Original Research Article
International Journal of Medical and Dental Sciences, *Vol 8(2), DOI: 10.18311/ijmds/2019/23503, July 2019*
ISSN (Print) : 2454-8952
ISSN (Online) : 2320-1118

Detection of Extended-Spectrum Beta Lactamases and AmpC Beta Lactamases Producing Uropathogenic *Escherichia coli* in a Tertiary Care Hospital

Rupinder Bakshi[1*], Vijay Kumar Sehgal[2], Perbhat Kansal[3] and Sarjiwan Kaur[4]

[1]Assistant Professor, Department of Microbiology, Government Medical College, Patiala - 147001, Punjab, India; rupindergill1@yahoo.co.in
[2]Professor & Head, Department of Pharmacology, Government Medical College, Patiala - 147001, Punjab, India
[3]Junior Resident, Department of Pharmacology, Government Medical College, Patiala - 147001, Punjab, India
[4]Senior Resident, Department of Microbiology, Government Medical College, Patiala - 147001, Punjab, India

Abstract

Background: The multidrug resistant among uropathogenic *E. coli* has become a potential threat to global health. The aim of the current study to evaluate the antimicrobial activities of nitrofurantoin and fosfomycin along with other antimicrobials against Extended Spectrum β-Lactamases (ESBL) and AmpC producer isolates from the most common organism *E. coli.* **Methods:** A total of 6046 clean catch midstream urine samples were collected and processed in Microbiology department of tertiary care hospital. The antimicrobial susceptibility of *E. coli* isolates was initially screened by Kirby-Bauer disk diffusion method. The resistant isolates were confirmed to be ESBL and AmpC producers by their respective phenotypic confirmatory tests of combined disc method. **Results:** Out of 6046 patients there were 1855 *E. coli* positive patients. Maximum patients in the age group of 21-30 years were 51.5% followed by 31-40 years where patients were 26%. 64.4% *E. coli* were isolated from female patients and 35.6% from male patients. *E. coli* showed higher sensitivity towards, fosfomycin (100%), imipenem (100%), nitrofurantoin (84.1%), piperacillin and tazobactam (77.3%), amikacin (76.1%) and while they showed high degree resistance pattern against Penicillin, cotrimoxazole, ciprofloxacin, norfloxacin and 2nd and 3rd generation cephalosporin. Out of 1855 *E. coli*, multi drug resistance was seen in 520 *E. coli* isolates. ESBL production was observed among 50% of *E. coli* isolates by combined disk method. Out of 520 isolates, 150 isolates showed resistance to one or more extended-spectrum cephalosporins and cefoxitin by Kirby-Bauer disk diffusion method. These were selected and screened for ESBL and AmpC production. Among 150 cefoxitin-resistant isolates, AmpC phenotype was detected in 100 isolates (66.6%) by AmpC disc method. The overall occurrence of AmpC in the study was found to be 19.2%. Susceptibility of ESBL and AmpC producers to fosfomycin, imipenem, nitrofurantoin and amikacin were found to be 100%, 98.5%, 89% and 75% respectively. **Conclusions:** There is increased prevalence of ESBL and AmpC producing *E. coli*. Thus, early detection of ESBL and AmpC producer *E. coli* by simple phenotypic methods is necessary to avoid treatment failure, where molecular techniques are not available.

Keywords: AmpC β-Lactamase, *Escherichia Coli*, Extended Spectrum β-Lactamase, Multi Drug Resistance

1. Introduction

Urinary Tract Infection (UTI) is one of the most common infections, mostly caused by gram negative bacteria and out of which *E. coli* is the most common isolate. *E. coli* is responsible for both community and hospital acquired UTI. Almost every female experiences some type of UTI during her lifetime. The excessive use of antibiotics in India is creating resistance in *E. coli*. In the recent past, there are alarming reports about the emergence and spread of antimicrobial resistant *E. coli* strains from all around the world[1-3].

**Author for correspondence*

Extended Spectrum β-Lactamases (ESBL) producing organisms which were discovered in 1983, are now a major problem in the area of infectious diseases[3]. The ESBL and AmpC producing *E. coli* have inflicted a significant threat to hospitalized patients as they can completely hydrolyzed oximino-beta lactams such as 3rd generation cephalosporins, which are mostly used in the treatment of hospital acquired infections. Use of broad-spectrum oral antibiotics and probably poor infection control practices may facilitate the spread of this plasmid-mediated resistance. In addition to known populations at risk, ambulatory patients with chronic conditions represent another patient population that may harbor ESBL-producing organisms[1-4,18].

ESBLs are strictly defined as β-lactamases capable of hydrolyzing penicillins, broad and extended spectrum cephalosporins and monobactams and are inhibited by clavulanic acid. They have been isolated from most of the members of family *Enterobacteriaceae*[7]. ESBLs are derived from genes for TEM and SHV by mutation. ESBLs are often located on plasmids that are transferable from one strain to another and between bacterial species. Although the prevalence of ESBLs is not exactly known but it is clearly increasing all over the world as it has been proved that 10-40 % of strains of *E. coli* express ESBLs. ESBL producing *E. coli* have been responsible for Multi Drug Resistance (MDR) in *E. coli* and pose a challenging infection control issue. So it is essential to identify ESBLs in routine and when detected, indicate the need for the use of appropriate antimicrobial agents[7].

