Identification of ESBL producing *Escherichia coli* from Urine Samples at Tertiary Care Hospital in Jhalawar

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Abstract

Introduction: Antibiotic resistance (ABR) is a serious worldwide threat to public health due to the emergence of multidrug resistant bacteria and is considered as a great problem in the treatment of bacterial infections both in hospital as well as community settings. Extended Spectrum Beta-Lactamase (ESBL) producing strains have emerged as a significant challenge to counter with present antibiotics.
Aims: Our study was aimed to know the prevalence of ESBL producing E. coli in our hospital setting for effective therapeutic outcome and patient care.
Materials and Method: A total of 459 urine samples of urinary tract infection (UTI) suspects were processed in the Microbiology Department at Jhalawar in Rajasthan, India. All samples were cultured on Mac Conkey Agar and Blood Agar and incubated at 37 °C for 24–48 h. The isolates were identified and confirmed using standard microbiological methods and biochemical reaction. Antibiotic sensitivity testing of all E. coli isolates was performed on Muller Hinton agar plates by Kirby-Bauer disk diffusion technique with guidelines established by the Clinical Laboratory Standards Institute (CLSI). Initial screening of ESBL producing E. coli was performed using the Cefotaxime and Ceftriaxone antimicrobial disc. Double-Disc Synergy Test (DDST) and CLSI confirmatory test i.e., Phenotypic Confirmatory Double-Disc Test (PCDDT) were performed for confirmation of ESBL-producing E. coli.
Results: Of the 459 samples processed, 212 isolates were found to be culture positive. Out of 212 positive isolates, 184 (86.79%) were identified as gram negative bacilli (GNB). Of the 184 GNB, 115 (62.50%) were detected as Escherichia coli followed by Klebsiella 30 (16.30%), Pseudomonas 21 (11.41%), Proteus 15 (8.15%), Citrobacter 8 (4.32%), and Acinetobacter 5 (2.71%). Out of 115 E. coli isolates, 86 (74.78%) were found to be ESBL-positive by screening method and 81 (70.43%%) were found to be ESBL producers by PCDDT and 68 (59.13%) were found to be ESBL producers by DDST. Imipenem and Piperacillin–tazobactum were the most active and reliable agents for the treatment of infections which were caused by the ESBL-producing organisms. The ESBL-producing strains were more resistant than non-ESBL producing strains. Among ESBL producers the resistance pattern was highest for Ceftriaxone followed by Cefotaxime and Ceftazidime.
Conclusion: As results showed that there was a high prevalence of ESBL production in our setup so, it is essential to report the ESBL production along with the routine sensitivity reports, which will help the clinician in selection of proper antibiotics.

Keywords: antibiotic resistance, Extended Spectrum Beta-Lactamase (ESBL), multidrug resistant, Escherichia coli

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INTRODUCTION

Urinary tract infections (UTIs) having *Escherichia coli* as etiological agent are common infections with an estimated annual global incidence of at least 250 million cases [1]. The incidence of Extended Spectrum Beta-Lactamase (ESBL)-producing *E.coli* has been increasing worldwide. It varies according to geographical location and is directly linked to use and misuse of antibiotics [2]. Antibiotic resistance (ABR) is a serious worldwide threat to public health due to the emergence of multidrug resistant bacterias.

Antibiotics that were previously used to treat bacterial infections are now rendered less

effective due to drug resistance, which in turn shows not only therapeutic difficulties, but is also associated with increased societal and medical costs, and a much higher mortality rate for patients suffering with infections of this kind.

ESBLs are the enzymes, mostly encoded by plasmids in result of mutation due to which bacteria show resistance to various β-lactam antibiotics including penicillin, cephalosporins and monbactams [3]. They are inhibited *in vitro* by β-lactamase inhibitor i.e., clavulanic acid [4]. The highest risk of infection with ESBL-producing organisms has been observed in patients with prolonged hospitalization, high score of severe illness, recent surgery, instrumentations, admission to an intensive care unit and catheterization [5].

