JIDC | THE JOURNAL OF INFECTION IN DEVELOPING COUNTRIES

Original Article

Prevalence of ESBL-producing *Enterobacteriaceae* isolated from blood cultures in Mali

Samba Adama Sangare[1,2,3], Almoustapha Issiaka Maiga[1,3], Ibrehima Guindo[3,4], Aminata Maiga[5], Namory Camara[1], Oumar Agaly Dicko[5], Souleymane Diallo[3,6], Flabou Bougoudogo[3,4], Laurence Armand-Lefevre[2], Antoine Andremont[2], Ibrahim Izetiegouma Maiga[5,7]

[1] Laboratory of Bacteriology, Gabriel Touré University Teaching Hospital, Bamako, Mali
[2] Laboratory of Bacteriology, Bichat- Claude Bernard University Teaching Hospital and UMR INSERM 1137 Iame Paris, France
[3] Faculty of Pharmacy, University of Sciences, Techniques, and Technologies of Bamako (USTTB), Bamako, Mali
[4] National Institute of Research in Public Health, Bamako, Mali
[5] Laboratory of Bacteriology, Point G University Teaching Hospital, Bamako, Mali
[6] Infectious Diseases Center «Charles Mérieux», Bamako, Mali
[7] Faculty of Medicine and Odontostomatology, University of Sciences, Techniques, and Technologies of Bamako (USTTB), Bamako, Mali

Abstract

Introduction: The increasing frequency of extended-spectrum beta-lactamase (ESBL)-producing Enterobacteriaceae is becoming a serious public health concern. This study sought to determine ESBL frequency in Enterobacteriaceae isolated from patients' blood cultures in two university teaching hospitals of Bamako, Mali.

Methodology: During a three-month period, the presence of Enterobacteriaceae from blood cultures of patients admitted to the university teaching hospitals of Bamako was evaluated. The microbial identifications were initially performed with an API 20E gallery and VITEK2 locally in Mali, and then confirmation in France was performed with a mass spectrometry MALDI-TOF in the bacteriology laboratory of the university teaching hospital of Bichat. Antibiotic susceptibility profiles were determined by the diffusion method as recommended by the European Committee on Antimicrobial Susceptibility Testing (EUCAST).

Results: The isolated species were *K. pneumoniae* (14/40; 35.0%), *E. coli* (11/40; 27.5%), and *E. cloacae* (9/40; 22.5%). Of the strains isolated, 21/34 (61.8%) had an ESBL phenotype, including 10/14 (71.4%) *K. pneumoniae*, 8/11 (72.7%) *E. coli*, and 3/9 (33.3%) *E. cloacae*.

Resistances associated with ESBL strains of *K. pneumoniae*, *E. coli*, and *E. cloacae* were as follows: gentamicin (10/10, 100%; 6/8, 75%; 2/3, 67%, respectively), amikacin (2/10, 20%; 0/8, 0%; 0/3, 0%, respectively), ofloxacin (8/10, 80%; 7/8, 87%; 3/3, 100%, respectively), and cotrimoxazole (10/10, 100%; 6/8, 75%; 3/3, 100%, respectively).

Conclusion: Almost two-thirds (61.8%) of Enterobacteriaceae isolated from our blood cultures were ESBL producers. Only susceptibilities to carbapenems and to amikacin were fully conserved within the strains.

Key words: Enterobacteriaceae, extended-spectrum beta-lactamases, blood cultures, Bamako, Mali

J Infect Dev Ctries 2016; 10(10):1059-1064. doi:10.3855/jidc.7536

(Received 12 August 2015 – Accepted 17 February 2016)

