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RESEARCH ARTICLE

PREVALENCE OF METALLO β LACTAMASES IN NON-FERMENTING GRAM NEGATIVE BACILLI FROM CLINICAL ISOLATES.

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ABSTRACT

Background and Objectives: Non fermenting gram negative bacilli (NFGNB)producing Metallo β lactamases (MBL) are an increasing cause of concern in the hospitals as they produce a therapeutic dilemma for the treating physician. The present study was undertaken to know the prevalence of MBL producing non fermenting gram negative bacilli from clinical isolates and their antibiotic resistance pattern. **Methods:** A total of 389 non fermenting gram negative bacilli were recovered from various clinical specimens. All the samples were processed for routine bacterial culture and antimicrobial susceptibility test as per standard protocol. They were further subjected to Metallo β-lactamase detection by Imipenem+ EDTA combined disc test. **Results:** By Imipenem-EDTA combined disk test 49 (12.59%) isolates were found to be Metallo β-lactamase positive.Among*Pseudomonas aeruginosa* 29 (10.58%) were Metallo β-lactamase producing while among Acinetobacter species 20 (17.39%) Metallo β-lactamase producing. Majority of Metallo β-lactamase producers were resistant to Gentamicin (87.75%), Levofloxacin (83.67%) and Gatifloxacin (71.42%) respectively. All isolates were sensitive to Polymyxin B. **Conclusion:** The prevalence of Metallo β-lactamase was 12.59% among NFGNB. Significantly higher resistance rate was observed by these isolates to almost all the drugs routinely used

Key words: NFGNB., Metallo β-lactamase., Imipenem-EDTA combined disk test.,

INTRODUCTION:

NFGNB are innately resistant to many antibiotics and are known to produce extended spectrum beta- lactamases (ESBLs) and Metallo beta- lactamases (MBLs).[1]

Carbapenems are the only reliable active antibiotic against many multi-resistant gram negative pathogens particularly those with extended spectrum beta-lactamase and Amp C enzymes. The emergence and diversity of carbapenemase producing strains is therefore a major concern.[2]

Gram-negative bacteria have at their disposal a plethora of resistance mechanism that they can sequester and/or evince, eluding the actions of carbapenems and other beta-lactams. The common form of resistance is either through lack of drug penetration (i.e outer membrane protein (OMP) mutations and efflux pumps), hyperproduction of an AmpC-type beta-lactamase, and carbapenem-hydrolyzing beta-lactamases.[3]

MATERIALS AND METHODS:

The present study was undertaken at the Department of Microbiology, Karnataka Institute of Medical Sciences (KIMS), Hubli from Dec 2010 to Nov 2011.

Source of data:

Clinical samples such as pus, urine, blood, body fluidsetc. obtained from patients admitted in Karnataka Institute of Medical Sciences hospital and received at the department of Microbiology.

Inclusion criteria:

Non repetitive, consecutive non-fermenting gram negative bacilli isolated from clinical samples obtained from hospitalised patients (IPD) received during study period.

Sample processing:

All the samples were processed for routine bacterial culture as per standard protocol.[4] Smears were prepared on clean glass slides. Gram stain performed and observed

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for the presence of any gram negative bacilli or gram variable cocco-bacilli. Samples were inoculated into Thio-glycollate broth, chocolate agar, MacConkey's agar and Blood agar . They were incubated at 37^0 C in ambient air for 24 to 48hours. Isolates were identified based on colony morphology, motility and relevant biochemical reactions. All organisms that grew on triple sugar iron agar and produced an alkaline reaction were provisionally considered to be NFGNB and identified further by using a standard protocol for identification.[4,5]

Antimicrobial susceptibility test:[6,7]

Antimicrobial susceptibility test was carried out with modified Kirby-Bauer disk diffusion method using current CLSI[9] recommendations. Commercially available antibiotic disks (Himedia, Mumbai) were used. The antibiotic susceptibility profile against Gentamicin, Amikacin, Gatifloxacin, Levofloxacin, Cephalosporins (Cefoxitin, Ceftazidime, Cefotaxime, Ceftriaxone, Cefepime), Piperacillin-Tazobactam, Imipenem and Polymyxin B were studied. *Pseudomonasaeruginosa* ATCC 27853 was used as control strain.[6]

The isolates were further subjected to following tests:

1. Metallo β -lactamase production detected by Combined disk diffusion method using Imipenem+EDTA combined disk.[8.9.10.11]

1. Detection of MBL production:[6]

Imipenemresistant isolates were selected for detection of MBL production[8].

