

## **STAPHYLOCOCCUS AUREUS EPIDEMIOLOGY AND ANTIBIOTIC RESISTANCE BEFORE AND AFTER THE START OF THE COVID-19 PANDEMIC**

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### **ABSTRACT**

During the Covid-19 pandemic, antibiotics such as macrolides and fluoroquinolones have experienced increased and irrational prescription.

The aim of this study is to determine the epidemiological profiles of *Staphylococcus aureus* and antibiotic resistance (January 1 to December 31, 2019) before and after (January 1, 2021 to May 31, 2022) the Covid-19 pandemic at the Avicenne Military Hospital in Marrakech.

Identification and susceptibility testing were performed on Phoenix® M50 to determine MIC, as well as measurement of inhibition diameters by the Mueller-Hinton (MH) agar disc diffusion method.

In the pre-pandemic study period, *Staphylococcus aureus* accounted for 8.01% of the isolates (n= 1073) and 5.05% of the isolates (1246) during the pandemic.

*Staphylococcus aureus* isolated (23.25%) in internal medicine followed by the intensive care unit (20.93%) before and after the start of the pandemic the intensive care unit (34.92%) followed by trauma (19.04%). The samples taken were Pus (44.18%) before the start of the pandemic compared to 47.61% after, followed by broncho alveolar lavage fluids (15.11%) compared to 20.63%, then blood cultures 12.79% compared to 11.11%.

Antibiotic resistance increased from 1.16% to 3.17% for Ciprofloxacin; from 2.7% to 4.76% for Levofloxacin, Erythromycin from 10.46% to 12.7%; Clindamycin from 3.48% to 11.11%.

Due to its high capacity to colonise and persist in the hospital environment, *Staphylococcus aureus* is important. The inappropriate use of antibiotics in Covid-19 could be the cause of increased resistance.

**Keywords:** *Staphylococcus aureus*, Covid-19 pandemic, Antibiotic resistance, Macrolides, Fluoroquinolones

### **INTRODUCTION**

*Staphylococcus aureus* (*S. aureus*) is a member of the Micrococcaceae family. On microscopic examination it appears as a cluster of Gram-positive cocci. *S. aureus* can be distinguished from other staphylococcal species by the golden pigmentation of its colonies, the positive coagulase test and the fermentation of mannitol [1]. It is one of the main agents of superficial and deep suppurative infections as well as toxic syndromes, responsible for significant morbidity and mortality, particularly in the context of hospital-acquired infections.

During the Covid-19 pandemic, certain families of antibiotics in the therapeutic arsenal against *S. aureus*, such as macrolides and fluoroquinolones, experienced increased and irrational prescribing, which may be responsible for an increase in resistance to these molecules.

The objective of this article is to determine the epidemiology and antibiotic resistance profile of *S. aureus* before and after the beginning of the Covid-19 pandemic at the Avicenne Military Hospital in Marrakech.

## MATERIALS AND METHODS

This is a retrospective descriptive study, based on data from the microbiology laboratory of the Avicenne Military Hospital in Marrakech (HMA). This study was conducted on all diagnostic samples from in patients or out patients received before the Covid-19 pandemic (from 1 January 2019 to 31 December 2019) and after the start of the pandemic (from 1 January 2021 to 31 May 2022).

Isolation of bacterial strains was performed on enriched and selective agar media incubated at 37°C for 24-48 hours.

Bacterial identification was based on the study of morphological, cultural and biochemical characteristics (API Staphgalleries), completed by automated identification using the Phoenix® M50 automated system.

After isolation and identification of the bacterial strain, an antibiogram is carried out by an automated method using micro-dilutions in liquid medium with the Phoenix® automaton, which determines the MICs, as well as the measurement of the inhibition diameters by the diffusion method of the antibiotic discs in Mueller-Hinton (MH) agar medium on Petri dishes incubated at 37°C for 24 hours.

The MICs and inhibition diameters are thus compared to the EUCAST references in order to determine the sensitivity profile of the bacterial strains.