Introduction

The production of extended-spectrum beta-lactamases (ESBLs) is the main mechanism of Enterobacteriaceae resistance to broad-spectrum cephalosporins [1]. Although ESBL is usually known to be associated with resistance in *Klebsiella* spp. and *Escherichia coli*, in recent reports, other Enterobacteriaceae such as *Citrobacter*, *Serratia*, *Proteus*, *Salmonella*, and *Enterobacter* have also been found to have ESBLs [2]. In *E. coli*, the increase of ESBL-associated resistance is attributed to plasmid transmission between the strains [3]; however, in other Enterobacteriaceae such as *K. pneumoniae*, the spread of clonal strains is most frequent [4]. According to the SMART study conducted between 2009 and 2010 in Europe, ESBL prevalence among *K. pneumoniae* and *E. coli* was 38.9% and 17.6%, respectively. In China, the prevalence of ESBLs among *K. pneumoniae* and *E. coli* varied from 61% to 67%, and in New Zealand, from 0% to 5% [5]. The ESBL prevalence among clinical strains varies between geographical regions. For instance, low prevalence rates (between 3% and 8%)

have been found in Sweden, Japan, and Singapore; much higher rates have been reported for Portugal (34%), Turkey (58%), and Latin America (from 30% to 60%) [2,6,7]. In Africa, Enterobacteriaceae held an important place in bacteremia cases. They are responsible for 41% of bacteremia cases from community, followed by non-*Salmonella* Enterobacteriaceae (12% of cases) [8]. In Gambia (2003–2005), 10.7% (93/871) of blood cultures were positive for pathogenic bacteria, of which 10% were *E. coli* [9]. In Tanzania (2011), 7.4% (17/231) of febrile children in a health center had bacteremia, and *E. coli* was isolated from 40% of blood cultures [10]. In Nigeria (2006–2007), 16.6% (174/1050) of children admitted to hospitals had positive blood cultures, including more than 30% of *K. pneumoniae* and *E. coli* cases [11]. In Ethiopia (2009), *E. coli* was isolated from 18.7% of the cases (67/359) in clinical samples of both hospitalized and non-hospitalized patients, of which 35.8% (24/67) were ESBL producers [12]. In Tanzania (2009–2010), 50.3% (92/183) of *K. pneumoniae* strains isolated from blood cultures were ESBL producers; 5.5% (5/92) of them were from the community and 94.5% (87/92) from hospitals [13]. In Ghana (2007) and Mali (2003), ESBLs were produced, respectively, by 49.4% and 63.4% of Enterobacteriaceae isolated in community and hospital samples [14,15]. Another study conducted later in Mali (2004–2006) on a total of 1,193 non-repetitive isolates of Enterobacteriaceae found 256 (21.5%) producers of an ESBL, 20.9% (156/747) in *E. coli*, 37.8% (82/217) in *K. pneumoniae*, 18.5% (15/81) in *E. cloacae*, 16.7% (2/12) in *M. morganii*, and 2.8% (1/36) in *P. mirabilis* [16].

In Mali, the rare data available on the prevalence of ESBL-producing Enterobacteriaceae isolated from blood cultures are frightening. Access to antibiotic susceptibility testing currently remains very limited in the country. Most people in the capital city, in most cases, get care in the primary health centers such as the referral health centers or in the community health centers, which are more accessible to them, but drug susceptibility testing is not available. Likewise, outside the capital city in the rest of the country, none of the eight regions of the country has continuously maintained drug susceptibility testing capacity. It has therefore become important to determine the prevalence of ESBL-producing strains among patients who require urgent appropriate treatment such as patients with bacteremia. Indeed, empirical treatments usually administered to these kinds of patients may not be effective if the patients happen to have an ESBL-producing Enterobacteriaceae. In this study, we sought to investigate the prevalence of ESBL phenotype among Enterobacteriaceae isolated from patients with positive blood cultures at the university teaching hospitals of Bamako in Mali.

Methodology

Type and place of the study

This was a prospective study conducted at the university teaching hospitals of Bamako (CHU Point G and CHU Gabriel Touré) from January to March 2014. The university teaching hospitals of Bamako are the structures of third reference level, representing the top of the pyramid of health care in Mali. In general, these are centers that receive patients with complicated diseases from other health care centers.

Patient recruitment

The study was open to any patients referred from another health center where they had been previously hospitalized, who had a body temperature ≥ 39°C with suspected invasive bacterial infection.

