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Original Article **Open Access**

Bacteriological profile of *Staphylococcus aureus* isolates at the Bogodogo University Hospital Center, Ouagadougou, Burkina Faso

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Abstract:

Background: *Staphylococcus aureus* is a common major human pathogen involved in a wide variety of infections. The objective of this study is to investigate the bacteriological profile of *S. aureus* at the Bogodogo University Hospital Center, Ouagadougou, Burkina Faso.
Methodology: This was a descriptive cross-sectional study conducted from January 1 to December 31, 2024 at the bacteriology-virology department of Bogodogo University Hospital. All biological samples (pus, blood, vaginal swabs, and effusion fluid) received in the laboratory were cultured on mannitol salt agar for isolation of *S. aureus.* The identification of *S. aureus* was based on morphological characteristics of the colonies described as round, smooth, convex colonies, well defined with a smooth, shiny surface, sometimes slightly oily, appearing in irregular clusters resembling "grapes" under the microscope, standard biochemical tests (catalase positive, coagulase positive, and oxidase negative), and the use of an API Staph® panel. Antibiotic susceptibility was determined on Müller-Hinton agar by the Kirby Bauer diffusion method, with inhibition zone diameters read and interpreted according to CASFM/EUCAST recommendations.
Results: A total of 1,530 bacteria were isolated from pathological samples of patients with infections at the hospital during the study period, of which 184 (12.0%) were *S. aureus*. Pus was the most common sample type, accounting for 98 isolates (53.2%). The mean age of the 184 patients is 30±19 years, with a range of 1 to 78 years, and a predominance of females (sex ratio = 0.73). The trauma department contributed the most isolates with 37 (20.1%). The isolates showed high resistance to penicillin G (96.0%, n=178) and erythromycin (42.3%, n=78). In terms of resistance mechanisms, 58.0% of the isolates produced penicillinase and 38.0% were methicillin-resistant *S. aureus* (MRSA) isolates.
Conclusion: This study highlights a high prevalence of *S. aureus* in biological samples of patients with infections (12.0%) at Bogodogo University Hospital, as well as high resistance to beta-lactam antibiotics. These results underscore the need to strengthen surveillance strategies and promote the judicious use of antibiotics in hospitals.

Keywords: *Staphylococcus aureus*; MRSA; Penicillinase; Bogodogo University Hospital; Burkina Faso.

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Profil bactériologique des isolats de *Staphylococcus aureus* au Centre Hospitalier Universitaire Bogodogo, Ouagadougou, Burkina Faso

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Résumé:

Contexte: *Staphylococcus aureus* est un pathogène humain majeur fréquent, impliqué dans une grande variété d'infections. L'objectif de cette étude est d'étudier le profil bactériologique de *S. aureus* au Centre Hospitalier Universitaire de Bobo-Dioulasso, à Ouagadougou, au Burkina Faso.
Méthodologie: Il s'agit d'une étude descriptive transversale menée du 1er janvier au 31 Décembre 2024 au sein du service de bactériologie-virologie du CHU de Bogodogo. Tous les prélèvements biologiques (pus, sang, écouvillons vaginaux et liquide d'épanchement) reçus au laboratoire ont été mis en culture sur gélose au mannitol et au sel pour l'isolement de *S. aureus*. L'identification de *S. aureus* s'est basée sur les caractéristiques morphologiques des colonies; colonies rondes, lisses, convexes, bien délimitées, à surface lisse et brillante, parfois légèrement huileuse, apparaissant en amas irréguliers évoquant des «grains de raisin» au microscope; sur les tests biochimiques standards (catalase positive, coagulase positive et oxydase négative); et sur l'utilisation du panel API Staph®. La sensibilité aux antibiotiques a été déterminée sur gélose Müller-Hinton par la méthode de diffusion de Kirby-Bauer, les diamètres des zones d'inhibition étant mesurés et interprétés selon les recommandations CASFM/EUCAST.
Résultats: Au total, 1530 bactéries ont été isolées à partir d'échantillons pathologiques de patients hospitalisés pour infection durant la période d'étude, dont 184 (12,0%) étaient des *S. aureus*. Le pus était le type d'échantillon le plus fréquent, représentant 98 isolats (53,2%). L'âge moyen des 184 patients était de 30±19 ans (de 1 à 78 ans), avec une prédominance féminine (sex-ratio = 0,73). Le service des urgences a fourni le plus grand nombre d'isolats, soit 37 (20,1%). Les isolats présentaient une forte résistance à la pénicilline G (96,0%, n=178) et à l'érythromycine (42,3%, n=78). Concernant les mécanismes de résistance, 58,0% des isolats produisaient de la pénicillinase et 38,0% étaient des Staphylococcus aureus résistants à la méthicilline (SARM).
Conclusion: Cette étude met en évidence une forte prévalence de Staphylococcus aureus dans les prélèvements biologiques de patients présentant des infections (12,0%) au CHU de Bogodogo, ainsi qu'une forte résistance aux bêta-lactamines. Ces résultats soulignent la nécessité de renforcer les stratégies de surveillance et de promouvoir un usage judicieux des antibiotiques en milieu hospitalier.

