

Antibacterial Susceptibility Profiles of *Staphylococcus aureus* Isolates from Different Patients at Specialist Hospital Sokoto, Nigeria

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Research Article

Keywords: antibiotic susceptibility, clinical isolates, Nigeria, *Staphylococcus aureus*

Posted Date: March 5th, 2026

DOI: <https://doi.org/10.21203/rs.3.rs-8979064/v1>

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Additional Declarations: No competing interests reported.

Abstract

Background: *Staphylococcus aureus* is a major cause of hospital- and community-acquired infections, and increasing resistance to commonly used antibacterial agents complicates treatment. This study assessed the antibacterial susceptibility profiles of *S. aureus* isolates from different samples at Specialist Hospital Sokoto (SHS), Nigeria.

Methods: We collected and processed 86 samples between April and September 2021 using standard microbiological techniques. *S. aureus* was identified phenotypically, and antibacterial susceptibility testing was performed using Kirby–Bauer disk diffusion method following Clinical and Laboratory Standards Institute (CLSI) M100-S24 (2014 edition) guidelines. Data were analyzed using Statistical Package for Social Sciences (SPSS) version 20.

Results: *S. aureus* was isolated from 19 of 86 samples, giving an overall distribution of 22.1% (95% confidence interval: 13.3% - 30.9%). Wound swabs yielded the highest isolates (6 of 86; 6.98%), then urine samples (4 of 86; 4.70%), with the highest occurrence among children aged 0–10 years (8 of 86; 9.3%). The isolates showed highest susceptibility to ceftriaxone and streptomycin (12 of 19; 63.2% each) and highest resistance to norfloxacin (17 of 19; 89.5%), cefuroxime (14 of 19; 73.7%), and amoxicillin (13 of 19; 68.4%). One isolate (1 of 19; 5.3%) showed intermediate susceptibility to each of amoxicillin, ceftriaxone and chloramphenicol.

Conclusion: A considerable burden of antibacterial resistance among *S. aureus* isolates was seen in this setting, highlighting the need for continuous local surveillance for antimicrobial stewardship. The low sample size and absence of molecular resistance characterization are among other key limitations of this study.

1.0 Background

Staphylococcus species are Gram-positive, nonspore-forming bacteria capable of growing under aerobic and anaerobic conditions (Dugan 2022). The genus includes more than 47 species classified into coagulase-positive and coagulase-negative groups. Among these, *Staphylococcus aureus* (*S. aureus*) is the most clinically important species and is responsible for a wide range of infections, including food-borne illnesses, urinary tract infections, soft tissue infections, and pneumonia, with over one million deaths reported in 2019 (Ikuta et al. 2022; Minter et al. 2023). Coagulase-negative species such as *Staphylococcus epidermidis* and *Staphylococcus haemolyticus* also contribute to hospital-associated infections (Nanoukon et al. 2017). The ability of *S. aureus* to transition from a commensal organism to a pathogenic agent reflects its adaptability (Asante et al. 2020).

Infections caused by *S. aureus* may progress from colonization to localized or systemic disease. Factors such as prolonged hospitalization, immunosuppression, and the use of invasive medical devices ease this transition, even among asymptomatic carriers (Anthony & Mayar 2024; Sangiorgio et al. 2024). Local infections commonly present as cellulitis or abscesses, while systemic infections may result in sepsis

and other serious complications (Pătraşcu et al. 2024; Maher & Anokhin 2024; Yamazaki et al. 2024). Antibacterial resistance has become a major global public health challenge (Muluye et al. 2014). Multidrug-resistant *S. aureus* (MDRSA) and methicillin-resistant *S. aureus* (MRSA) are one of the leading causes of difficult-to-treat infections worldwide (Harkins et al. 2017; Mohammad et al. 2014; Thati et al. 2011; Yousefi et al. 2017). MRSA strains are resistant to β -lactam antibiotics, including penicillins and cephalosporins, and increasing resistance to other commonly used antibiotics has further reduced treatment options (Kayastha et al. 2010; Mohammad et al. 2014; Thati et al. 2011).

