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EC MICROBIOLOGY
Retrospective Study

Bacteriological Profile of Bacterial Infections in the Adult Emergency Department CHU Hassan II FES

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Abstract

Infectious emergencies are a frequent reason for consultation and admission to an emergency department; bacteriological examinations then represent an essential diagnostic means for these pathologies. The objective of our study was to characterize the bacterial ecology of various infections in the emergency department, and to determine the resistance profile of the main bacteria isolated. We conducted a retrospective study over a 12-month period from June 2021 to June 2022 in the emergency department of the Hassan II University Hospital in FES, including all patients who had undergone bacteriological examinations. we carried out 3557 bacteriological samples, 3124 cytobacteriological examinations of urine, 153 lumbar punctures, 107 pus samples, 88 respiratory samples, 52 punctures and 33 blood cultures were taken; the average age of our patients was 48.4 years with a female predominance (64%). The positivity rate was 18.2%. During our study, 520 bacteria were isolated. Gram-negative *bacilli* (GNB) predominate at 90%, represented mainly by *Enterobacteriaceae* (77%), divided essentially into *Escherichia coli* (60%), *Klebsiella pneumoniae* (15%) and *Proteus mirabilis* (2%), followed by non-fermenting Gram-negative *bacilli* (13%), including 8% *Pseudomonas aeruginosa* and 5% *Acinetobacter baumannii*. Gram-positive *Cocci* represents 10% of bacterial isolates, including 5% *Staphylococcus aureus*, 4% *Enterococcus faecalis* and 1% *Streptococcus pneumoniae*.

The study of antibiotic sensitivity shows that resistance to aminopenicillins was 76%. Resistance to the amoxicillin-clavulanic acid association was encountered in 31% of cases and resistance to 3rd generation cephalosporin in 22% of cases. 12% of *Escherichia coli* and 9% of *Klebsiella pneumoniae* produced extended spectrum beta lactamase (ESBL), 6% of *Klebsiella pneumoniae* were carbapenemase producers. *Acinetobacter baumannii* was sensitive to colistin alone. All strains of *staphylococci aureus* were methicillin-sensitive.

The average length of hospitalization for our patients was 4.5 days, the evolution of which was favorable for 89% of patients, and death in 11% of cases.

Keywords: *Infection; Bacteriological Sampling; Antibiogram; Bacterial Resistance*

Introduction

Infectious pathology is a frequent cause of admission to the emergency department. The National Hospital Ambulatory Medical Care Survey identified infections among the top 20 discharge diagnoses for patients treated in the ED, including pneumonia, cellulitis, abscesses

and urinary tract infections, consequently antimicrobials were identified as the second largest class of drugs prescribed in the ED, just behind analgesics, with a rate of 13.4% taking into account all drugs prescribed [1]. Routine antibiotic prescribing is associated with an increase in bacterial resistance in patients with community-acquired infections, drawing particular attention. The aim of our work is to establish the bacteriological profile of infections in patients admitted to the CHU HASSAN II emergency department in Fez, and to assess the antibiotic resistance of the various bacteria isolated.

Materials and Methods

This is a retrospective descriptive study spread over a 12-month period from June 2021 to June 2022 carried out in the adult emergency department of Hassan the II University Hospital in FES, including all patients who had undergone bacteriological examinations.

Bacteriological samples were analyzed at the microbiology laboratory of Hassan II University Hospital in FES.

Inclusion criteria: All patients aged over 15 admitted to the emergency department and having had a bacteriological sample taken.

Exclusion criteria: Sampling excluded neonatal patients and children under 15 years of age. In a second stage, repeated samples from patients from whom the same germ had been isolated at the same site were excluded.

The different types of bacteriological samples taken in emergency departments:

- Urine cytobacteriological tests were systematically requested in the presence of urinary signs (dysuria, pollakiuria, mictional burning).
- Pus samples were taken by swab if there were signs of skin infection, intraoperative sampling or abscess puncture.
- Respiratory samples consisted of cytobacteriological examination of sputum in conscious patients, bronchoalveolar lavage or protected distal sampling in intubated or tracheostomized patients, and were taken in the event of purulent respiratory secretions or in the presence of a focus on chest radiography.
- Blood cultures were requested in any patient presenting hyperthermia above 38.7, hypothermia below 36.5, shivering, or biological signs of sepsis.
- Pleural, pericardial, ascites or joint fluid punctures were performed in the event of warning signs.

