Original Research Article

**Prevalence and antibiotic-resistant pattern of *Staphylococcus aureus* and *Coagulase negative Staphylococci* isolated from wounds among patients** **attending** **Mogadishu Somali Türkiye Recep Tayyip Erdogan Training and Research Hospital**

ABSTRACT

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| --- |
| Infections caused by *Staphylococcus* species are frequently linked to wounds, particularly in patients who are hospitalized. Wounds can serve as a source of bacteria that lead to cross-contamination and pose a risk for methicillin-resistant Staphylococcus aureus (MRSA) infections.**Aim:** to determine the prevalence and antibiotic Resistance Pattern of staphylococcus species Isolates from Wound infections in a Mogadishu Somali Turk Recep Tayyip Erdogan research and teaching hospital**Patients and methods:** A retrospective cross-sectional study design was used for this study, and 1423 patients diagnosed with wound infection were recruited.**Results:**Among the 1,423 individuals surveyed, the overall prevalence of *Staphylococcus species* isolated was 299 (21%). The prevalence of *Staphylococcus aureus* was recorded at 16.4%, whereas coagulase-negative staphylococci (CoNS) accounted for 4.6%. Staphylococcus aureus exhibited significant resistance rates to several antibiotics, including Penicillin G (98.7%), Ampicillin (84%), Tetracycline (74%), Erythromycin (73.9%), and Cefoxitin (64%). Conversely, coagulase-negative Staphylococcus showcased high resistance rates to Cefoxitin (66.7%), Erythromycin (70.2%), Ampicillin (85%) and Penicillin G (100%). Notably, both S. aureus and CoNS demonstrated considerable sensitivity to Vancomycin, Linezolid, Daptomycin, and Quinupristin/Dalfopristin.**Conclusion:**The study revealed a notable prevalence of *Staphylococcus aureus* in wound infections, accompanied by significant antibiotic resistance. These findings emphasize the necessity of monitoring resistance patterns to guide treatment strategies effectively. Continued research and surveillance are crucial in the ongoing effort to combat this adaptive pathogen. |

*Keywords:* ***Keywords:*** *Staphylococcus aureus, Coagulase negative Staphylococcus, drug-resistant, Somalia.*

1. INTRODUCTION

**Introduction**

Bacterial wound infections from antimicrobial-resistant bacteria increase morbidity rates and healthcare costs, contributing significantly to illness and mortality in developing countries (Shimekaw et al., 2022). Wound infections in hospitalized patients are frequently caused by *Staphylococcus aureus, Escherichia coli, coagulase-negative Staphylococcus* (CoNS), *Pseudomonas aeruginosa*, Proteus mirabilis, Enterobacter aerogenes and Klebsiella pneumonia(Bandy et al., 2022).

The *Staphylococcus* genus is divided into two groups based on their coagulase enzyme production, coagulase-positive (CoPS) and coagulase-negative staphylococci (CoNS) (Miszczak et al., 2023). *Staphylococcus aureus* ranks among the most common pathogens acquired in both community and hospital settings, leading to various local and systemic infections. The emergence of methicillin-resistant (MRSA) and even multidrug-resistant strains of *S. aureus* poses a significant public health challenge(Wendel et al., 2023).

*Staphylococcus aureus*, a prevalent pathogen responsible for pyogenic infections, also serves as a natural component of the human skin flora (Sapkota et al., 2019). Specifically, Surgical Site Infections (SSI) caused by *methicillin-resistant Staphylococcus aureus* (MRSA) have become a severe complication, resulting in higher mortality rates, longer hospital stays, and increased expenses (Anderson & Kaye, 2009). Antimicrobial resistance in *Staphylococcus* is most prevalent in low-income and lower-middle-income countries. Presently, methicillin-resistant Staphylococcus pathogens rank among the top causes of mortality, with a global prevalence ranging from 1% to 80%(Ong’era et al., 2023). The resistance rates of *S. aureus* infection and multidrug-resistant strains are on the rise, posing challenges for clinical anti-infective treatment(Guo et al., 2020). *Methicillin-resistant Staphylococcus aureus* (MRSA) denotes strains of bacteria that have acquired resistance to all existing β-lactam antibiotics, including penicillins and cephalosporins. This resistance is attributed to the *mecA gene*, which encodes Penicillin-Binding Protein 2a, thereby diminishing the bacteria's capacity to effectively bind to beta-lactam antibiotics(Al-Sarar et al., 2024).