AmpC β-lactamases are clinically important cephalosporins which are encoded on the chromosomes of many *Enterobacteriaceae* and a few other organisms, where they mediate resistance to cephalothin, cefazolin, cefoxitin, most penicillins, and β-lactamase inhibitor/β-lactam combinations. AmpC β-lactamase activity is not affected by the ESBL inhibitor i.e. by clavulanic acid. AmpC enzymes belong to Class-C in the Ambler structural classification of beta lactamases, while they were assigned as Group one in the functional classification scheme of Bush *et al*. Genes for AmpC β-lactamases are may be chromosomal mediated or plasmid mediated in the members of the family *Enterobacteriaceae*. AmpC over production along with porin mutations of the outer membrane, can reduce susceptibility to carbapenems, in particular in plasmid mediated AmpC producers.[8,11,22]

Porins are chemically selective and transport only one group of molecules and are specific for one molecule so the β-lactam and fluoroquinolone antibiotics they pass through porins to reach their targets in gram negative bacteria. Bacteria can develop resistance to these antibiotics by mutation of the gene that encodes the porin the antibiotics are then excluded from passing through the outer membrane resulting in multidrug resistance[8]. So, ESBL producing organisms are frequently resistant to many other classes of antibiotics including aminoglycosides and fluoroquinolones thus; treatment of these infections is often a therapeutic challenge[6]. The alternative treatment for ESBLs producing *E. coli* includes carbapenems, β-lactam/β-lactamase inhibitor combinations and other antimicrobials like nitrofurantoin and fosfomycin. Fosfomycin is a phosphonic acid bactericidal agent which is known for four decades and is particularly useful for urinary tract pathogens. This is an oral drug and has been found to be effective against ESBLs producing *Enterobacteriaceae* isolate. Although nitrofurantoin has been used for the last many years and is used for the treatment of uncomplicated UTIs, but its pharmacodynamic properties are still not fully explored. Both the drugs are now a days explored because of increasing resistance. In present study we aimed to evaluate the antimicrobial activities of nitrofurantoin and fosfomycin along with other antimicrobial agents against ESBL and AmpC producer isolates from the most common organism *E. coli*[9, 13].

2. Materials and Methods

The present study was conducted at a referral tertiary care teaching hospital. A total of 6046 clean catch midstream urine samples were collected in a sterile container from both outpatient and inpatient attending Rajindra Hospital Patiala (July 2017-December 2017). Urine samples were transported immediately to Department of Microbiology Government Medical College, Patiala for processing. Uncentrifuged urine samples were 1st examined under microscope for presence of pus cells, RBCs, epithelial cells and bacteria. Then the urine samples were inoculated on MacConkey's and Blood agar plates by using calibrated loop delivering 0.001 ml of sample and incubated at 37°C aerobically for 24 hrs. For gram negative bacilli more than $10^{[5]}$ colonies per ml of single organism were considered significant. The organisms were identified by colony characters, gram's staining and biochemical reactions[26].

Antibiogram profile of these isolates was determined to commonly used antibiotics (Hi-media) such as Ampicillin (30µg), amoxyclav (30/10µg), piperacillin + tazobactam (100/10µg), amikacin (30µg), gentamicin (10µg), ciprofloxacin (5µg), norfloxacin (10µg), cefoxitin (30µg), cefotaxime (30µg), ceftazidime (30µg), cefepime (30µg), imipenam (10µg), aztreonam (30µg), cotrimaxozole (25µg), nitrofurantoin (300µg) and Fosfomycin (200µg) along with screening for ESBL production as recommended by the Clinical Laboratory Standards Institute (CLSI). Isolates showing resistance to 2nd and 3rd generation cephalosporins were shortlisted for confirmatory tests of ESBL production. The isolates were screened for presumptive AmpC production by testing their susceptibility to cefoxitin (30µg) antibiotic discs (Himedia, Mumbai) using Kirby Bauer disk diffusion method. All the isolates with an inhibition zone diameter of ≤14mm for cefoxitin were labeled as AmpC positive and were subjected to confirmatory test.

2.1 Tests for ESBL-Production

2.1.1 Screening Test

All the *E. coli* isolates were screened for ESBLs by disc diffusion method.[17] In the presumptive test to detect potential ESBL producers, all the isolates were screened for susceptibility to ceftazidime (30µg) and cefotaxime (30µg) antibiotic discs (Himedia, Mumbai). Results were interpreted based on the CLSI guidelines as follows: zones of inhibition of ≤22mm for ceftazidime and ≤27mm for cefotaxime indicated ESBL production. The less susceptible or resistant isolates were subjected to confirmatory test.

2.1.2 Confirmatory Test

The ESBL producing *E. coli* isolates were confirmed by CLSI phenotypic confirmatory test of combined disc assay method[15]. One disc each of ceftazidime (30µg) and cefotaxime (30µg) alone and one in combination ceftazidime and clavulanic acid (30/10µg) were placed at a distance of 20mm on a Muller Hinton agar plate inoculated with a bacterial suspension of 0.5 McFarland turbidity standards, and incubated overnight at 37°C. The ESBL-producing strains showed ≥5mm increase in zone diameter for either antimicrobial agent tested in combination with clavulanic acid versus its zone when tested alone[9,10,22].

2.1.3 Double Disk Approximation Test

Double disk approximation test was performed by using amoxy-clav (20/10µg) + ceftazidime (30µg). The disks were placed 15 mm apart. The organisms were considered to be producing ESBL when the zone of inhibition around any of these cephalosporin discs showed a clear-cut increase towards the augmentin disc[17].

2.1.4 Combined Disk Method

Combined disk method was performed using cefatazidime (30µg) and ceftazidime + clavulanic acid (30/10µg). The disks were placed 20 mm apart. A > 5 mm increase in a zone diameter for antimicrobial agent tested in combination with clavulanic acid versus its zone when tested alone are ESBL producers[17, 24].