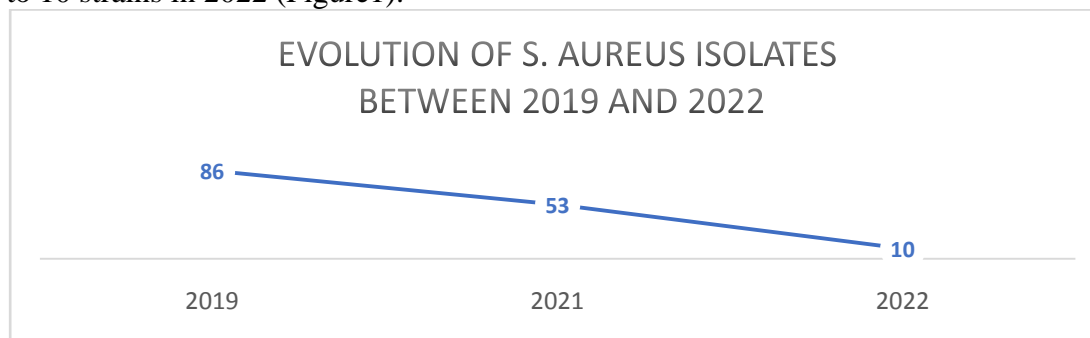
## RESULTS

### 1-Overall prevalence of *S. aureus* before and after the start of the pandemic

During the study period, before the pandemic, *S. aureus* represented 8.01% (n=86) of all the germs isolated during this period (1073 germs). Enterobacteriaceae occupied the first place followed by *S. aureus*. During the pandemic, *S. aureus* accounted for 5.05% (n=63) of all the germs isolated during this period (1246 germs). Enterobacteriaceae always occupy the first place followed by *S. aureus*.

### 2- Evolution of *S. aureus* isolates

The frequency of *S. aureus* isolation decreased during our study period from 86 strains in 2019 to 10 strains in 2022 (Figure1).



**Figure 1 : Evolution of *S. aureus* isolates between 2019 and 2022**

### 3- Sex distribution

The distribution of *S. aureus* isolates according to sex showed a male predominance with 70 strains isolated before the pandemic, i.e. a sex ratio M/F of 4.3, and 45 strains isolated during the pandemic, i.e. a sex ratio M/F of 2.5.

### 4- Distribution according to hospital departments

During the pre-Covid-19 period, *S. aureus* was found in the different activity sectors of the AMH, with a clear predominance in the internal medicine and trauma departments, which each accounted for 23.25% of *S. aureus* isolates, followed by the intensive care unit with 20.93% of isolates.

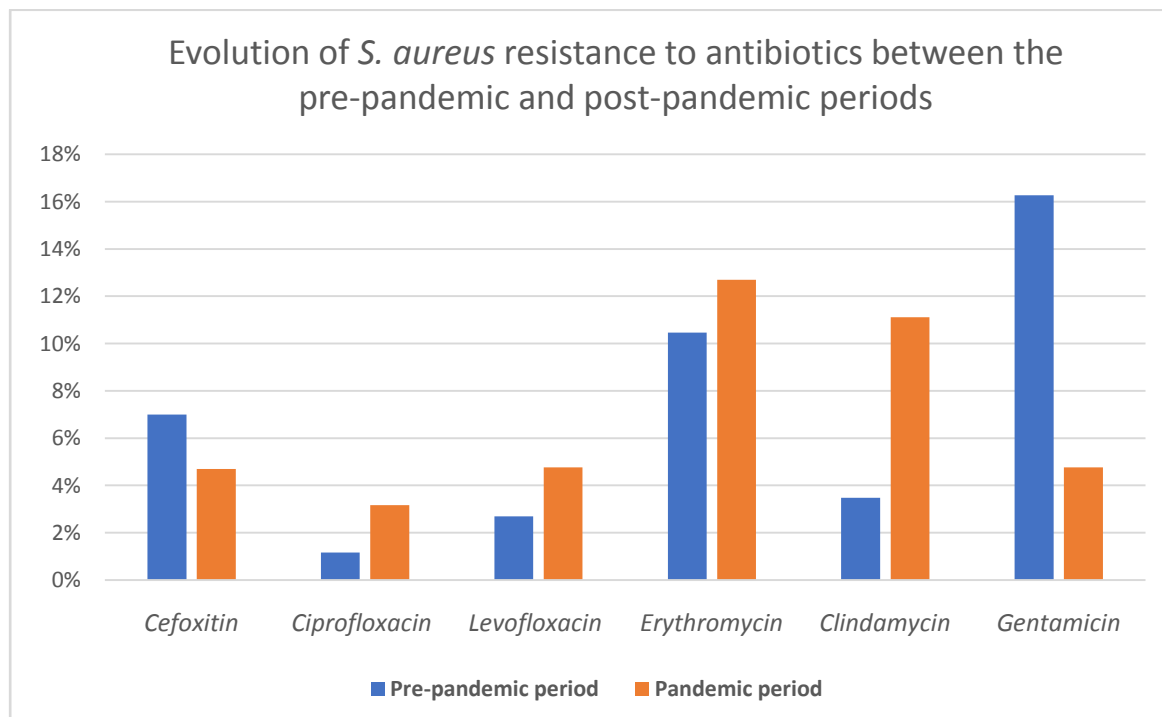
During the pandemic period, *S. aureus* was mostly isolated from the intensive care unit, followed by the trauma unit with a rate of 34.92% and 19.04% respectively.