Laboratory detection of ESBL production can be problematic [4, 6–13] but its detection is important because its spread within the hospital may lead to endemic occurrence and repeated outbreaks from time to time. Another important implication of ESBL production is failure to treat ESBL producing organisms because of limited therapeutic choices [14]. The first report of plasmid encoded ESBL was published in Germany (1983) [15]. The first outbreak of multidrug resistant bacteria expressing ESBL was reported in France in 1987 [16].

With the spread of ESBL-producing Gram negative bacilli (GNB) in hospitals all over the world, it is necessary to know the prevalence of ESBL-producing GNB in a hospital so as to formulate an antibiotic policy in high risk units where infections due to resistant organism is higher. Therefore, the present study was undertaken to know the prevalence of ESBL-producing *E. coli* in our hospital setting for effective therapeutic outcome and patient care.

AIMS
1. Isolation and identification of ESBL producers from urinary sample in the patients.
2. To find out the prevalence of ESBL among *E. coli.*
3. To determine the antibiotic susceptibility pattern of ESBL producers to beta-lactam

antibiotics and combinations of beta-lactam + beta-lactamase inhibitors.
4. To help the clinicians to choose the right empirical treatment.

MATERIAL AND METHOD
A total of 459 urine samples of UTI suspects which were received from January 2017 to September 2017 were processed in the Microbiology Department, Jhalawar, Rajasthan, India. All samples were cultured on Mac Conkey Agar and Blood Agar and incubated at 37 °C for 24–48 h. The isolates were identified and confirmed using standard microbiological methods including Gram staining, colonial morphology on media, growth on selective media, lactose and mannitol fermentation, H_2S production, catalase, oxidase, coagulase, indole and citrate utilization, and urease test. Antibiotic sensitivity testing of all *E. coli* isolates was performed on Muller Hinton agar (MHA) plates by Kirby-Bauer disk diffusion technique with guidelines established by the Clinical Laboratory Standards Institute (CLSI). All *E.coli i*solates were included in the study.

Antibiotic Susceptibility Testing
Susceptibility to various antimicrobial agents was determined by Disc diffusion method of Kirby Bauer on MHA (Hi-media) as described by the Clinical Laboratory and Standard Institute (CLSI) guidelines. The following antibiotic discs (drug concentration in µg) were used: Amikacin (30), Ceftazidime (30), Cefotaxime (30), Ceftriaxone (30), Co-trimoxazole (25), Imipenem (10), Ciprofloxacin (5), Cefoperozone–sulbactam (30), Piperacillin–tazobactam (30), Nitrofurantoin (30), Piperacillin (100), Amoxyclav (20/10), Azithromycin (15).

Test for ESBL Production
Screening Test
All *E.coli* isolates were subjected to screening tests by using Cefotaxime (30 µg) and Ceftriaxone (30 µg) discs. Those isolates with Cefotaxime zone <=27 mm and Ceftriaxone zone <=25 mm were considered as ESBL producer and then those isolates were subjected to confirmatory tests.

Confirmatory Test
Double Disc Synergy Test (DDST): According to the British Society for Antimicrobial Chemotherapy (BSAC) guidelines [17] isolates which were presumed to be ESBL producers on the basis of the screening test results, were picked up and emulsified in saline to a 0.5 McFarland's turbidity standard. Discs of Ceftazidime (30 µg), Cefotaxime (30 µg) and Amoxyclav (20 µg Amoxycillin and 10 µg Clavulanic acid) were placed at a distance of 20 mm from center to center in a straight line, with the Amoxyclav disc in the middle on a plate of MHA being inoculated with the test strain. The plates were incubated at 37 °C aerobically overnight. Isolates which showed an enhancement of the zone of inhibition as greater than 5 mm on the Amoxyclav side of the disc as compared to that which was seen on the side without Amoxyclav, were confirmed as ESBL producers [17] (Figure 1).
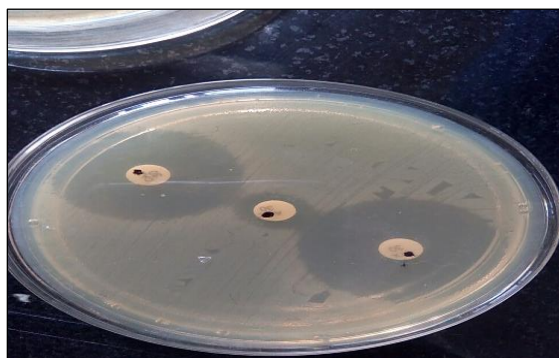