Sample collection

For each blood culture, venous blood (8 to 10 mL from adults and 1 to 5 mL from infants) was collected and injected directly into a BD Bactec Plus Aérobie/F blood culture bottle (Becton Dickinson, Franklin Lakes, USA) or BD Bactec Peds Plus/F blood culture bottle (Becton Dickinson, Franklin Lakes, USA), which was then introduced into a Bactec 9050 (Becton Dickinson, Franklin Lakes, USA). Only one blood culture per patient was performed. The aseptic blood sample collection was performed following the manufacturer's instructions.

Bacterial identification

In Bamako, Mali, Drigalski lactose agar (bioMérieux, Marcy l'Etoile, France) was used for the selective isolation of Enterobacteriaceae. The primary identification was done by the API 20E system (bioMérieux, Marcy l'Etoile, France), with the galleries inoculated with calibrated bacterial suspensions. The confirmation was done using the automated phenotypic identification system VITEK2 (bioMérieux, Marcy l'Etoile, France).

Enterobacteriaceae strains were kept in cryovials in 10% of glycerol and stored in a -80°C freezer before getting shipped to Paris for further testing.

Drug susceptibility testing and ESBL determination

Antimicrobial susceptibility testing was performed by the Kirby-Bauer method, a diffusion method, as

recommended by the European Committee on Antimicrobial Susceptibility Testing (EUCAST) [17]. The following antibiotics were tested: amoxicillin (25 µg), amoxicillin + clavulanic acid (20 µg + 10 µg), ticarcillin (75 µg), cefotaxime (30 µg), ceftazidime (10 µg), cefepime (30 µg), cefoxitin (30 µg), ertapenem (10 µg), imipenem (10 µg), gentamicin (10 mg), amikacin (30 µg), trimethoprim + sulfamethoxazole (25 µg), nalidixic acid (30 µg), ofloxacin (5 µg), tetracycline (30 µg), and fosfomycin (50 µg). The diameters of inhibition allowed the results to be categorized as susceptible or resistant. Phenotypic detection of ESBL production was done by a synergy test that involves the use of a third-generation cephalosporin and clavulanic acid, as described by the Clinical and Laboratory Standards Institute (CLSI) [18].

Quality control

All identifications were confirmed in France by mass spectrometry MALDI-TOF (Bruker, Wissenbourg, France) in the bacteriology laboratory of Bichat University Teaching Hospital. The mass spectrometer allows identification of bacteria by analysis of their total proteins (ribosomal proteins and membrane-associated proteins).

Ethical considerations

This study was approved by the ethics committee of the Faculty of Medicine and Odonto-Stomatology/Faculty of Pharmacy, University of Sciences, Techniques and Technologies of Bamako (USTTB). Written consent was obtained from all patients included in the study.

Results

Patients' characteristics

From a total of 843 blood cultures collected from patients hospitalized at CHU Point G, Enterobacteriaceae were isolated from 14 blood cultures. Similarly, of 1,262 blood cultures taken from children hospitalized in the pediatric department of CHU Gabriel Touré, Enterobacteriaceae were isolated from 25 blood cultures. The patients' ages ranged from 31 to 40 years (42.9%) at CHU Point G, and from 1 to 5 years (48.0%) at CHU Gabriel Touré (Table 1). Of all participants, 57.1% and 64.0% from CHU Point G and CHU Gabriel Touré, respectively, were males; 28.6% and 28.0% of patients, respectively, were living in the urban area of the Commune I of Bamako City (the most populated neighborhood of Bamako) (Table 1).

K. pneumoniae was the predominant species on both sites, representing 42.9% and 30.8% of Enterobacteriaceae isolated at CHU Point G and CHU Gabriel Touré, respectively (Table 2). *E. coli* was the second-most common at CHU Point G (28.6%). At CHU Gabriel Touré, *E. coli* and *E. cloacae* shared the same second position, with 26.9% of Enterobacteriaceae isolated (Table 2). One patient had two strains of *E. coli* and *E. cloacae* at CHU Gabriel Touré.