- Imipenem-EDTA combined disc test:

A suspension of the test isolate equivalent to 0.5 McFarland turbidity was swabbed on Muller Hinton agar plate and two 10µg imipenem disks were placed on the plate. 10µl of EDTA solution was added to one of them to obtain the desired concentration (750µg). After overnight incubation at 37^0 C, the inhibition zones of imipenem and imipenem+EDTA disks were compared.

Interpretation:

- If the increase in inhibition zone with imipenem-EDTA disc is ≥7mm than the imipenem disc alone, it is considered as MBL positive.

Statistical analysis:

Chi square test was used with appropriate correction to see the significance of difference between the sensitivity of various drugs in MBL producing strains using SPSS software. p≤0.05 was considered significant.

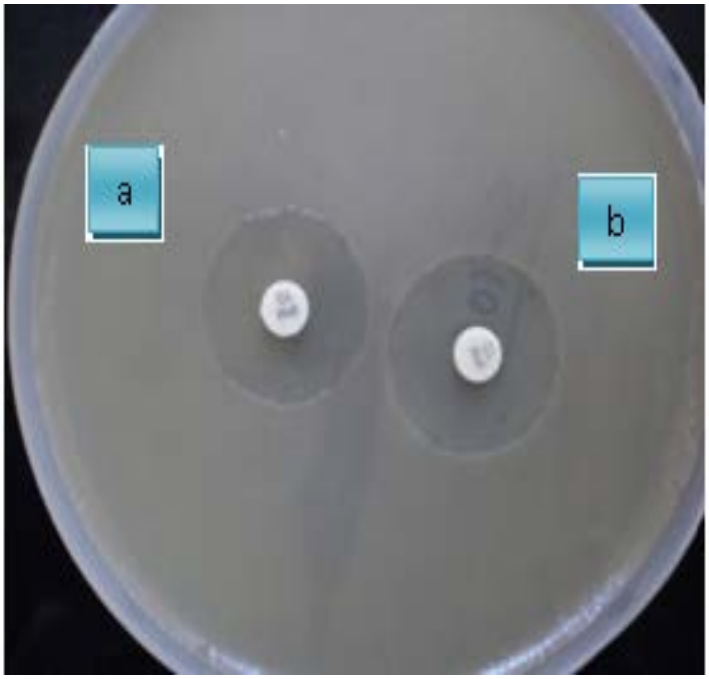

Figure: 1

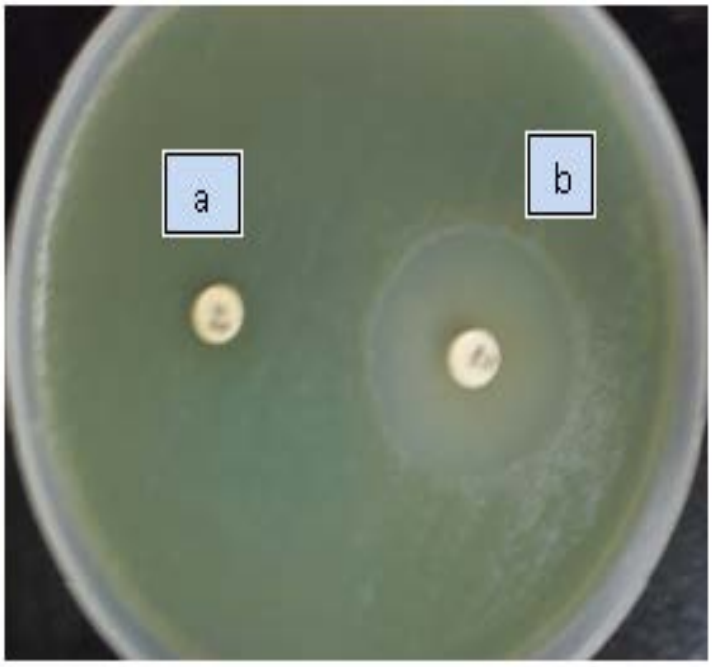

Figure: 2

Figure 1: Metallo β-lactamase-Combined disc diffussion test: (a) Imipenem (b) Imipenem+EDTA.