Fig. 1: *Double disc Synergy Test (DDST).*

CLSI Confirmatory Test (PCDDT-Phenotypic Confirmatory Double Disc Test)
For this test disc of Ceftazidime (30 µg) and Ceftazidime plus Clavulanic acid (30/10 µg) were placed on MHA and incubated. An increase of > 5 mm in the zone of inhibition of the combination discs in comparison to the Ceftazidime disc alone was considered to be a marker for ESBL production. *E. coli* ATCC 25922 and *K. pneumonia* ATCC 700603 were used as negative and positive controls, respectively (Figure 2).

RESULT
Of the 459 samples processed, 212 isolates were found to be culture positive. Out of 212 positive isolates, 184 (86.79%) were identified as GNB and 28 (13.20%) as gram positive cocci (GPC). Of the 184 GNB, 115 (62.50%) were detected as *E. coli* followed by *Klebsiella* 30 (16.30%), *Pseudomonas* 21 (11.41%), *Proteus* 15 (8.15%), *Citrobacter* 8 (4.32%), and *Acinetobacter* 5 (2.71%). Out of 115 *E. coli*, 86 (74.78%) were found to be ESBL positive by screening method and 81 (70.43%) were found to be ESBL producers by PCDDT and 68 (59.13%) were found to be ESBL producers by DDST (Table 1).

Fig. 2: *PCDDT-Phenotypic Confirmatory Double Disc Test.*

Table 1: *ESBL Producing E. coli by Various Test.*

Organism (N)	PCDDT test N (%)	DDST test N (%)
Escherichia coli (115)	81 (70.43%)	68 (59.13%)

Imipenem and Piperacillin–tazobactum were the most active and reliable agents for the treatment of infections which were caused by the ESBL-producing organisms. The ESBL strains were more resistant than non-ESBL producing strains. Among ESBL producers the resistance pattern was highest for Ceftriaxone followed by Cefotaxime and Ceftazidime.
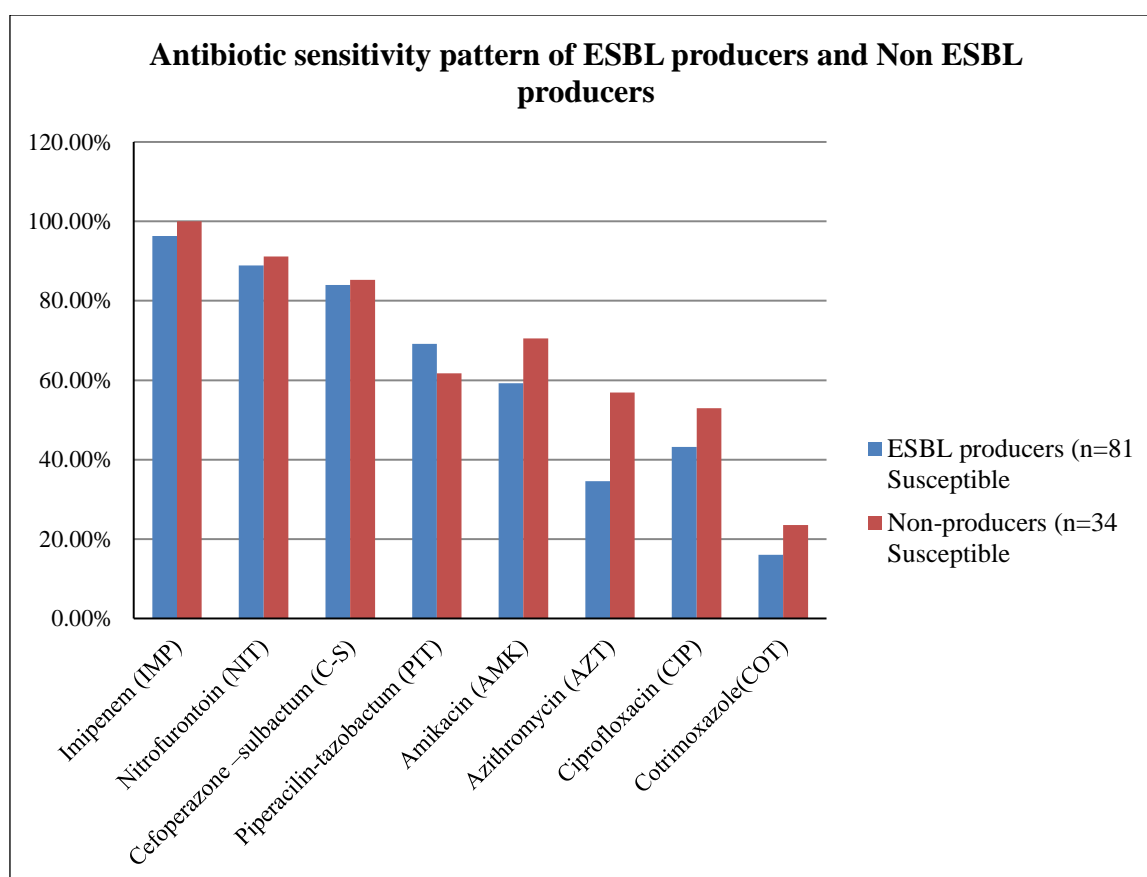
The antibiotic sensitivity pattern for ESBL producer revealed that maximum sensitivity was seen for Imipenem (96.29%), followed by Piperacillin–tazobactum (69.13%), Amikacin (59.25%), Azithromycin (34.56%), Ciprofloxacin (43.20%), and Cefepime (33.33%) (Table 2).

