

Antimicrobial Susceptibility Pattern of Extended-spectrum Beta-lactamases Producing Organisms Isolated in a Tertiary Care Hospital, Bangladesh

Abstract

Context: Infection caused by extended-spectrum beta-lactamases (ESBL) producing organism is a major problem regarding antibiotic resistance. **Aims:** The aim of this study was to find out the antibiogram of ESBL producing organisms isolated from various samples. **Settings and Design:** This cross-sectional study was carried out in the Department of Microbiology of a Tertiary Care Hospital, Dhaka, Bangladesh from January to June 2014. **Subjects and Methods:** One Hundred and seventy-nine ESBL producing Gram-negative organisms detected phenotypically by double-disc synergy test were enrolled in this study. Required data were collected from the records of the Microbiology laboratory. **Results:** ESBL production was detected in 16.07% (179/1114) of isolated organism. Of *Escherichia coli*, 15.75% were ESBL producers; 14.01% *Pseudomonas* spp., 36.84% *Proteus* spp., 18.57% *Klebsiella* spp., and 21.05% of *Acinetobacter* spp., were ESBL producers. Maximum (43.58%) ESBL producers were isolated from surgery departments, and wound swabs yielded majority (53%) of them. About 13% ESBL producers were isolated in outdoor patients mostly from community-acquired infections. Most ESBL producers were resistant to commonly used antibiotics. Carbapenems especially imipenem was the most effective drug showing excellent sensitivity; colistin and piperacillin/tazobactam also had better sensitivity result. Most of the ESBL producers showed a good sensitivity to amikacin, but all of them were highly resistant to ciprofloxacin. **Conclusions:** ESBL production should be detected routinely in all Microbiology laboratories. Infection control, rational use of antibiotics must be done promptly to prevent the development and spread of ESBL producing organisms.

Keywords: Antibiogram, Bangladesh, extended-spectrum beta-lactamases

Introduction

Extended-spectrum beta-lactamases (ESBLs) are enzymes that mediate resistance to extended spectrum, for example, third generation cephalosporins as well as monobactams.^[1] Infections caused by ESBL producing organism represent a major problem, antibiotic resistance and is of great importance because of its clinical implication with higher mortality rate and health-care cost.^[2,3]

ESBL is found in a variety of *Enterobacteriaceae* and other organisms including *Pseudomonas* species.^[4] ESBL producing organisms were initially isolated from nosocomial infections but are now also from community-acquired infections.^[5,6] Plasmid coding for ESBL enzymes may carry coresistance genes for other non- β -lactam antibiotics.^[7] Carbapenems are considered to be the antibiotic of choice in infections caused by ESBL-producer.^[8,9] Hospital

acquired isolates are more resistant than community-acquired isolates.^[10]

The prevalence and distribution of ESBL producers differ from country to country and from hospital to hospital.^[11] A limited number of studies on the prevalence of ESBL in Bangladesh show a high rate of ESBL producers.^[12,13] It is essential to report ESBL production along with the routine sensitivity reporting, which will help proper antibiotic selection.^[14]

This study was performed to find out the antibiotic sensitivity pattern of ESBL producing organisms isolated from the various clinical specimens in a tertiary care hospital in Bangladesh.

Subjects and Methods

This study was done in the Department of Microbiology of a tertiary care hospital,

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Dhaka from January 2014 to June 2014. Phenotypically detected 179 Gram-negative bacilli that were reported as ESBL producing isolates were included in this cross-sectional study. Data regarding the identity of the patient, referring departments, type of specimen, isolated organisms, and the culture sensitivity pattern was collected from the records of the microbiology laboratory using a predesigned data collection form.

Antimicrobial susceptibility testing

Various specimens (wound swab, pus, blood, tracheal aspirate, body fluids, urine, sputum, high vaginal swab, etc.) were processed for culture, and the antimicrobial susceptibility pattern of the isolated organisms was determined by Kirby-Bauer disc diffusion method using commercially available antibiotic discs (Oxoid, UK).^[15] The organisms were tested against different antibiotics and commonly used discs were amikacin (30 µg), amoxycylav (20 µg amoxycillin/10 µg clavulanic acid), ceftazidime (30 µg), ceftriaxone (30 µg), ciprofloxacin (5 µg), colistin (10 µg), gentamicin (10 µg), imipenem (10 µg), levofloxacin (5 µg), meropenem (10 µg), and piperacillin/tazobactam (100/10 µg). Zone of inhibition was recorded as “Sensitive” or “Resistant” according to the Clinical and Laboratory Standards Institute (CLSI) guideline.^[16]