Test negative for MBL production

Figure 2: Combined disc diffussion test: (a) Imipenem (b) Imipenem+EDTA.

Test positive for MBL production

RESULTS AND OBSERVATIONS:

A prospective study was conducted to know the prevalence of different β-lactamases among non-fermenting gram negative bacilli isolated from various clinical specimens received at the Department of Microbiology, Karnataka Institute of Medical Sciences, Hubli, during the period Dec 2010 to Nov 2011.

2758 bacterial isolates 389 (14.1%) were Non-fermenting gram negative bacilli recovered from various clinical specimens like pus (207), sputum(61), urine(55), ear discharge (31), blood (8), cerebrospinal fluid (8), pleural fluid (6), ascitic fluid (6), post operative drain (3), aspiration from liver abcess (2), corneal scraping (1) and tracheal secretion (1).

Table 1: Detection ofMetalloβ-lactamase by Imipenem-EDTA combined disc test positive:

Organism	No. of isolates resistant to Imipenem	Imipenem-EDTA combined disc test positive isolates No (%)
Pseudomonas aeruginosa (274)	32	29 (10.58)
Acinetobactercalcoaciticus-baumaniicomplex(99)	21	20 (20.2)
Acinetobacterlwoffii (10)	0	0
Acinetobacterhemolyticus (6)	0	0
TOTAL (389)	53	49 (12.59)

Among the 389 total isolates 53 were resistant to imipenem and 49 (75.38%) were detected as Metalloβ-lactamase producers by Imipenem-EDTA combined disc test.

- Of the 389 isolates, 53 (13.62%) were resistant to imipenem.
- A total of 49(12.59%) isolates were found to be Metalloβ-lactamase positive by Imipenem-EDTA combined disc test.

Maximum number of β-lactamaseproducing organisms were isolated from pus {ESBL-96(49%), Amp C-35(53%), MBL-29(59%)} followed by urine {ESBL-29(15%), Amp C 9(14%), MBL-5(10%)} and sputum {ESBL-28(14%), Amp C-8(12%), MBL-7(15%)}.

Table 2: Prevalence ofMetalloβ-lactamase among different non-fermenting gram negative organisms.

Organism	Metalloβ-lactamase positive no (%)
Pseudomonas aeruginosa (274)	29 (10.58)
Acinetobactercalcoaciticus-baumaniicomplex (99)	20 (20.2)
Acinetobacterlwoffii(10)	0
Acinetobacter hemolyticus(6)	0
TOTAL (389)	49 (12.59)

Table 3: Co-existence of AmpCβ-lactamases and Metalloβ-lactamases among different organisms.

Organism (no)	AmpC and Metalloβ-lactamase positive no (%)
Pseudomonas aeruginosa(274)	4 (1.45)
Acinetobactercalcoaciticus-baumaniicomplex (99)	7 (7.07)
AcinetobacterLwoffii (10)	0
Acinetobacterhemolyticus(6)	0
TOTAL (389)	11 (2.82)

11 (2.8%) isolates demonstrated the coexistence phenotype of both Metalloβ-lactamase and AmpC β-lactamases.

Table 4: Distribution ofMetalloβ-lactamases positive non-fermenting gram negative bacilli isolate in the hospital ward.

Wards	Metalloβ-lactamase positive no (%)
Surgery	15(30.61)
Medicine	14(28.57)
Orthopedics	6(12.24)
Burns	4(8.16)
ENT	2(4.08)
OBG	5(10.2)
Pediatric	2(4.08)
Ophthalmology	0
NICU	1(2.04)
Total(389)	49(12.59)

(Graph 3depict distribution of Metalloβ-lactamase isolates in the hospital.
Maximum number of the extended spectrum β-lactamase, AmpC andMetalloβ-lactamase harbouring non-fermenting gram negative bacilli isolates were obtained from the Surgery, Medicine and Orthopedics wards.

Table 5: Comparison of Antibiotic resistance pattern of Metalloβ-lactamase positive and Metalloβ-lactamase negative Non fermenting gram negative bacilli.