2.2 Detection of AmpC

2.2.1 AmpC Disc Test

AmpC discs were prepared in laboratory by applying 1:1 mixture of saline and 100 × Tris-EDTA in 20µl volume to sterile filter paper discs, then allowing discs to dry, and stored at 2 to 8°C. A lawn culture of cefoxitin susceptible *E. coli* ATCC 25922 was made on the Mueller Hinton agar and a 30µg cefoxitin disc was placed in the centre. AmpC discs were rehydrated with 20µl of saline and several colonies of each test organism were applied to a disc immediately prior to use. The inoculated AmpC disc with the test organism

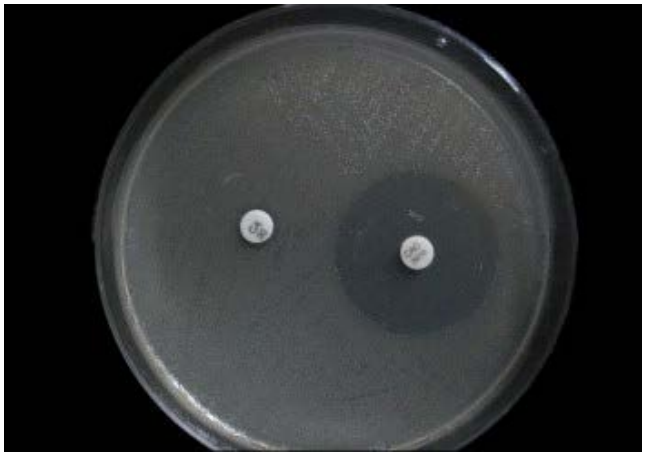

Figure 1. Phenotypic confirmation test of an ESBL producing strain showing zone size of more than 5 mm in the disk with Ceftazidime and Clavulanic Acid (CAC) as compared to ceftazidime (CA).

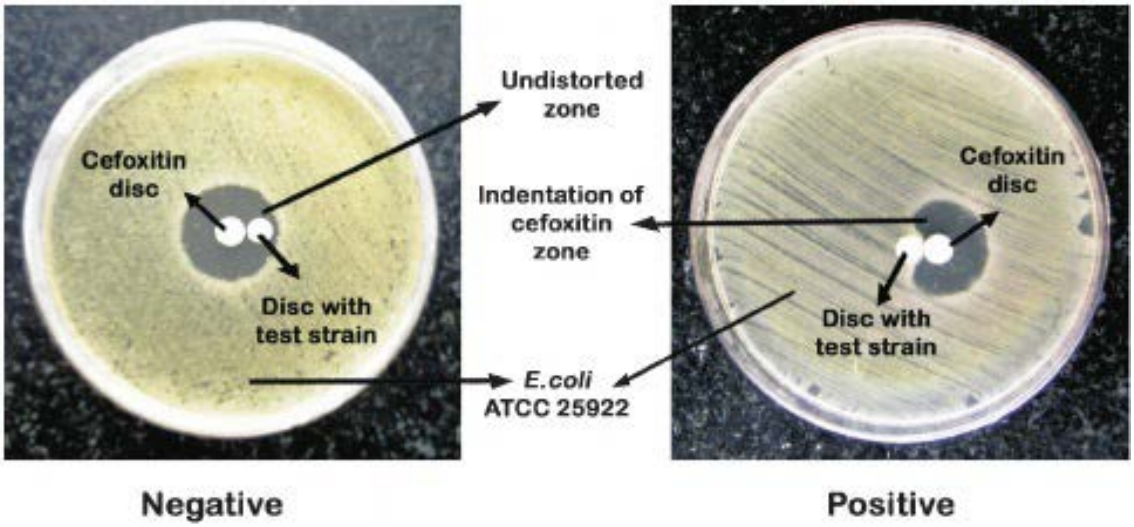

Figure 2. AmpC detection by AmpC disc and Cefoxitin disc.

is inverted and is then placed on agar plate touching the cefoxitin disc. The plate was inoculated for 18-24 hrs at 37°C. After 24 hrs flattening (distortion) of the zone of inhibition around cefoxitin antibiotic disc were examined on plates, indicating enzymatic inactivation of cefoxitin by AmpC enzyme (a positive result), or the absence of a distortion, indicating no significant inactivation of cefoxitin (a negative result)[9,10,23].

2.2.2 Quality Control

E. coli ATCC 25922 was used for the quality control of ESBL and AmpC testing methods (Figure 1 and 2).

3. Results

6046 urine samples were processed between July 2017 and December 2017, out of *E. coli* was the most common organism isolated in 1855 (30.6%) cases. Out of 1855 *E. coli* culture positive cases 1190 samples were from indoor patients while 665 samples were from outpatient department. Out of 1855 isolates of *E. coli*, maximum patients were in the age group of 21-30 years 51.5% (n=955) followed by 31-40 years 26% (n=480). 64.4% (n=1195) were obtained from females and 35.6% (n=660) were obtained from males. The p value for this data is 0.02 (<0.05) showing that the data obtained during the study is significant (Table 1 and Figure 3a,b). In the present study, *E. coli* showed higher sensitivity towards, fosfomycin (100%), imipenem (100%) nitrofurantoin (84.1%), piperacillin + tazobactam (77.3%) and amikacin (76.1%), whereas high degree resistance pattern against penicillins, cotrimoxazole, ciprofloxacin, norfloxacin, 2nd and 3rd generation cephalosporin and cotrimaxozole (p value = 5.93) (Table 2 and Figure 4a,b).

