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# Nasal Carriage of Methicillin-Resistant *Staphylococcus aureus* in Intensive Care Units of Two University Hospitals in Cameroon

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***Authors' contributions***

*This work was carried out in collaboration among all authors. Authors HGK, YLGNT and ELM designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors JD, ACB, MN and BJ acquired analyzed, interpreted data, managed the literature searches and revised article critically. Authors POE and AE revised the article critically. All authors have seen and approved the final version of the manuscript.*

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## ABSTRACT

**Aim:** The aim of this work was to carry out a screen for methicillin-resistant *Staphylococcus aureus* (*S. aureus*) in nasal cavity of patients in the intensive care units of the University Hospital Center (UHC) and the Central Hospital of Yaounde (CHY) in Cameroon.
**Study Design:** A cross-sectional descriptive study was carried out.
**Pace and Duration of the Study:** Collection of nasal swab was done in Intensive Care Unit of University Teaching Hospital of Yaounde, and Intensive Care Unit of Central Hospital of Yaounde. Identification and susceptibility test were done in bacteriology laboratory of University Hospital Center, Yaounde between August 2018 and March 2019.
**Methods:** Nasal swabs were collected from patients by performing rotation in each nose. The identification of bacteria was carried out by observation of mannitol fermentation on Chapman agar, catalase, coagulase and DNAse tests. The susceptibility test was carried out by the method of diffusion of the discs in Mueller-Hinton agar.
**Results:** A total of 29 *S. aureus* were identified from 127 patients of which 44.10% were women and 55.90% were men. The antibiotic resistance profile showed cross-resistance of *S. aureus* between cefoxitin and others antibiotics with high resistance of amoxicillin, Amoxi / Clavulanic, fusidic acid, gentamycin and tetracycline with rates ranging from 62% to 82%. We detected 58.62% resistant species to cefoxitin and 51.72% were resistant to vancomycin. Statistical analysis found that there was not association between age groups, gender with nasal carriage of *S. aureus*. However there was an association (P=0,0060) between the hospital attended and the portage of *S. aureus.*
**Conclusion:** The prevalence of Methicillin-resistant *S. aureus* (MRSA) is quite high in intensive care patients. *Staphylococcus aureus* isolated from carriers also shows resistance to others antibiotics. This can increase the incidence of nosocomial infections. There is a need to implement effective control strategies to prevent infection cross transmission in intensive care Units.


*Keywords: Antibiotic resistance; MRSA; Staphylococcus aureus; nosocomial infections.*

## 1. INTRODUCTION

Resistance to antibiotics has become a major health problem, considered since 2014 by the WHO as a public health priority [1]. This is attributed to its exponential growth for certain bacteria threatening the quality of care. This bacterial resistance is responsible for an increase in morbidity and mortality, the length of hospital stay and leads to the use of more expensive and generally more toxic drugs [2]. One of the most important multidrug-resistant observed in hospitals is that of Methicillin-Resistant *Staphylococcus aureus* (MRSA) [3]. This bacterium is responsible for an undeniable number of surgical site infections, associated with worrying morbidity and mortality, as well as at considerable costs [4].

A study of Combes et al. [5] in 274 intensive care units and intensive care showed that the mortality rate due to *S. aureus* pneumonia was higher with MRSA (16.9%) compared to *S. aureus* sensitive to methicillin (SASM) (0.7%). In Cameroon, the study of Clotilde et al., [6] revealed that 15.4% of nosocomial infections in the intensive care unit of Laquintinie hospital were attributed to *Staphylococcus aureus*. The University Hospital Center (UHC) of Yaounde and the Central Hospital of Yaounde (CHY) are two University hospitals receiving a large proportion of patients in the intensive care unit. However, no screening for MRSA is carried out when patients are admitted to the intensive care unit. The WHO states that a person infected with MRSA has a 64% higher probability of dying than a patient having a non-resistant form [1]. This poses the problem of dissemination from MRSA patients to non-MRSA patients hospitalized in intensive care.

It therefore becomes necessary to screen patients admitted to the intensive care unit of these hospitals, in order to better manage patients and limit the spread of MRSA. To implement infection prevention methods and programs to control the transmission of MRSA in intensive care, this study aimed to carry out a screening of the nasal carriage of MRSA in patients arriving at the intensive care units of the University Hospital Center and the Central Hospital of Yaounde in Cameroon.