### 5- Distribution according to the nature of the samples

The distribution of *S. aureus* isolates according to the nature of the samples revealed the predominance of strains in pus samples with a rate of 44.18% before the pandemic and 47.61% after the start of the pandemic, followed by broncho alveolar lavage fluids with a rate of 15.11% before the pandemic and 20.63% after the start of the pandemic, and then blood cultures with a rate of 12.79% before the pandemic and 11.11% after the start of the pandemic.

### 6- Antibiotic resistance profile of *S. aureus*

*S. aureus* was resistant to Cefoxitin at 7% before the pandemic compared to 4.7% during the pandemic. Resistance to Fluoroquinolones increased from 2.7% in the pre-pandemic period to 4.76% after the start of the pandemic for Levofloxacin and from 1.16% to 3.17% before and after the start of the pandemic for Ciprofloxacin respectively Erythromycin resistance increased from 10.46% before the pandemic to 12.7% during the pandemic. Clindamycin resistant strains increased from 3.48% before the pandemic to 11.11% after the start of the pandemic. Gentamicin resistance dropped from 16.27% before the pandemic to 4.76% during the pandemic (Figure 2).



**Figure 2 : Evolution of *S. aureus* resistance to antibiotics (pre- and post-pandemic Covid-19 period)**

## DISCUSSION

### 1-General prevalence of *S. aureus*

During the study period, before the pandemic *S. aureus* represented 8.01% of all isolates. After the onset of the pandemic *S. aureus* accounted for 5.05% of all isolates during this period. An Indian study found higher rates of *S. aureus* isolation with a percentage of 12.79% before the pandemic and 12.75% during the pandemic [2]. In contrast, a study in Greece found similar figures to ours with a rate of 8.77% before the pandemic and 6.23% during the pandemic [3].

There was a decrease in the frequency of *S. aureus* isolation in all studies during the Covid-19 pandemic period compared to the pre-pandemic period as also shown in the Singapore study [4].

### 2- Gender distribution

The gender distribution of *S. aureus* isolates showed a predominance of males with 70 strains isolated before the pandemic, giving a sex ratio of 4.3 M/F, and 45 strains isolated after the onset of the pandemic, giving a sex ratio of 2.5 M/F. In the Indian study there was a predominance of females (all germs combined) with a sex ratio before the pandemic of 0.61 and during the pandemic of 0.96[2].

### 3- Antibiotic resistance profile of *S. aureus*

In our study, between the pre-pandemic and pandemic periods, there was a decrease in resistance to Cefoxitin and Gentamicin, whereas resistance to Fluoroquinolones, Erythromycin and Clindamycin increased.

Similar results were reported in a Mexican study showing an increase in *S. aureus* resistance between the pre-pandemic and pandemic periods to Oxacillin, Levofloxacin, Erythromycin and Clindamycin [5].

The Greek study also found an increase in resistance to oxacillin from 34.3% to 44.8% [3].

**Table I : Comparison of *S. aureus* resistance rates before and during the pandemic**

TBA resistance	Before the pandemic			During the pandemic		
	Indian study [2]	Greek study[3]	Our study	Indian study [2]	Greek study[3]	Our study
<b>Cefoxitin</b>	46%	34,3%	7%	33,3%	44,8%	4,7%
<b>Levofloxacin</b>	-	-	2,7%	-	-	4,76%
<b>Ciprofloxacin</b>	29%	-	1,16%	22,2%	-	3,17%
<b>Erythromycin</b>	35%	-	10,46%	22,2%	-	12,7%
<b>Clindamycin</b>	53%	-	3,48%	38,8%	-	11,11%
<b>Gentamicin</b>	-	-	16,27%	-	-	4,76%

## CONCLUSION

*Staphylococcus aureus* occupies an important place in hospital pathology because of its great capacity to colonise and persist in the hospital environment, its increasing frequency, its pathogenic potential and its capacity to continually acquire resistance.

Our study allowed us to describe the epidemiological and resistance profile of *S. aureus* before and during the COVID-19 pandemic at the Avicenne Military Hospital in Marrakech during the

years 2019, 2021 and 2022, based on the data available in the microbiology laboratory registers.

#### **POTENTIAL CONFLICT OF INTEREST**

None declared.

#### **AUTHORS CONTRIBUTION**

All authors have contributed to the conduct of this work. All authors also declare that they have read and approved the final version of the manuscript.

#### **ETHICAL CONSIDERATION**

All the data has been collected anonymously following patient confidentiality.

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