During this period, out of 1855, 520 consecutive, non-repetitive, MDR *E. coli* was isolated from urine samples of patients with both community- and hospital-acquired UTI. Out of 520 cases, 370 were resistant to penicillin, 1st and 2nd generation cephalosporins and 150 were also resistant to cefoxitin. ESBL production was observed in 50% (260/520) of *E. coli* isolates by double disk and combined disk method. The double disk approximation test failed to detect ESBLs in 14 isolates of *E. coli* which were detected by combined disk method. Susceptibility of ESBL producers to fosfomycin, imipenem, nitrofurantoin and amikacin were found to be 100%, 98.5%, 89% and 75% respectively. About 46% (n=238) of ESBL producers

Table 1. Distribution of cases according to age and gender

Age in years	Total cases (N-1855)	Male (N-660)	Female (N-1195)
<20 years	50 (2.6%)	24 (1.2%)	26 (1.4%)
21- 30 years	955 (51.5%)	389 (20.9%)	566 (30.5%)
31-40 years	480 (25.8%)	90 (4.8%)	390 (21%)
41-50 years	180 (9.7%)	55 (2.9%)	125 (6.7%)
51-60 years	120 (6.4%)	60 (3.2%)	60 (3.2%)
>60 years	70 (3.8%)	42 (2.3%)	28 (1.5%)
Total	**1855 (100%)**	**660 (35.6%)**	**1195 (64.4%)**

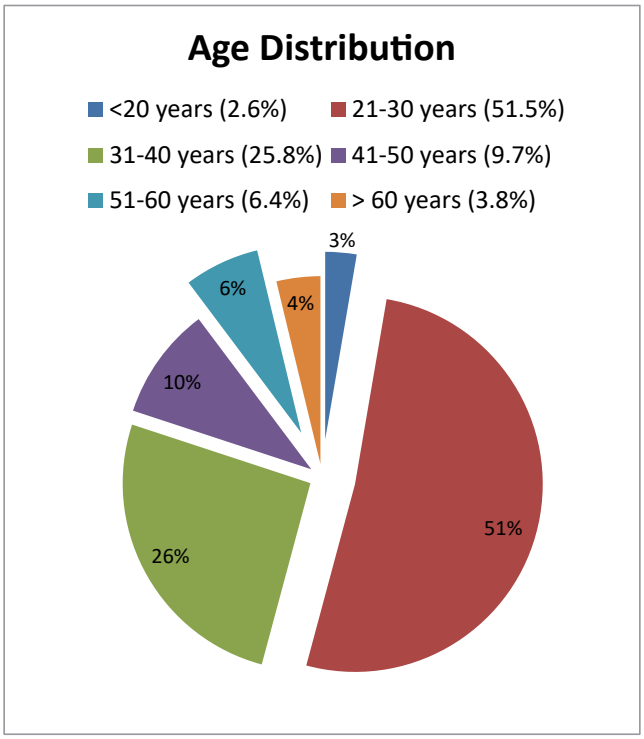

Figure 3a. Distribution of cases according to age.

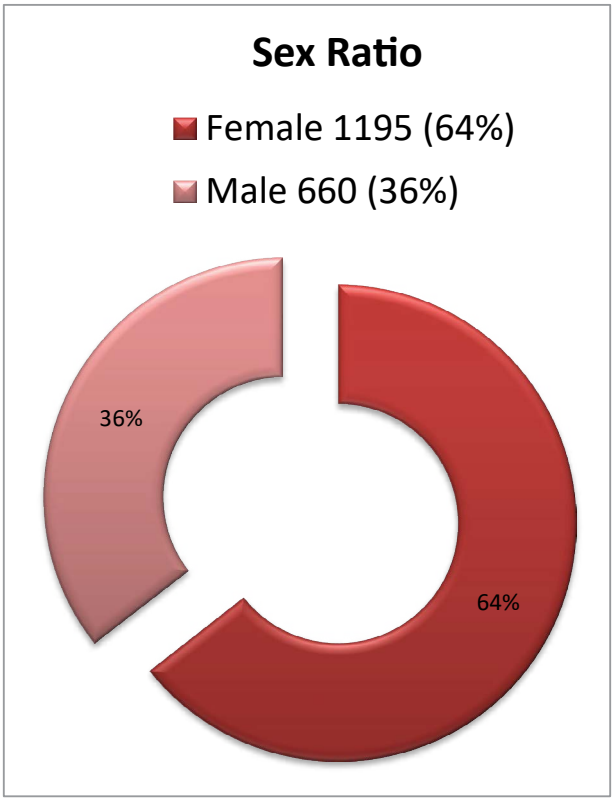

Figure 3b. Distribution of cases according to gender.

Table 2. The Antimicrobial resistance pattern (percentage) of 1855 uropathogenic *E. Coli* to commonly prescribed antibiotics

Name of antimicrobial agent	Total antimicrobial sensitivity	Total antimicrobial resistance
Ampicillin	109 (5.8%)	1746 (92.3%)
Amoxy - clav	503 (27.1%)	1352 (73.9%)
Piperacillin+ Tazobactem	1433 (77.3%)	422 (22.7%)
Gentamicin	1351 (72.8%)	504 (27.2%)
Amikacin	1412 (76.1%)	443 (23.8%)
Ciprofloxacin	1060 (57.1%)	795 (48%)
Norfloxacin	1070 (57.7%)	785 (43.3%)
Cefoxitin	1305 (70.4%)	550 (29.6%)
Cefotaxime	1355 (72%)	520 (28%)
Cefatzidime	1355 (72%)	520 (28%)
Cefepime	1796 (96.8%)	59 (3.1%)
Imipenem	1853 (99.89%)	2 (0.1%)
Aztreonam	1853 (99.89%)	2 (0.1%)
Co Trimoxazole	350 (18.8%)	1505 (72.8%)
Nitrofurantoin	1578 (84.1%)	277 (14.9%)
Fosfomycin	1855 (100%)	Nil

Table 3. The antimicrobial resistance pattern (percentage) of 520 ESBLS and AmpC producing uropathogenic *E. coli*

Name of antimicrobial agent	Total antimicrobial sensitivity	Total antimicrobial resistance
Amoxiclav	130 (25%)	390 (75%)
Piperacillin/ tazobactam	436 (83.8%)	84 (16.2%)
Aztreonam	520 (100%)	Nil
Gentamicin	345 (66.3%)	175 (33.7%)
Amikacin	375 (72%)	145 (28%)
Ciprofloxacin	290 (55.8%)	230 (44.2%)
Imipenem	512 (98.5%)	8 (0.5%)
Nitrofurantoin	437 (84%)	83 (16%)
Fosfomycin	520 (100%)	Nil