For each sample received in the microbiology laboratory, we carried out a direct examination stained with the GRAM stain, which gives us information on the type of bacteria and the associated inflammatory reaction. White and red blood cell counts were also carried out for urinary samples, and punctures of biological fluids. All samples were cultured on solid media, and pus samples were cultured on brain-heart broth (BHI). Incubation was carried out at 37°C in a 5% aerobic atmosphere for 24 to 48 hours in an incubator. Bacteria were identified by API gallery or automated on Becton Dickinson Phoenix 100.

The antibiogram was inoculated on Muller Hinton medium, followed by deposition of the antibiotic discs to be tested. Incubation took place at 37°C for 24 hours, and results were interpreted by reading the diameter of the zone of inhibition in accordance with EUCAST (European Committee on Antimicrobial Susceptibility Testing) recommendations.

Screening for Extended Spectrum Beta Lactamase (ESBL) producing bacteria was carried out qualitatively by looking for a champagne cork appearance between the amoxicillin-clavulanic acid (AMC) disc and the 3rd generation cephalosporin (C3G) discs.

Carbapenemase screening was carried out using imipenem and ertapenem discs and confirmed by carbapenemase cassettes using immunochromatographic techniques. The minimum inhibitory concentration of ceftazidime-avibactam was measured for therapeutic purposes.

Data were collected using an Excel spreadsheet based on patients' medical records. Quantitative and qualitative variables were described in terms of mean and percentage.

Results

In all, we took 3,557 bacteriological samples; the average age of our patients was 48.4 years, and they were predominantly female (64%). The various samples taken included 3124 urine cytobacteriological tests, 153 lumbar punctures, 107 pus samples, 88 respiratory samples, 52 punctures and 33 blood cultures. The positivity rate was 18.2%. In our study, 520 bacteria were isolated. Gram-negative *bacilli* (GNB) predominated with a rate of 90%, represented mainly by *Enterobacteriaceae* (77%), divided essentially into *Escherichia coli* (60%), *Klebsiella pneumoniae* (15%) and *Proteus mirabilis* (2%), followed by non-fermenting Gram-negative *bacilli* (13%), including 8% *Pseudomonas aeruginosa* and 5% *Acinetobacter baumannii*. Gram-positive *Cocci* represents 10% of bacterial isolates, including 5% *Staphylococcus aureus*, 4% *Enterococcus faecalis* and 1% *Streptococcus pneumoniae.*

Cytobacteriological urine samples are the most frequently requested examinations in emergency departments. We received 3124 samples, i.e. 87.8% of cases, of which 65.1% were negative, 18.2% polymorphic and 16.7% positive, i.e. 521 urinary tract infections were diagnosed. *Escherichia coli was* isolated in 75% of cases, i.e. 391 patients, followed by *Klebsiella pneumoniae* 16% of cases, i.e. 84 patients, *Enterococcus faecalis* 3%, i.e. 16 cases, *Pseudomonas aeruginosa* 1.3%, i.e. 7 patients, *Staphylococcus aureus* 2%, i.e. 10 patients, *Staphylococcus saprophyticus* 1.1%, i.e. 6 patients, *Proteus mirabilis* 1%, i.e. 5 patients, and lastly *Acinetobacter baumannii and Serratia marcescens* isolated in 2 patients, with a rate of 0.3% for each bacterium.

Pus samples were taken from 107 patients, with an average age of 46.96 years and a predominance of males (61%). 66% of pus samples received by the laboratory were positive, i.e. 71 bacteria were isolated. *Enterobacteriaceae* were the most frequently encountered germs, with a rate of 54%, broken down into *Escherichia coli* in 45% of cases, i.e. 32 patients, *Klebsiella pneumoniae* in 3%, i.e. 2 patients, 2 cases of *Proteus mirabilis*, 1 case of *Enterobacter cloacae*, and 3 cases of unidentified *Enterobacteriaceae*.