A high resistance rate was seen for Cotrimoxazole (83.95%), Ceftriaxone (80.24%), Ceftazidime (79.01%), Amoxyclav (80.2%), Piperacillin (83.95%), and Cefotaxime (77.77%).

Table 2: *Antibiotic Sensitivity Pattern of ESBL Producers and Non-ESBL Producers.*

Antibiotics	ESBL producers (n=81) susceptible	Nonproducers (n=34) susceptible
Imipenem (IMP)	78 (96.29%)	34 (100%)
Nitrofurontoin (NIT)	72 (88.88%)	31 (91.17%)
Cefoperazone–sulbactum (C-S)	68 (83.95%)	29 (85.29%)
Piperacilin–tazobactum (PIT)	56 (69.13%)	21 (61.76%)
Amikacin (AMK)	48 (59.25%)	24 (70.51%)
Azithromycin (AZT)	28 (34.56%)	19 (56.88%)
Ciprofloxacin (CIP)	35 (43.20%)	18 (52.94%)
Cotrimoxazole(COT)	13 (16.04%)	8 (23.52%)

Chi sq 3.325   p value =0.8534

Fig. 3: *Antibiotic Sensitivity Pattern of ESBL Producers and Non ESBL Producers.*

Imipenem and Piperacillin–tazobactum were the most active and reliable agents for the treatment of infections which were caused by the ESBL producing organisms. The ESBL strains were more resistant than non-ESBL producing strains. Among non-ESBL producers the resistance pattern was highest for Ceftriaxone followed by Cefotaxime and Ceftazidime (Figure 3).

The antibiotic sensitivity pattern for ESBL producer revealed that the maximum sensitivity was seen for Imipenem (96.29%), followed by Nitrofurointoin (88.88%), Piperacillin–tazobactum (69.13%), Amikacin (59.25%), Azithromycin (34.56%) and Ciprofloxacin (43.20%).