Recent global surveillance data indicate increasing antibacterial resistance among *S. aureus* and other bacterial pathogens worldwide, particularly in low- and middle-income countries, underscoring the need for updated local susceptibility data (WHO 2025a). In developing countries, the impact of antimicrobial resistance is particularly severe due to limited access to diagnostics and alternative therapies (ARC 2022; Estany-Gestal et al. 2024; Pulingam et al. 2022). A recent study from a tertiary healthcare facility in Calabar, Nigeria, reported a high prevalence of multidrug-resistant *Staphylococcus aureus*, with resistance patterns linked to indiscriminate antibiotic use and associated risks of poor treatment outcomes (Umoh et al. 2024).

In Sokoto state, Adeiza et al. documented frequent nasal carriage of *S. aureus* and methicillin-resistant strains among patients and healthcare workers, with high resistance to commonly used antibiotics, underscoring the persistence of resistant strains in hospital settings (Adeiza et al. 2020). Although several studies have reported *S. aureus* susceptibility patterns in various parts of Nigeria, data from Sokoto state, particularly from Specialist Hospital Sokoto, remain limited. Earlier studies conducted in this region were constrained by small sample sizes, restricted specimen types, and narrow antibiotic panels, limiting their applicability to current state. In contrast, the present study provides updated epidemiological data by incorporating a broader range of clinical specimens and a wider panel of commonly prescribed and reserved antibacterial agents. This approach offers a more comprehensive representation of local resistance profiles, thereby filling an important knowledge gap and supporting evidence-based antimicrobial stewardship in Sokoto state.

Given the clinical importance of *S. aureus* and the growing challenge of antimicrobial resistance, this study aimed to find the frequency, distribution, and antibacterial susceptibility profile of *S. aureus* isolates recovered from different clinical samples at Specialist Hospital Sokoto, with analysis by specimen type and selected demographic characteristics.

2.0 MATERIALS AND METHODS

2.1 STUDY AREA

This study was conducted at Specialist Hospital Sokoto, which is in Sokoto South Local Government Area of Sokoto State. Sokoto State is in the northwestern geopolitical zone of Nigeria and was carved out of the defunct northwestern state on 3rd February 1976. According to the National Population

Commission (2010), population figures stand at 3,702,676 people spread over an area of 33,776.89 square kilometers of land (UNFPA 2023).

2.2 STUDY POPULATION

The study population included both inpatients and outpatients attending Specialist Hospital Sokoto at the time of the study.

2.3 STUDY DESIGN

This was a hospital-based prospective, observational cross-sectional study. Clinical samples were collected consecutively from patients attending Specialist Hospital Sokoto during the study period, based on routine clinical requests from attending physicians. Convenience sampling was not employed.

2.4 SAMPLE SIZE DETERMINATION

The sample size for this study was guided by standard approaches for prevalence-based descriptive studies and by feasibility within the study setting. In the absence of recent, suitable, species-specific prevalence data for *S. aureus* from the study location during the study period, sample collection was conducted consecutively based on patient presentation, laboratory capacity, and the study period. A minimum sample size of 74 was initially estimated using a 95% confidence level and a 5% margin of error, and this was adjusted to 81 to account for potential attrition. Ultimately, a total of 86 different clinical samples were collected and analyzed during the study period.

2.5 SAMPLE COLLECTION

Clinical samples were collected from patients attending Specialist Hospital Sokoto between April 2021 and September 2021. Samples including urine, blood, wound swabs, ear swabs, nasal swabs, high vaginal swabs (HVS), endocervical swabs (ECSs) and cerebrospinal fluid (CSF) were collected from different patients at Specialist Hospital Sokoto and transported to the research laboratory immediately for processing. Relevant demographic and clinical data (age, sex, patients' gender and type of laboratory test requested) were all collected from the laboratory request forms of those patients.

To ensure sample quality during transport, all clinical specimens were collected aseptically using sterile containers or swabs. Swab samples (wound, ear, nasal, high vaginal, and endocervical swabs) were placed in proper sterile transport media immediately after collection, while urine, blood, and cerebrospinal fluid samples were collected into sterile, leak-proof containers. All specimens were transported promptly to the microbiology laboratory within 1–2 hours of collection to preserve sample integrity and prevent contamination.