## 2. MATERIALS AND METHODS

### 2.1 Clinical Specimens

A total of 127 nasal swabs were collected from 127 patients who received intensive care at the University Hospital Center and at the Central Hospital of Yaoundé, Cameroon from August 2018 to March 2019. The nasal swabs were taken with strictly respect of the aseptic conditions to avoid any risk of contamination since most of these patients were in a critical condition. The swab was moistened with physiological solution when the nasal cavities were dry, then introduced horizontally into the anterior nostril of the patient about 2 cm in the axis of the cornets and the nasal secretions were collected by performing five complete rotations of the swab. Approval to perform the study was obtained from the ethics committee of Cameroon (Ref N$^0$ 2018/10/1111/CE/CNERSH/SP).

### 2.2 Identification

Identification was perform as described by Kateete et al. [7], Adel and Talbi [8]. Chapman agar was seeded with each sample and incubated at 37°C for 24 h. The isolated bacteria were identified firstly by the morphology of their colonies, the Gram stain followed by mannitol fermentation, catalase, coagulase and DNase tests.

### 2.3 Antimicrobial Susceptibility Testing

Sensitivity tests were performed using disc diffusion method on Mueller Hinton agar according to the recommendations of the Antibiotic Committee of the French Society [9]. Briefly, the discs were deposited on the surface of the Mueller-Hinton agar previously inoculated with a 0.5 McFarland suspension of bacteria. After 24 h of incubation at 37°C., the diameters of zone of inhibition were measured. The interpretative reading of the inhibition diameters would refer to the critical diameters of this CA-SFM. The discs used were Cefoxitin (30 µg), Clindamycin (30 µg), Fusidic acid (10 µg), Amoxicillin / clavulanic acid (30 µg), Amoxicilline (25), Cotrimoxazole (1.25 / 23.75 µg), Erythromycin (15 µg), Gentamycin (10 µg), Levofloxacin (5 µg), Ofloxacin (5 µg), Oxacillin (5 µg), Pristinamycin (15 µg), Tetracycline (30 µg), Vancomycin (30 µg).

### 2.4 Statistical Analysis

Statistical analysis and graphs were performed with the GraphPad software, version 5.03 and excel version 2013 respectively.

## 3. RESULTS

### 3.1 Description of the Population Studied

The study population consisted of 55.90% (n = 72) patients at UHC, including 56.94% (n = 41) men and 43.06% (n = 31) women. We sampled 44.10% (n = 55) at the CHY, of which 54.54% (n = 30) were men and 45.46% (n = 25) women. Fig. 1 illustrates the distribution of the study population by age group in the two hospitals.

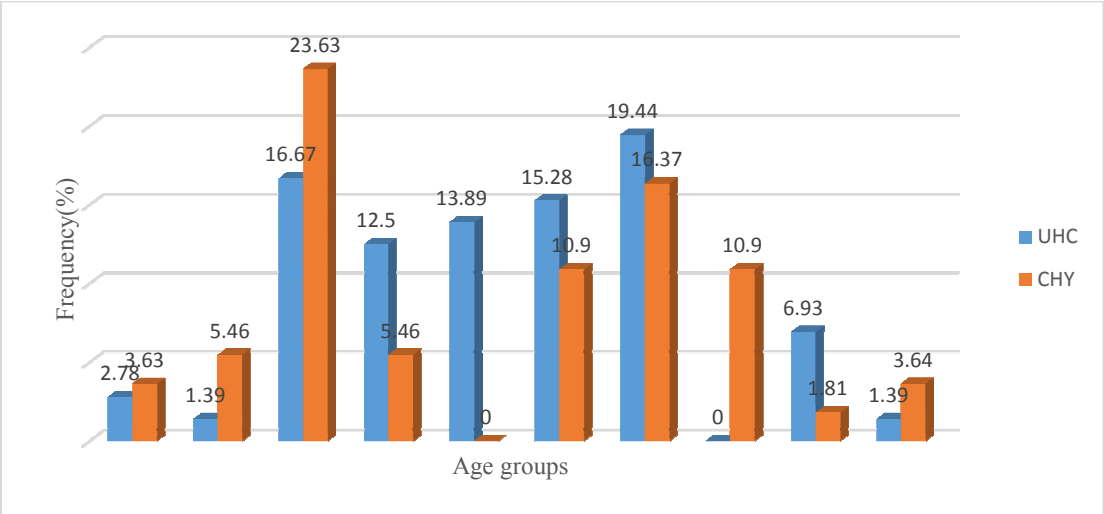


**Fig. 1. Distribution of the population according to age groups**

The most representative age group was that of 20-30 years with a frequency of 23.63% for the CHY, followed by that of 60-70 years with a frequency of 19.44% for UHC. At the CHY, no patient was between 40 and 50 years, while 13.89% of patients were represented in the intensive care unit of the UHC. In contrast, patients with an age range of 70-80 years were seen only at the central hospital.