Mots-clés: *Staphylococcus aureus*; SARM; pénicillinase; CHU de Bogodogo; Burkina Faso

Introduction:

Staphylococcus aureus are Gram-positive cocci, highly resistant in the external environment and non-fastidious in culture. It is a major human pathogen capable of causing a wide range of infections, including skin infections, septicemia, pneumonia, endocarditis, postoperative infections, and foodborne infections. *S. aureus* has a strong ability to adapt, which allows it to develop various mechanisms of antibiotic resistance, including the production of penicillinase (β-lactamase), and the carriage of *mecA* and *mecC* genes, which confer resistance to β-lactams (1). Staphylococcal infections are observed in many clinical situations, both in community-acquired and nosocomial settings, and *S. aureus* is the pathogen most often implicated in nosocomial infections (2).

Resistance to certain antibiotics has emerged in some strains of *S. aureus* isolated from many biological samples such as methicillin or oxacillin, clindamycin, fluoroquinolones, vancomycin, and erythromycin (3). As soon as penicillin G was introduced into therapy, staphylococci capable of destroying the antibiotic by producing penicillinase were discovered. Studies have shown that more than 90% of *S. aureus* strains are resistant to penicillin G (4). *S. aureus* infection has become a growing concern for global public heath due to the emergence of methicillin-resistant strains (MRSA) in both healthcare facilities and the community (5). These staphylococci have acquired the *mec* gene, which enables the synthesis of an enzyme (PBP2a or PBP2') with very low affinity for β-lactams, preventing them from exerting their inhibitory action (6).

In France, according to the latest data from the National Reference Center for Staphylococci, approximately 30% of hospital isolates of *S. aureus* are resistant to methicillin (7). In the United States, MRSA causes approximately 75,000 cases of infection and nearly 10,000 deaths per year (8). In Africa, *S. aureus* infection is also a major public health problem, particularly due to MRSA strains. Several studies conducted in different countries on the continent have shown an average MRSA prevalence of approximately 32.0%, highlighting the extent of resistance in the region (9). In Burkina Faso, Ba et al., (10) in 2019 reported a MRSA prevalence of 32.0%

This study aims to investigate the antibiotic profiles of *S, aureus* isolates responsible for bacterial infections at Bogodogo University Hospital Center, Ouagadougou, Burkina Faso, in order to provide updated epidemiological data to optimize strategies to combat this growing threat to public health and improve patient care.

Materials and method:

Study setting, design and duration:

This was a descriptive cross-sectional study conducted over a 12-month period (January 1 to December 31, 2024) at the Bogodogo University Hospital Center (CHU-B) in Ouagadougou, Burkina Faso.

Ethical considerations:

The study protocol was submitted for approval to the CHU-B management and the Health Research Ethics Committee under reference number 2024-10-318. Patient anonymity and data confidentiality were strictly ensured, in accordance with current ethical principles. The data collected were used exclusively for scientific purposes.

Study population and inclusion criteria.