Antibiotics	Metalloβ-lactamase negative NFGNB n=340		Metalloβ-lactamase positive NFGNB n=49		p value
	Resistant	%	Resistant	%	
Gentamicin	85	25	43	87.75	0.05
Amikacin	50	14.7	28	57.14	0.05
Gatifloxacin	81	23.82	35	71.42	0.05
Levofloxacin	105	30.88	41	83.67	0.05
Cefipime	73	21.47	49	100	0.01
Ceftazidime	216	63.52	49	100	>0.05
Imipinem	4	1.17	49	100	0.0001

MBL producing organisms were more drug resistant, difference was statistically significant towards all the antibiotics used in the study except for Ceftazidime.

Table 6: Comparison of Antibiotic sensitivity pattern of Metalloβ-lactamase positive Non-fermenting gram negative bacilli.

Antibiotics	Metalloβ-lactamase positive NFGNB N=49	
	Sensitive	%
Gentamicin	6	12.24
Amikacin	21	42.85
Gatifloxacin	14	28.57
Levofloxacin	9	18.36
Cefipime	0	0
Piperacillin-tazobactam	0	0
Imipinem	0	0
Polymyxin B (300µg)	49	100

Table 7: Analysis of the risk factors for non-fermenting gram negative bacilli infection by MBL positive isolates.

Risk factors	MBL positive No (n=49) (%)
Burns (30)	4(8.16)
Carcinomas (18)	3(6.12)
Catheterization(136)	30(61.22)
Chronic ailment(116)	17(34.69)
Diabetis mellitus. (18)	2(4.08)
HIV Positive(9)	0
Hospitalization of 5 days or more (200)	39(79.59)
ICUs (Intensive care units) (6)	1(2.04)
Neurological Disorders(6)	1(2.04)
Sepsis (9)	1(2.04)
Surgical Intervention(173)	35 (71.42)

The major risk factors for infection with Metalloβ-lactamases producing non-fermenting gram negative bacilliwerehospitalization of 5 days or more, surgical intervention and catheterization.

DISCUSSION

Nonfermentative gram-negative bacilli (non-fermenters) cause a significant number of infections, particularly in the hospitalised patients and immunocompromised hosts. *Pseudomonas aeruginosa* and *Acinetobacterbaumanii*are the most common nonfermenters pathogenic for humans. Infections caused by other species are relatively infrequent.[11]

Infections caused by *Pseudomonas aeruginosa* are difficult to treat as the majority of isolates exhibit varying degrees of innate resistance. Acquired resistance is also reported by the production of plasmid mediated AmpC beta lactamase, extended spectrum β-lactamase and metallo β-lactamase (MBL) enzymes. With the increase in occurrence and types of these multiple β-lactamase enzymes, early detection is crucial.[12]

Antimicrobial treatment of the nosocomial infections caused by these agents may be compromised by multiple drug resistance to β-lactams, aminoglycosides and fluoroquinolones. Imipenem, a broad spectrum beta-lactam antibiotic and the first carbapenem to be used for clinical use, is an important drug for treatment of such infections. Imipenem offers the advantage of being more stable to most β-lactamases than the third generation cephalosporins. Unfortunately paralleling its increasing use in the west, resistance to imipenem has increased mainly among gram negative bacilli and particularly *P. aeruginosa*.[11]

Resistance rates vary from country to country. Overall, isolates from Latin American countries show the lowest susceptibility rates to all antimicrobial agents followed by Asian-Pacific isolates and European strains. Strains from Canada exhibit the best global susceptibility testing results.[11]

In the present study, 389 (14.1%) isolates were non-fermenting gram negative bacilli recovered from various clinical specimens at the department of Microbiology, Karnataka Institute of Medical Sciences, Hubli from Dec 2010 to Nov 2011. Out of which 274(70.43%) were *Pseudomonas aeruginosa*, 99 (25.44%) were *Acinetobactercalcoaciticus - baumanii complex*, 10 (2.57%) were *Acinetobacterlwoffiiand* 6(1.54%) were *Acinetobacterhemolyticus.* Study conducted by Malini A, Deepa E K, et al. reported non fermenting gram negative bacilli isolation rate as 4.5%. *Pseudomonasaeruginosa* as the most common isolate (53.8%).[5]

Maximum number of non fermenting gram negative bacilli were isolated from pus (53.21%) followed by sputum (15.68%) and urine (14.13%).NoyalMariya Joseph, SujathaSistla et al.[13] reported, non-fermenters (77.8%) were the most predominant pathogens causing Ventilator-Associated Pneumonia in the Critical Care Units and the Medicine Intensive Care Unit (48.3%).