Table 1. Distribution of patients according to sex, age range, and location

Characteristics	CHU Point G (n = 14)	CHU Gabriel Touré (n = 25)
Gender		
Male	8 (57.1%)	16 (64.0%)
Female	6 (42.9%)	9 (36.0%)
Age range (in years)		
<1	/	7 (28.0%)
1–5	/	12 (48.0%)
6–10	/	4 (16.0%)
>10	/	2 (8.0%)
10–20	2 (14.3%)	/
21–30	5 (35.7%)	/
31–40	6 (42.9%)	/
> 40	1 (7.1%)	/
Location		
Commune I / Bamako	4 (28.6%)	7 (28.0%)
Commune II / Bamako	1 (7.1%)	3 (12.0%)
Commune III / Bamako	3 (21.4%)	3 (12.0%)
Commune IV / Bamako	2 (14.3%)	4 (16.0%)
Commune V / Bamako	0 (0.0%)	3 (12.0%)
Commune VI / Bamako	0 (0.0%)	2 (8.0%)
Other*	4 (28.6%)	3 (12.0%)

* Other: Kati/Koulikoro, Bougouni/Sikasso, Baraouli/Ségou, Ouelessebougou/Koulikoro, Wayerma/Sikasso

ESBL phenotype

In total, 21/34 strains had an ESBL phenotype (61.8%), of which 8/12 (66.7%) were from CHU Point G and 13/22 (59.1%) from CHU Gabriel Touré (Table2). These ESBL-producing Enterobacteriaceae were distributed as follows: 10/34 (29.4%) of *K. pneumoniae*, 8/34 (23.6%) of *E. coli*, and 3/34 (8.8%) of *E. cloacae* (Table 2).

Combining both sites (CHU Point G and CHU Gabriel Touré), *K. pneumoniae*, *E. coli*, and *E. cloacae* were the only ESBL-producing Enterobacteriaceae found, and among these, 10/14 (71.4%) were *K. pneumoniae*, 8/11 (72.7%) were *E. coli*, and 3/9 (33.3%) were *E. cloacae* (Table 3).

The associated resistances in ESBL-producing strains of *K. pneumoniae*, *E. cloacae*, and *E. coli* were

Table 2. Distribution of patients based on isolated germs and identified extended-spectrum beta-lactamases (ESBLs)

Characteristics	CHU Point G	CHU Gabriel Touré
Isolated bacterial agents	**(n = 14)**	**(n = 26)**
Klebsiella pneumoniae	6 (42.9%)	8 (30.8%)
Escherichia coli	4 (28.6%)	7 (26.9%)*
Enterobacter cloacae	2 (14.3%)	7 (26.9%)*
Morganella morganii	1 (7.1%)	1 (3.9%)
Proteus mirabilis	1 (7.1%)	0 (0.0%)
Salmonella Enteritidis	0 (0.0%)	3 (11.5%)
ESBL research**	**(n = 12)**	**(n = 22)**
Klebsiella pneumoniae ESBL+	5 (41.7%)	5 (22.7%)
Escherichia coli ESBL+	2 (16.7%)	6 (27.3%)
Enterobacter cloacae ESBL+	1 (8.3%)	2 (9.1%)
Klebsiella pneumoniae ESBL -	1 (8.3%)	3 (13.6%)
Escherichia coli ESBL -	2 (16.7%)	1 (4.6%)
Enterobacter cloacae ESBL -	1 (8.3%)	5 (22.7%)

* 1 *Escherichia coli* and 1 *Enterobacter cloacae* isolated from the same patient; ** *Morganella morganii*, *Proteus mirabilis and Salmonella enteritidis* were not ESBL-producing and therefore not counted.

86% for gentamicin (10/10, 100%; 6/8, 75%; 2/3, 67%, respectively), 9.5% for amikacin (2/10, 20%; 0/8, 0%; 0/3, 0%, respectively), 86% for ofloxacin (8/10, 80%; 7/8, 87%; 3/3, 100%, respectively), and 90% for cotrimoxazole (10/10, 100%; 6/8, 75%; 3/3, 100%, respectively) (Table 3).

