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Research Article

Antibiotic Resistance Profiles of *Escherichia Coli* Strains Isolated in Senegal

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Abstract

The overall objective of this study is to contribute to national surveillance of antibiotic resistance in the *Escherichia coli* species. The specific objectives are to establish the resistance profiles of isolated *E. coli* strains against different families of antibiotics.

During our study period, from January 1 to February 28, 2023, fifty-one (51) strains of *Escherichia coli* from hospitalized and outpatients were isolated. Among the patients, 55% were male and 41% female. The remaining 4% were of unspecified gender. The patients' ages ranged from three (3) to eighty-nine (89) years. The majority of patients came from the neurology department and were outpatients. Urine represents the pathological product from which the most *E. coli* strains were isolated.

The isolated strains were mostly resistant to the beta-lactam family with 84.31% to amoxicillin, 87.50% to ticarcillin and 64.71% to amoxicillin plus clavulanic acid. On the other hand, the strains were very sensitive to imipenem and ertapenem with 3.13% and 11.76% resistance. For the quinolone family, the strains were resistant to levofloxacin and norfloxacin respectively at 55.10% and 62.07%.

Introduction

Misuse combined with incorrect prescribing of antimicrobial drugs in humans and animals, can lead to a significant increase in acquired bacterial resistance to antibiotics. According to a 2010 study in France [1], bacterial resistance was perceived as a national problem by 91% of physicians. In the same study, 65% of them felt it was a problem in their daily practice. With this rapidly expanding scourge, the world is moving toward an era where common infections that have been treated for decades could once again be fatal [2].

Enterobacteriaceae, which cause serious bacterial infections, have developed several resistance mechanisms against many antibiotics [3]. These resistances are becoming increasingly common; particularly those of Escherichia coli strains [4]. Indeed, this species has strains responsible for community infections with multi-resistance to antibiotics [5]. The percentage of these strains was clearly increasing in many places, particularly in France, Southern Europe (Greece and Turkey), Africa, and the Maghreb [6,7].

Furthermore, the situation is becoming more alarming with the emergence of new mechanisms conferring resistance to last-resort antibiotics such as carbapenems [2].

Material and Methods

Strains

Fifty-one (51) *E. coli* strains from the Bacteriology Laboratory of the National University Hospital of Fann, isolated between January 1 and February 28, 2023, were studied. Bacteriological samples were collected from male and female patients, both hospitalized and non-hospitalized, from various departments of the hospital.

The pathological products from which these strains were isolated were: urine, blood, pus, vaginal and urethral sampling. Identification was based on the morphological, biochemical, and cultural characteristics of *Escherichia coli*.

Antibiogram

The antibiogram was performed using the agar diffusion technique according to the recommendations of the CA-SFM (Antibiogram Committee of the French Society of Microbiology).

To perform the agar diffusion technique, a standardized inoculum of bacteria (0.5 McFarland) was dabbed onto the surface of a Mueller-Hinton (MH) agar plate. Filter paper discs impregnated with antimicrobial agents were placed on the agar.

The plates were inverted after placing the discs; a preincubation within 15 minutes of disc placement was also performed. The different antibiotics used in our study were: amoxicillin, amoxicillin plus clavulanic acid, ticarcillin, ticarcillin plus clavulanic acid, cefepime, cefotaxime, aztreonam, ertapenem, imipenem, amikacin, tobramicin, nalidixic acid, levofloxacin, norfloxacin, colistin, cotrimoxazole and Fosfomycin.

Results

The majority of patients in the study were men, with a percentage of 55%. Women accounted for 41%, while those whose gender was not specified represented 4% (Table 1 and Figure 1).

Patients ranged in age from 3 to 89 years; however, the most common age group was 60 to 80 years. Samples from inpatients

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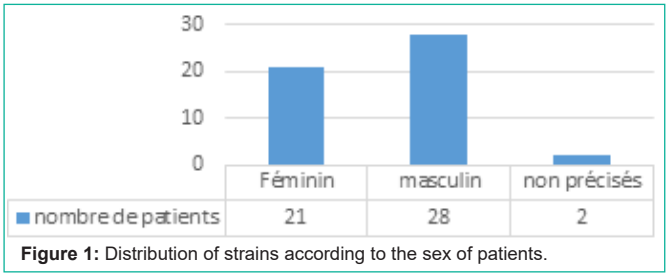

Figure 1: Distribution of strains according to the sex of patients.

Table 1: Distribution of strains by patient sex.

Sex	Number
Female	21 (41%)
Mal	28 (55%)
Unspecified	2 (4%)

accounted for 41%, compared to 43% from outpatients. The origin of 16% of the samples was not specified (Table 2 and Figure 2).

Pathological products came from all departments of the hospital. The neurology department was the most represented with 33.33% followed by the thoracic and cardiovascular surgery department (CTCV) with 19.05% and the infectious and tropical diseases department (ITD = MIT) with 14.29% (Table 3 and Figure 3).