Detection of extended-spectrum beta-lactamases by double-disc diffusion synergy method

ESBL production in Gram-negative organism was detected by double-disc synergy test on Mueller-Hinton agar media as described by Jarlier *et al.* and following the CLSI guideline.^[16,17]

Results

Among the isolated Gram-negative bacteria, 16.07% (179/1114) were ESBL producing organisms. *Escherichia coli* was the most commonly isolated ESBL producers, 15.75% of which produced ESBL; 14.01% of the isolated *Pseudomonas* spp., 36.84% *Proteus* spp., 18.57% *Klebsiella* spp., and 21.05% of isolated *Acinetobacter* spp., were ESBL producing organisms [Table 1].

Maximum 54.75% of ESBL producing organisms were isolated from wound swab specimen followed by pus (24.02%). Others specimens that yielded the growth of ESBL producers were tracheal aspirate (5.03%), urine (3.91%), blood (3.35%), sputum (2.79%), and others (6.15%) [Figure 1].

Highest ESBL producers (43.58%) were isolated from admitted patients of different surgery units which were followed by the National Institute of Burn and Plastic Surgery (16.76%). More than 87% ESBL producing bacteria were isolated from inpatient departments [Figure 2].

Carbapenems were the most effective antibiotics against *E. coli*, *Klebsiella* spp. and *Pseudomonas* spp.; colistin

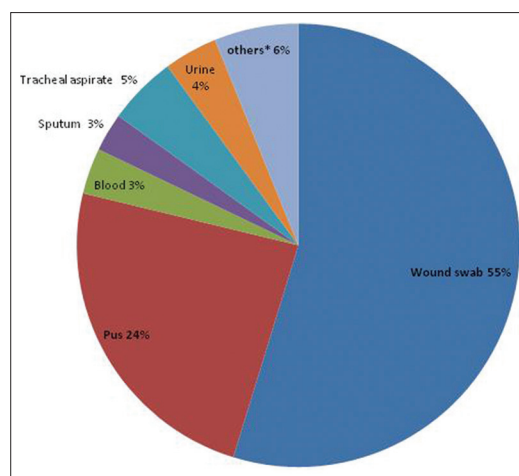


Figure 1: Rate of isolation of extended-spectrum beta-lactamases producing bacteria from different clinical specimens (*others –high vaginal swab, ascitic fluid, pleural fluid, pus from liver abscess, bile, etc.)

Table 1: Rate of isolation of extended-spectrum beta-lactamases producing gram negative organism

Organism	Total isolate	ESBL producer, n (%)
<i>Escherichia coli</i>	565	89 (15.75)
<i>Pseudomonas</i> species	421	59 (14.01)
<i>Proteus</i> species	38	14 (36.84)
<i>Klebsiella</i> species	70	13 (18.57)
<i>Acinetobacter</i> species	19	4 (21.05)
Total	1113	179 (16.08)

ESBL: Extended-spectrum beta-lactamases

was found most efficacious against *Acinetobacter* spp. and *Klebsiella* spp. Piperacillin/tazobactam was the most effective antibiotic against *Klebsiella* spp. and *Proteus* spp. [Table 2].

Discussion

The detection of ESBL-mediated resistance in microorganism is of paramount importance because of limited therapeutic options.^[2] Although the prevalence of ESBL producer varies from country to country, it is more in Asia.^[18] In Bangladesh, rate of ESBL producing bacteria isolated were 23% in 2008 and 24.85% in 2012.^[12,19] In the present study, 16.07% of the Gram-negative organisms were detected as ESBL producer. The low rate of ESBL in the present study could be due to the inclusion of all indoor and outdoor patients’ samples for study while previous studies were done on infected surgical wound, burn wound or ICU patients only.^[12,19]

E. coli was the most commonly isolated organism in this study followed by *Pseudomonas* spp., *Proteus* spp., *Klebsiella* spp. In Bangladesh, the prevalence of ESBL producer among different organisms varied in different studies and the reported prevalence was higher than the present study.^[12,13] The discrepancy of the isolation rate may be due to the varying prevalence of infection

Table 2: Antibiotic sensitivity pattern of extended-spectrum beta-lactamases producing organisms

ESBL producers	Sensitivity (%)									
	I	M	A	G	C	C-t	A	C	P/t	L
<i>Escherichia coli</i>	97.7	94.7	77.9	35.8	25.3	22.6	10.1	85	87.9	34.4
<i>Pseudomonas</i>	82.1	80.4	28.8	5.7	9.3	1.9	13.6	47.5	7.9	7.3
<i>Klebsiella</i>	100	100	46.2	23.1	30.8	44.4	15.4	100	100	61.5
<i>Proteus</i>	85.7	92.9	42.9	7.7	40	0	0	35.7	100	0
<i>Acinetobacter</i>	75	50	25	0	0	0	0	100	0	0