Baheraet al.[14] isolated 37.36 % *P.aeruginosa* from bronchoalveolar lavage, 23.07 %from blood, 15.38% from tracheal aspirate.

Metallo β-lactamases:

A total of 53 (13.62%) isolates were resistant to imipenem. Among these 49 (12.59%) were detected as Metallo β-lactamases producers by Imipenem-EDTA combined disc test. Surveillance in Brooklyn, New York, revealed that approximately 2 of every 3 isolates of Acinetobacter species were resistant to carbapenem.[15] In an Australian study *A. baumannii* isolates recovered from blood, 64% were resistance to meropenem.[16] Among the *P. aeruginosa* 31.1 % meropenem resistance was documented by Noyal MJC et al[17]. These findings clearly show a rising trend in the carbapenem resistance among the nonfermenters.

Imipenemresistance in non Metallo β-lactamases producers may be due to lack of permeation of porin or porin deficient mutants.[3]

Ceftazidime has been recommended by many authors to screen MBL producers[19,20.18]. Franklin C et al.[18] opined that with the emergence of carbapenem-susceptible MBL-carrying organisms, the issue of which isolates to select for phenotypic MBL detection is now more challenging. Clearly, screening only carbapenem-resistant organisms, as is most often performed, is suboptimal. On the other hand, selecting all isolates creates unnecessary work with a lower yield.

HoriehSaderiet al.[21] reported that in phenotypic method, 65 imipenem-resistant isolates produced MBL enzyme and four isolates were MBL negative which correlates with our study.Deshmukh D G et al.[8] observed among gram negative isolates 2.97% were MBL producer, of which 11 (1.7%) were non-fermenters.

Imipenem-EDTA combined disc test:

Several phenotypic methods are available for the detection of MBL-producing bacteria. All these methods are based on the ability of metal chelators, such as EDTA and thiol-based compounds, to inhibit the activity of MBLs. While most of these tests are technically demanding, expensive, time-consuming, and often subjective to interpret.[22,23]

The combined disk test using EDTA with imipenem is simple to perform and interpret and can be easily introduced into the workflow of a clinical laboratory[24]. This test has been used in several studies where it produced excellent sensitivity and specificity for detecting MBL-producing *P. aeruginosa* strains.[19,22,24]

By the above method 49 (12.59%) were identified as Metallo β-lactamases producers.

The following are the various reports of Metallo β-lactamasesproducers using theImipenem-EDTA combined disc test:

Noyal MJC et al.[17] observed that EDTA disk synergy test detected MBL production in additional 9 Pseudomonas species and 2 Acinetobacter species, which were missed by the modified Hodge test. Based on these findings, EDTA disk synergy test seems to be a better method for MBL detection than modified Hodge test. Though the reason for the difference in the performance of these two tests is not clear, similar results have been observed in other studies by Jesudason MV et al.[25] and Lee K et al.[22]

Bergès L. DeplanoA et al.[26] reported that MBL-Combined Disk test was positive in 62%, of these 55% were MBL-E-test positive. All carbapenem-resistant isolates with negative MBL- Combined Disk screening were confirmed as E-test and PCR negative. MBL-Combined Disk test appeared to be an easy and sensitive tool for rapid screening of MBL producing *P. aeruginosa* isolates and MBL-E-test could be considered for confirmation of MBL production. Renu G, Rajeev T, et al.[9] expressed that there was 100% concordance between the Combined Disk Test and MBL E test strips in their study. According to Yong et al.[10] the imipenem (IMP) 10 µg-EDTA 750 µg combined disc test has 95.7% sensitivity and 91.0% specificity for detection of Metallo-β-lactames in MBL-producing Pseudomonas spp and Acinetobacter spp.Franklin C et al.[18] reported that the phenotypic (combined disk method) MBL detection method identified all isolates that were confirmed to be carrying an MBL by PCR (100% sensitivity).