Discussion

During this study, we investigated the prevalence of ESBL-producing strains in our collection of patients' blood samples. Our findings have important clinical implications in patient management in Mali. Notably, we found that 21 out of our 34 isolated strains (61.8%) were ESBL producers, of which 10 (29.4%) were identified as *K. pneumoniae*, 8 (23.6%) as *E. coli*, and 3 (8.8%) as *E. cloacae*. These results are similar to a study conducted in Kabul, which reported 110 (51.9%) ESBL-producing Enterobacteriaceae [19], and to a study conducted in China, where about 109 Enterobacteriaceae were found, including 57 (52.3%) ESBL producers (38 *E. coli* and 19 *K. pneumoniae*) [20]. Also in Tanzania, in a study on neonatal sepsis, 50.3% of the *K. pneumoniae* were found to be ESBL producers [13]. Importantly, a much more recent study in India (2014) in a nephrourology teaching institute showed that among Enterobacteriaceae isolated from blood cultures, 39.6% were ESBL producers [21]. Meanwhile, in a university teaching hospital in South Korea, only 27.7% Enterobacteriaceae [22] were ESBL producers, which is relatively lower compared to that reported in other hospitals.

Studies in other geographical areas have shown lower rates of ESBL production among Enterobacteriaceae isolated from blood cultures. In Peru for instance, among 85 isolates of Enterobacteriaceae, 30 (35.2%) were ESBL producers, of which 16 (18.8%) were *E. coli* and 14 (16.4%) *K.*

Table 3. Resistant to antibiotics at both sites

Antibiotics	Bacterial germs					
	***K. pneumonia* n=14**	***E. coli* n=11**	***E. cloacae* n=9**	***M. morganii* n=2**	***P. mirabilis* n=1**	***S. e*nteritidis n=3**
Amoxicillin	14 (100)	11 (100)	9 (100)	2 (100)	1 (100)	3 (100)
Amoxicillin/clavulanic acid	11 (78.6)	11 (100)	9 (100)	2 (100)	0 (0.0)	3 (100)
Ticarcillin	14 (100)	11 (100)	4 (44.4)	0 (0.0)	1 (100)	3 (100)
Cefotaxime	10 (71.4)	10 (90.9)	4 (44.4)	0 (0.0)	0 (0.0)	0 (0.0)
Ceftazidime	10 (71.4)	10 (90.9)	4 (44.4)	0 (0.0)	0 (0.0)	0 (0.0)
Cefepime	10 (71.4)	8 (72.7)	4 (44.4)	0 (0.0)	0 (0.0)	0 (0.0)
Cefoxitin	0 (0.0)	3 (27.3)	9 (100)	0 (0.0)	0 (0.0)	0 (0.0)
Ertapenem	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Imipenem	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Gentamicin	11 (78.6)	7 (63.6)	2 (22.2)	0 (0.0)	0 (0.0)	0 (0.0)
Amikacin	2 (14.3)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Trimethoprim/sulfamethoxazole	13 (92.8)	9 (81.8)	3 (28.5)	1 (50)	0 (0.0)	2 (66.6)
Nalidixic acid	8 (57.1)	10 (90.9)	3 (33.3)	1 (50)	0 (0.0)	0 (0.0)
Ofloxacin	8 (57.1)	10 (90.9)	3 (33.3)	1 (50)	0 (0.0)	0 (0.0)
Tetracycline	9 (64.3)	11 (100)	3 (33.3)	2 (100)	1 (100)	3 (100)
Fosfomycin	10 (71.4)	2 (18.2)	9 (100)	2 (100)	1 (100)	0 (0.0)
ESBL	10 (71.4)	8 (72.7)	3 (33.3)	0 (0.0)	0 (0.0)	0 (0.0)

ESBL: extended-spectrum beta-lactamase

pneumoniae [23]. In the Kingdom of Saudi Arabia, of 601 isolates of Enterobacteriaceae from a military hospital, 95 (15.8%) were ESBL producers, of which 46 (7.6%) were *K. pneumoniae*, 15 (2.5%) were *E. coli*, 15 (2.5%) were *E. cloacae*, and 19 (3.2%) were other ESBL-producing Enterobacteriaceae [24]. In Turkey, 40 of 120 (33.3%) Enterobacteriaceae strains were ESBL producers, of which 25 (20.8%) were *E. coli*, 13 (10.8%) were *K. pneumoniae*, and 2 (1.7%) were *E. cloacae* [25].

