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# Bacteriological Profile and Antibiotic Sensitivity of Strains Isolated from Diabetic Foot Pus at the FANN University Hospital

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## ABSTRACT

***Introduction:*** *Foot damage is one of the most serious complications of diabetes mellitus due to its functional and vital prognosis. The objective of this study is to determine the bacteriological profile and sensitivity of bacteria isolated from diabetic foot pus.*

***Methodology:*** *This is a retrospective study of pus samples from diabetic foot wounds received by the laboratory between January 2017 and December 2021. Bacteria were identified based on their morphological, cultural, and biochemical characteristics. Antibiograms were performed using the agar diffusion method in accordance with CASFM recommendations. The data were analyzed using Excel software.*

***Results:*** *A total of 86 diabetic foot pus samples were received, and 75 tested positive in culture, i.e., 87.20%. The most represented age group was 60 to 80 years old. Males predominated, accounting for 54.65% of cases, with a sex ratio of 1.20. Of the 92 strains isolated, the three most frequently encountered species were Proteus spp (22.88%), Staphylococcus aureus (20.65%), and Pseudomonas aeruginosa (14.13%).*

*Meticillin resistance was observed in 57.8% of Staphylococcus aureus strains. Of the 56 strains of Enterobacteriaceae isolated, 26 were producers of extended-spectrum beta-lactamases (ESBL), representing 46.42%, with Klebsiella spp. being the most common.*

***Conclusion:*** *The emergence of antibiotic resistance in bacteria is an additional problem for the treatment of patients with diabetic foot, hence the need for continuous monitoring of these resistances in the various healthcare facilities in Senegal.*

**Keywords**
Diabetic foot, Antibiotic resistance, CHNU Fann.

## Introduction

Diabetics are exposed to various complications that constitute the very severity of their disease. With regard to foot lesions, which become infected and gangrenous very easily in diabetics, studies agree that the risk of amputation in diabetic patients is 15 to 20 times higher than in the general population. It turns out that diabetes is particularly conducive to infections [1].

While the discovery of insulin in 1921 significantly improved the management of diabetes, bacterial resistance remains a major concern because it can worsen the functional and even vital prognosis of these patients.

It is in this context that we undertook this study, the overall objective of which was to determine the bacteriological profile and sensitivity of bacteria isolated from diabetic foot pus at the Bacteriology-Virology Laboratory of the Fann University Hospital, with the following specific objectives:

- To determine the bacterial etiologies of diabetic foot pus
- To describe the sensitivity profile of the isolated bacteria to the antibiotics tested
- Provide the distribution of bacteria according to epidemiological characteristics

## Methodology

This is a retrospective descriptive study based on the analysis of laboratory records and antibiogram data sheets. It covers a 5-year period from January 2017 to December 2021. All pus samples from diabetic foot wounds received by the laboratory during the study period were included.

In the laboratory, bacteria were identified based on their morphological, cultural, biochemical, and antigenic characteristics. Antibiograms were performed using the gel diffusion or Kirby Bauer method, in accordance with CASFM recommendations.

The following antibiotic molecules were tested during the study: Amoxicillin; Amoxicillin + Clavulanic acid; Ticarcillin; Cefalotin; Cefoxitin; Cefotaxime; Ceftazidime; Imipenem; Amikacin; Gentamicin; Nalidixic acid; Ciprofloxacin; Cotrimoxazole

Data concerning patients, pus samples, bacterial identification, and antibiotic sensitivity results were collected from records and antibiogram results sheets and then analyzed using Excel software.

## Results

The ages of our sample ranged from 11 to 93 years old. The average age was 59 years old. The most represented age group was 60 to 80 years old. In our study, males were predominant, accounting for 54.65% of the sample. The sex ratio was 1.20. (Tables 1 and 2).

**Table 1:** Distribution of patients by gender.

| Gender | Number | % |
|---|---|---|
| Male | 47 | 54 .65 |
| Women | 39 | 45.35 |
| Total | 86 | 100 |

**Table 2:** Distribution of patients by age group.

| Age group (years) | Number | % |
|---|---|---|
| < 20 | 01 | 1.16 |
| [20-40] | 01 | 1.16 |
| [40-60] | 28 | 32.55 |
| [60-80] | 43 | 50 |
| ≥80 | 05 | 5.81 |

Of the 86 diabetic foot pus samples received, 75 had a positive culture, representing 87.20% positivity with otentially pathogenic strains (Figure 1).