2.6 INCLUSION and exclusion criteria

Patients of all ages and sexes who gave clinical specimens for bacteriological analysis during the study period were eligible for inclusion. Duplicate samples from the same patient, stool, and samples with inadequate labeling or insufficient volume were excluded from the study.

2.7 Sample Processing and Identification

All media used in this study were prepared according to the manufacturer's instructions. Clinical samples were cultured on blood agar and mannitol salt agar (Oxoid, UK) and incubated at 37°C for 16–18 hours under aerobic conditions. Identification of *S. aureus* was performed using standard microbiological techniques, including Gram staining, catalase test, coagulase test, and mannitol fermentation (Cheesbrough 2009). Antibacterial susceptibility testing was conducted using the Kirby–Bauer disk diffusion method on Mueller–Hinton agar (Oxoid, UK). The agar depth was kept at approximately 4 mm, and plates were incubated aerobically at 37°C for 16–18 hours before interpretation of inhibition zone diameters according to CLSI M100-S24 (2014 edition) guidelines (CLSI 2014).

2.8 ANTIBACTERIAL SUSCEPTIBILITY TESTING

Antibacterial susceptibility was assessed via the Kirby-Bauer disk diffusion method on Mueller - Hinton agar following CLSI guidelines (CLSI 2012). Zones of inhibition were measured in millimeters using a calibrated ruler, and the interpretation of inhibition zone diameters was carried out using **organism-specific disk diffusion interpretive criteria for *Staphylococcus aureus* as provided in CLSI M100-S24 (2014 edition)** which was the version available at the time of analysis in the study laboratory at the time of the analysis (CLSI 2014). The inoculum was standardized to the 0.5 McFarland standard ($1-2 \times 10^8$ CFU/ml). For visual comparison, the inoculum tube and the 0.5 McFarland standards were examined against a card with a white background and contrasting black lines (CLSI 2012). The antibacterial disks used are as follow: amoxicillin, ampicillin–cloxacillin, cefuroxime, ceftriaxone, ciprofloxacin, levofloxacin, norfloxacin, pefloxacin, gentamicin, streptomycin, erythromycin, rifampicin, cotrimoxazole and chloramphenicol. Antibacterial susceptibility testing was performed using these commercially prepared antibacterial disks of standard potencies, as supplied by the manufacturer, and interpreted according to CLSI M100-S24 (2014) guidelines. Breakpoint values were not reproduced in the manuscript tables, as interpretations were made directly following the cited CLSI document (CLSI 2014).

Quality control of antibacterial susceptibility testing was performed using *Staphylococcus aureus* ATCC 25923 as the control strain. The control organism was tested alongside clinical isolates, and inhibition zone diameters for all antibacterial disks were within the acceptable ranges specified by the Clinical and Laboratory Standards Institute (CLSI) guidelines (CLSI 2014). Antibacterial disks were stored and used according to manufacturer's specifications, and disk potency was routinely verified.

MRSA-specific screening using oxacillin or ceftioxin disks, molecular detection of resistance genes, Double-disk diffusion test (D-test), and Minimum inhibitory concentration (MIC) determination were not performed due to limited laboratory resources.

The antibacterial disks selected for testing were chosen based on their frequent prescription for *staphylococcal* infections in the study setting, availability in routine clinical practice, and relevance to local antimicrobial stewardship policies.

2.9 DATA ANALYSIS

Data obtained from the study were summarized using descriptive statistics and presented as frequencies and percentages in tables. Statistical analysis was performed using the Statistical Package for Social Sciences (SPSS) version 20. Due to the relatively small number of *S. aureus* isolates and uneven subgroup distributions, inferential statistical testing was not included, and findings were interpreted descriptively.

2.10 Ethical considerations

Ethical approval

for this study was obtained from the Sokoto State Health Research Ethics Committee under the Sokoto State Ministry of Health (Approval No: SMH/1580/V. IV)

2.11 Assisted Writing

In some parts of this manuscript, some preliminary text suggestions and rephrasing were generated with the aid of ChatGPT (Large Language Model). All final contents were critically reviewed and fully revised by the authors to reflect the original analysis and interpretation.

