Evaluation of antimicrobial susceptibility of *Escherichia coli* strains isolated in Rabat University Hospital (Morocco)

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Abstract

**Background:** *Escherichia coli* (*E. coli*) is the most commonly isolated bacteria in human pathology. In Morocco the data concerning the nature and the rates of antibiotic resistance of *E. coli* in both hospitals and city environment remains relatively poor and needs further investigations.

**Methods:** During a 16 months period, *E. coli* isolates were collected from different culture specimens received in the Bacteriology Department of the Military teaching Hospital Mohammed-V-Rabat for routine diagnostic purposes. *E. coli* isolates were identified and their antimicrobial susceptibility pattern was determined.

**Results:** A total of 1369 *E. coli* isolates comprising 33% (1369/4110) of culture-positive samples were consecutively collected. Isolates of *E. coli* were, in 40.5% (554/1369) of cases from hospitalized patients and in 59.5% (815/1369) of cases from outpatients. Urine isolates represented 82% (1123/1369) of the cases. High rates of resistance were found for amoxicillin (42.5%), cefalotin (30.4%), norfloxacin (29.9%) and sulfamethoxazole (37.7%). The detection rate of ESBL was 6.1% (85/1369). In hospitalized patients 11.9% of the isolates of *E. coli* (66/554) had an ESBL phenotype while in outpatients cases only 2.3% of isolates of *E. coli* (19/815) had this phenotype.

**Conclusions:** Our findings suggest that more judicious use of antibiotics is needed especially in probabilistic treatment. The emergence of ESBL in the Moroccan cities is an indicator of the severity of this problem that is not limited to health care facilities.

**Keywords:** *Escherichia coli*, Antimicrobial susceptibility, Morocco
The aim of this study is to determine the resistance rate of *E. coli* isolates to different antibiotics in the Rabat Military Teaching Hospital Mohammed V and to compare these rates of resistance between hospitalized patients and outpatients and between urine isolates and other isolates.

**Methods**

**Materials**

The present study was conducted in the bacteriology department of the Rabat Military Teaching Hospital Mohammed V. Retrospectively from April 1, 2012 to July 31, 2013. We included all *E. coli* isolates received from hospitalized patients and outpatients. We highlight that under Moroccan law no ethical approval is required for a retrospective study based on laboratory data and no consent from patients is necessary to carry out further tests on samples collected for other purposes.

In order to eliminate duplicates, only one strain isolated from the same patient with the same antibiotic susceptibility was included.

**Bacterial identification and antimicrobial susceptibility**

The identification of bacterial isolates was based on cultural, morphological and biochemical characteristics. Biochemical identification was set up using API20E (bio-Mérieux SA, Marcy-l’Étoile/France).

Antibiotic susceptibility was determined using the agar diffusion method (Mueller–Hinton medium) and its interpretation was made according to the recommendations of antibiogram committee of the French Society for Microbiology [12].

Antibiotics tested were: amoxicillin–clavulanic acid, cephalothin, cefoxitin, ceftriaxone, ertapenem, gentamicin, amikacin, norfolexacin, cotrimoxazole and fosfomycin.

Detection of extended β-lactamases (ESBL) was performed by phenotypic method based on the detection of synergy between amoxicillin–clavulanic acid disc and three discs of third-generation cephalosporins: cefotaxim, ceftazidime and cefepime [12].

**Statistical analysis**

The Chi square test was used to compare resistance rates. The difference between the frequencies was considered to be significant when *p* was <0.05.

**Results**

During the period of our study, were received at the bacteriology department a total of 32,522 samples. The sex ratio male/female was 1.03 (16,515/16,007). The rate of urine samples was 25.09% (8159/32,522) with a sex ratio male/female 0.73 (3459/4700). The overall incidence of isolation of *E. coli* was 33.3% (1369/4110). The sex ratio male/female was 0.65 (538/830). Isolates of *E. coli* were in 40.5% (554/1369) of cases from hospitalized patients and in 59.5% (815/1369) of cases from outpatients. Urine isolates represented 82% (1123/1369) of the cases.

Isolates with ESBL phenotype represented 6.1% of all *E. coli* isolates (85/1369). In hospitalized patients 11.9% of the isolates of *E. coli* (66/554) had an ESBL phenotype while in outpatients cases only 2.3% of isolates of *E. coli* (19/815) had this phenotype. Furthermore 84.4% (43/66) of the isolates with ESBL phenotype in hospitalized patients were also resistant to fluoroquinolones (FQ resistance + ESBL).

High rates of resistance were found for amoxicillin–clavulanic acid (42.5%), cefalotin (30.4%), norfolexacin (29.9%) and cotrimoxazole (37.7%).

Table 1 shows the rates of resistance (R + I) of *E. coli* isolates depending on the nature of patients. Frequencies of resistance among isolates from hospitalized patients were higher than those from outpatients in the case of: amoxicillin–clavulanic acid (*p* < 0.001), cephalothin (*p* < 0.001), cefoxitin (*p* = 0.001), ceftriaxone (*p* < 0.001), amikacin (*p* = 0.001) and norfolexacin (*p* = 0.003).

