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Original Research Article

Incidence of Carbapenem-Resistant Enterobacteriaceae at A Tertiary Care Hospital

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Abstract:

Introduction: Carbapenem-resistant *Enterobacteriaceae* (CRE), has been documented across the globe and is linked to elevated mortality rates. CRE pathogens have caused graveconcern due to the limited choice of antibiotics for treating infections caused by them. Therefore, timely detection of CRE is very important for its treatment and prevention.

Aims &Objectives: To know the prevalence of CRE in our hospital and to determine the incidence of predominant Carbapenem-resistant Enterobacteriaceae (CRE) species in different areas of the hospital.

Materials & Methods: This was an observational retrospective study involving the analysis of nonrepetative 299 specimens of patients of all ages and sexes from indoor and outdoor patient departments (OPD) from June 2020 to September 2020 at the tertiary care hospital. All specimens were processed and Enterobacteriaceae organisms were isolated by culture and identified by biochemical reactions and further identified as carbapenem-resistant strains by anti-microbial susceptibility testing for carbapenems, done by Kirby-Bauer disk diffusion method according to Clinical and Laboratory Standards Institute guidelines(CLSI).

Result: There were 299 Enterobacteriaceae organisms isolated from received specimens out of which 86(28.76%) isolates were carbapenem-resistant. Most of the CRE was isolated from urinary samples (47.67%)and from ICUs (31.40%) and Wards (55.81%). Most commonly isolated CRE organism was Klebsiella species (65.12%).

Conclusion: Our study shows a high incidence of carbapenem-resistant *Klebsiella species* (65.12%) among isolated *Enterobacteriaceae.* A significantly high incidence rate of Carbapenem-resistant Enterobacteriaceae was observed amongst indoor patients(87.20%) & was of hospital-associated infections. Hence early detection of CRE organisms and the application of appropriate infection control measures can help prevent and control CRE infections.

Keywords: Carbapenem-resistant Enterobacteriaceae (CRE), Carbapenems, Antibiotic resistant

Introduction

Carbapenem-resistant *Enterobacteriaceae* (CRE), has been documented across the globe and is linked to elevated mortality rates. CRE pathogens have caused grave concern due to the limited choice of antibiotics for treating infections caused by them. Therefore, timely detection of CRE is very important for its treatment and prevention.

In 2017, WHO published a list of antibiotic-resistant bacteria against which there is an urgent-need to develop new antibiotics. [1] This list is divided into three categories depending on the urgency with which new antibiotics are needed: critical, high, and medium priority. Among the high priority category are carbapenem and3rd generation cephalosporin resistant *Enterobacteriaceae*.

Enterobacteriaceae are common pathogens causing severe infections such as bloodstream infections, pneumonia, complicated urinary tract infections, and complicated intra-abdominal infections. As a result, antibiotic resistance in *Enterobacteriaceae* has significant clinical and socioeconomic consequences. [2,3]

Aims & Objectives

- To know the prevalence of Carbapenem-resistant *Enterobacteriaceae.*
- To determine the incidence of predominant Carbapenem-resistant *Enterobacteriaceae*

(CRE) species in different areas of the hospital.

Material & Method

This was an observational retrospective study involving the analysis of 299 specimens received from patients of all ages and sex admitted to all intensive care units, and indoor and outdoor departments (OPD) from June 2020 to September 2020 at the microbiology laboratory of tertiary care hospital, Ahmedabad.

Blood, urine, wound swab, pus, tissue, drain, biliary secretion, urinary catheter, stool, and respiratory specimens were received for culture at the microbiology laboratory.

Enterobacteriaceae organisms isolated by culture and identified by biochemical reactions and further identified as carbapenem-resistant strains by antimicrobial susceptibility testing for carbapenems, done by Kirby-Bauer disk diffusion method on Mueller- Hinton agar, according to Clinical and Laboratory Standards Institute guidelines (CLSI)2020.

Zone diameter of imipenem(10mcg) ≤19 mm was considered resistant according to CLSI 2020. [4] The MIC values were interpreted according to the CLSI cutoff levels.

Detection of MIC was done by Epsilometer test (E-test) using Meropenem E-stripon Mueller- Hinton agar, Carbapenem non-susceptibility was identified when MIC was ≥4 mcg/mL for meropenem, according to CLSI 2020. We had not included repetitive specimens of the same patient with the same isolates. [5]

Result

A total of 299 Enterobacteriaceae organisms were isolated from received specimens out of which 86 (28.76%) isolates were carbapenem-resistant (fig.1).