Different studies from India reported MBL producing isolates ranging from 7 to 65%.[27,28,29,30,31]

In our study Metalloβ-lactamase production was observed in 29 (10.58%) of *Pseudomonas aeruginosa*and20 (20.2%) of*Acinetobactercalcoaciticus-baumaniicomplex.*

Gupta V et al.[27] reported MBL in 7.5% of the *Pseudomonas* aeruginosa isolateswhich correlates with our study.Varaiya A et al. quoted a higher range of 20.8% among *Pseudomonas aeruginosa* isolates.[32] In India prevalence of MBL producing *P.aeruginosa* ranging from 8 to 14% [32,33,34] and in foreign countries ranging from 2 to 16%.[24,35,36,37]

Distribution among different samples:

Majority of Metalloβ-lactamase producing organisms were also isolated from pus 29 (59%). Hirakata et al.[33] observed in their study that the predominant source of isolation for MBL positive *P.aeruginosa* was urinary tract (40.0%) followed by respiratory tract (18.8%). Franklin C

et al.[18] reported 40% were from respiratory tract specimens, 26% were from blood, 12% were from vascular catheter tips. Various studies have reported range of Metalloβ-lactamaseproducing NFGNB in pus (15-36.8%), wounds (10-15%), urine (6-40%),respiratory tract (18.8-40%), invasive devices (1-26%) and blood (10.6-26%).[8,18,33]

Distribution of the isolates in the hospital:

Significant number of the ESBL, AmpC, MBL positive strains were isolated from Surgery ward 60 (30.15%), 25 (37.87%), 15 (30.61%), followed by Medicine 51 (25.62%), 20 (30.3%), 14 (28.57%) and Orthopedics 32 (16.08%), 4 (6.06%), 6 (12.24%) respectively.

It is apparent that various mechanisms exist for the production of multiple β-lactamases especially in high pressure units like Surgery, Medicine and Orthopedics where newer β-lactams are being routinely prescribed.[38]

K PrabhatRanjan, NeelimaRanjan, et al.[39] reported that *P. aeruginosa* was the most prevalent (29.6%) among all the pathogens isolated from the surgical wound. Anupurba and colleagues[40] quoted 32%, where asHani and colleagues[41] found a prevalence rate of 27.78%.Iraida E. Robledoet al.[23] reported 60% of resistant strains Acinetobacter species were from ICU.

Male to female ratio was 1.74: 1.

MBL isolates 11 (22.44%) were in 41-50 years age group.

Mean age in the study group is 38.1 ± 18.48 years.

There was no statistically significant difference observed between male and female gender regarding ESBL, AmpC and Metallo β-lactamases producers.

Antibiotic sensitivity pattern of MBL producing organisms:

Higher resistance among MBL producers was observed to gentamicin 43(87.75%), levofloxacin 41 (83.67%) and gatifloxacin 35 (71.42%). Comparatively lower resistance was observed to amikacin 28 (57.14%) and 100% sensitivity to Polymyxin B.

Other studies have reported range of MBL isolates resistance to Gentamicin (70-86%)[12,22] and Amikacin(73-92.9%).[9,18,21,42,43,44]Possible reasons for the variety of antibiotic-resistance rates in the different studies was not understood, but it may reflect the amount of antibiotics used in various settings.[21]

Metallo β-Lactamases are inhibited by metal chelators such as EDTA but are not affected by therapeutic β-lactamase inhibitors like sulbactam, tazobactam, or clavulanic acid.[36]

HoriehSaderi et al. also observed Sixty-nine percent of *P. aeruginosa* isolates as multidrug resistant and resistant to the agents in 2 or more of the following antimicrobial categories: β-lactam antibiotics, including imipenem, aminoglycosides and fluoroquinolones. Multidrug resistance was more prevalent in imipenem-resistant isolates than imipenem-susceptible isolates (87% vs 29%)[36].