The study population included all patients with clinical infections in the hospital from whom biological samples (pus, blood, vaginal swabs, and effusion fluid) were collected and received by the bacteriology-virology unit at CHU-B for *Staphylococcus aureus* isolation on culture.

Laboratory analysis:

Clinical samples were cultured on Mannitol salt agar and incubated aerobically for 24 hours to isolate *S. aureus,* which was identified on the culture media based on the morphological characteristics of the colonies (round, smooth, convex colonies with well-defined, smooth, shiny surfaces, sometimes slightly oily, appearing as irregular clusters resembling "grapes" under the microscope), standard biochemical tests (catalase positive, coagulase positive, and oxidase negative), and the use of an API Staph® panel.

Antibiotic sensitivity was determined by the Kirby Bauer disc diffusion method on Müller-Hinton (MH) agar with inhibition diameters read and interpreted as sensitive or resistant according to CASFM/EUCAST recommendations.

To detect penicillinase production, penicillin G (1 U) was used to assess the intrinsic sensitivity of the pathogen. Cefoxitin (30 µg) was used as a substitute marker to detect methicillin-resistant strains (MRSA), replacing oxacillin in agar diffusion tests, in accordance with current CA-SFM/EUCAST recommendations.

Data collection:

The data collected include sociodemographic data (age, sex, patient's department of origin) and bacteriological data (type of sample, antibiotic resistance profile, and resistance phenotype identified). The data were extracted from laboratory notebooks, laboratory records, and biological analysis reports. A standardized data collection form was designed for systematic entry of information.

Data analysis:

Data entry and analysis were performed using Stata software.

Results:

During the period of the study, a total of 1,530 bacterial strains were isolated from patients with infections in the hospital, of which 184 (12.0%) were *S. aureus*. Of these, 97 (53.0%) were isolated from pus samples, and 38 (21.0%) from blood cultures (Fig 1). Of the 184 patients infected with *S. aureus*, females predominated with 106 (58.0%) compared to 78 males (42.0%), giving a sex ratio (M:F ratio) of 0.73. The average age of the patients was 30±19 years, with a range of 1 to 78 years (Table 1). Majority of *S. aureus*-positive cultures were from the trauma department (20.1%, n=37/184) while gynaecology-obstetrics department was second with, 33 (17.9%), followed by the rheumatology department with 25 (13.6%) (Fig 2).

Table 1: Sociodemographic characteristics of patients with *Staphylococcus aureus* infection in the study

Variable	Number	Percentage
Age group (years)		
0-20	48	26.1
21-40	88	47.8
41-60	17	9.2
61-80	31	16.8
Sex		
Male	78	42.0
Female	106	58.0
M: F ratio	0.73	
Total	**184**	**100**