A high resistance rate was seen in ESBL producers for Amoxyclav (80.2%), Cotrimoxazole (83.95%), Ceftriaxone (86.41%), Piperacillin (87.65%), Cefotaxime (90.12%), and Ceftazidime (92.59%).
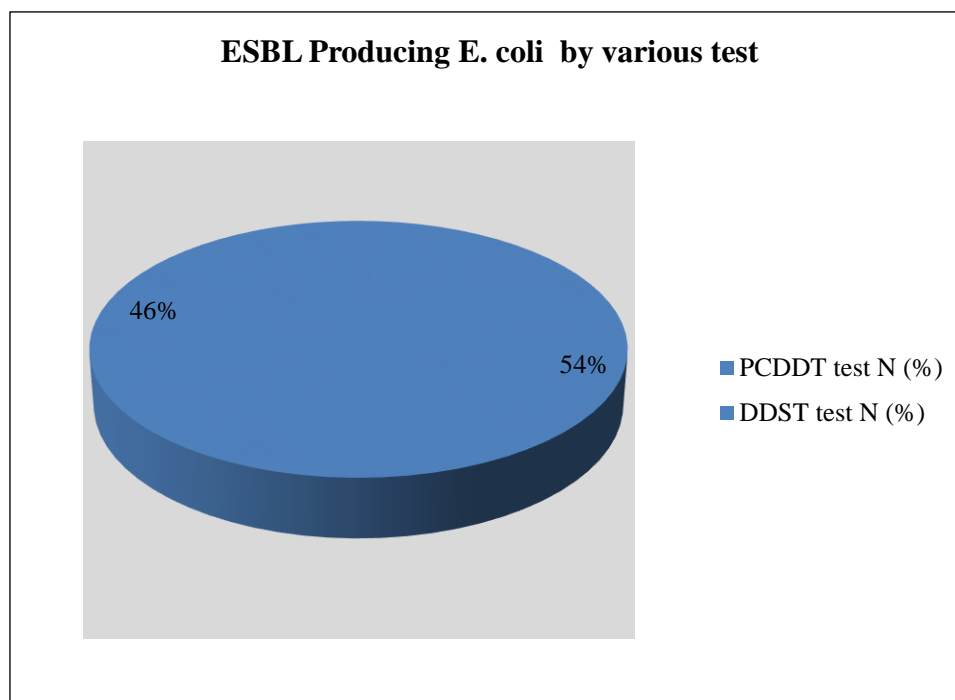
Fig. 4: *ESBL Producing E. coli by Various Test.*

DISCUSSION

The emergence and rapid spread of ESBL producing bacteria has become a worldwide problem indicating that continuous monitoring systems and effective infection control measures are absolutely required.

Prevalence of ESBL varies across continents, countries and hospitals as demonstrated by large scale studies such as SENTRY, SMART [18], MYSTIC [19]. As per the SMART study conducted in Asian-Pacific in 2007, the prevalence of ESBL production in Enterobacteriaceae was reported to be highest from India. ESBL production among *E. coli was* 79.0% [18]. Rodrigues *et al.* [20] reported 65.8% ESBL positivity among *E. coli*. This finding correlated well with those of our study. The occurrence of ESBL producers among *E. coli* in the current study was 81/115 (70.43%). In another study from Dehradun, India Sapna *et al.* [21] reported 53% ESBL-positive *E. coli* which shows less prevalence as compared to our results. Similarly in a study from Nepal, Chander and Shrestha [22] reported only 13.51% ESBL-positive *E. coli* which indicates great variation in ESBL positivity throughout India (Table 3).

Carbapenems (including Imipenem, Meropenem, and Ertapenem) have the most consistent activity against ESBL-producing organisms, showing their stability to hydrolysis by ESBLs. In our study also Carbepenems are the most effective with 96.29% ESBL producers sensitive to Imipenem.