*Coagulase-negative Staphylococcus* (CoNS) particularly *S. epidermidis, S. haemolyticus, and S. saprophyticus* are the most prevalent infective agents in hospital-acquired infections(Kumari et al., 2020). In the past, CoNS were viewed as benign bacteria. However, in recent decades, treating CNS infections has become more difficult due to the rise of methicillin-resistant strains that have decreased sensitivity to glycopeptides and various traditional and modern antibiotics(Latif et al., 2015).

There is a notable absence of published research on the prevalence and antibiotic resistance patterns of Staphylococcus strains isolated from wounds in Somalia. This lack of data poses a significant challenge as it hampers the understanding of the prevalence and resistance patterns of Staphylococcus, which in turn can contribute to an increase in morbidity rates, therapeutic inefficacy, and instances of hospital-acquired infections. This study aimed to find out the prevalence and antibiotic-resistant pattern of staphylococcus isolate from wounds among patients attending Mogadishu Somali Türkiye Recep Tayyip Erdogan Training and Research Hospital.

2. material and methods

**2.1** Study **area and design**

This retrospective analysis was conducted by reviewing records of wound samples that arrived at the Microbiology laboratory of the Erdogan Hospital in Mogadishu, from January 2022 to June 2024. This study was approved by the Clinical Research Ethics Committee of the Mogadishu Somali Turkish Training and Research Hospital (Reference number: MSTH/18178). The privacy of patient's personal information was maintained throughout the study in accordance with the Helsinki Declaration. Codes were used instead of names and ID numbers to protect patient confidentiality. The wounds were sampled for microbiological analysis before any administration of antibiotics. In total, 1423 wound samples were collected from January 2022 to June 2024 patients.

**2.2 Sample collection**

Following a brief superficial cleansing of wounds with physiological saline, each specimen was gathered by rotating a sterile, premoistened swab (Nuova Aptaca SRL, Canelli, Italy) over a 1 cm² area of the wound in a zig-zag pattern, moving from the center outward. The swab was then placed into a tube containing the transport medium (Nuova Aptaca SRL) and sent to the hospital's Microbiology laboratory for further culture analysis.

***2.3.*****Identification of Staphylococcus species**

Following collection, the wound samples were promptly dispatched to the microbiology unit within 30 minutes in a sterile sample container. They were subsequently cultured in 2mL of tryptone soy broth with NaCl and incubated aerobically at 35 ̊C for 24 hours, after which 50-μL aliquots of the broth were inoculated onto mannitol salt agar plates. Colonies were selected based on colony morphology and were then sub-cultured on to tryptic soy agar (TSA). Positive catalase and coagulase reactions were considered presumptive positive for S. aureus, on the other hand positive catalase and negative Coagulase considered as CoNS. All specimens underwent Gram staining, which was examined at x100 magnification using oil immersion.

**2.4. Antimicrobial Susceptibility pattern**

Antimicrobial sensitivity tests were conducted by CLSI guidelines, utilizing the Kirby Bauer disk diffusion method. The organisms were tested on Mueller–Hinton agar using the following antibiotics: Ceftriaxone (30 mcg), Trimethoprim/sulfamethoxazole (1.25/23.75 mcg), Ciprofloxacin (5 mcg), Amikacin (30 mcg), Meropenem (10 mcg), erythromycin (15 μg), clindamycin (2 μg), tetracycline (30 μg), linezolid (30 μg), cefoxitin (30 μg), Vancomycin (30 μg), Linezolid (30 μg), Daptomycin (30 μg), Quinupristin/ Dalfopristin (15 μg).

Briefly, a bacterial suspension with a turbidity equivalent to the McFarland 0.5 standard (1.5× 108 colony forming unit/mL) was prepared. Antibiotic disks were placed onto the inoculated Mueller-Hinton agar (Que-lab, Canada) plates with the appropriate distances and the plates were then incubated at 35 °C for 16–18 h. The inhibition zones were measured and interpreted according to the 2019 CLSI guidelines. *S. aureus* ATCC 25923 was used as the quality control strain.