3.0 Results

3.1 Distribution of Clinical Samples

A total of 86 clinical samples were collected from patients attending Specialist Hospital Sokoto. Of these, samples that yielded bacterial growth on culture were further processed, and 19 isolates were phenotypically identified as *Staphylococcus aureus*. These confirmed *S. aureus* isolates were subsequently analyzed for distribution by sample type and demographic characteristics and subjected to antibacterial susceptibility testing. The distribution of sample types is presented in Table 1, with wound swabs accounting for the highest proportion (17 of 86; 19.8%), followed by ear swabs (16 of 86; 18.6%), urine samples (13 of 86; 15.1%), then other sample types. Overall, *Staphylococcus aureus* was isolated from 19 of the 86 samples analyzed, giving an overall distribution of 22.1% (95% confidence interval: 13.3% – 30.9%).

3.2 Distribution of *Staphylococcus aureus* Isolates by Demographic Characteristics

Of the 19 *S. aureus* isolates recovered, 12 were obtained from male patients and 7 from female patients, representing proportions of 14.0% (12/86) and 8.1% (7/86) of the total samples, respectively (Table 2). These distributions are presented descriptively.

With respect to age, the highest proportion of *S. aureus* isolates was seen among patients aged 0–10 years (8 of 86; 9.3%). No isolates were recovered from patients in the 41–50-year age group or among those aged 61 years and above which may be attributed to the low sample size (Table 2). Given the limited number of isolates, age-related distributions were described without inferential statistical testing.

3.3 Distribution of *Staphylococcus aureus* Isolates by Sample Source

About sample sources, wound swabs yielded the highest number of *S. aureus* isolates (6 of 86 samples; 6.98%). This was followed by urine samples, from which 4 isolates were obtained accounting for 4.7% (4/86) of the total isolates (Table 2).

3.4 Antibacterial Susceptibility Profiles of *Staphylococcus aureus* Isolates

Susceptibility results are presented as frequencies and percentages of susceptible and resistant isolates based on CLSI M100-S24 (2014 edition) categorical interpretation. The isolates showed the highest susceptibility to ceftriaxone and streptomycin (12 of 19; 63.2% each), followed by ciprofloxacin and rifampicin (11 of 19; 57.9% each) (Table 3)

The highest resistance rates were seen against norfloxacin (17 of 19; 89.5%), cefuroxime (14 of 19; 73.7%), and amoxicillin (13 of 19; 68.4%). One isolate (1 of 19; 5.3%), showed intermediate susceptibility to each of amoxicillin, ceftriaxone and chloramphenicol (Table 3).

Isolates were not classified as multidrug-resistant (MDR) or extensively drug-resistant (XDR) because testing was limited to phenotypic disk diffusion and was not stratified by antibacterial classes; therefore, reliable MDR/XDR classification was not possible. Methicillin-resistant *S. aureus* (MRSA) was not determined because oxacillin or cefoxitin susceptibility testing and molecular confirmation were not performed and these were noted as some of the limitations.

Table 1
Distribution of clinical samples collected from patients at Specialist Hospital
Sokoto (n = 86)

Biological Samples	Number of samples, n (%)
Urine	13 (15.1)
HVS	9 (10.5)
ECS	11 (12.8)
Wound Swab	17 (19.8)
Ear Swab	16 (18.6)
Blood Culture	4 (4.7)
Nose Swab	8 (9.3)
CSF	8 (9.3)
Total	86 (100) ^a
Footnote:	
^a Percentages are calculated based on the total number of samples (n = 86)	
HVS, high vaginal swab	
ECS, endocervical swab	
CSF, cerebrospinal fluid	

Table 2

Distribution of clinical samples (n = 86) and *S. aureus* isolates (n = 19) by sex, age group and specimen type