Tsering *et al.* [31] in a similar study have reported that 97.53% ESBL producers were sensitive to Imipenem which is almost same as in our study and 48.11% of isolates were sensitive to Piperacillin–tazobactam. In the present study, sensitivity to Piperacillin–tazobactum was 69.13% and sensitivity to Cefoperazone–sulbactum was 83.95%. In another study by Mohanty *et al.* [34] sensitivity of ESBL-positive isolates was reported to be 81.37% to Piperacillin–tazobactam, 76.06% to Cefoperazone–sulbactam and 45.48% to Ticarcillin–clavulanic. Manoharan *et al.* [26] reported 89.7% sensitivity to Amikacin and 85.3% to Piperacillin–tazobactam. Sarma *et al.* [35] reported sensitivities to Piperacillin–tazobactam 89%, Amikacin 22%, Gentamicin 56%, and Tobramycin 78%. Similar kind of resistance pattern was also reported in SMART [18] study (Asia-Pacific) and MYSTIC [19] study (Table 4).

Table 3: *ESBL Producing E. coli Detection Rates in Different Indian Studies.*

Authors	Year	ESBL positive *E. coli* (%)
Trupti Bajpai *et al.* [23]	2014	41.6%
Meet Sharma *et al.* [24]	2013	52.49%
Mohamudha *et al.* [25]	2012	87.1%
Manoharan *et al.* [26]	2011	78%
Shoorashetty *et al.* [27]	2011	41%
Sridhar Rao [28]	2008	62.91%
Wani *et al.* [29]	2009	52.94%
Goyal *et al.* [30]	2009	63.6%
Tesring *et al.* [31]	2009	26.15%
Agarwal *et al.* [32]	2008	30%
SMART study [18]	2007	79%
Kumar *et al.* [33]	2006	24.8%
Rodrigues *et al.* [20]	2004	65.8%
Sapna *et al.* [21]	2015	53%
Chander *et al.* [22]	2013	13.51%
Current study	2017	70.43%

Table 4: *Sensitivity Pattern in International Studies.*

Organism	Antibiotics	Our study	SMART study	MYSTIC study
E. coli	Imipenem	96.29%	98%	98.2%
E. coli	Piperacillin–tazobactum	69.13%	98.5%	94.2%

Nitrofurantoin has also shown good sensitivity among urinary isolates and is a good choice for UTI, being available orally and cheaper than its alternatives.

Many workers have found that resistance to third generation cephalosporins coexists with resistance to other antibiotics such as, Cotrimoxazole, Ciprofloxacin, Amikacin etc. indicating multidrug resistance pattern. We found such associated resistance with Cotrimoxazole, Amikacin and fluroquinolones.

CONCLUSION

In the current study, a high prevalence of ESBL-producing *E. coli* was detected. Most of these isolates were from hospitalized patients indicating that these were important nosocomial pathogens. The outpatient presence of ESBL is of concern as it shows that ESBL is spreading fast in the community and responsible for community-acquired ESBLs. Delayed recognition and inappropriate treatment of severe infections caused by ESBL producers with cephalosporin has been associated with increased morbidity. In antibiotic sensitivity pattern many ESBL producers were found resistant to non β-lactam antibiotics such as quinolones and to lesser extent to aminoglycosides. Nitrofurantoin was found as a good choice in the form of oral drug for treatment.

It is clear that reporting of ESBL production along with the routine susceptibility testing is essential, which will help the clinician in prescribing proper antibiotics. To reduce the prevalence of antimicrobial resistant pathogens, including ESBL-producing *E.coli*, effective infection control measures such as hand washing and proper hospital hygiene are required.

There must be some guidelines for the judicious use of antibiotics and policies should be formulated which will help in minimizing the emergence of resistant bacteria among the patients. In the last it has been felt that there is a need to formulate some strategies to detect and prevent the emergence of ESBL-producing strains for the effective treatment.