3. results and discussion

**3.1. Results**

A total of 1,423 patients were recruited in this study. Among them, the majority of diagnoses were male, constituting 61.9% (881 out of 1,423), while female patients with wound infections represented 38.1% (542 out of 1,423). The largest segment of patients was within the 21-40 age group, comprising 40%, followed by those under 20 years at 27%, the 41-60 age group at 16.5%, and patients over 60 years at 16.4%. as shown in Table 1.

The study revealed the prevalence of S. aureus among Staphylococcus species isolated from patients during the research period was 16.4 % (233 out of 1423), while *Coagulase-Negative Staphylococci* (CoNS) accounted for 4.6 % (66 out of 1423). See Table 2.

The resistance profile for each bacterial strain was assessed based on the total number of isolates per strain type. As indicated in Table 3, 76.8% of the total isolates exhibited a multidrug-resistant (MDR) profile, demonstrating resistance to at least three classes of antibiotics. The overall MDR rate for Staphylococcus isolates was 73.2%, with *Staphylococcus aureus* at 76.8% and *coagulase-negative Staphylococci* (CoNS) at 60.6%. The rate of monodrug resistance among S. aureus isolates was 12.9%, while for CoNS isolates, it was 13.6%. Ultimately, 13.7% of Staphylococcus isolates displayed no resistance to any antibiotics, with *S. aureus* contributing 8% and CoNS 5.7%. Table 4 presents the Staphylococcus species isolated along with their respective resistance profiles.

Out of the 233 *Staphylococcus aureus* isolates recovered, 60.1% (140/233) were identified as methicillin-resistant Staphylococcus aureus (MRSA), while the remaining 39.9% were methicillin-sensitive *Staphylococcus aureus* (MSSA). The prevalence of *MRSA* was slightly higher in females at 32.1% (75/233) compared to males at 27.9% (65/233). The highest incidence of *MRSA*, at 24.9% (58/233), was observed in the age group of 21–40 years, followed by 21.5% (50/233) in individuals under 20 years. Conversely, the age groups 41–60 years and over 60 years exhibited the lowest rates of MRSA, at 7.3% (17/233) and 6.4% (15/233), respectively.

Both *S. aureus* and CoNS exhibited significant resistance to cefoxitin, ampicillin, Erythromycin, and penicillin G. Notably. Conversely, both *S.aureus* and CoNS demonstrated high sensitivity to vancomycin, linezolid, daptomycin, and quinupristin/dalfopristin. For more details on sensitivity and resistance profiles, please refer to Table 5. These findings underscore the critical importance of selecting appropriate antibiotics for treatment, given the high prevalence of resistance. The high sensitivity to vancomycin, linezolid, daptomycin, and quinupristin/dalfopristin suggests these antibiotics remain effective options for treating infections caused by these resistant strains. However, continuous monitoring is essential to detect any emerging resistance patterns. Clinicians should remain vigilant and rely on updated antibiograms to guide therapy, ensuring both the efficacy of treatment and the reduction of resistance development. Additionally, implementing robust infection control measures and antibiotic stewardship programs could further help in managing and reducing the spread of resistant strains within healthcare settings.

Table 1. Sociodemographic features of the patients with wound infection at Mogadishu Somali Türkiye Recep Tayyip Erdogan Training and Research Hospital.

|  |  |  |
| --- | --- | --- |
| Sex | Frequency | Percent % |
| Male | 881 | 61.9% |
| Female | 542 | 38.1% |
| Total | 1423 | 100% |
| Age |  |  |
| Less than 20 | 385 | 27.1% |
| 21-40 | 570 | 40% |
| 41-60 | 235 | 16.5% |
| Above 60 | 233 | 16.4% |
| Total  | 1433 | 100% |

Table 2. The prevalence of *S. aureus* and *CoNS* isolated from patients with wound infection at Mogadishu Somali Türkiye Recep Tayyip Erdogan Training and Research Hospital.

|  |  |  |
| --- | --- | --- |
| Species | Frequency | Percent % |
| *Staphylococcus aureus* | 233 | 16.4% |
| *Coagulase-negative Staphylococcus* | 66 | 4.6% |
| Total | 299 | 21% |