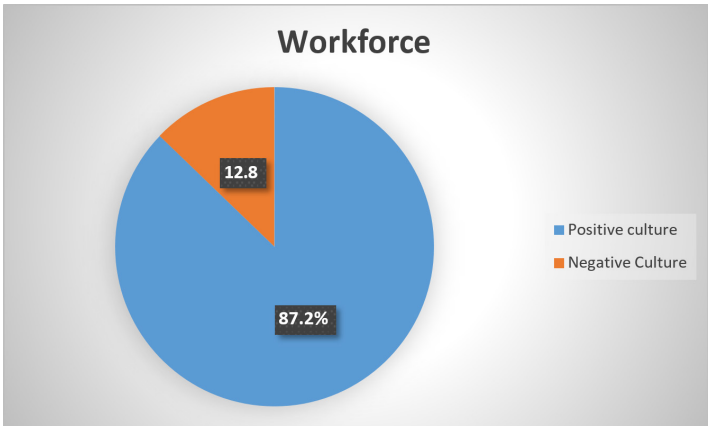


**Figure 1:** Culture positivity rate.

Of the 92 strains isolated, the three most frequently encountered species were *Proteus spp (22.88%), Staphylococcus aureus (20.65%), and Pseudomonas aeruginosa (14.13%). These three species accounted for more than 50% of the strains isolated* (Figure 2).

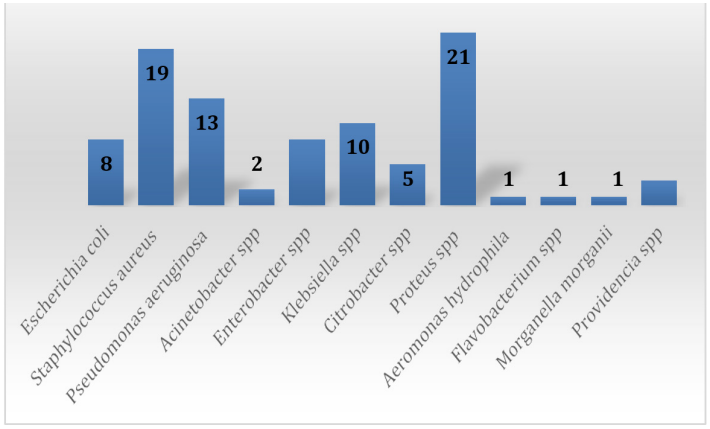


**Figure 2:** Mapping of bacteria isolated from diabetic foot pus.

The bacteriological profile was largely dominated by enterobacteria (60.86%) of the isolated strains. The study of bacterial sensitivity to antibiotics showed that the isolated bacteria were resistant to at least one antibiotic molecule

For *Proteus spp*, the resistance rates observed were 80.9% for amoxicillin and cotrimoxazole, followed by 71.4% for the combination of amoxicillin + clavulanic acid, and 71.4% for nalidixic acid. Imipenem and amikacin were 100% active against the bacteria isolated in the study.

For *Staphylococcus aureus* strains*, pefloxacin and ciprofloxacin* showed the highest level of resistance at 78.5%, followed by *penicillin at 73.6% and erythromycin at 63.1%.* Good sensitivity was noted with *vancomycin,* at a rate of 100%. *Methicillin- resistant Staphylococcus aureus (MRSA)* is currently a public health problem [2]. Its isolation is not necessarily synonymous with increased virulence [3]. *Methicillin* resistance was observed in 57.8% of isolated *Staphylococcus aureus strains; 42.2% of Staphylococcus aureus strains* did not show resistance to *methicillin.*

*Among non-fermentative Gram-negative bacteria, Pseudomonas spp. showed good sensitivity. The highest level of resistance observed was 18% with fluoroquinolones [4].*

Of the 56 strains of enterobacteria isolated, 26 were producers of extended-spectrum beta-lactamases, i.e., 46.42%. Among the ESBL-producing enterobacteria, *Klebsiella spp.* was the most common. (Table 3)

**Table 3:** Répartition des entérobactéries productrices de BLSE.

| **Entérobactérie BLSE** | **Effectifs** | **%** |
|---|---|---|
| *Escherichia coli* | 5 | 19 ,3 |
| *Enterobacter spp* | 5 | 19 ,3 |
| *Proteus spp* | 4 | 15,4 |
| *Klebsiella spp* | 7 | 26,5 |
| *Morganella morganii* | 1 | 3,9 |
| *Citrobacter spp* | 3 | 11,7 |
| *Providencia spp* | 1 | 3,9 |
| Total | 26 | 100% |

## Discussion

Foot damage is one of the most serious complications of diabetes mellitus due to its functional and vital prognosis. It is a public health issue due to its economic impact and serious repercussions on patients' quality of life.

Our study looked at 86 diabetic pus samples received by the laboratory over a period from January 2017 to December 2021 (5 years). The distribution of the study population showed a male predominance with a sex ratio of 1.2, which is consistent with data in the literature reporting that men are generally more prone to foot ulcers and amputations [9].