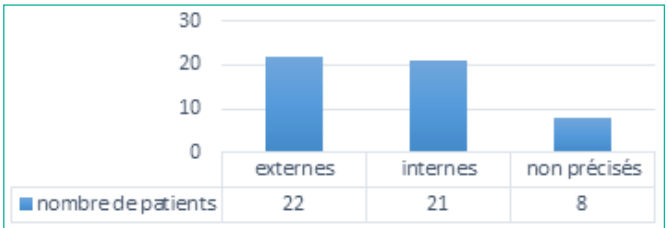

Figure 2: Distribution of strains according to patient status.

Table 2: Distribution by patient status.

Status	Number of patients
External	22 (43%)
Internal	21 (41%)
Unspecified	8 (16%)

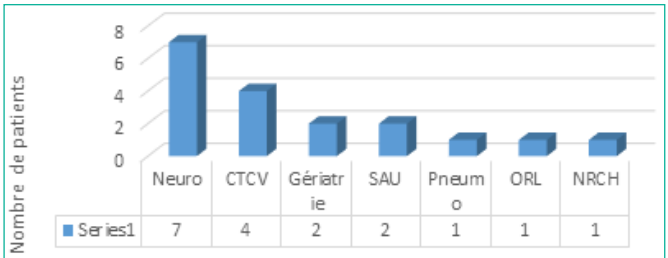

Figure 3: Distribution according to the service of origin.

Table 3: Distribution by Service of Origin.

Services	Percentages
Neurology	33,33% (7)
CTCV	19,05% (4)
ITD / MIT	14,29% (3)
Geriatrics	9,52% (2)
Emergency reception service / SAU	9,52% (2)
Pneumology	4,76% (1)
ENT / ORL	4,76% (1)
Neurosurgery / NRCH	4,76% (1)

Table 4: Distribution of strains isolated according to the pathological product.

Pathological products	Pus	Urine	Blood	Vaginal sample
Numbers	11(21,57%)	32(62,75%)	6(11,76%)	2(3,92%)

The most frequently received pathological products were urine with a percentage of 62.75%, followed by pus (21.57%) and blood (11.76%) (Table 4, Figure 4).

Regarding beta-lactam antibiotics, very high resistance to amoxicillin (84.31%), ticarcillin (87.50%), and amoxicillin/clavulanic acid (64.71%) was observed.

Cephalosporins, particularly cefotaxime and cefepime, exhibited resistance of 50% and 54.90%, respectively.

51.11% of the *E. coli* strains in the study were resistant to aztreonam, unlike imipenem and ertapenem, for which only 3.13% and 11.76% of strains exhibited resistance (Table 5).

6.12% of strains were resistant to amikacin, 55.10% and 62.07% to levofloxacin and norfloxacin respectively (Table 6).

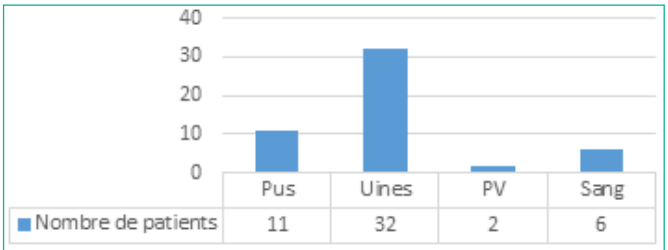

Figure 4 : distribution of strains according to the pathological product.

Table 5: Resistance to beta-lactams of isolated strains.

Antibiotics	Number of strains tested	Critical values	Number of resistant strains	Percentage of resistant strains
Amoxicillin	51	19	43	84,31%
Amoxicillin / Clavulanic acid	51	19	33	64,71%
Ticarcillin	48	20-23	42	87,50%
Ticarcillin / Clavulanic Acid	49	20-23	40	81,63%
Cefepime	51	24-27	28	54,90%
Cefotaxime	24	17-20	12	50,00%
Aztréonam	45	28	23	51,11%
imipenem	32	19-50	1	3,13%
Ertapenem	51	25	6	11,76%

Table 6: Resistance of strains to aminoglycosides (quinolones and others).

Antibiotics	Number of strains tested	Critical values	Number of resistant strains	Percentage of resistant strains
Amikacin	49	18	3	6,12%
Tobramicin	50	16	8	16,00%
Nalidixic Acid	45	14	15	33,33%
Levofloxacin	49	19-23	27	55,10%
Norfloxacin	29	22	18	62,07%
Colistin	47	16	0	0%
Cotrimoxazole	29	14-Nov	23	79,31%
Fosfomycin	49	21	5	10,20%

Discussion

The objective of our study was to determine the antibiotic resistance profiles of *E. coli* strains isolated at Fann Hospital in Dakar, Senegal. It should be noted that E. coli is the primary species implicated in cases of Gram-negative bacteremia [8]. In our study, the percentage of men from whom *E. coli* was isolated was higher than that of women, with a rate of 55% versus 41%, compared to another study conducted in

2022 at the same facility, which showed a slight dominance of women, with 51% versus 49% of men [9]. This female predominance in the previous study could be explained by the high frequency of urinary infection caused by *E. coli*, the shortness of their urethra, the anatomy of their perineum and the frequency of sexual intercourse favoring the opening of the urethral meatus which facilitates the access of germs to the bladder [10-12]. In our case, the predominance of men could be caused by a more frequent consultation of the latter during the period concerning our study at the hospital level. However, this male predominance (68.4% against 31.6%) is reported by a study carried out at the bacteriology laboratory of the Moulay Ismail Military Hospital in Meknes, Morocco [12].