In our study, none of our *Salmonella enterica* were ESBL producers, while in Nepal, 72.0% of *Salmonella* isolated from blood cultures were ESBL producers [26]; however, in another study, only 0.5% of *S. enterica* were found to be ESBL producers [27]. Moreover, we noted that the frequency of ESBL-producing Enterobacteriaceae varies randomly between countries. For example, 32.0% of *K. pneumoniae* were reported in India [28], but only 8.1% of *E. coli* in the United Kingdom [29]. Also, on 44 ESBL-producing Enterobacteriaceae in New Zealand, 40.9% were *K. pneumoniae*, 36.3% were *E. coli*, 20.5% were *E. cloacae*, and 2.3% were *E. aerogenes* [30].

Another interesting finding on the distribution of species in our study is the predominance of *K. pneumoniae* in both sites: 42.9% and 30.8% at CHU Point G and CHU Gabriel Touré, respectively. This result confirms the predominance of *K. pneumoniae* among Enterobacteriaceae from blood cultures in hospitalized patients exposed to nosocomial infections. *E. coli* and *E. cloacae* came in second position with, respectively, 28.6% and 14.3% at CHU Point G, and 26.9% and 26.9% at CHU Gabriel Touré. This predominance of *K. pneumoniae* was also reported in Kabul, Afghanistan; of 212 Enterobacteriaceae isolated from blood cultures, 66 sere *K. pneumoniae*, 42 (19.8%) were *E. cloacae*, and 35 (16.5%) were *E. coli* [19]. That study had a bigger sample size and the study period covered two years (November 2009 to November 2011), while ours covered only a period of three months in order to find preliminary data for Mali. Our results were different from those of a tertiary care university teaching hospital in South Korea, where 101 Enterobacteriaceae strains were isolated from blood cultures, of which 80 (79.2%) were *E. coli* and 21 (20.8%) were *K. pneumoniae* [22]. This distribution has been also observed in China in blood cultures performed in children having hematological malignancy and undergoing chemotherapy; of 109 Enterobacteriaceae strains, 58 (53.2%) were *E. coli* and 51 (46.8%) were *K. pneumoniae* [20]. Therefore, it can easily be concluded that in these South Korean and Chinese studies, *E. coli* was the predominant bacteria, although those studies were conducted in a hospital setting.

Conclusions

Among our isolates, *K. pneumoniae* was the predominant species of the Enterobacteriaceae of our study. About two-thirds (61.8%) of the isolates from blood cultures were ESBL-producing Enterobacteriaceae. Of the panel of antimicrobials we tested, only carbapenems and amikacin were fully effective on all the strains.

Acknowledgements

We acknowledge the Laboratory of Bacteriology, CHU Point G in Bamako (Mali) and the Laboratory of Bacteriology, CHU Bichat Claude Bernard in Paris (France) for funding this study in terms of materials, laboratory reagents and supplies.

We also acknowledge the University of Sciences, Techniques, and Technologies of Bamako (USTTB) of Mali for financial assistance under the "Training Program of Trainers" to Dr. Samba A Sangare.

References

1. Livermore DM (1995) Beta-Lactamases in laboratory and clinical resistance. Clin Microbiol Rev 8: 557-584.
2. Paterson DL, Bonomo RA (2005) Extended-spectrum beta-lactamases: a clinical update. Clin Microbiol Rev 18: 657-686.
3. Hernandez JR, Martinez-Martinez L, Canton R, Coque TM, Pascual A (2005) Nationwide study of *Escherichia coli* and *Klebsiella pneumoniae* producing extended-spectrum beta-lactamases in Spain. Antimicrob Agents Chemother 49: 2122-2125.
4. Pessoa-Silva CL, Meurer Moreira B, Camara Almeida V, Flannery B, Almeida Lins MC, Mello Sampaio JL, Martins Teixeira L, Vaz Miranda LE, Riley LW, Gerberding JL (2003) Extended-spectrum beta-lactamase-producing *Klebsiella pneumoniae* in a neonatal intensive care unit: risk factors for infection and colonization. J Hosp Infect 53: 198-206.
5. Po-Liang L, Yung-Ching L, Han-Siong T, Yu-Lin L, Yuag-Meng L, Cheng-Mao H, Chi-Chang H, Chun-Eng L, Wen-Chien K, Jen-Hsien W, Hung-Jen T, Kwok-Woon Y, Yao-Shen C, Yin-Ching C, Yingchun X, Yuxing N, Yen-Hsu C, Po-Ren H (2012) Epidemiology and antimicrobial susceptibility profiles of Gram-negative bacteria causing urinary tract infections in the Asia-Pacific region: 2009-2010 results from the Study for Monitoring Antimicrobial Resistance Trends (SMART). Int J Antimicrob Agents 40 Suppl 1: 37-43.
6. Hanberger H, Garcia-Rodriguez JA, Gobernado M, Goossens H, Nilsson LE, Struelens MJ (1999) Antibiotic susceptibility among aerobic gram-negative bacilli in intensive care units in 5 European countries. French and Portuguese ICU Study Groups. JAMA 281: 67-71.
7. Lewis MT, Yamaguchi K, Biedenbach DJ, Jones RN (1999) In vitro evaluation of cefepime and other broad-spectrum beta-