Variable	Category	Number of samples examined n (%)	<i>S. aureus</i> isolates n (%)
Sex	Male	44	12 (14.0)
	Female	42	7 (8.1)
	0–10	18	8 (9.3)
	11–20	25	4 (4.7)
Age group	21–30	19	3 (3.5)
	31–40	11	2 (2.3)
	41–50	4	0 (0.0)
Specimen type	51–60	8	2 (2.3)
	60	1	0 (0.0)
	Wound swab	17	6 (6.9)
	Urine	15	4(4.7)
	Ear swab	16	1(1.2)
	Nose swab	6	2(2.3)
	Blood culture	4	2(2.3)
	ESC	5	3(3.5)
	HVS	3	1(1.2)
Total		86 (100) ^a	19 (22.1) ^b
Footnote:			
^a Percentages are calculated based on the total number of samples (n = 86)			
^b Percentages are calculated based on <i>S. aureus</i> isolates (n = 19)			

Inferential statistical testing was not performed due to small number counts.

Table 3
Antibacterial sensitivity and resistance patterns of *Staphylococcus aureus* isolates (n = 19)

Antibiotic	Sensitive n (%) ^a	Resistant n (%) ^b
Pefloxacin	8 (42.1)	11 (57.9)
Gentamycin	8 (42.1)	11 (57.9)
Ampicillin+ Cloxacillin	7 (36.8)	12 (63.2)
Cefuroxime	5 (26.3)	14 (73.7)
Amoxicillin	5 (26.3)	13 (68.4)
Ceftriaxone	12 (63.2)	6 (31.5)
Ciprofloxacin	11 (57.9)	8 (42.1)
Streptomycin	12 (63.2)	7 (36.8)
Cotrimoxazole	10 (52.6)	9 (47.4)
Erythromycin	10 (52.6)	9 (47.4)
Norfloxacin	2 (10.5)	17 (89.5)
Rifampicin	11 (57.9)	8 (42.1)
Chloramphenicol	6 (31.5)	12 (63.2)
Levofloxacin	10 (52.6)	9 (47.4)
Footnote:		
^a Percentages of sensitivity are calculated based on <i>S. aureus</i> isolates (n = 19)		

^b Percentages of resistance are calculated based on the *Staphylococcus aureus* isolates (n = 19).

4.0 Discussion

The global increase in antibiotic resistance is occurring more rapidly than the development of new antimicrobial agents, posing a serious public health threat worldwide. The prolonged, inappropriate, and unregulated use of antibiotics is still one of the major contributors to the emergence of resistant pathogens, making some antibacterial therapies ineffective (Musa et al 2022).

Staphylococcus aureus is an opportunistic pathogen associated with life-threatening infections that often result in prolonged hospitalization, increased antibiotic use, elevated healthcare costs, and high morbidity and mortality (Akhtar Danesh et al. 2019). Numerous studies have reported on the prevalence and antibiotic resistance patterns of *S. aureus*, reflecting the organism's capacity to develop resistance

to commonly used antimicrobial agents (Musa et al. 2022). Recent reviews from West Africa reported a high burden of multidrug-resistant bacterial pathogens in both healthcare and community settings, underscoring antimicrobial resistance as a major regional public health challenge (Diop et al. 2025). Systematic analyses from West Africa have also documented moderate to increasing antibacterial resistance among common bacterial pathogens, raising concerns about the continued effectiveness of standard empirical antibiotic regimens (Kerlly et al. 2017).

In the present study, a total of 86 clinical samples were collected from patients attending Specialist Hospital Sokoto, with an overall *S. aureus* distribution of 22.1%. This finding is consistent with reports from other parts of Nigeria, where prevalence rates of 21.3% (Sunday et al. 2020) and 21.9% (Mamman et al. 2022) have been documented. Comparable prevalence rates have also been reported outside Nigeria, including 28.9% in Cameroon (Bissong et al 2016), 23.6% in Ethiopia (Godebo et al. 2013), and 26.7% in Tanzania (Mshana et al. 2009). Although the distribution recorded in this study is relatively lower than those reported in some settings, *S. aureus* is still an important clinical and public health concern in Sokoto. Variations in prevalence across studies may be attributed to differences in sample types, study populations, diagnostic methods, and local epidemiological factors.