Patients taken from the intensive care unit of UHC suffered from several pathologies. Among the patients infected with *S. aureus*, 29 presented comorbidities including 19 at UHC and 10 at CHY.

The most common pathology was burns and hemorrhagic stroke with a same frequency of 10.34% (n = 3), followed by complicated hearth failure, sepsis and trauma with a frequency of 6.89% (n=2) respectively. Each of the 17 other infected patients had one of these pathologies: metabolic disorder, severe acute pneumonia, severe malaria, complex recto-vesical fistula, digestive hemorrhagic ulcer, pulmonary acidosis embolism, hydroelectrolytic disorder, generalized dermatosis, acute toxic hepatitis, complicated encephalopathy, Cardiac shock, epilepsy, gastroenteritis, meningitis associated with malaria, craniotomy, coma, hemorrhagic shock.

### 3.2 Prevalence of *Staphylococcus aureus*

Of the 127 patients sampled during our study, 29 were carriers of *S. aureus* with 51.72% (n = 15) of men and 48.27% (n = 14) of women and a sex ratio of 0.9. Fig. 2 shows the carry rate in the source population.

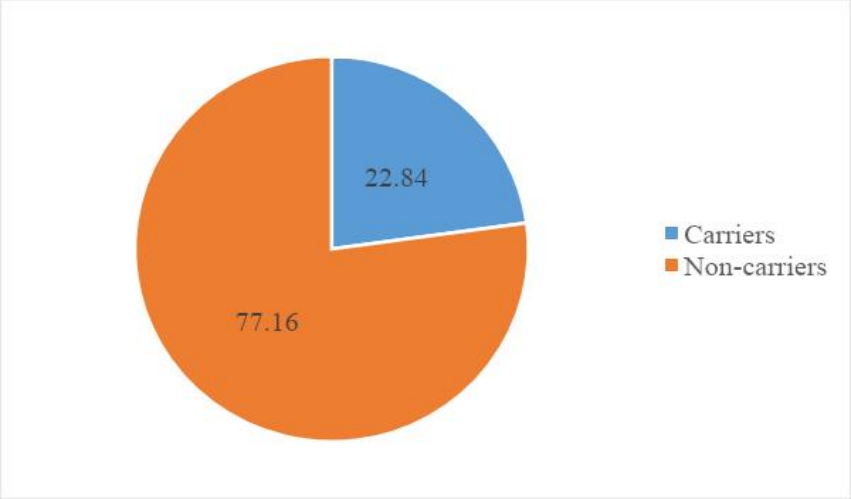


**Fig. 2. Overall frequency of nasal carriage of *S. aureus***

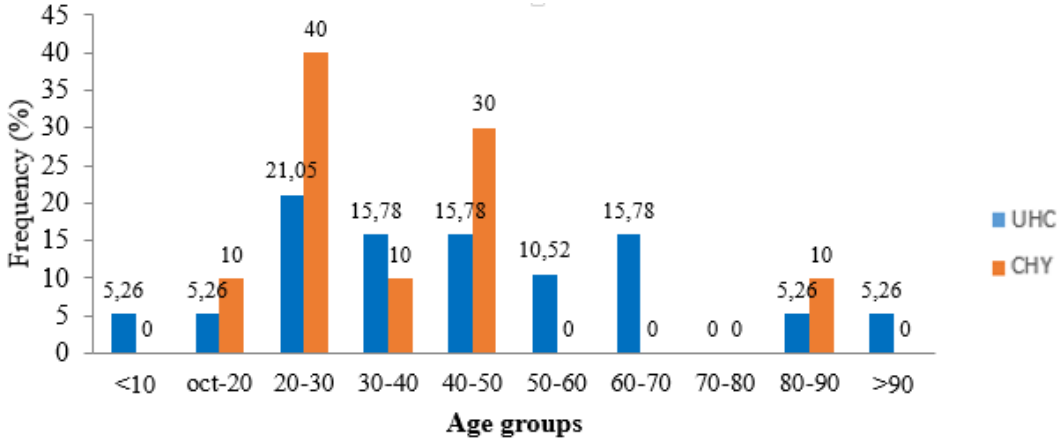


**Fig. 3. Distribution of *S. aureus* carriers according to age group**

Among the 29 carriers of *S. aureus* 65. 51% were from UHC and 34% from CHY. The majority of carriers were in the 20 to 30 year age group with frequencies of 21.05% and 40% respectively for UHC and CHY (Fig. 3). No patient was under the age of 10 or over the age of 90 at the Central Hospital in Yaounde.