Among non-fermenting BGN, *Acinetobacter baumannii* was isolated in 30% of cases (21 patients), and *Pseudomonas aeruginosa* in 3% (2 patients).

Gram-positive *cocci* accounted for 13% of bacteria isolated from pus, represented mainly by *Staphylococcus aureus* (6%, i.e. 4 patients), *Enterococcus faecalis* (4%, i.e. 3 patients) and *Group B Streptococcus* (3%, i.e. 2 patients).

A total of 88 respiratory samples were received, of which 32% were positive. A total of 29 bacteria were isolated, broken down into *Klebsiella pneumoniae* 35% (10 patients), *Pseudomonas aeruginosa* 28% (8 patients), *Acinetobacter baumannii* 15% (5 patients), *Staphylococcus aureus* 10% (2 patients), *Streptococcus pneumoniae and Escherichia coli* with a rate of 6% (2 patients) for each bacterium.

For biological fluid punctures, 153 lumbar punctures were performed, 42% of which were cytology-positive, i.e. 64 cases of meningitis were diagnosed, of which 2 cultures were positive for *Streptococcus pneumonia*, and the other for *Pseudomonas Sp.* For pleural, pericardial, peritoneal and joint punctures, 52 samples were received, 68% of which were cytology-positive, i.e. 35 cases, of which only one culture was positive for *Escherichia coli.*

As regards blood cultures, 33 series were received at the laboratory, of which only one was positive for *Staphylococcus aureus.*

Resistance profile

In our study, 10% of *Escherichia coli* isolated were wild-type, 76% of strains showed resistance to aminopenicillins, 31% to the amoxicillin-clavulanic acid combination, and 25% to 1st-generation cephalosporins (C1G). Thus, 20% of strains were resistant to 3rd-

Germ	ECBU	Pus sampling	Respiratory sampling	Ponction	Blood culture
Escherichia coli	75%	45%	6%	33,33%	-
Klebsiella pneumoniae	16%	3%	35%	-	-
Acinetobacter baumannii	0,3%	30%	15%	-	-
Pseudomonas aeruginosa	1,3%	3%	28%	33,33%	-
Proteus mirabilis	1%	1%	-	-	-
Enterobacter cloacae	-	1%	-	-	-
Serratia marcescens	0,3%	-			
Staphylococcus aureus	2%	6%	10%	-	100%
Staphylococcus saprophyticus	1,1	-	-	-	-
Enterococcus faecalis	3%	4%	-	-	-
Streptococcus pneumonia	-	-	6%	33,33%	-
Group B Streptococcus	-	3%	-	-	-

***Table 1**: Germ distribution by site.*

generation cephalosporins, 12% of which produced an ESBL (extended-spectrum beta-lactamase), i.e. 37 patients. With regard to other antibiotics, 28% of strains were resistant to trimethoprim-sulfamethoxazole, 27% to quinolones, 6% to gentamicin and 2% to amikacin. All bacteria were sensitive to carbapenems and colistin.

Klebsiella pneumoniae strains (78) were resistant to amoxicillin clavulanic acid and C1G by 30% and 18% respectively, 15% of bacteria were resistant to C3Gs, 9% of which were ESBL, corresponding to 7 patients, 16% were resistant to quinolones, 13% to trimethoprim-sulfamethoxazole and 2% to gentamycin. 6.4% of *Klebsiella pneumoniae* had OXA 48 carbapenemases, i.e. 5 cases, while all *Klebsiella pneumoniae* strains were sensitive to colistin and amikacin.

Proteus mirabilis strains were resistant to C3G in 6% of cases, with no cases of ESBL, 8% were resistant to quinolones and 5% to trimethoprim-sulfamethoxazole. All strains were sensitive to carbapenems.

A single strain of *Enterobacter cloacae* was isolated, becoming sensitive to all antibiotic discs apart from natural resistance.

Concerning non-fermenting BGN, all *Acinetobacter baumannii* strains were colistin-susceptible, 90% resistant to amikacin and imipenem, and multi-resistant to other antibiotics. For *Pseudomonas aeruginosa,* 10% of strains were resistant to ciprofloxacin and ticarcillin, 6% to ceftazidime, 5% to imipenem and 2% to amikacin.