The highest isolation rate of *S. aureus* in this study was recorded in wound samples (6.98%), which agrees with findings from studies conducted in Nigeria by Akpudo et al. (2023), who reported the highest prevalence (54.5%) in wound samples, and Musa et al. (2022), who reported a prevalence of 26.7%. In contrast, Gaire et al. (2021) reported the highest prevalence in urine samples. The high occurrence of *S. aureus* in wound samples may be explained by the organism's natural colonization of human skin and mucosal surfaces, from which it can easily gain access to open wounds through direct contact, shared items, or poor hygiene practices (Kanaga 2014).

Age-specific distribution revealed that children aged 0–10 years had the highest frequency of *S. aureus* infections (9.3%). This finding is consistent with reports from Niger State, Nigeria (Mamman et al 2022), where the highest prevalence was seen among younger age groups. Conversely, no isolates were recovered from patients aged 41 years and above, similar to findings reported by (Mamman et al 2022), who also observed lower prevalence among older adults. The higher prevalence among younger children may be attributed to underdeveloped immune systems and increased exposure to contaminated surfaces through play activities (Emmanuel & Magaji 2011).

Sex-specific distribution showed that males accounted for a higher proportion of *S. aureus* isolates (14.0%) than females. This observation is consistent with the findings of Kumurya (Kumurya 2017) but contrasts with reports from Minna (Mamman et al 2022), Abia (Ifediora et al. 2019), and Zaria (Akpudo et al. 2023), where higher prevalence was seen among female subjects. These discrepancies may be related to differences in study duration, sample size, and local risk factors (Akpudo et al. 2023). Increased exposure of males to physical stress, occupational hazards, and injuries may also contribute to their higher susceptibility to *S. aureus* infections (Emmanuel & Magaji 2011).

In this study, *S. aureus* isolates showed the highest susceptibility to ceftriaxone and streptomycin (63.2% each), followed by ciprofloxacin and rifampicin (57.9% each). These findings differ from those reported by Asiya et al. (2022), who saw high resistance to ciprofloxacin and high susceptibility to rifampicin. However, partial agreement was seen with the findings of Bunza et al. (2019), who reported ciprofloxacin as one of the most effective antibiotics against *S. aureus* isolates in Sokoto.

The development of antimicrobial resistance in *S. aureus* has been reported globally. Recent WHO surveillance shows widespread global antimicrobial resistance, with substantial proportions of bacterial infections resistant to standard therapies, particularly in settings with limited diagnostic and stewardship capacity (WHO 2025b). In this study, high resistance rates were seen against norfloxacin (89.5%), cefuroxime (73.7%), amoxicillin (68.4%), ampicillin–cloxacillin, and chloramphenicol (63.2% each). Similar resistance patterns have been reported in Abakaliki (Ariom et al. 2019) and Kenya (Wilfred et al. 2018), where resistance to commonly used antibiotics exceeded 90%. The reduced susceptibility of *S. aureus* to several most used antibiotics observed in this study is consistent with earlier reports (Wilfred et al. 2018). The high resistance observed to commonly used antibacterial agents such as amoxicillin, cefuroxime, ampicillin-cloxacillin, chloramphenicol and particularly norfloxacin may be attributed to their widespread availability and frequent misuse in the community, often without prescription. Such practices exert selective pressure that promotes the emergence and persistence of resistant *Staphylococcus aureus* strains (Olajide et al. 2025). The observed resistance rates should also be interpreted cautiously given the relatively small number of isolates evaluated. The observed variations in the distribution and susceptibility profiles compared with other studies may reflect differences in sociodemographic characteristics, healthcare-seeking behavior, and antimicrobial access across study settings. In resource-limited environments, unregulated antimicrobial use, self-medication, and empirical prescription without laboratory guidance are common and may contribute to selective pressure favoring resistant *S. aureus* strains.

The relatively higher susceptibility observed for ceftriaxone, streptomycin, ciprofloxacin, and rifampicin underscores the importance of routine susceptibility testing to guide empirical therapy and reduce inappropriate antibiotic use. Continuous generation of up-to-date local susceptibility data is therefore essential for strengthening antimicrobial stewardship, promoting rational antibiotic use, and guiding effective empirical therapy.