**Table 1. Association between sex, age, hospital and portage of *S. aureus***

| Variable | P value | Statistically significant |
|---|---|---|
| Gender | 0,6057 | No |
| Age | 0,5118 | No |
| Hospital | 0,0060 | Yes |

Table 1 show that the hospital structure is a risk factor for nasal colonization of *S. aureus* (P<0,005). In the present study, the prevalence of nasal colonization by *S. aureus* was higher in the intensive care unit of the UHC with a value of 65.5% while in the intensive care unit of the CHY the prevalence was 34.48%. This would be due to the high proportion of patients sampled at UHC compared to CHY. Patients with the ages of 20 and 30 had the highest carry rate, but Anova analysis found that there was no significant difference with other age groups. Studies by Oguzkaya-artan et al. [10] in Turkey also found that there was no association between age and nasal carriage of *S. aureus*. Concerning Gender, there is no significant difference in male carriers compared to women.

### 3.3 Resistance Associated with MRSA Profile

The observation of the clinical categorization in Table 2 reveals several resistant strains of *S. aureus* in each hospital. A large proportion was observed at the University Hospital Center compared to the Central Hospital.

With regard to Fig. 4, the strains of *S. aureus* showed at least one resistance for all of the antibiotics tested. A large proportion of *S. aureus* was resistant to amoxicillin (82.75%), amoxicillin /clavulanic acid (68.96%), fusidic acid (65.51%), gentamycin (65.51%), tetracycline (62.06%), cefoxitin (58.62%), ofloxacillin (55.17%), oxacillin (55.17%), erythromycin (55.17%) and vancomycin (51.72%).

**Table 2. Distribution of *S. aureus* according to clinical categorization**

| Hospitals | *S. aureus* | Resistant | Intermediate | Sensitive |
|---|---|---|---|---|
| UHC | **19** | 11 (57,9%) | 4 (21,05%) | 4 (21,05%) |
| CHY | **10** | 6(70%) | 1(10%) | 2(20%) |

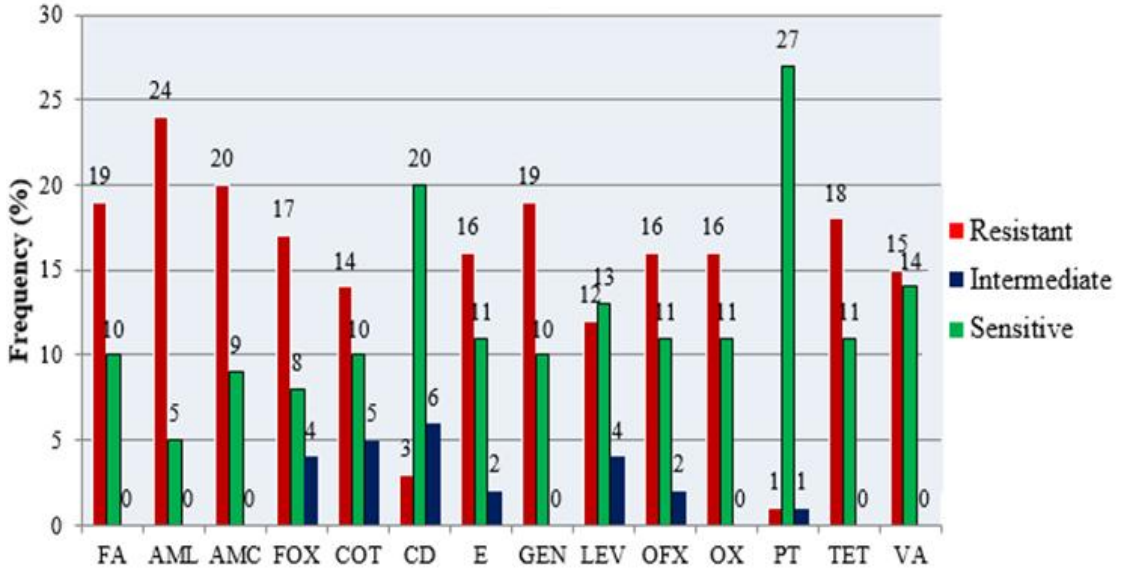


**Fig. 4. Antibiotic susceptibility profile of strains of *S. aureus* isolated from carriers**

It emerges from this work that the majority of *S. aureus* species were resistant to methicillin (58.62%), followed by 17.24% intermediate and 24.14% susceptible. Resistance to methicillin was determined by the appearance of inhibition diameter around cefoxitin ≤ 21 mm [11].