The average age of the study patients was 47, 43 years. This high average age was explained by the frequency of infections in the elderly and/or those who were sexually active. In older people, this could also be explained by a weakened immune system [2,9].

In addition, the pathological product from which *E. coli* strains were most frequently isolated was urine (62.75%). A similar result was obtained in 2021 [2]. This could be due to a high frequency of urinary tract infections.

Regarding antibiotics, amoxicillin was once the most widely used molecule in the treatment of infections caused by *Escherichia coli* [14]. The sensitivity of this bacterium to this antibiotic has decreased significantly, as evidenced by our study, with very high resistance of strains to amoxicillin (84.31%). A similar result was obtained in a 2021 study in Cameroon [2].

A study conducted in Marrakech showed almost 65% resistance to amoxicillin in *Escherichia coli* strains [9]. This acquired resistance is the result of excessive consumption of amoxicillin.

The strains we isolated also showed resistance to amoxicillin-clavulanic acid at 64.71%; a similar result has been obtained in other studies; however, these rates are higher than those reported in other studies where the resistance rate to amoxicillin-clavulanic acid varied between 31 and 49.7%. A lower rate was also obtained in a study in Marrakech with 43% resistance of strains to amoxicillin-clavulanic acid, in Algeria with a sensitivity percentage of 76% [2,9,15].

This increase in resistance could be explained by hyperproduction of penicillinase, or by inactivation of the inhibitor itself (clavulanic acid) [2].

Ticarcillin resistance is also very high (87.50%), a similar rate was obtained in a 2021 study, but this rate is slightly higher than that of a 2017 study (83.5%) and significantly higher than those reported in France, Italy, and Cameroon, where rates ranged between 30 and 60% [2,15].

The resistance rate of strains to cefepime is 54.90%, a rate almost identical to that obtained in a 2021 study, but compared to the result obtained in a 2018 study (40.9%), the rate obtained is slightly lower than ours [2,15].

With cefotaxime, a resistance rate of 50% was obtained, much higher than that of a study where we had a sensitivity rate of 91.2% of the isolated *E. coli* strains. For aztreonam, a resistance rate of 50.11% was obtained, which is higher than the results of studies conducted in 2018 with 44% and in 2021 with 29.26% resistance to aztreonam [2,15].

Carbapenems (ertapenem and imipenem) proved to be very effective, especially imipenem with a resistance rate of 3.13% and 11.76% for ertapenem. Similar rates were reported in studies conducted in 2018 and 2021, but significantly higher rates were observed in other countries, including Bulgaria (21.2%), Cyprus (21.8%), Italy (2.8%), Romania (29.5%), and Greece (63.9%) between 2015 and 2018, and in Morocco (Marrakech) with a resistance rate of 0% [2,16].

Carbapenem resistance is due to the presence of carbapenemase and is increasingly described worldwide; this is a significant problem because carbapenems are very often the last active molecules to combat resistant bacteria [16].

The resistance rate to nalidixic acid is 33.33%, a rate lower than that obtained in a 2021 study (57.64%) but close to that obtained in Morocco (38.42%). Furthermore, our resistance rate is higher than that obtained in France (8.3% [2].

The resistance of *E. coli* to amikacin is 6.12%, a resistance rate that can be considered low. A study conducted in 2017 showed resistance close to that obtained at 7.1%. An almost similar rate was obtained in Marrakech (8%); and studies conducted in France revealed that 2% of strains were resistant to amikacin [14, 16]. The resistance of strains to tobramicin is 16%, a low rate compared to levofloxacin and norfloxacin, which have 55.10% and 62.07% respectively, therefore rates much higher than that of tobramicin.

Conclusion

Bacterial resistance to one or more antibiotics is a major public health problem worldwide, especially in developing countries. To closely monitor this scourge, performing antibiograms and consistently interpreting the results are essential tools. It is in this context that we conducted this study, which consisted of determining the antibiotic resistance profiles of *E. coli* strains isolated at the Fann bacteriological laboratory from January 1 to February 28, 2023. The study revealed high levels of resistance to several classes of antibiotics. This is due to several factors, such as excessive and poorly controlled use of antibiotics by patients, the emergence of *E. coli* adaptation mechanisms to its environment, and non-compliance with antibiotic treatment protocols by patients and physicians.

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