Therapeutic options:

The unique problem with MBLs is their unrivalled broad spectrum resistance profile. These MBL positive strains are usually resistant to ß-lactams, aminoglycosides and fluoroquinolones. However remain susceptible to polymyxins.[3]In the absence of therapeutic MBL inhibitors, polymyxins have shown to be effective in the treatment of MBL producing *P. aeruginosa* infections. It has been claimed that Polymyxins are not as toxic as previously thought.[45] However, they should not be used in monotherapy. A combination therapy must be preferred. An aminoglycoside or a fluoroquinolone molecule that may have retained some activity against the isolate may be chosen substantiated by rapid determination of its MIC levels for the isolate.

Risk factors for different β-lactamase producing non-fermenting gram negative bacilli infection.

In our study the major risk factors for infection with β-lactamase producing non-fermenting gram negative bacilli were Hospitalization of 5 days or more, Surgical intervention and Catheterization.

Hirakata et al.[33] have found malignancy as a risk factor for acquisition of MBL producing *P.aeruginosa*. with 53.8% of *P.aeruginosa* recovered from patients with malignancy. In our study 6.12% cases had malignant disease.

Hirakata et al. also suggested the possible risk factors for infection or colonization with MBL producers include long term hospitalization, administration of antineoplastic agents and use of indwelling urinary catheters[33] which correlates with our study.

NoyalMariya Joseph, SujathaSistla et al.[13] observed prior antibiotic therapy and current hospitalization of five days or more were independent predictors of Ventilator-Associated Pneumonia caused by MDR pathogens. Exposure to antibiotics is a significant risk factor for colonization and infection with nosocomial multidrug-resistant pathogens.Zavascki AP, Barth AL, Gaspareto PBet al.[46]quoted neurological disease, urinary tract infection, and renal failure as risk factors. Simone AranhaNoue´r, MarcioNucci,et al.[37] observed that MBL colonization and/or infection was associated with immunosuppression, receipt of hemodialysis and hospitalization in the preceding year. Shashikala et al.[47] stated 20.7 % carbopenem resistant *P.aeruginosa* isolates from endotracheal aspirates showing indwelling devices as major risk factors. *Pseudomonas aeruginosa* is

a leading cause of nosocomial infections in burn patients.[36]

A. baumannii has the ability to survive in the hospital environment as well as on dry surfaces and this aid in their easy transmission amongst hospitalized patients resulting in possible hospital outbreaks[11]. The selective pressure by the extremely high usage of antibiotics against *A. baumannii* bacteria as well as its ability to accept foreign DNA containing antimicrobial resistant determinants could be one of the reasons behind Acinetobacter incredible resistance to major different antibiotics worldwide.[11]

In the absence of novel agents the spread of MBL producers may lead to therapeutic dead ends. The early detection of MBL producing *P.aeruginosa* may avoid the future spread of these multi-drug resistant strains.Antimicrobial stewardship programs, infection prevention and control measures must be strictly adhered to in the efforts of tackling the rising resistance amongst non fermenting gram negative bacilli to multiple antibiotics. The failure to do so may impact on outbreak containment and the spread of these resistant strains in healthcare settings.

CONCLUSION:

- A prospective study conducted to know the prevalence of different β-lactamases among 389(14.1%) non-fermenting gram negative bacilli isolated from various clinical specimens.
- Of these 274(70.43%) were *Pseudomonas aeruginosa*, 99(25.44%) were*Acinetobactercalcoaciticus-baumanii complex*, 10(2.57%) were *Acinetobacterlwoffiiand* 6(1.54%) were *Acinetobacterhemolyticus.*
- Imipenem resistance was seen in 54 (13.88%) isolates, of which only 49 (12.6%) were detected as MBL producers by Imipenem-EDTA combined disk test.
- Coexistence of ESBL and AmpC producers observed among 39 (10.02%) isolates and AmpC and MBL producers among 11(2.82%) isolates.
- Majority of MBL producers exhibited significantly higher drug resistance to all the antibiotics used in the study. All the isolates were susceptible to Polymyxin B.
- Monitoring and judicious usage of cephalosporins and Imipenem, periodic surveillance of antibiotic resistance patterns and efforts to decrease empirical antibiotic therapy would go a long way in addressing some of the problems associated with Metallo β-lactamases producers. Maintenance of strict antibiotic policy in the hospital is a must to fight against antibiotic resistance.

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