For Gram-positive *cocci*, 100% of *Staphylococcus aureus* strains were penicillinase-resistant, and no cases of methicillin-resistant *Staphylococcus aureus* (MRSA) or glycopeptide resistance were observed. Resistance to quinolones, amikacin and sulfamethoxazole + trimethoprim was 8%, 5% and 2% respectively.

Enterococcus faecalis strains were sensitive to erythromycin, with low resistance to quinolones (2%) and sulfamethoxazole+ trimethoprim (1%).

One case of susceptible *Streptococcus pneumonia* was recorded.

	Antibiotic resistance (%)			
	Enterobacteria		Non-fermenting BGN	
	Escherichia coli	*Klebsiella pneumoniae*	*Pseudomonas aeruginosa*	*Acinetobacter baumannii*
Aminopenicillins	76	-	-	-
Amoxicillin-clavulanic acid	31	30	-	-
Cephalothin	25	18	-	-
3rd generation cephalosporins	20	15	-	-
Imipenem	0	6,4	5	90
Ertapenem	0	6,4	-	100
Amikacin	2	00	2	90
Gentamycin	6	2	2	100
Colistin	0	0	0	0
Ciprofloxacin	27	16	10	100
Norfloxacin	27	16	10	100
Trimethoprim/Sulfamethoxazole	28	13	-	100
Ceftazidime	22	15	6	100
Ticarcillin	NT	NT	10	100
Piperacillin	NT	NT	10	100
Aztreonam	NT	NT		100
Piperacillin-Tazobactam	NT	NT	NT	100

***Table 2**: Germ resistance to antibiotics.*

Therapeutic management of patients admitted to the emergency department involved the administration of probabilistic antibiotic therapy in 60% of cases, with amoxicillin/clavulanic acid prescribed in 45% of cases, followed by ceftriaxone (28%) and ciprofloxacin (22%). Gentamicin was prescribed as an adjuvant in 45% of cases.

Patients infected with *Acinetobacter baumannii,* were put on colistin, and patients with carbapenemase-producing bacteria were put on the ceftazidime-avibactam combination. For both types of bacteria, patients were isolated with disinfection of the circuit and admission departments, and cases were reported to the Comité de Lutte contre les Infections Nosocomiales (CLIN).

The average length of hospital stay for our patients was 4.5 days, with extremes ranging from 1 to 15 days. The outcome was favorable in 89% of cases, and death in 11%.

Discussion

Bacterial infections are a frequent reason for admission to emergency departments, and can be life-threatening. Although early and accurate recognition is crucial to improving prognosis, diagnosis often remains difficult due to highly variable clinical presentations [2], responsible for widespread prescription of antibiotic therapy which leads to a decrease in the susceptibility of common bacteria to antibiotics; more particularly, resistance to β-lactam antibiotics, aminoglycosides, fluoroquinolones and sulfonamides; hence, seriously threatening patients' lives. At the same time, the emergence of new antibacterial drugs is making the problem of drug addiction ever more serious [3]. The recent discovery of superbugs in India and other countries is a serious consequence of antimicrobial drug abuse, but at

present there is still no effective treatment that can replace antibiotics to inhibit pathogens [4], and so the rational use of antibiotics has become an important topic for clinical use. The principle of rational drug use is to understand the distribution of pathogens and the trends and characteristics of drug resistance.

In our study, 3557 samples were received, with an average age of 48.4 years and a predominance of females. The Fasla study showed an average age of 42.6 +/- 18.76 years, but with a predominance of males (sex ratio m/f = 2) [5]. This result could be explained by the predominance of urinary tract infections in our study, and the fact that this infection is more frequent in women than in men.

Knowledge of bacterial epidemiology is essential to adapt antibiotic prescriptions and improve prognosis. Until the 80s, gram-negative bacteria were predominant, but in the 90s, gram-positive bacteria began to emerge, with *Staphylococcus* predominating. This increase is linked to the use of intravenous devices and the progressive colonization of catheter penetration points by cutaneous flora [6].