### 3.4 Statistical Analysis

Chi-square test and student t test revealed the absence of a statistically significant relationship among gender, age and *S. aureus* nasal carriage, respectively. However, a significant relationship was demonstrated with *S. aureus* nasal carriage and frequented hospital ($P<0.05$) (Table 1). The prevalence of nasal carriage of MRSA is thus significantly elevated in reanimation service of UHC.

## 4. DISCUSSION

*Staphylococcus aureus* is one of the most common bacteria causing infections in patients in the intensive care unit [12]. It can cause community acquired infections and nosocomial infections. A study carried out on 663 subjects from six departments revealed nasal carriage of MRSA in 25.17% of patients [13]. The results of our study show that out of 127 patients from the intensive care units of two hospitals, 13.38% were carriers of methicilin-resistant *Staphylococcus aureus*. This is lower than the results of Ouidri et al. [13]. This could be explained by the sample size which is smaller in our study. The nasal cavities represent a major reservoir allowing the dissemination of MRSA in the intensive care unit [12] showed the importance of nasal carriage of MRSA by indicating the frequency of carriage on different parts of the human body: nose (27%), pharynx (10-20%), neck (10%), skin of the thorax (15%), skin of the abdomen (15%), armpit (8%), forearm (5%) and ankle (10%).

When gender is taken into account, the sex ratio attributed to the carriage of *S. aureus* in men and women was 0,9. The evaluation of the association between sex and the carriage of *S. aureus* allowed to find that the portage does not depend on the sex. These results are in agreement with those of Ouidri et al. [13], although some studies have shown that men are predominantly carriers of *S. aureus* compared to women [10,14].

Regarding sensitivity to antibiotics, *S. aureus* has developed various resistance to antibiotics. Several techniques for detecting methicillin resistance in *S. aureus* have been developed. They included phenotypic techniques using sensitized latex to detect PLP2a and screening tests for cefoxitin [15]. Several studies have demonstrated resistance to methicillin by the use of cefoxitindiscs [16]. For *S. aureus*, the cefoxitin disc test is comparable to that of oxacillin to detect resistance by production of PLP2a (mecA gene); however, the cefoxitin disc is easier to read, and this is therefore the preferred method.

Over 58% of *S. aureus* was resistant to methicillin. This bacteria has developed cross-resistance between cefoxitin, oxacillin and the other β-lactams. Referring to the study conducted by Ouidri et al., [13], the prevalence of MRSA was 5.42%, which is much lower than that obtained in this study. The high resistance rates of *S. aureus* may be due to its very high genetic plasticity, facilitating the acquisition of antibiotic resistance genes and developing regulatory mechanisms to adapt to increasing concentrations of antibiotics [17]. Low frequencies of resistance have been observed with the sulfonamides associated with trimethoprim and the quinolones. This study presented a high sensitivity of the strains to Pristinamycin and to Clindamycin with respective levels of 93.10% and 68.96%. Although no strain showed intermediate susceptibility to Vancomyin, the resistance rate (51.72%) to this antibiotic was slightly higher than the sensitivity rate (48.27%).

This study showed that there was an association between the hospital attended and the portage of *S. aureus*. Prevention methods include screening patients admitted to the intensive care unit and implementing precautionary methods. A study has shown that without screening patients, there was a decrease in the transmission of nosocomial infections when patients were isolated in individual rooms [18]. However, this strategy remains limited since studies have shown a 2.5-fold increase in contamination carried from the doors of the rooms of infected patients compared to the doors of patients not infected with *S. aureus* [19]. However, contamination of the doors of non-infected patients demonstrates dissemination in hospitals.

## 5. CONCLUSION

The present study was able to highlight MRSA from 127 volunteer patients admitted to the intensive care units of UHC and CHY. The

prevalence of Methicillin-resistant *S. aureus* (MRSA) is quite high in intensive care patients. *Staphylococcus aureus* isolated from carriers also shows resistance to others antibiotics. This can increase the incidence of nosocomial infections. It is important to implement a Screening of MRSA on patients at admission in intensive care unit. This is considered as a strategy to prevent infection cross transmission in intensive care units.

## CONSENT

As per international standard informed and written participant consent has been collected and preserved by the authors.

## ETHICAL APPROVAL

Approval to perform the study was obtained from the ethics committee of Cameroon (Ref No 2018/10/1111/CE/CNERSH/SP).

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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