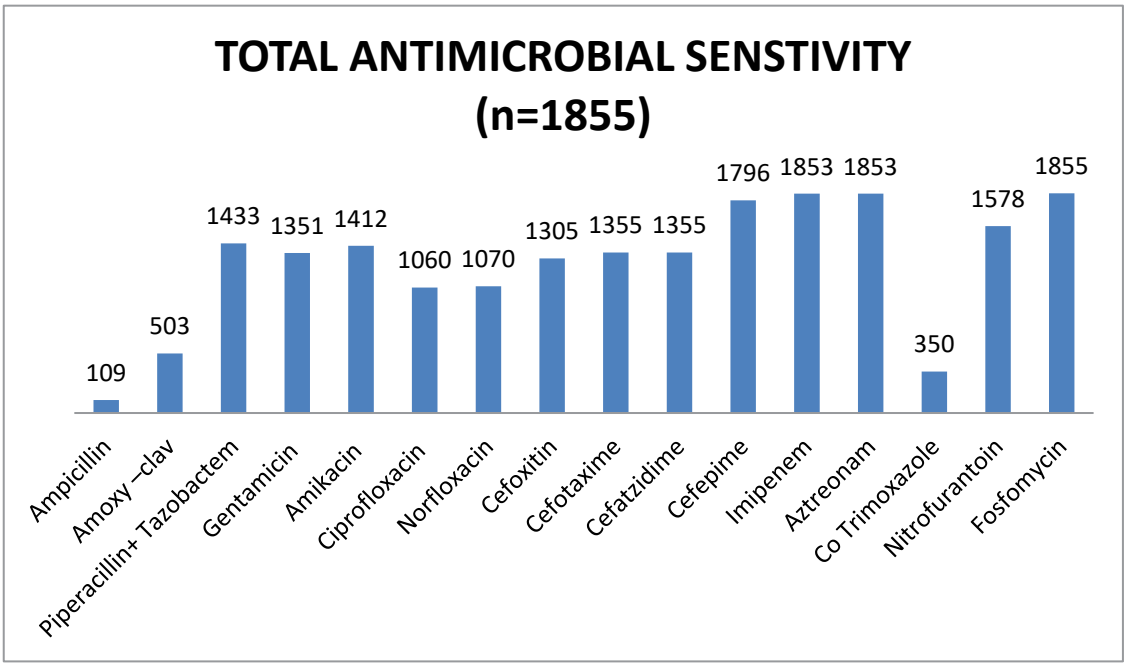

Figure 4a. Total antimicrobial sensitivity (n-1855).

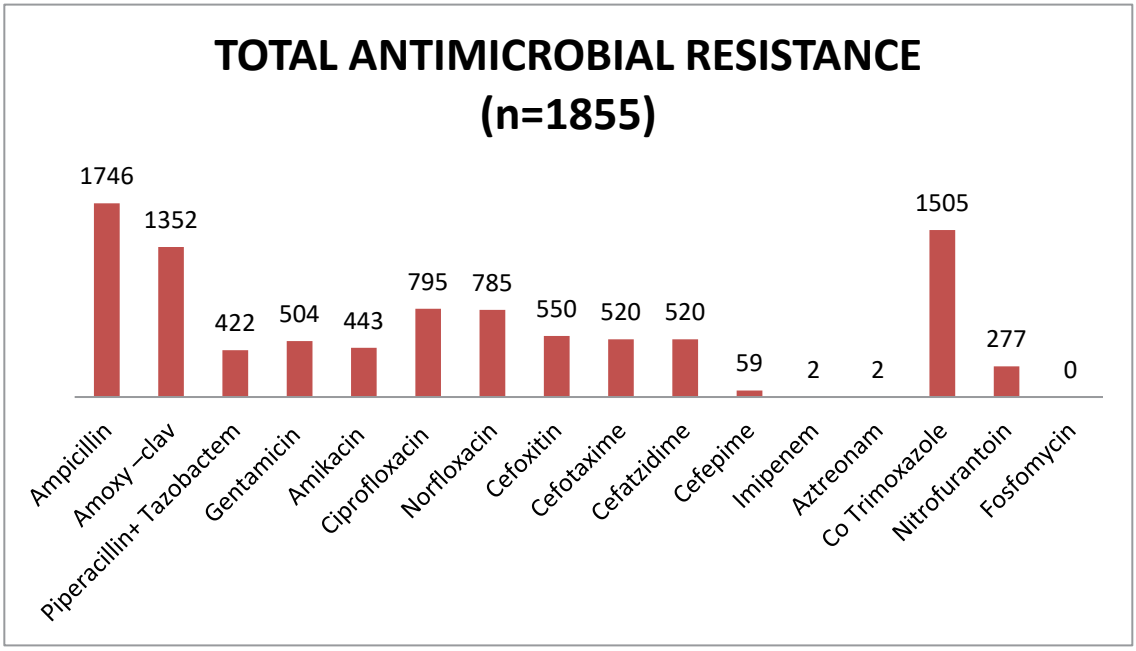

Figure 4b. Total antimicrobial resistance (n-1855).

were from patients admitted in ICU and 30% (n=157) of ESBL producers were obtained from patients admitted in surgery units. Out of 520 ESBL producers, maximum number of patients were in the age group of 41-60 years 53.8% (n=280) followed by 61-80 years age group (35.5%). These ESBL positive isolates were obtained from 175 male and 375 female patients. 92.3% (n=480) of ESBL producer isolates from inpatients and 7.6% (n=40) from outpatients. The antibiotic resistance pattern of these isolates is shown in (Table 3 and Figure 5a,b).