In our series, BGNs were the most frequently isolated germs (90%), with *Escherichia coli* the most frequent agent (77%). Gram-positive *Cocci* were isolated in only 10% of cases, represented essentially by *Staphylococcus aureus* (6%). Our results concur with those of Kllili k [7], in which BGNs, notably *Enterobacteriaceae* (*Escherichia coli* in the lead), were the most frequently isolated. Viallon, on the other hand, reports a predominance of Gram-positive *cocci*, with 35% of *S. pneumonia* and 14% of *Staphylococcus aureus* [8].

The SCOPE study revealed that gram-positive *cocci* were isolated in 64% of 10617 episodes of bacteremia [9], which is in line with Moumille's study, according to which gram-positive *cocci*, particularly *Staphylococci* and *Enterococci*, are becoming increasingly important [10]. On the other hand, Bursic found that *Acinetobacter* was the main germ found, with a rate of 25.1%, followed by *Pseudomonas* 14.9%, *Klebsiella* 14.2% and *Enterobacter* 4.4% [11].

The high rate of BGN isolated in our study was explained on the one hand by the large number of ECBUs performed, and on the other hand by unfavorable hygiene conditions and poor sampling conditions.

Escherichia coli showed high resistance to aminopenicillins, amoxicillin-clavulanic acid, cephalothin, trimethoprim-sulfamethoxazole and quinolones, while retaining sensitivity to imipenem and amikacin, This was consistent with S Bou-Antoun's study, which revealed that *Escherichia coli* had high resistance to ciprofloxacin, indicating that its resistance to quinolones and cephalosporins is still very high, and that *Escherichia coli*'s resistance rate to imipenem was low [12].

Klebsiella pneumoniae strains showed an increased rate of resistance to C3Gs, with the appearance of ESBL- and carbapenemase-positive bacteria. These results were in line with a study by Lijun Tian, who observed a significant increase in the occurrence of carbapenemase-producing *Klebsiella pneumoniae* infections, which is associated with increased mortality in infected patients [13]. A study carried out in southern Europe showed a higher incidence of inappropriate empirical treatment for multidrug-resistant *Klebsiella pneumoniae* bloodstream infection, leading to a more than twofold increase in patient mortality [14].

Rising levels of antibiotic-resistant *Escherichia coli* and *Klebsiella pneumoniae* are the result of overuse of antibiotics and self-medication by patients at the slightest sign of infection.

As regards, *Acinetobacter baumannii* is a common colonized pathogen in hospitals, and is also a relatively common pathogen of nosocomial acquired pneumonia. It was an extremely drug-resistant strain [15]. This is consistent with our study, in which this bacterium was isolated from 5% of all samples, and the strains isolated were resistant to imipenem and amikacin in 90% of cases. *Acinetobacter baumannii* in the emergency department is mainly due to nosocomial infection during hospitalization [16], and there are few reports of *Acinetobacter baumannii* causing community-acquired infection.

Pseudomonas aeruginosa is a highly resistant bacterium, frequently found in hospitals and often responsible for nosocomial infections.10% of strains isolated in our series were resistant to ciprofloxacin and ticarcillin respectively, 6% to ceftazidime, 5% to imipenem and 2% to amikacin. Ghorashi, who found an estimated resistance rate of 25% to fluroquinolones, 35% to amikacin and 50% to ceftazidime [17].

In the case of *Staphylococcus aureus,* there was near-resistance to penicillin, low resistance to amikacin and the sulfamethoxazole + trimethoprim combination. Rates of methicillin-resistant, vancomycin-resistant and tigecycline-resistant Staphylococcus aureus were always zero. Our results are similar to those of Mohamed Lemine, where the strains isolated from the various pathological products were resistant to penicillin in over 96% of cases, followed by cotrimoxazole (66 - 75%). vancomycin and amikacin, on the other hand, were active on all the strains isolated [18].

In our study, *Enterococcus faecalis* strains were sensitive to erythromycin, with low levels of resistance to quinolones (2%) and sulfamethoxazole+ trimethoprim (1%), in line with Arnaud Pradel, who found that 8 out of 44 cases of *Enterococcus* were resistant to cotrimoxazole, only one patient had an *Enterococcus* with high-level resistance to gentamicin, and no resistance to vancomycin was found [19].