REFERENCES

1. Ronald AR, Nicolle LE, Stamm E. Urinary tract infection in adults: research priorities and strategies. *Int J Antimicrob Agents.* 2001**;** 17: 343–8p.
2. Taneja N, Rao P, Arora J, *et al.* Occurrence of ESBL & Amp-C beta-lactamases susceptibility to newer antimicrobial agents in complicated UTI. *Ind J Med Res. 2008*; 127: 85–8p.
3. Ummadevi S, Joseph NM, Kumari K, *et al.* Detection of ESBLs, AmpC beta lactamase and metallo-beta-lactamases in clinical isolates of ceftazidime resistant *P. aeruginosa. BJM.* 2011; 42(1): 1284–8p.
4. Paterson DL, Bonomo RA. Extended-spectrum beta-lactamases: a clinical update. *Clin Microbiol Rev.* 2005; 18(4): 657–86p.
5. Robillard NJ. Broad-host-range gyrase A gene probe. *Antimicrob Agents Chemother.* 1990; 34: 1889–94p.
6. Bradford PA. Extended-spectrum β-lactamases in the 21st century: characterization, epidemiology, and detection of this important resistance threat. *Clin Microbiol Rev.* 2001; 14: 933–51p.
7. Livermore DM. Beta-Lactamases in laboratory and clinical resistance. *Clin Microbiol Rev.* 1995; 8: 557–84p.
8. Luzzaro F, Mezzatesta M, Mugnaioli C, *et al.* Trends in production of extended-spectrum β-lactamases among enterobacteria of medical interest: report of the second Italian nationwide survey. *J Clin Microbiol.* 2006; 44: 1659–64p.
9. Moland ES, Sanders CC, Thomson KS. Can results obtained with commercially available MicroScan microdilution panels serve as an indicator of β-lactamase production among *Escherichia coli and Klebsiella* isolates with hidden resistance to expanded-spectrum cephalosporins and aztreonam*? J Clin Microbiol.* 1998; 36: 2575–9p.
10. Pfaller MA, Segreti J. Overview of the epidemiological profile and laboratory detection of extended-spectrum betalactamases. *Clin Infect Dis.* 2006**;** 42: S153–S163.
11. Sturenburg E, Mack D. Extended-spectrum betalactamases: implications for the clinical microbiology laboratory, therapy, and infection control. *J Infect.* 2003; 47: 273–95p.
12. Tenover FC, Raney PM, Williams PP, *et al.* Evaluation of the NCCLS extended-spectrum β-lactamase confirmation methods for *Escherichia coli* with isolates collected during Project ICARE. *J Clin Microbiol.* 2003**;** 41: 3142–6p.
13. Thomson KS. Controversies about extended-spectrum and AmpC beta-lactamases. *Emerg Infect Dis.* 2001**;** 7: 333–6p.
14. Ullah F, Malik SA, Ahmed J. Antimicrobial susceptibility pattern and ESBL prevalence in *Klebsiella pneumoniae* from urinary tract infection in the North–West of Pakistan. *Afr J Microbiol Res.* 2009**;** 3: 676–80p.
15. Knothe H, Shah PDP, Krcmery V, *et al.* Transferable resistance to cefotaxime, cefoxitin, cefamandole and cefuroxime in clinical isolates of *Klebsiella pneumoniae* and *Serratia marcescens. Infection.* 11(6): 315–17p.
16. Brun–Buisson C, Legrand P, Philippon A, *et al.* Transferable enzymatic resistance to third-generation cephalosporins during nosocomial outbreak of multiresistant *Klebsiella pneumoniae. Lancet.* 1987; 2(8554): 302–6p.
17. Jonathan N. Screening for extended-spectrum Beta–Lactamase producing pathogenic enterobacteria in district general hospitals. *J Clin Microbiol.* 2005; 43(3): 1488–90p.
18. Hawser SP, Bouchillon SK, Hoban DJ, *et al.* Emergence of High Levels of Extended-Spectrum-{beta}-Lactamase Producing Gram-Negative Bacilli in the Asia Pacific Region: Data from the Study for Monitoring Antimicrobial Resistance Trends (SMART) Program. *Antimicrob Agents Chemother.* 2007; 53(8): 3280–4p.
19. Jones RN, Pfaller MA. Antimicrobial activity against strains of *Escherichia coli* and *Klebsiella* spp. with resistance phenotypes consistent with an extended-spectrum β-lactamase in Europe. *Clin Microbiol Infec.* 2003; 9(7): 708–12p.
20. Rodrigues C, Joshi P, Jani SH, *et al.* Detection of β-lactamases in nosocomial gram negative clinical isolates. *Ind J Med Microbiol.* 2004; 22(4): 247–50p.