There were 150 isolates showing resistance to one or more extended-spectrum cephalosporins and cefoxitin by Kirby-Bauer disk diffusion method. These were selected and screened for AmpC production. Among

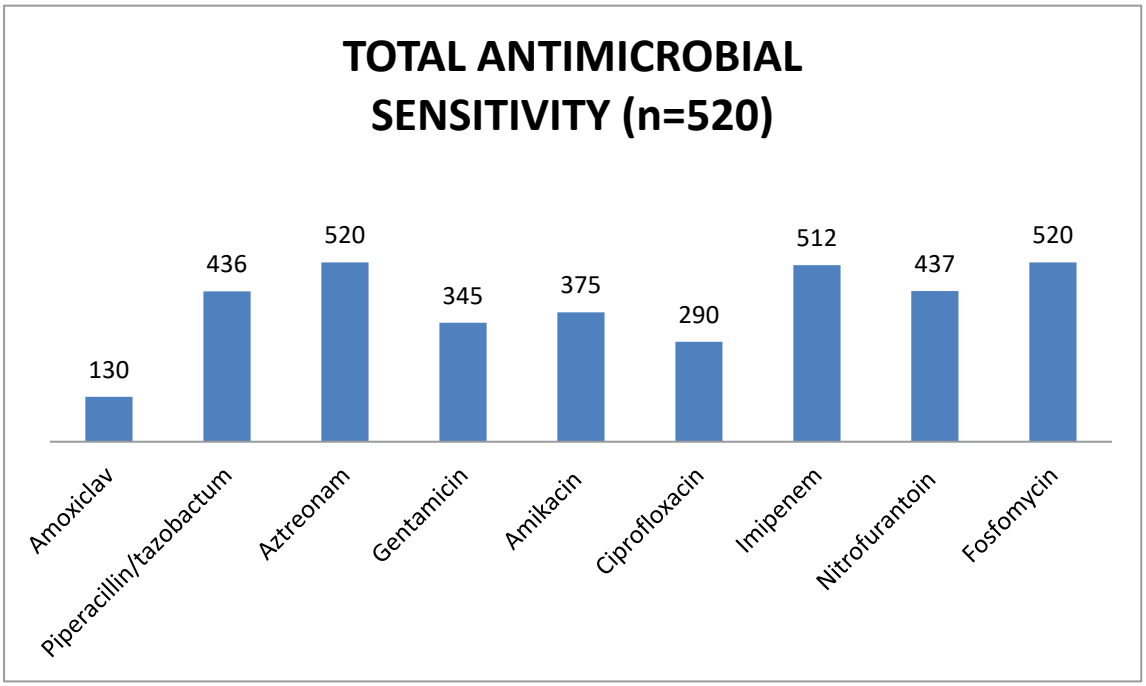

Figure 5a. Total antimicrobial sensitivity (n-520).

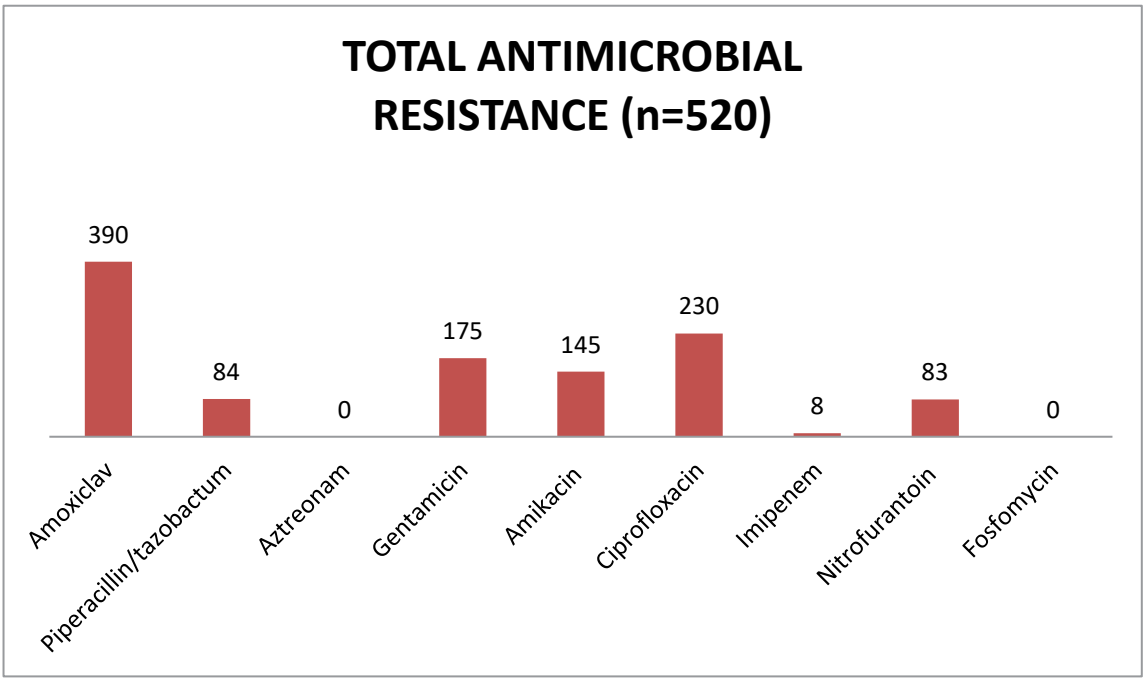

Figure 5b. Total antimicrobial resistance (n-520).

150 cefoxitin-resistant isolates, AmpC phenotype was detected in 100 isolates (66.6%) by AmpC disc method. The overall occurrence of AmpC in the study was found to be 19.2% (n=100). ESBL and AmpC producing *E. coli* showed good susceptibility to fosfomycin (100%) nitrofurantoin (84%), carbapenems (98.5%), followed by piperacillin + tazobactam (83.8%) and amikacin (72%) (p value = 3.3) (Table 3).