Only one case of susceptible *Streptococcus pneumoniae was* found, which is in line with the results recorded by Abdelhamid FASLA [5], all the strains of *Streptococcus pneumoniae* isolated in his study were susceptible to betalactam antibiotics, amikacin and fluoroquinolones [5].

The flow of patients through the emergency department makes it an important target for interventions aimed at reducing inappropriate antimicrobial prescribing. Thus, the decision to prescribe antibiotic therapy must be justified by the benefit it brings to the patient in terms of mortality or morbidity. The prescription of antibiotics should therefore be limited to infections whose bacterial origin is highly probable, and for which other measures are not sufficient. Some situations require immediate probabilistic antibiotic therapy, due to the risk of rapid dissemination of germs or an increase in bacterial inoculum favoring the development of septic shock, which has a high mortality rate. In certain situations, antibiotic therapy must await bacteriological identification.

The choice of an antibiotic depends on its predictable activity on the presumed micro-organisms, its good diffusion in the infected site, and the absorption, elimination and tolerance capacities of the infected subject. Obtaining effective antibacterial concentrations at the infected site is essential to prevent bacterial growth and avoid the emergence of resistant bacteria. For mild infections, the best-tolerated, narrow-spectrum antibiotics should be chosen, as they have the least impact on the commensal flora. In the case of serious infections, the focus should be on efficacy, and broad-spectrum, bactericidal antibiotics should be used.

The vast majority of infections seen in emergency departments are community-acquired, with germs that are generally sensitive to the antibiotic indicated, and monotherapy is often sufficient. Antibiotic combinations are indicated for three purposes:

1. The first objective is to reinforce the efficacy of treatment by increasing bactericidal activity, thanks to the synergistic effect of the combination. This is one of the objectives of antibiotic therapy for septic shock, acute endocarditis and infections in neutropenic patients [20]. The most interesting synergistic bactericidal activity is observed when betalactam antibiotics are combined with aminoglycosides or fluoroquinolones [21].
2. The second objective of the combination is to broaden the antibacterial spectrum in the treatment of severe microbiologically undocumented infections (purulent meningitis, severe pneumonia) [22] or potentially multi-microbial infections (necrotizing cellulitis, intra-abdominal infections).

3. The final objective is to prevent the predictable emergence of resistant mutants when certain antibiotics are used to eradicate certain bacterial species (fluoroquinolones, rifampicin, fusidic acid in staphylococcal infections; fluoroquinolones, betalactam antibiotics in Pseudomonas aeruginosa infections).

Apart from these circumstances, antibiotic combinations should be avoided because of the antagonistic action of certain antibiotics, the risk of increased adverse effects, and the high cost.

In the United States, the number of patients consulting emergency departments is estimated at a 100 million per year, with antibiotics prescribed for 15.7% of these patients [23], primarily as a probabilistic treatment, which is responsible for the emergence of antibiotic-resistant bacterial strains.

According to Elbouti A [24], the most common pathologies are respiratory and urinary system disorders, and penicillins, fluoroquinolones and cephalosporins were the most frequently prescribed families of antibiotics, as described in the present work.

Various studies have reported that therapeutic failure in the event of infection is due to bacteria resistant to the empirical antibiotic therapy initially administered [25], hence the essential role of emergency physicians in rational and appropriate antimicrobial prescribing.

The average length of hospital stay in our study was 4.5 days, and our results are close to those in the literature: 5.2 days for Fasla [5], and 2.75 for Klili [7].

At the end of this course, 89% of patients had a favorable outcome and 11% of patients died. Our results are close to those of the study by Kllili [7], recording 12% of deaths, and lower than those of Fasla [5], who reached 31.3%.

Conclusion

The management of infectious diseases in the emergency department represents a major challenge in view of their morbidity and mortality. Hence, the importance of instituting early empirical antibiotic therapy in line with recommendations, the bacteriological profile of emergency department infections, and the antibiogram, requiring the involvement of emergency physicians responsible for prescribing probabilistic antibiotic therapy and biologists who ensure safe, high-performance diagnosis with the aim of reducing the emergence of antibiotic resistance and improving patient prognosis.

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