This study has several limitations; the sample size was modest, and the number of *Staphylococcus aureus* isolates was small, limiting statistical power, subgroup analyses, and generalizability. Therefore, findings are presented descriptively and should be interpreted cautiously. Methicillin-resistant *Staphylococcus aureus*/vancomycin-resistant *Staphylococcus aureus* (MRSA/VRSA) screening was not performed, as ceftioxin or oxacillin testing and *mecA/mecC* detection were unavailable, and key anti-Gram-positive agents such as vancomycin and linezolid were not tested. Antibacterial susceptibility testing was restricted to phenotypic disk diffusion without MIC determination, D-test, molecular resistance characterization, or genomic analysis, precluding assessment of multidrug-resistant/extensively drug-resistant/pandrug-resistant (MDR/XDR/PDR) phenotypes and resistance

mechanisms. The single-center, cross-sectional design and absence of temporal, antibiotic-utilization, and outcome data further limit broader epidemiological inference. Consequently, the results should therefore be interpreted as baseline local surveillance data and may inform future multicenter studies incorporating minimum inhibitory concentration (MIC)-based and molecular approaches.

4.1 Contributions and Implications of the Study

This study provides updated local data on the distribution and antibacterial susceptibility profiles of *Staphylococcus aureus* isolates from different clinical samples in Specialist Hospital Sokoto, an area where recent and comprehensive surveillance data are limited. By examining multiple sample types and a broad panel of commonly prescribed antibacterial agents, the findings may be informative in this resource-limited setting. These findings are consistent with world health organization (WHO) 2025 reports emphasizing the need for strengthened local surveillance to guide empirical therapy and antimicrobial stewardship (WHO 2025a).

The observed resistance to several frequently used drugs underscores the importance of routine susceptibility testing to guide empirical therapy and reduce inappropriate antibiotic use. These findings highlight the urgent need for strengthened antimicrobial stewardship programs in Sokoto hospitals, including routine resistance surveillance, rational antibiotic prescription, and continuous education of community and healthcare workers on the dangers of antibacterial resistance. A larger multicenter study, ideally incorporating molecular approaches among others, to monitor evolving resistance trends and inform evidence-based infection control and treatment strategies are also needed

4.2 Conclusion

A distribution rate of 22.1% among various clinical samples collected at Specialist Hospital Sokoto was shown in this study. This signifies the role of *S. aureus* as a significant public health threat. Therefore, the best way to regulate *S. aureus* infections is by performing regular monitoring of antibacterial/antibiotic resistance profiles to help formulate antibiotic policies and effective infection control practices. This study demonstrated a moderate burden of *Staphylococcus aureus* infections at Specialist Hospital Sokoto, with a relatively high resistance rates to some commonly used antibacterial agents. The susceptibility data showed that ceftriaxone, streptomycin, ciprofloxacin, and rifampicin showed relatively higher in vitro activity (susceptibility rates 50%) against the isolates assessed. However, their clinical use should be guided by routine antimicrobial susceptibility testing, and strict adherence to local and national treatment guidelines. Continuous antimicrobial resistance surveillance remains essential to inform evidence-based antimicrobial stewardship and improve patient management.

Declarations

Ethical Statement and Consent to Participate

This study was performed following the principles of the Declaration of Helsinki. Approval was obtained from the **Sokoto State Health Research Ethics Committee - Sokoto State Ministry of Health, Sokoto State, Nigeria** (Approval Ref. No. SMH/1580/V. IV, dated April 2021). Written informed consent was obtained from all participants prior to the sample collection.

Funding

The authors did not receive support from any organization for the submitted work.

Author Contribution

Muhammad Sani conceived and designed the study, performed laboratory analyses, analyzed the data, and drafted the manuscript. Olasumbo Funmilayo Ashcroft supervised the study and reviewed the manuscript for important intellectual content. Sani Muhammed contributed to data collection, laboratory work, and manuscript revision. Adamu Muhammad Ibrahim contributed to the study design, data interpretation, and critical revision of the manuscript. All authors have read and approved the last version of the manuscript.

Data Availability

All datasets generated and analysed during this study are included in this published article. More details are available from the corresponding author upon reasonable request.

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