4. Discussion

ESBLs and AmpC β-lactamase producing *E. coli* are now a major problem in hospitalized patients throughout the world. The prevalence of ESBLs and AmpC production among urinary isolates varies greatly worldwide and in geographic areas and are rapidly changing over time. There is need to develop quick screening methods to assess the enzymes causing resistance mechanism in their isolates by the Clinical laboratories, so that appropriate therapy can be given.

In present study *E. coli* was the most common isolate and it was most predominant among females (64.4%), as studies done in other parts of India and abroad[1-3,20,25]. Detection of for ESBLs and AmpC with recommended zone sizes should be immediately applied to suggest the presence of an ESBL.

In present study, ESBL production was observed in 50% (n=260) of *E. coli* isolates by combined disk method. The double disk approximation test failed to detect ESBLs in 14 isolates of *E. coli* which was earlier detected by combined disk method. Similar studies were done by other authors who reported 50-80 % ESBL detection by combined disc method[9,12,14-17]. ESBL production varies from region to region because of variation in selection of antimicrobials.

In our study, out of 150 cefoxitin-resistant isolates, AmpC phenotype was detected in 100/150 isolates (66.6%) by AmpC disc method. The overall occurrence of AmpC among MDR *E. coli* in this study was found to be 19.2% (100/520) which is similar to the study done in Egypt (2015) who reported overall prevalence of AmpC producing *E. coli* 22%, whereas the study conducted at Chandigarh reported much higher incidence of AmpC among *E. coli* i.e. 45% [18,19]. The data on the prevalence of AmpC detection in *E. coli* in India is not widely available due to limited studies done for its detection.

Susceptibility of ESBLs and *AmpC producers E. coli* to fosfomycin, imipenam, nitrofurantoin and amikacin were found to be 100%, 98%, 83.8% and 72% respectively. Similar results were reported by other studies that showed susceptibility of ESBL producers to imipenam and amikacin at 100 and 68% respectively[17,18,25].

5. Conclusion

Developing countries lack the facility of molecular methods for the detection of various types of ESBLs and Amp C producing *E. coli*. To overcome this problem, various phenotypic methods are recommended for routine use to detect ESBLs and Amp C producing *E. coli* in diagnostic laboratories. Awareness and detection of ESBLs and AmpC is necessary to prevent misreporting and hence treatment failure. Currently carbapenems are the most active and reliable agent for the treatment of infections due to ESBLs and AmpC producing organisms. Nitrofurantoin and fosfomycin can be used at the other alternative in MDR *E. coli*. Antibiotic Stewardship program is an effective way to prevent increase in MDR *E. coli*.

6. Limitations of the Study

- This study identifies the multiple mechanisms involved in drug resistance among *E. coli* by phenotypic methods where the expensive molecular techniques are not available.
- The limitation of this study was that the support of use of genotypic method to detect types of ESBL and Amp-C β-lactamase production at gene level was not available in our Institute.

7. References

1. Babypadmini S, Appalaraju B. Extended spectrum beta lactamases in urinary isolates of *Esch. coli* and *K. pneumoniae* prevalence and susceptibility pattern in tertiary care hospital. Ind. J. Med. Microbiol. 2004; 22:172-74.
2. Ebbing Lautenbach, Jean Baldus Patel, Warren B. Bilker, Paul H. Edelstein, Neil O Fishman. Extended-spectrum β-lactamase-producing *Escherichia coli* and *Klebsiella pneumoniae*: Risk factors for infection and impact of resistance on outcomes, Clin. Infect. Dis. 2001 Apr; 15;32(8):1162-71. https://doi.org/10.1086/319757. PMid: 11283805.
3. Gupta V, Yadav A, Joshi RM. Antibiotic resistance pattern in uropathogenes. Indian Journal of Med. Microbial. 2008; 20(2):96-98.
4. Jabeen K, Zafir A, Hassan R. Comparison of double disc and combined disc method for the detection of extended spectrum β-Lactamases in *Enterobacteriaceae*, Department of Pathology, Aga Khan University, Karachi. J. Pak. Med. Assoc. 2003; 53(11):510.
5. Livermore DM. B-Lactamases in laboratory and clinical resistance. Clin. Microbiol. Rev. 1995; 8:557-84. https://doi.org/10.1128/CMR.8.4.557. PMid: 8665470, PMCid: PMC172876.