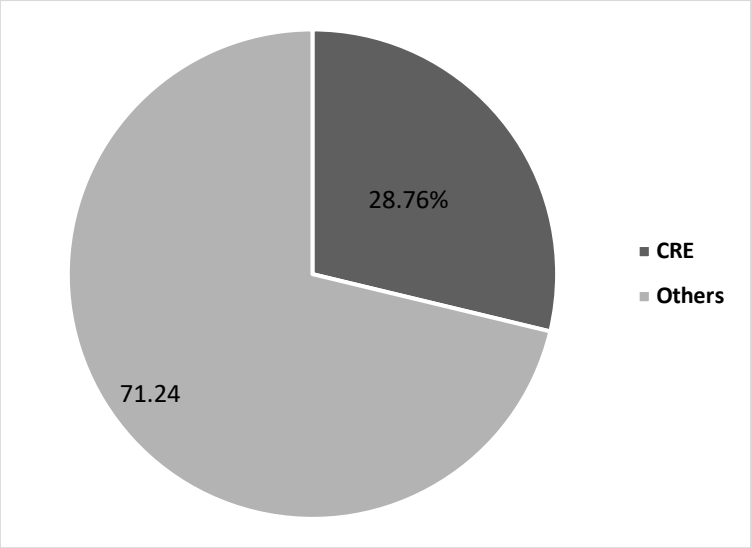

Figure 1: Carbapenem Resistant Enterobacteriaceae isolates

Out of 86 CRE isolates, 50 (58.14%) were from specimens of adult patients (14-59 year), 6 (6.97%) were from specimens of paediatric (0-13 years) patients, and 30 (34.88%) were from specimens of elder patients (age>60). CRE isolates from male patients were 43 (50%) and from female patients were 43 (50%).

Out of 299 isolated Enterobacteriaceae 177 were from urine out of which 41 isolates were CRE(23.16%), 40 were from sputum out of which 6 isolates were CRE (15%), 19 were from the blood out of which13 were CRE (68.42%), 50 were from pus and swab out of which 16 were CRE (32%), 4 were from tissue out of which 3 were CRE (75%), 3 were from stool out of which 2 were CRE (66%), 1 was from biliary secretion which was CRE (100%), 2 were from urinary catheters both were CRE (100%) and 5 were from tracheal aspirate out of which 4 were CRE (80%). (Table 1)

Table 1: CRE Isolates

Specimen Type	Total Enterobacteriaceae Isolates	CRE Isolates	%

Urine	177	41	23.16%
Blood	19	13	68.42%
Tracheal aspirate	5	4	80.00%
Sputum	40	6	15.00%
Pus	50	16	32.00%
Biliary secretion	1	1	100.00%
Tissue	4	3	75.00%
Stool	3	2	66.67%
Total	299	86	28.76%

Out of 86 CRE isolates from various specimen, 30 (34.88%) were and 56 (65.12%) were *Klebsiella species*. (fig.2). Out of 41 CRE isolates from urine, 19 (46.34%) were *E. coli* and 22 (53.66%) were *Klebsiella species*. Out of 13 CRE isolates from Blood, 3 (23.08%) were *E. coli* and 10 (76.92%) were *Klebsiella species*. Out of 16 CRE isolates from Pus, 4 (25%) were *E. coli* and 12 (75%) were *Klebsiella species*. There are 6 CRE organisms isolated from sputum, and all were *Klebsiella species* (100%). Out of 3 CRE isolated from tissue specimen and all 3 (100%) were *Klebsiella species*. Out of 4 CRE isolates from tracheal aspirate, 1 (25%) were *E. coli* and 3 (75%) were *Klebsiella species*. All the CRE organism isolated from stool specimen were *E. coli* (n=2, 100%). There is 1 CRE isolated from biliary secretion which was *E. coli* (100%). (Table 2).

Table 2: CRE Isolates

Specimen Type	E. coli	%	Klebsiella Species	%	Total	%
Urine	19	46.34%	22	53.66%	41	47.67%
Blood	3	23.08%	10	76.92%	13	15.12%
Tracheal aspirate	1	25.00%	3	75.00%	4	4.65%
Sputum	0	0.00%	6	100.00%	6	6.98%
Pus	4	25.00%	12	75.00%	16	18.60%
Biliary secretion	1	100.00%	0	0.00%	1	1.16%
Tissue	0	0.00%	3	100.00%	3	3.49%
Stool	2	100.00%	0	0.00%	2	2.33%
Total	30	34.88%	56	65.12%	86	100%