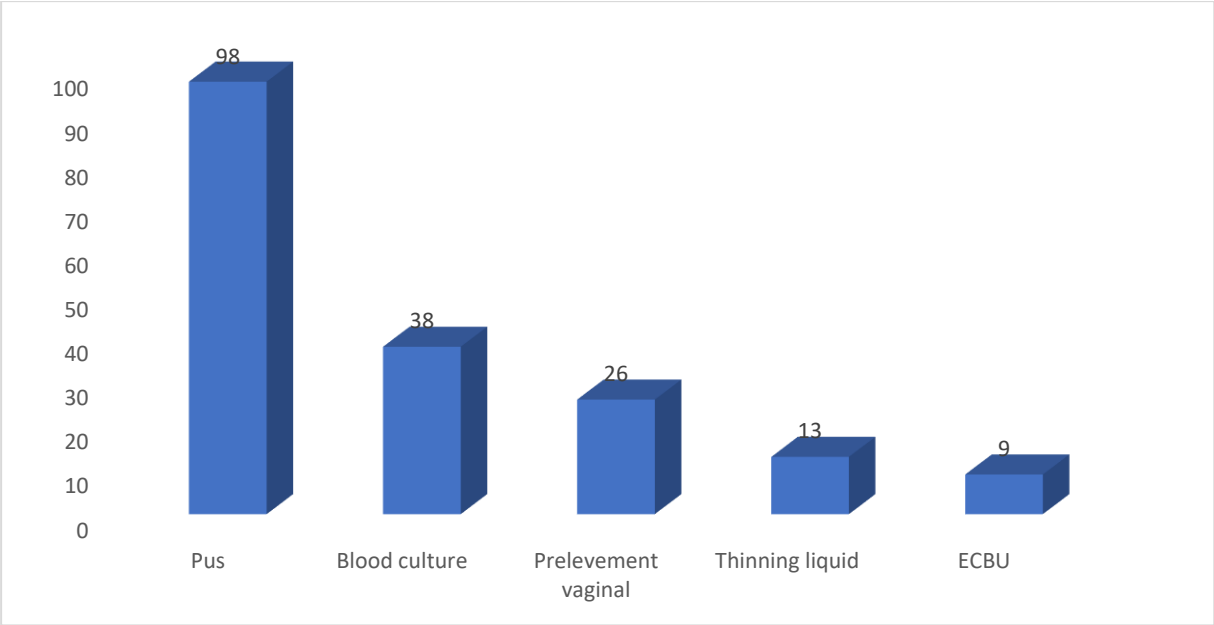

Fig 1: Frequency distribution of pathological samples from patients with *Staphylococcus aureus* infections

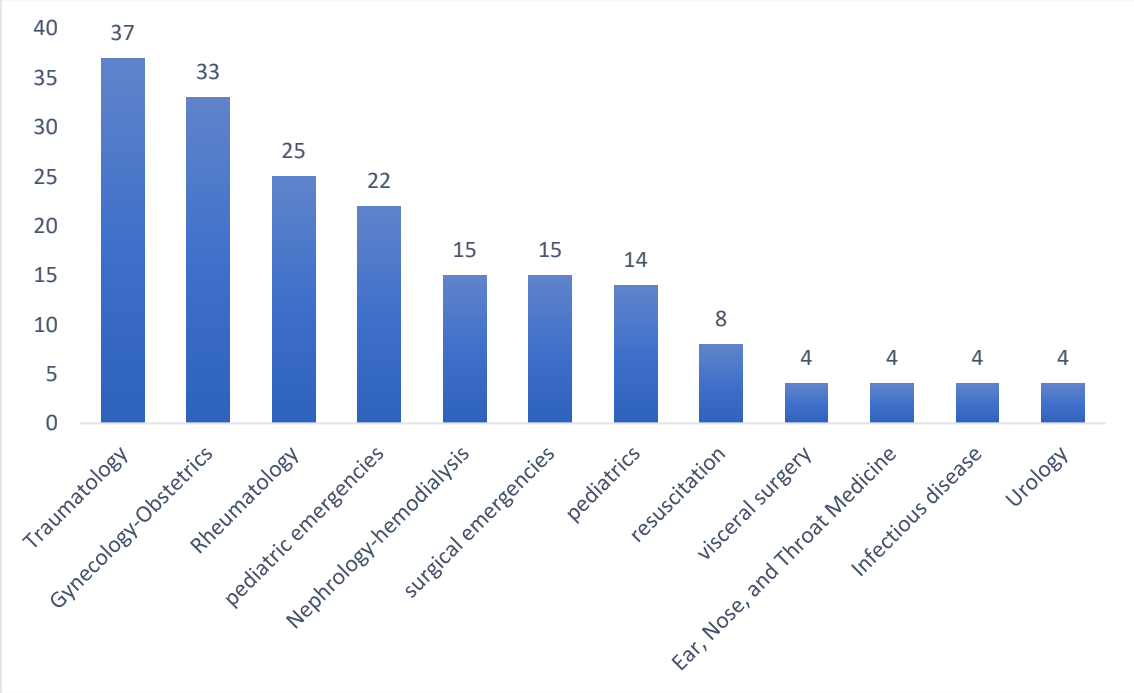

Fig 2: Frequency distribution of pathological samples from patients with *Staphylococcus aureus* infections by clinical department

The results of the antibiotic susceptibility test show that *S. aureus* isolates were resistant to penicillin G (96.0%, n=178) and cefoxitin (38.0%, n=70) indicating phenotypic methicillin-resistant strains (MRSA). For aminoglycosides, 72.8% (n=134) of the isolates were resistant to gentamicin and 23.9% (n=44) to kanamycin. For macrolides and related compounds, 42.3% (n=78) of the isolates were resistant to erythromycin, while 20 (10.8%) were resistant to clindamycin.