Table 3. *Staphylococcus* species isolated wound infection by type of resistant type

|  |  |  |  |
| --- | --- | --- | --- |
|  | Monodrug resistant | Multiple drug-resistant | Non-resistant |
| Species  | Frequency  | Percent % | Frequency  | Percent % | Frequency  | Percent % |
| *S. aureus* | 30 | 12.9% | 179 | 76.8% | 24 | 10.3% |
| *CoNS* | 9 | 13.6% | 40 | 60.6% | 17 | 25.8% |
| Total | 39 | 13% | 219 | 73.2% | 41 | 13.7 |

Table 4. Distribution of MRSA and MSSA isolated from a wound specimen

|  |  |  |
| --- | --- | --- |
|  | *MRSA* Detected | *MRSA* Not detected |
| Frequency | Percent | Frequency | Percent |
| Sex |
| Male | 65 | 27.9% | 54 | 23.2% |
| Female | 75 | 32.1% | 39 | 16.7% |
| Total | 140 | 60.1% | 93 | 39.9% |
| Age |
| Under 20 | 50 | 21.5% | 35 | 15% |
| 21-40 | 58 | 24.9% | 27 | 11.6% |
| 41-60 | 17 | 7.3% | 20 | 8.6% |
| Above 60 | 15 | 6.4% | 11 | 4.7% |
| Total | 140 | 60.1% | 93 | 39.9% |

Table 5. Antibiotic susceptibility profile of *Staphylococcus* species isolated from patients with wound infection.

|  |  |  |
| --- | --- | --- |
| Antibiotic | *Staphylococcus aureus**(n=233)* | *Coagulase Negative**Staphylococcus(n=66)* |
| Resistant | Susceptible | Resistant | Susceptible |
| Vancomycin | 3(1.4%) | 219(98.6%) | - | 61(100%) |
| Ampicillin | 42(84%) | 8(16%) | 17(85%) | 3(15%) |
| Trimethoprim/sulfamethoxazole | 92(50.8%) | 89(49.2%) | 22 (47.8%) | 24(52.2%) |
| Tetracycline | 114(74.5%) | 39(25.5%) | 2(50%) | 2(50%) |
|  Linezolid  | 7(4.3%) | 154(95.7%) | 1(4%) | 24(96%) |
| Fusidic Acid | 14(21.5%) | 51(78.5%) | 13(26%) | 37(74%) |
| Ciprofloxacin | 50(29.2%) | 121(70.8%) | 8(22.2%) | 28(77.8%) |
| Clindamycin | 51(24%) | 162(76%) | 14(30.4%) | 32(69.6%) |
| Penicillin G | 152(98.7%) | 2(1.3%) | 16(100%) | - |
| Cefoxitin | 140(60.1%) | 93(39.9%) | 36(66.7%) | 18(33.3%) |
| Quinupristin | 11(13.3%) | 72(86.7%) | 2(4.5%) | 42(95.5%) |
| Daptomycin | 6(7.3%) | 76(92.7%) | - | 53(100%) |
| Erythromycin | 85(73.9%) | 30(26.1%) | 33(70.2%) | 14(29.8%) |

**3.2. Discussion**

Our study investigated the prevalence of *Staphylococcus* species isolated from wound infections among patients attending Mogadishu Somali Türkiye Recep Tayyip Erdogan Training and Research Hospital. Among the 1423 individuals surveyed, 233 patients tested positive for Staphylococcus aureus, resulting in an isolation rate of 16.4 % (233/1423). This finding closely aligns with the results of the Alharbi study, which reported a 17.1% isolation rate from wound swabs(Alharbi, 2022). Similarly, Nițescu et al. (2023) documented a Staphylococcus aureus prevalence of 12%. Our study is lower than the study conducted by Muluye et al in Ethiopia which reported a prevalence of Staphylococcus aureus at 32.9% (Muluye et al., 2014) and (Ndedy et al., 2023) in Cameroon which reported 26 %. This discrepancy could be attributed to various factors, such as differences in sample size, population demographics, or methodologies used in the studies. Further investigation and more standardized approaches might be necessary to understand the variations in prevalence rates fully. Nonetheless, our findings underscore the importance of continued surveillance and targeted interventions to manage and reduce the incidence of Staphylococcus aureus infections in our region.