Table 2 shows the rates of resistance (R + I) of *E. coli* isolates depending on the nature of sample. Frequencies of resistance among isolates from urine samples were lower than those from others samples in the case of: amoxicillin–clavulanic acid (*p* < 0.001), cephalothin (*p* < 0.001), cefoxitin (*p* = 0.004), ceftriaxone (*p* < 0.001), gentamicin (*p* < 0.001) and amikacin (*p* < 0.001).

The rate of simultaneous resistance to all of the three antibiotics which are most used orally (AMC + SXT + FQ) was 8.3% in isolates from hospitalized patients compared to 9.9% outpatients (*p* = 0.34).

**Discussion**

In our study *E. coli* represented over a third of the total isolates of our department. Urinary tract remains the main site of colonization-infection totaling about 82% of all isolates. These proportions are similar to those found in French and European epidemiological studies [13, 14].

We recorded important levels of resistance (R + I) for amoxicillin–clavulanic acid (38% in outpatients and 48.1% in hospitalized patients) these percentages of resistance are comparable to those of Onerba-France—with 36% in city and 45% in hospital [15]. Rates of resistance (R + I) for AMC in hospitalized patients were higher than those from outpatients (*p* < 0.001).

ESBL and resistance to fluoroquinolones are the two most worrying phenomena [16]. A review of Moroccan data shows varying levels of frequency of ESBL by region,
structures and the size of the populations studied. These rates vary between 7 and 15 % [17, 18].

Our study showed a 12.4 % rate of ESBL E. coli in hospitalized patients, this rate remains similar to that recorded by a recent study in Rabat [17] and lower than the one recorded in Khartoum-Soudan [8]. ESBL is not limited to health care facilities; international studies show that in community setting rates of ESBL E. coli range from 1.3 to 4.8 % [19–21]. We recorded a 2.5 % rate of ESBL E. coli in our outpatients.

Fluoroquinolone resistance is associated with the misuse of these molecules in human and veterinary medicine [22]. This resistance varies from one geographic area to another with 10 % in France and United States vs. 40 % in China [15, 23, 24].

Our study found a rate of resistance of E. coli to fluoroquinolones 29.9 % which is similar to that recorded in Rabat [17] with a frequency of resistance among isolates from hospitalized patients higher than those from outpatients (p = 0.003).

A frequent association between genetic determinants of Qnr and those of ESBL was reported by several studies [25]. In our study we found 43 multiresistant strains (ESBL + FQ resistance), more genetic studies are needed to characterize the nature of fluoroquinolone resistance determinants carried by these strains.

The rate of resistance to aminoglycosides remains relatively low (gentamicin 11.1 %, amikacin 1.3 %) as reported in the literature [8]. Amikacin appears to be the most effective molecule of this class of antibiotics explained by the fact that it is strictly used in hospitals and is rarely used in the first line therapy.

In our study, fosfomycin remains largely active on isolates of E. coli with low resistance rates especially among urine isolates (1.9 %). These results suggest that we should favor the use of fosfomycin as a molecule for the empirical treatment of community urinary infections.

### Conclusion

Periodic monitoring of antibiotic resistance in different bacterial isolates has become essential given the constant evolution of the bacterial ecology and the emergence of antibiotic resistance. The high rate of multiresistance shown in this study should encourage us to be more judicious in the use of antibiotics especially in probabilistic treatment. Indeed the 10 % threshold of resistance is substantially exceeded for several antibiotics used in our hospital. The emergence of ESBL in the community is an indicator of the seriousness of this problem which appears not to be limited to health care facilities.

### Abbreviations

AMC: amoxicillin/clavulanic ac; AK: amikacin; CRO: ceftriaxone; E. coli: Escherichia coli; ERT: ertapenem; ESBL: extended spectrum beta lactamase; FQ: fluoroquinolone; Qnr: quinolone resistance nodding protein.
fluoroquinolones: FOS: fosfomycin; FOX: cefoxitin; GEN: gentamicin; KF: cefalotin; NOR: norfloxacin. Onerba: Observatoire National de l’Epidémiologie de la Résistance; SXT: cotrimoxazole.

Authors’ contributions
NA collated the data and prepared the manuscript. MF and AL supervised the project. AS performed the statistical analysis. AM, CM, YS and LI performed the relevant literature search. AL reviewed the article for relevance. ME study conception and design. All authors read and approved the final manuscript.

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Acknowledgements
We thank all the staff of the bacteriology department of the Mohammed V military teaching hospital.

Compliance with ethical guidelines
We declare that we have no competing interests.

Competing interests

Compliance with ethical guidelines

Received: 21 April 2014 Accepted: 24 August 2015 Published online: 30 August 2015

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