For fluoroquinolones, 70.6% (n=130) were resistant to ciprofloxacin and 47.8% (n=88) to norfloxacin. For cotrimoxazole, resistance was observed in 45.6% (n=84) of the isolates. In contrast, resistance to fusidic acid and linezolid was low and seen in only 8.1% (n=15) and 3.8% (n=7) of the isolates respectively, as shown in Table 2.

Table 2: Antibiotic resistance of *Staphylococcus aureus* isolates

Antibiotics	Number of resistant isolates	Percentage (%)
β-lactams		
Penicillin G	178	96.7
Cefoxitin	70	38.0
Aminoglycosides		
Gentamicin	134	72.8
Tobramycin	42	22.8
Kanamycin	44	23.9
Macrolides		
Erythromycin	78	42.3
Clindamycin	20	10.8
Fluoroquinolones		
Ciprofloxacin	130	70.6
Nofloxacin	88	47.8
Other class		
Tetracycline	86	46.7
Cotrimoxazole	84	45.6
Chloramphenicol	86	46.7
Fusidic acid	15	8.1
Linezolid	7	3.8
Fosfomycin	56	30.4

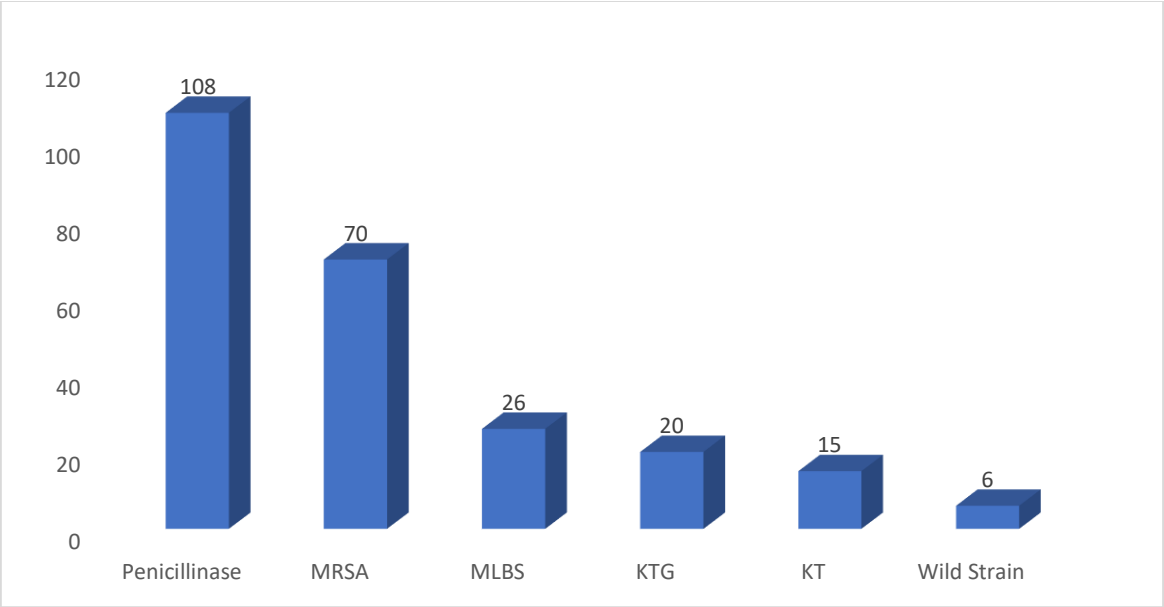

Fig 3: Frequency of antibiotic resistance mechanism and phenotypes in the *Staphylococcus aureus* isolates

Analysis of resistance mechanisms and phenotypes showed penicillinase production in 58.7% (n=108) of the isolates, while 38.0% (n=70) of the isolates were identified as MRSA. Specific resistance phenotypes also identified include 26 (14.1%) isolates with macrolide-lincosamide-streptogramin (MLS_B) phenotype, 20 (10.9%) isolates with kanamycin-tobramycin-gentamicin (KTG) phenotype, and 15 (8.2%) isolates with kanamycin-tobramycin (KT) phenotype as shown in Fig 3.