The 60-80 age group was the most represented, accounting for 50% of our study population. This does not corroborate the results of studies conducted in developing countries showing a predominance in younger age groups (40-59 years). However, studies conducted in developed countries have shown a predominance of diabetics among subjects over the age of 60 [10], which is consistent with the results of our study**.** This trend is due in part to higher risk factors in this age group. Of the eighty-six (86) diabetic foot pus samples received by the laboratory, seventy- five (75), or 87.20%, had a positive culture. Previous studies conducted in 2014 by HANOGBE L. et al. [11] reported a prevalence of 84.5%, which is comparable to our findings.

The study showed that bacterial mapping was characterized by a certain diversity, with the three most frequently encountered species among the 92 isolated strains being *Proteus spp (22.88%), Staphylococcus aureus (20.65%), and Pseudomonas aeruginosa (14.13%).* These same bacterial species were found in other studies conducted by Niangaly O. [12], who reported a predominance of 67.4% of *Staphylococcus aureus, Escherichia coli, and Proteus spp*.

Betalacamines were the molecules most affected by resistance. Regarding Gram- positive bacteria, 73.6% of *Staphylococcus aureus* isolated in our study were resistant to penicillins. Niangaly O. [12] found 88.9% resistance to penicillin.

In addition, 57.8% of *Staphylococcus aureus* isolates were resistant to methicillin. Similar results were reported by HANOGBE L, et al. [11] in 2014, with 50% resistance to methicillin. However, a lower result was noted by other studies conducted in Dakar in university hospitals, with 3.4% MRSA [15].

Methicillin resistance confers resistance to all beta-lactams on these bacteria, thus hindering their treatment with these molecules, except for glycopeptides.

Our study showed that glycopeptides, particularly vancomycin, were highly effective, with a rate of 100%.

In addition, good activity of aminoglycosides was noted, with 73.7% for gentamicin and 52.7% for kanamycin. It is therefore necessary to maintain this level of efficacy for the general population. These results are corroborated by studies by Niangaly O. [12], which reported an efficacy of 74.1% for kanamycin and 88% for gentamicin on *Staphylococcus aureus* strains.

With regard to quinolones, our study showed a resistance rate of 78.5% for ciprofloxacin, which is slightly lower than that found by Niangaly O. [14], which was 91.6% for ciprofloxacin. For macrolides, 63.1% of *S. aureus* strains were resistant to erythromycin; Niangaly O. [12] found a higher activity of erythromycin on *Staphylococcus aureus* strains of 73.3% in the general population. However, only 15.7% of strains were resistant to lincomycin.

With regard to enterobacteria, resistance to most of the antibiotics

tested was noted. Proteus spp showed high resistance to beta-lactams, particularly amoxicillin and ticarcillin, with resistance rates of 80.9% and 61.9% respectively. Beta-lactamase inhibitors improved this level of resistance, with 71.4% for the combination of amoxicillin and clavulanic acid. Resistance was lower for cephalosporins (23.8% for cefoxitin, 19% for cefotaxime and ceftazidime). For aminoglycosides, amikacin was 100% active against, gentamicin 52.9%. Resistance to quinolones was 71.4% for nalidixic acid and 66.6% for ciprofloxacin. The level of resistance to cotrimoxazole for Proteus strains was 80.9%.

Good activity was observed against most antibiotics, with 100% resistance to aminoglycosides (gentamicin, amikacin), 18% resistance to fluoroquinolones, and 10% resistance to imipenem in Pseudomonas aeruginosa strains. In 2011, Sivanmaliappan and Sevanan [16] reported that 100% of Pseudomonas aeruginosa isolates were resistant to norfloxacin, 66.6% were resistant to gentamicin and imipenem, and 16.6% were resistant to cefotaxime.

46.42% of Enterobacteriaceae exhibited an ESBL-type resistance phenotype. The results of HANOGBE L, et al. [11] showed that 27% of Enterobacteriaceae produced ESBL. The study conducted by Sow I, et al. in 2013 on the investigation of ABG practice and the resistance phenotypes of predominant bacterial species in Senegal reported that more than 14% of isolated Enterobacteriaceae were producers of extended-spectrum beta-lactamase (ESBL), a figure lower than ours [15]. These results show an increase in these MDRs, hence the need for rigorous surveillance of these strains. *Klebsiella pneumoniae* strains predominated in our study, followed *by Escherichia coli* and *Enterobacter spp*.

## Conclusion

Diabetic foot is a real problem due to the harmful consequences that it can cause. This is all the more worrying given that most of the bacteria isolated in this study were resistant to beta-lactams, aminoglycosides, and fluoroquinolones. Cases of co-resistance were also noted in multidrug-resistant bacteria such as methicillin-resistant Staphylococcus aureus (MRSA) and extended-spectrum beta-lactamase-producing Enterobacteriaceae (ESBL). Thus, continuous monitoring of bacterial resistance to antibiotics in different healthcare settings would allow for the updating of probabilistic treatments as resistance emerges.

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