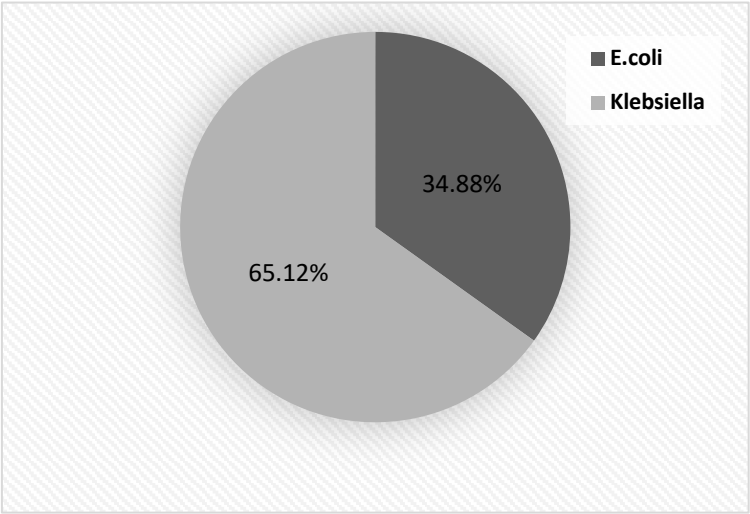

Figure 2: Carbapenem Resistant Enterobacteriaceae

Out of 299 Enterobacteriaceae isolates, 42 were from ICUs out of which 27wereCRE (64.28%).117 were from wards out of which 48 were CRE (41.02%).140were from OPD out of which 11 were CRE (7.85%). Out of 86 CRE isolates, 27 (31.40%) were from ICUs, 48 (55.81%) from wards, and 11 (12.79%) from OPDs. (Table 3)

Out of 27 CRE isolated from specimens received from various ICUs, 13 (48.15%) were *E. coli* and 14 (51.85%) were Klebsiella species. Out of 48 CRE isolates from wards, 11 (22.91%) were *E. coli*

and 37 (77.08%) were *Klebsiella species*. Out of 11 CRE isolates from OPDs, 6 (54.55%) were E. coli and 5 (45.45%) were Klebsiella species. (Table 3).

Table 3: Distribution of Carbapenem Resistant Organisms

Area	E. coli	%	Klebsiella spp.	%	Total	%
ICUs	13	48.15%	14	51.85%	27	31.40%
Wards	11	22.92%	37	77.08%	48	55.81%
OPDs	6	54.55%	5	45.45%	11	12.79%
Total	30	34.88%	56	65.12%	86	100%

Discussion

There were 86 (28.76%) isolates out of 299 *Enterobacteriaceae* isolated shows carbapenem-resistant. A study done by Pawar et al showed 31.77% CRE prevalence, which is similar to our findings. [6] Out of 86 CRE isolates most of them were isolated from urinary specimen (n=41,47.67%), followed by pus (n=16,18.60%) and blood (n=13,15.12%) specimens.In contrast, study done by Saeed et al. found tracheal aspirate (27.3%) and urine specimens (26.3%) as the most common source of CRE isolates. [7] Study done by Nair et al found that majority of CRE were isolated from urine specimens (46%). [8] The rise in CRE infection occurrences in these samples could be linked to catheter-associated urinary tract infections, central line-associated bloodstream infections, or surgical site infections.

Out of all CRE isolates(n=86), most of them were *Klebsiella species*(n=56,65%). Similarly, study done by Pawar et al showed 63% of *Klebsiella species* isolates were carbapenem-resistant. [6]

Out of 86 CRE isolates,27(31.40%) CRE isolated in specimens received from ICUs and 48 (55.81%) CRE isolated in specimens received from wards. Similarly, Nair et al found higher prevalence of CRE isolates from ICUs (26%) and Wards (42%). [8] Healthcare-related risk factors for CRE infection may include extended hospitalization, the presence of invasive medical devices, and prior exposure to antimicrobial agents. [9,10,11,12]

All the CRE isolates in our study were susceptible to tigecycline and polymyxin B, similarly to the study done by Guh et al. and Han et al.[13,14] This renders them the most effective combination for initial empirical therapy for suspected severe CRE infection.

Conclusion

A significant carbapenem resistance rate of 28.76% was observed among isolated *Enterobacteriaceae*. The global increase in CRE infections is alarming due to the association of these highly virulent bacteria with elevated morbidity and mortality rates. Regular surveillance and timely implementation of bundled infection control measures, such as early identification, rapid patient cohorting, enhanced contact precautions, and education/training programs, are essential for preventing and managing CRE infections. Understanding the local resistance patterns, as outlined in this study, suggests that combination therapy with polymyxin B and tigecycline could be the optimal empiric frontline treatment for suspected serious CRE infections.

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