc diffusion method was used to identify microorganism susceptibility. Data was received after 5 days. All the data was digitalized in the format of Microsoft Excel sheets. This data was then analyzed using Statistical Package for the Social Sciences version 27 (IBM Corp. Released 2020). Descriptive statistics were calculated for sociodemographic variables, organisms found on culture and their relative sensitivity to antibiotics.

**Ethical approval** was taken from the Ethical Review Board of Pakistan Institute of Medical Sciences (PIMS) with ERB Ref. No. F.11-6/2023-TCA-(Admin)-BCC dated 11th June, 2023.

## Results

A total of 274 culture reports were analyzed. These swab cultures were taken from admitted patients at BCC, Islamabad. Out of the total, 122 (44.5%) were male patients, 152 (455.4%) were females. About 39.7% (109) patients were children less than 12 years of age.

Among 274 samples 50 (18.2%) samples revealed no growth. The most common growth cultured on samples obtained from burn wound infections were *Pseudomonas aeruginosa*, accounting for 113 (41.2%) swab cultures. The second most common bacteria were *Klebsiella pneumoniae* with 71 (25.9%) swab cultures. Only 40 (14.6%) cultures were positive for MRSA. The remaining 50 swab cultures either revealed no growth at all or included other uncommon species, including *Proteus mirabilis*, *Escherichia coli*, etc.

MRSA showed 100% sensitivity to vancomycin and 92.5% sensitivity to linezolid. *Staphylococcus aureus* was totally resistant to penicillin and piperacillin + tazobactam were totally resistant. The sensitivity percentages of different antibiotics are depicted in Table I and Table II. The data analysis showed that all patients diagnosed with this infection were initially treated at other burn units for more than 48 hours prior to being sent to BCC, PIMS.

**Table I: Sociodemographic Characteristics of Burn Wound Patients**

Gender	Age group	<i>Pseudomonas aeruginosa</i>	<i>Klebsiella pneumoniae</i>	MRSA	None or others	Grand Total
Male	0-12	24	15	12	9	60
	13-65	31	26	11	20	88
	65+	2	1	1	0	4
	Total	57	42	24	29	122
Female	0-12	23	11	7	8	49
	13-65	30	11	8	13	62
	65+	3	7	1	0	11
	Total	56	29	16	21	152
Grand Total		113	71	40	50	274

**Table II: Percentage Sensitivity of Antibiotics for MRSA (%)**

Antibiotic	Percentage sensitivity
Augmentin	0.0
Ceftazidime	0.0
Ceftriaxone	0.0
Chloramphenicol	60.0
Ciprofloxacin	20.0
Clindamycin	12.5
Co-trimoxazole	10.0
Doxycycline	57.5
Erythromycin	0.0
Gentamycin	2.5
Imipenem	5.0
Linezolid	92.5
Oxacillin	0.0
Penicillin	2.5
Piperacillin + tazobactam	0.0
Vancomycin	100.0

## Discussion

Antibiotic resistance is growing at an alarming rate and is a major public health concern worldwide. Increase in resistance over the years can be attributed to various factors such as overuse of antibiotics, inappropriate prescriptions and extensive antimicrobial use in foods.<sup>12,13</sup> This study also acts as a watchdog to investigate novel resistance developing against antibiotics, thereby taking necessary precautionary steps to reduce further antibiotic resistance. Antibiogram is

maintained and updated regularly. The nature of such a specific study demonstrates its crucial requirement in the development of the antibiogram in our clinical setting.

A study carried out on burn wounds at the Jinnah Burn and Reconstructive Surgery Center, Lahore, Pakistan showed that 751 samples of organisms isolated were *Staphylococcus aureus*, and of those 421, (56%) were MRSA. MRSA was resistant to multiple drugs; however, linezolid showed to have maximum effect against MRSA. Although the prevalence of MRSA was high but the sensitivity to antibiotics, especially Linezolid, was consistent with our result.<sup>14</sup>

Another study compiled the data of patients from 3 burn units of Karachi revealed that 10 cultures (24.6%) were positive for MRSA, all of the culture were 100% sensitive to vancomycin and chloramphenicol, 20% were sensitive to clindamycin. These results are consistent with our findings which showed 99.63% sensitivity of MRSA to vancomycin, 91% sensitivity to linezolid and 12.5% sensitivity to clindamycin although the prevalence of MRSA was high.<sup>15</sup>