21. Chauhan S, Mahawal BS, Ramola DC. Extended spectrum β-lactamases in urinary isolates of *Escherichia coli*— prevalence and susceptibility pattern at a tertiary care hospital. *Int J Res Med Sci*. 2015; 3(7): 1622–6p.

22. Chander & Shrestha. Prevalance of extended spectrum beta lactamase producing *Escherichia coli* and *Klebsiella pneumoniae* in urinary isolates in a tertiary care hospital in Kathmandu, Nepal. *BMC Res Notes*. 2013; 6: 487p.

23. Bajpai T, Pandey M, Varma M, *et al*. Prevalence of extended spectrum beta-lactamase producing uropathogens and their antibiotic resistance profile in patients visiting a tertiary care hospital in central India: Implications on empiric therapy. *Ind J Pathol Microbiol*. 2014; 57(3): 407p.

24. Sharma M, Pathak S, Srivastava P. Prevalence and antibiogram of extended spectrum β-lactamase (ESBL) producing Gram negative bacilli and further molecular characterization of ESBL producing *Escherichia coli and Klebsiella* spp. *J Clin Diag Res*. 2013; 7(10): 2173–7p.

25. Mohamudha PR, Harish BN, Parija SC. Molecular description of plasmid-mediated AmpC betalactamases among nosocomial isolates of *Escherichia coli & Klebsiella pneumoniae* from six different hospitals in India. *Ind J Med Res*. 2012; 135: 114–19p.

26. Manoharan A, Premalatha K, Chatterjee S, *et al*. Correlation of TEM, SHV and CTX-M extended spectrum beta lactamases among Enterobacteriaceae with their *in vitro* antimicrobial susceptibility. *Ind J Med Microbiol*. 2011; 29(2): 161–4p.

27. Shoorashetty RM, Nagarathnamma T, Prathibha J. Comparison of the boronic acid disk potentiation test and cefepime-clavulanic acid method for the detection of ESBL among AmpC-producing Enterobacteriaceae. *Ind J Med Microbiol*. 2011; 29(3): 297–301p.

28. Sridhar Rao P, Basavarajappa K, Krishna G. Detection of extended spectrum beta-lactamase from clinical isolates in Davangere. *Ind J Pathol Microbiol*. 2008; 51(4): 497–9p.

29. Wani K, Thakur M, Siraj FA, *et al*. Extended Spectrum -Lactamase Mediated Resistance in *Escherichia coli* in a Tertiary Care. *Int J Health Sci*. 2009; 3(2): 155–63p.

30. Goyal A, Prasad K, Prasad A, *et al*. Extended spectrum beta-lactamases in *Escherichia coli & Klebsiella pneumoniae* & associated risk factors. *Ind J Med Res*. 2009; 129(6): 695–700p.

31. Tsering D, Das S, Adhiakari L, *et al*. Extended spectrum beta-lactamase detection in gram-negative bacilli of nosocomial origin. *J Glob Infect Dis*. 2009; 1(2): 87–92p.

32. Agarwal P, Ghosh A, Kumar S, *et al*. Prevalence of extended-spectrum b-lactamases among *Escherichia coli* and *Klebsiella pneumoniae* isolates in a tertiary care hospital. *Ind J Pathol Microbiol*. 2008; 51(1): 139–42p.

33. Kumar M, Lakshmi V, Rajagopalan R. Occurance of extended spectrum beta-lactamases among Enterobacteriaceae spp. isolated at a tertiary care institute. *Ind J Med Microbiol*. 2006; 24(3): 208–11p.

34. Mohanty S, Singhal R, Sood S, *et al*. Comparative *in vitro* activity of betalactam/beta-lactamase inhibitor combinations against gram negative bacteria. *Ind J Med Res*. 2005; 122(5): 425–8p.

35. Sarma JB, Bhattacharya PK, Kalita D, *et al*. Multidrug-resistant Enterobacteriaceae including metallo-beta-lactamase producers are predominant pathogens of healthcare-associated infections in an Indian teaching hospital. *Ind J Med Microbiol*. 2011; 29(1): 22–7p.

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