ESBL: Extended-spectrum beta-lactamases, I: Imipenem, M: Meropenem, A: Amikacin, G: Gentamicin, C: Ciprofloxacin, C-t: Co-trimoxazole, A: Amoxycylav, C: Colistin, P/t: Piperacillin/tazobactam, L: Levofloxacin

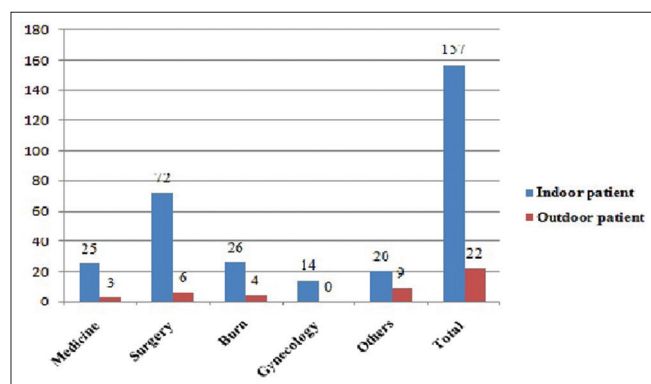


Figure 2: Pattern of distribution of extended-spectrum beta-lactamases producing isolates in hospital and community

causing bacteria from area to area and even hospital to hospital. Different hospital deals with different types of disease and use different antibiotics.

Maximum ESBL producers were isolated from specimen of different surgery departments. The majority of the ESBL producing isolates were from inpatients which are in agreement with a study by Bindayna in Bahrain.^[3] The reason might be due to the fact that drug-resistant gene that are carried by plasmid, are easy to transmit to other bacteria in hospital setting. The ESBL isolation of 13% from the outdoor patients, representing community-acquired infections, shows that ESBL producing organisms are not uncommon in the community and is in agreement with Helfand and Bonomo.^[6]

Almost all types of specimen that were sent for culture yielded growth of ESBL producing organisms. The majority of them were isolated from wound swab and pus. This tertiary care hospital deals with a large number of patients including causality and surgical departments and also has the biggest burn unit in the country. This is the reason of huge number of wound swab and pus specimen that may also yielded the growth of maximum ESBL producers. Many of these patients were receiving long-time treatment and frequent antibiotic switch without culture sensitivity. Organisms may develop resistance during prolonged antimicrobial therapy, and initially susceptible bacteria may become resistant within few days after initiation of treatment.^[16]

ESBL producing organisms usually show resistance to non- β -lactam antibiotics as the genes encoding β -lactamases are often located on plasmids that also encode genes for resistance to other antibiotics.^[20,21] ESBL producers were mostly resistant to antibiotics that are commonly used in Bangladesh. Carbapenems were the most efficacious drugs; imipenem and meropenem showed 80% to 100% sensitivity except against *Acinetobacter* spp. in this study, which is in accordance with findings of recent studies.^[9,12] Although only few cases showed resistance this resistance to carbapenems is a matter of great concern in the treatment of infection.

The majority of the ESBL producers showed a comparatively good sensitivity to amikacin, and the pattern is consistent with other studies in Bangladesh.^[9,12,22] The reason behind such low resistance might be the less use of this antibiotic in this hospital. The result indicates that amikacin may be considered as an alternative drug in infections caused by ESBL producers. Ciprofloxacin is a very important antibiotic, but all ESBL producers showed high resistance to it. This finding is consistent with studies who reported ESBL-producing organisms were highly resistant to ciprofloxacin.^[9,12,22] The higher rate of resistance to ciprofloxacin might be due to the fact that this drug is used widely for many infections such as enteric fever which is endemic in Bangladesh.

Colistin and piperacillin/tazobactam showed good sensitivity in this study. All isolated *Klebsiella* and *Acinetobacter* spp. were sensitive to colistin, and except for *Pseudomonas* and *Acinetobacter* spp. piperacillin/tazobactam showed a good sensitivity to ESBL producers. These two injectable drugs are not usually used outside of hospital settings, and they are considered mainly as reserved drugs and are being used for those who are resistant to most other antibiotics.

There are very limited treatment options available for these pathogens. Hence, early detection and appropriate antibiotic application remain a significant priority in controlling the development and spread of ESBL producing organisms.

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Conflicts of interest

There are no conflicts of interest.

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