A study carried out by Department of Microbiology Mamata Medical College; 32.12% cultures were positive for MRSA. 100% were resistant to penicillin, 84.9% resistant to Ciprofloxacin, 28.3% resistant to linezolid and no resistant to Vancomycin. The results were consistent with our study however resistance to linezolid was particularly alarming, but no such resistant was found in our study<sup>16</sup>. Another study of India found *Pseudomonas aeruginosa* as the most common isolate (37%) followed by *Klebsiella pneumoniae* (15%), which are consistent results with our study.<sup>17</sup>

Another study carried out in India showed 59.39% cultures were positive for MRSA. No resistance was found against vancomycin and linezolid but 35.45% cultures were resistant to Clindamycin. In this study, 34.93% cultures were positive for *Pseudomonas aeruginosa*. In our study, 41.2% cultures were positive for *Pseudomonas aeruginosa* and no

resistance to Vancomycin with 92.5% sensitivity to linezolid was observed.<sup>18</sup>

A study carried out in the burn unit of a tertiary care centre in Ghana, Africa showed 11% of patients were MRSA positive, no resistance was found against Vancomycin and Linezolid, 35% resistant to Chloramphenicol, which is consistent with our study, however no resistance to ceftazidime was observed in this study however, in our study MRSA was completely resistant to ceftazidime.<sup>19</sup>

Another study carried out in Bolan Medical Complex Hospital and Sandeman Provincial Hospital, Quetta, Pakistan found that the most common infective organism was *Pseudomonas aeruginosa*, showing a positive statistic 58.9%, which is consistent with our study of 41.2%. Their study found that colistin, meropenem and imipenem were most sensitive against *P. aeruginosa*.<sup>20</sup> In a study conducted at Department of Burn and Plastic Surgery, Allama Iqbal Teaching Hospital, Dera Ghazi Khan, Punjab, Pakistan, *Pseudomonas aeruginosa* was the most common organism (34.9%) to be reported in burns-related infections, followed by 15% for *Klebsiella pneumoniae* and 2.9% for MRSA.<sup>21</sup> Vancomycin and linezolid were most effective against MRSA as found in our study.<sup>21</sup>

A recent meta-analysis of studies conducted across China analyzed 62,819 isolated samples of burns-related infection swabs and yielded that *Staphylococcus aureus* was the most common organism, followed by *Pseudomonas aeruginosa* and *Klebsiella pneumoniae*. *Staphylococcus aureus* was most sensitive to linezolid followed by vancomycin and clindamycin.<sup>22</sup> These findings were consistent with the results of our study.

**Study strengths:** Our study comprises of data gathered from samples collected over a period of one whole year, which reduces the chances of any seasonal variations in the distribution of MRSA infections. Moreover, the samples were collected in a completely sterile, uniform and organized manner and tested on state-of-the-art instruments in accordance with international Clinical and

Laboratory Standard Institute (CLSI) guidelines. Our study sample consists of data from a wide range of age groups. Hence, the results are applicable to the population of all age groups.

**Study limitations:** This study has some limitations. Firstly, the study consists of data from a single center, representing a distribution of prevalence and antibiotic susceptibility patterns over a specific region. Secondly, only 40 sample of MRSA were retrieved, which are not enough to represent less common resistance patterns. Thirdly, we focused only on infections associated with burn wounds; other surgical wounds could yield different resistance patterns for the same antibiotics.

**Study recommendations:** Based on our study findings, we recommend judicious and evidence-based use of antibiotics. The antibiotics stewardship programs should be strengthened to incorporate small clinics, private hospital setups, pharmacies and medical stores to allow controlled use of antibiotics. The antibiogram developed using this study will help us in the judicious use of antibiotics and slow down the epidemic of antibiotic resistance. Strict policy measures should be taken to reduce over-the-counter dispense of antibiotics. Awareness campaigns should be launched via digital, electronic and print media to educate the public regarding the rational use of antibiotics. These measures would help reduce the trend of antibiotic resistance in future and decrease burden on the healthcare budget.

## Conclusion

Our study shows less prevalence of MRSA in our unit with no vancomycin and minimal linezolid resistance as compared to other mentioned studies. We achieved low prevalence MRSA and antibiotic resistance due to judicious use of antibiotics, maintenance of antibiogram and following aseptic technique. We maintain a strict policy regarding visitors for patients, if any visitor or caregiver is permitted to visit, they are required to wear surgical caps, mask and shoe covers. For medical

professionals hence reducing the chances of any contamination of the environment of wards. At the Burn Care Centre, PIMS, Islamabad, the Advance Burn Life Support protocols of the American Burn Association are followed. Burn patients are treated with proper wound cleansing, occlusive dressing and antibiotic cleansing wipes. These measures helped reduce the prevalence of MRSA in our burn center.

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