Discussion:

The 12.0% prevalence of *S. aureus* infection in this study is significant but the prevalence is known to vary according to geographical context, characteristics of the populations studied, and types of samples analyzed. This prevalence is comparable to that reported by Diallo et al., (11) in 2021 at the Dakar University Hospital, with *S. aureus* isolation rate of 11.5% in both community-acquired and

nosocomial infections. In contrast, Faye et al., (12) in a study conducted in 2018 at the Ouagadougou University Hospital, reported a higher rate of 18.7%, a result that could be explained by the high proportion of skin infections and abscesses in their cohort. The frequency reported in these various studies confirms the major role of *S. aureus* as an opportunistic pathogen involved in many suppurative infections, particularly skin, bone, respiratory, and blood infections. This high prevalence justifies the need for continuous microbiological surveillance, which is all the more important given the growing emergence of resistant strains, particularly MRSA.

In this study, pus was the most frequent sample collected for isolation of *S. aureus* from infected patients, with 98, representing 53.2% of all samples collected. This result is consistent with the well-known cutaneous and suppurative infections usually caused by *S. aureus*, which is often involved in both community- and hospital-acquired infections. Our finding is consistent with that reported by Traoré et al., (14) in 2019 at the Bamako University Hospital, where *S. aureus* was isolated in 58.0% of pus samples analyzed in a hospital setting, making this type of sample the main source of isolation of the *S. aureus*. Similarly, Ndiaye et al., (15) in 2020 at Aristide Le Dantec Hospital in Dakar reported a similar frequency of 54.0% in skin suppurations, highlighting the high prevalence of this pathogen in skin and soft tissue infections. In comparison, Kouadio et al., (16) in Côte d'Ivoire reported a slightly lower frequency (47.0%) in pus, probably due to a greater diversity of pathogens in nosocomial wound infections. It should also be noted that the high proportion of *S. aureus* in purulent samples in our series may reflect a delay in the management of skin infections, promoting suppuration, or even poor hygiene in the community.

Analysis of the distribution of *S. aureus* cases by hospital department showed a marked predominance in the trauma department, which accounted for 20.10% of the isolates. This data suggests that *S. aureus* infections are common in trauma patients, who often have open wounds, exposed fractures, or have undergone surgery, all of which are factors that promote colonization or infection by this pyogenic pathogen. However, our results contrast with that reported by Aidoun et al., (17) in Algeria, where the distribution of cases differed significantly with 34.48% of strains from intensive care unit, 13.79% from pediatrics department, and 13.79% from general surgery department. This discrepancy can be explained by several factors including differences in hospital organization (e. g., presence or absence of a separate trauma department), profile of patients admitted to each department (age, immune status, severity of conditions), and the infection control and prevention protocols specific to each institution. Furthermore, in a study conducted in Abidjan by Kacou et al., (18) surgery ranked first (27.0%) in terms of *S. aureus* isolation, followed by trauma (18.0%) and pediatrics (12.0 %). This shows that the frequency of *S. aureus* infections is closely linked to invasive procedures, the presence of wounds, and skin colonization, which are typical of surgical and traumas patients.

It should also be noted that the risk of nosocomial *S. aureus* infection is higher in departments such as intensive care, due to the proliferation of invasive devices (catheters, probes, ventilators), the immunocompromised state of patients, and prolonged hospitalization. These conditions are conducive for the emergence of multidrug-resistant strains, particularly MRSA which warrants specific analysis in a future study. These results confirm that the trauma department is a significant reservoir of S. *aureus* infections in our hospital, calling for increased vigilance in the prevention of healthcare-associated infections (HAIs) in this department.