lactams in 22 medical centers in Japan: a phase II trial comparing two annual organism samples. The Japan Antimicrobial Resistance Study Group. Diagn Microbiol Infect Dis 35: 307-315.
8. Reddy EA, Shaw AV, Crump JA (2010) Community-acquired bloodstream infections in Africa: a systematic review and meta-analysis. Lancet Infect Dis 10: 417-432.
9. Hill PC, Onyeama CO, Ikumapayi UN, Secka O, Ameyaw S, Simmonds N, Donkor SA, Howie SR, Tapgun M, Corrah T, Adegbola RA (2007) Bacteraemia in patients admitted to an urban hospital in West Africa. BMC Infect Dis 7: 2.
10. Msaki BP, Mshana SE, Hokororo A, Mazigo HD, Morona D (2012) Prevalence and predictors of urinary tract infection and severe malaria among febrile children attending Makongoro health centre in Mwanza city, North-Western Tanzania. Arch Public Health 70: 4.
11. Ogunlesi TA, Ogunfowora OB, Osinupebi O, Olanrewaju DM (2011) Changing trends in newborn sepsis in Sagamu, Nigeria: bacterial aetiology, risk factors and antibiotic susceptibility. J Paediatr Child Health 47: 5-11.
12. Mulualem Y, Kasa T, Mekonnen Z, Suleman S (2012) Occurrence of extended spectrum beta (b)-lactamases in multi-drug resistant *Escherichia coli* isolated from a clinical setting in Jimma university specialized hospital, Jimma, southwest Ethiopia. East Afr J Public Health 9: 58-61.
13. Mshana SE, Hain T, Domann E, Lyamuya EF, Chakraborty T, Imirzalioglu C (2013) Predominance of *Klebsiella pneumoniae* ST14 carrying CTX-M-15 causing neonatal sepsis in Tanzania. BMC Infect Dis 13: 466.
14. Feglo P, Adu-Sarkodie Y, Ayisi L, Jain R, Spurbeck RR, Springman AC, Engleberg NC, Newton DW, Xi C, Walk ST (2013) Emergence of a novel extended-spectrum-beta-lactamase (ESBL)-producing, fluoroquinolone-resistant clone of extraintestinal pathogenic *Escherichia coli* in Kumasi, Ghana. J Clin Microbiol 51: 728-730.
15. Tande D, Jallot N, Bougoudogo F, Montagnon T, Gouriou S, Sizun J (2009) Extended-spectrum beta-lactamase-producing *Enterobacteriaceae* in a Malian orphanage. Emerg Infect Dis 15: 472-474.
16. Duval V, Maiga I, Maiga A, Guillard T, Brasme L, Forte D, Madoux J, Vernet-Garnier V, De Champs C (2009) High prevalence of CTX-M-type beta-lactamases among clinical isolates of *Enterobacteriaceae* in Bamako, Mali. Antimicrob Agents Chemother 53: 4957-4958.
17. European Committee on Antimicrobial Susceptibility Testing (2014) Clinical breakpoints. Available: http://www.eucast.org/clinical_breakpoints. Accessed 12 April 2014.
18. Clinical and Laboratory Standards Institute (2011) Performance standards for antimicrobial susceptibility testing. Twenty-first informational supplement. Document M100-S21, CLSI: Wayne, PA, USA.
19. Tariq TM (2014) Bacteriologic profile and antibiogram of blood culture isolates from a children's hospital in Kabul. J Coll Physicians Surg Pak 24: 396-399.
20. Zheng ZJ, Tang YM (2012) Drug resistance of extended-spectrum-beta-lactamases-producing bacteria in children with hematological malignancy after chemotherapy. Zhongguo Dang Dai Er Ke Za Zhi 14: 518-520.