6. Paterson DL, Bonomo RA. Extended spectrum β-lactamses: A clinical update. Clin. Microbiol. Rev. 2005; 18(4):657-86. https://doi.org/10.1128/CMR.18.4.657-686.2005. PMid: 16223952, PMCid: PMC1265908.
7. Rupp M, Fey PD. Extended Spectrum Beta-Lactamase (ESBL) producing *Enterobacteriaceae*: Considerations for diagnosis, prevention and drug treatment. Department of Internal Medicine, University of Nebraska Medical Center, Omaha, Nebraska, USA. Drugs. 2003; 63(4):353-65. https://doi.org/10.2165/00003495-200363040-00002. PMid: 12558458.
8. Neeraj Kumar Tulara. Nitrofurantoin and Fosfomycin for extended spectrum beta lactamases producing *E. coli* and *Klebsiella pneumoniae*. J. Glob. Infect. Dis. 2018 Jan-Mar; 10(1):19-21. https://doi.org/10.4103/jgid.jgid_72_17. PMid: 29563719, PMCid: PMC5850758.
9. Azap Ö, et al. Risk factors for extended-spectrum β-lactamase positivity in uropathogenic *Escherichia coli* isolated from community-acquired urinary tract infections. Clinical Microbiology and Infection. Feb. 2010; 16(2); 147:151. https://doi.org/10.1111/j.1469-0691.2009.02941.x. PMid: 19689464.
10. Clinical and Laboratory Standards Institute. Performance standards for antimicrobial susceptibility testing. Twenty fifth informational supplement. CLSI document M100-S25. Wayne PA: CLSI; 2015.
11. Naveen Grover, Col AK, Sahni Brig, Bhattacharya S. Therapeutic challenges of ESBLS and AmpC beta-lactamase producers in a tertiary care center. Med. J. Armed. Forces. India. 2013 Jan; 69(1):4-10. https://doi.org/10.1016/j.mjafi.2012.02.001. PMid: 24532926, PMCid: PMC3862620.
12. Chervet D, et al. Antimicrobial resistance in community-acquired urinary tract infections in Paris. Medecineet Maladies Infectieuses. 2017.
13. Fahad A, et al. Incidence and molecolar characterization of the extended spectrum beta lactamase-producing *Escherichia coli* isolated from urinary tract infections in Eastern Saudi Arabia. Saudi. Med. J. 2017; 38(8):811-15. https://doi.org/10.15537/smj.2017.8.18578. PMid: 28762433, PMCid: PMC5556297.
14. Smita Sood, Ravi Gupta. Antibiotic resistance pattern of community acquired uropathogens at a Tertiary Care Hospital in Jaipur, Rajasthan. Indian J. Community Med. 2012; 37(1):39-44. https://doi.org/10.4103/0970-0218.94023. PMid: 22529539, PMCid: PMC3326806.
15. Black JA, Moland ES, Thomson KS. AmpC disc test for detection of plasmid-mediated AmpC β-Lactamases in *Enterobacteriaceae* lacking chromosomal AmpC β-Lactamases. Journal of Clinical Microbiology. 2005; 43(7):3110-13. https://doi.org/10.1128/JCM.43.7.3110-3113.2005. PMid: 16000421, PMCid: PMC1169113.
16. Yashavanth R, Ronald R, Anita K, Narendra N, Faseela T. Uropathogens and their antimicrobial susceptibility pattern in a tertiary care hospital. Journal of Evolution of Medical and Dental Sciences. Oct. 2012; 1(4):467.
17. Umadevi S, Kandha Kumari G, Joseph NM, Kumar S, Easow JM. Prevalence and antimicrobial susceptibility pattern of ESBL producing gram negative Bacilli. J. Clin. Diag. Res. 2011; 5(2):236-39.
18. Soha A, el -hady, Lamiaa A Adel. Occurnec and detection of AmpC β-lactamses among *Entrobacteriaceae* isolates from patients at Ain Shans University Hospital. The Egyptian Journal of Medical Human Genetics. 2015; 16:239-44. https://doi.org/10.1016/j.ejmhg.2015.03.001.
19. Gupta V, Garg R, Chander J. Detection of AmpC β-lactamses in gram negative bacilli - A study from North India. Int. J. Infect. Dis. 2008; 12(1):e121. https://doi.org/10.1016/j.ijid.2008.05.301.
20. Mana Baziboroun, Masomeh Bayani, Zahara Poormonstaseri, Mehran Shokri, Tahmineh Biazar. Prevalence and antibiotic susceptibility patteren of extended spectrum beta lactamses producing *Escherchia coli* isolated from outpatients with Urinary tract infections in Babool, Northern of Iran. Curr. issues in Pharma Med. Sci. 2018; 31(2):61-64. https://doi.org/10.1515/cipms-2018-0013.
21. Rajendra Karadiya, saroj Hooja, Nital Pal, Rajni Sharma, Rakesh Maheswari, Ramesh Mishra. Prevalence and antimicrobial susceptibility of ESBL and AmpC β-lactamases producing *Escherichia coli* and *Klebsiella pneumoniae* from various clinical samples: An emerging threat. Journal of Evolution of Medical and Dental Sciences. 2016; 5(32):1729-34. https://doi.org/10.14260/jemds/2016/408.
22. Bhola Shankar Sah, Manita Aryal, Dipak Bhargava, Amrullah Siddique. Drug resistance pattern of bacterial pathogens of *Enterobacteriaceae* family. Tribhuvan University Journal of Microbiology. 2017; 4(1). https://doi.org/10.3126/tujm.v4i0.21672.
23. Manchanda V, Singh NP. Occurrence and detection of AmpC beta-lactamases among Gram-negative clinical isolates using a modified three-dimensional test at Guru Tegh Bahadur Hospital, Delhi, India. J. Antimicrob. Chemother. 2003 Feb; 51(2):415-18. https://doi.org/10.1093/jac/dkg098. PMid: 12562713.
24. Chakrawarti A, Dongol P, Khanal H, Subba P, Banerjee JJ. Extended spectrum beta lactamases detection and multiple antibiotic resistance indexing of *Escherichia coli* from urine samples of patients from a referral hospital of eastern Nepal. Int. J. Appl. Sci. Biotechnol. 2015; 3(3):423-26. https://doi.org/10.3126/ijasbt.v3i3.12924.

25. Vellanki Naga Madhavi, Puppala Subbulu. Prevalence and antibacterial susceptibility testing pattern of bacterial pathogens causing urinary tract infections in community. Journal of Evolution of Medical and Dental Sciences. 2016; 5(30):1528-31. https://doi.org/10.14260/jemds/2016/360.

26. Rupinder Bakshi, Geeta Walia, Anita Gupta. Microbiological profile of UTI along with their antibiotic sensitivity pattern with special reference to Nitrofurantoin. World Academy of Science, Engineering and Technology International Journal of Medical. Health, Biomedical, Bioengineering and Pharmaceutical Engineering. 2015; 9(9). www.waset.org.

How to cite this article: Bakshi R., Sehgal VK., Kansal P. and Kaur S. Detection of Extended-Spectrum Beta Lactamases and AmpC Beta Lactamases Producing Uropathogenic *Escherichia coli* in a Tertiary Care Hospital. Int. J. Med. Dent. Sci. 2019; 8(2): 1783-1792.