In this study, *S. aureus* showed a worrying resistance profile, particularly to certain commonly used antibiotics. Resistance was very high resistance to penicillin G (96.0%) confirming the almost universal loss of efficacy of this antibiotic against *S. aureus* strains. This rate is consistent with data in the literature, as numerous studies report resistance to penicillin G of over 90.0%, due to the production of penicillinases (β-lactamases) by majority of strains. For example, Traoré et al., (14) in Mali reported a penicillin G resistance rate of 94.3%, while in Algeria, Aidoun et al., (17) reported a similar rate of 95.5%.

Regarding erythromycin, our study showed a resistance rate of 42.48%, which remains high. This upward trend in macrolide resistance has been observed in several countries. By way of comparison, Faye et al., (20) in Senegal reported resistance of 39.2%, while Kouadio et al., (19) in Côte d'Ivoire reported a rate of 45.8%, reflecting a gradual decline in the effectiveness of this molecule. In contrast, we noted good activity of fusidic acid and linezolid, with low resistance rates of 7.9% and 3.92%, respectively. These results are consistent with those of the ONERBA multicenter study in France in 2020, where resistance to linezolid in *S. aureus* remained below 2.0% and resistance to fusidic acid around 5.0% (13). These antibiotic molecules therefore remain valuable against multidrug-resistant strains, particularly in the treatment of severe or invasive skin infections.

However, it is important to emphasize that the use of these antibiotics must be restricted and supervised, particularly linezolid, which is a 'last-resort' antibiotic, in order to

prevent the emergence of resistant strains, as has already been reported sporadically in certain regions. These data highlight the need for regular monitoring of the sensitivity profiles of *S. aureus* strains and reinforce the call for rational use of antibiotics, adapted to the results of the antibiogram.

In this study, 58.0% of the *S. aureus* isolates produced penicillinase, while 38.0% were methicillin-resistant (MRSA) strains. This dual mechanism of resistance, enzymatic and structural, highlights the remarkable adaptability of this pathogen to β-lactam antibiotics. The production of penicillinase, responsible for resistance to penicillin G, remains one of the primary mechanisms of resistance developed by *S. aureus*. Although most hospital strains have already acquired this trait, the 58.0% rate observed in our study indicates that more than half of the isolates remain resistant to natural penicillins. This result is slightly lower than that reported by Aidoun et al., (17) in Algeria, where 74.0% of strains expressed penicillinase. On the other hand, Faye et al., (20) in Senegal found a rate closer to ours, at 61.5%. This variability can be explained by differences in antibiotic pressure, prescribing practices, and prophylactic antibiotic therapy protocols between institutions

The MRSA rate of 38.0% in our study, represents a moderate to high prevalence but is still a cause for concern. This rate is comparable to that of Kouadio et al., (19) in Côte d'Ivoire (41.0%), but remains lower than the rate reported in some Maghreb countries, such as Tunisia, where Ben Abdallah et al., (21) reported a MRSA rate of 50 to 60% in hospitals. Internationally, the CDC (USA) estimated in 2022 an average MRSA prevalence of 30 to 40% in resource-limited hospitals, with peaks in intensive care units (22). This phenomenon highlights the need for effective strategies to prevent resistance to *S. aureus* infections

Conclusion:

This study, conducted at the Bogodogo University Hospital Center (CHU-B) in Ouagadougou Burkina Faso, showed a relatively high frequency of *S. aureus* infections and a high prevalence of MRSA in the *S. aureus* population. MRSA isolates are particularly resistant to other antibiotics, with the exception of linezolid and fusidic acid, which remain active. It is essential to understand the epidemiological profiles of pathogens and their sensitivity to antibiotics in order to rationalize the use of these antimicrobial agents and limit the development of multidrug-resistant bacteria.

Contributions of authors:

All authors were involved in the study conceptualization, execution, and writing of the manuscript, and all read and approved the final version of the manuscript submitted for publication.

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Conflict of interest:

The authors declare that they have no conflicts of interest in relation to the content of this article

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