21. Gohel K, Jojera A, Soni S, Gang S, Sabnis R, Desai M (2014) Bacteriological profile and drug resistance patterns of blood culture isolates in a tertiary care nephrourology teaching institute. Biomed Res Int 2014: 153747.
22. Nam YS, Cho SY, Yang HY, Park KS, Jang JH, Kim YT, Jeong JW, Suh JT, Lee HJ (2013) Investigation of mutation distribution in DNA gyrase and topoisomerase IV genes in ciprofloxacin-non-susceptible *Enterobacteriaceae* isolated from blood cultures in a tertiary care university hospital in South Korea, 2005-2010. Int J Antimicrob Agents 41: 126-129.
23. Adrianzen D, Arbizu A, Ortiz J, Samalvides F (2013) Mortality caused by bacteremia *Escherichia coli* and *Klebsiella* spp. extended-spectrum beta-lactamase- producers: a retrospective cohort from a hospital in Lima, Peru. Rev Peru Med Exp Salud Publica 30: 18-25.
24. El-Khizzi NA, Bakheshwain SM (2006) Prevalence of extended-spectrum beta-lactamases among *Enterobacteriaceae* isolated from blood culture in a tertiary care hospital. Saudi Med J 27: 37-40.
25. Metan G, Demiraslan H, Kaynar LG, Zararsiz G, Alp E, Eser B (2013) Factors influencing the early mortality in haematological malignancy patients with nosocomial Gram negative bacilli bacteraemia: a retrospective analysis of 154 cases. Braz J Infect Dis 17: 143-149.
26. Gautam K, Pokhrel BM, Bhatta DR, Shrestha CD (2012) Studies on extended spectrum beta lactamase (ESBL) producing *Salmonella* isolates from clinical samples of Nepal. Nepal Med Coll J 14: 204-206.
27. Pokharel BM, Koirala J, Dahal RK, Mishra SK, Khadga PK, Tuladhar NR (2006) Multidrug-resistant and extended-spectrum beta-lactamase (ESBL)-producing *Salmonella enterica* (serotypes Typhi and Paratyphi A) from blood isolates in Nepal: surveillance of resistance and a search for newer alternatives. Int J Infect Dis 10: 434-438.
28. Zakariya BP, Bhat V, Harish BN, Arun Babu T, Joseph NM (2011) Neonatal sepsis in a tertiary care hospital in South India: bacteriological profile and antibiotic sensitivity pattern. Indian J Pediatr 78: 413-417.
29. Horner C, Fawley W, Morris K, Parnell P, Denton M, Wilcox M (2014) *Escherichia coli* bacteraemia: 2 years of prospective regional surveillance (2010-12). J Antimicrob Chemother 69: 91-100.
30. Freeman JT, McBride SJ, Nisbet MS, Gamble GD, Williamson DA, Taylor SL, Holland DJ (2012) Bloodstream infection with extended-spectrum beta-lactamase-producing *Enterobacteriaceae* at a tertiary care hospital in New Zealand: risk factors and outcomes. Int J Infect Dis 16: e371-e374.

Corresponding author

Samba Adama Sangare, PharmD, MSc, PhD Student
Laboratory of Bacteriology
University Teaching Hospital Paris Nord Val de Seine Bichat - Claude Bernard
46, rue Henri Huchard 75877 PARIS Cedex 18
Phone: +336 58 18 72 12, Box-Office: +331 40 25 85 01
Fax: +331 40 25 85 81
Email: vieuxsamba@yahoo.fr

Conflict of interests: No conflict of interests is declared