Our research found the prevalence of coagulase-negative staphylococcus (CoNS) to be 4.6% (66 out of 1,423 samples). This finding is lower than the 7.8% prevalence reported by Upreti et al. (2018) in Ethiopia and the 12% prevalence reported by Ashagrie et al(Ashagrie et al., 2021). Additionally, our findings are significantly lower than those of Ahmed et al., who reported a prevalence of 47.3% among Egyptian patients after surgery. Discrepancies in methodologies and the efficacy of infection control systems between hospitals may account for this variation.

Methicillin resistance refers to *S. aureus* strains that show resistance to isoxazoyl penicillins, including methicillin, oxacillin, and flucloxacillin. MRSA is also resistant to all β-lactam antibiotics that are currently authorized for use. our study revealed that the prevalence of MRSA was 60.1%, which is markedly higher than rates reported in other African countries, such as 8.8% in Hawasa, Ethiopia(Sahle & Merid, 2024). 40.7% in Kiambu County Kenya(Iliya et al., 2020), 53% in Kenyata National Hospital in Nairobi Kenya(Mutonga et al., 2019) and 56% in Selected tertiary hospitals in Uganda(Mayito et al., 2024). The differences in prevalence may be linked to variations in infection control practices, the study population, and antibiotic stewardship standards between countries. These results suggest that MRSA continues to be a public health concern in Somalia and poses a significant challenge due to the dependence on second-line medications, which are more expensive and harmful, potentially exacerbating the issue of drug resistance.

Our study found a significant prevalence of *Staphylococcus* species that are resistant to various antibiotics: 76.8% for S. aureus and 60.6% for coagulase-negative Staphylococci (CoNS). These figures are notably higher than those reported by Chen et al. (2023), which showed a multi-drug-resistant rate of 18.56% for Staphylococcus aureus and 10.89% for CoNS.

In our study Both *S. aureus* and *CoNS* showed significant resistance to cefoxitin, ampicillin, tetracycline, trimethoprim-sulfamethoxazole, erythromycin, and penicillin G, However, they were highly sensitive to vancomycin, linezolid, daptomycin, and quinupristin/dalfopristin. Several studies highlighted Staphylococcal isolates ' resistant pattern in different from our finding, Ong’era et in Kenya reported Staphylococcus isolates that are highly resistant to amoxicillin and ceftazidime for CoNS and ceftazidime, amoxicillin, and streptomycin for S. aureus (Ong’era et al., 2023). Also, (Ambachew et al., 2022) in Ethiopia concluded a considerably high magnitude of MRSA and inducible clindamycin resistance S. aureus isolates. These discrepancies in resistance patterns may be attributed to several factors, including regional variations in antibiotic usage, healthcare practices, and differences in the genetic makeup of bacterial populations. Furthermore, the selective pressure exerted by the widespread use of antibiotics in different regions can lead to distinct resistance profiles. It is also possible that environmental factors and infection control measures play significant roles in shaping these patterns.

4. Conclusion

In conclusion, our data showed that the prevalence of *Staphylococcus* species isolated was (21.1%), and the most common isolate species was *Staphylococcus aureus* 16.4%. The prevalence of *CoNS* was (4.6%). Both *S. aureus* and *CoNS* showed the highest resistance to Penicillin G, Cefoxitin, Ampicillin, and Tetracycline and superior sensitivity to Vancomycin, Linezolid, Daptomycin, and Quinupristin.

Consent (where ever applicable)

The ethics committee waived the requirement for informed consent since this was a retrospective study. However, at the hospital, which serves as a training and research facility, patients are generally asked to provide consent prospectively. In cases involving minors or individuals who are unable to provide consent themselves, their legal guardian, parent, or next of kin is asked to provide consent on their behalf prospectively. Information about the gender and age of the patients was also provided.

Ethical approval (where ever applicable)

study was approved by the Clinical Research Ethics Committee of the Mogadishu Somali Turkish Training and Research Hospital (Reference number: MSTH/18178).

Definitions, Acronyms, Abbreviations

*MRSA, Methicillin-resistant Staphylococcus aureus; CoNS, Coagulase negative staphylococcus; AMP, Ampicillin; SXT, Trimethoprim-sulfamethoxazole; TET, Tetracycline; FA, Fusidic acid; CIP, Ciprofloxin; CLI, Clindamycin; PG, Penicillin G; CXT, Cefoxitin; QUI,* *Quinupristin; DAP, Daptomycin; ERY, Erythromycin.*

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Details of the AI usage are given below:

1.

2.

3.

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