Antimicrobial Resistance among Commonly Encountered Bacteria Isolated in 2013 – The ESKAPE Menace

Anuradha S De*, Baveja S, D’Souza D and Patwegar S
Department of Microbiology, L.T.M. Medical College and Hospital, Mumbai, India

Abstract

Introduction: The most serious, life-threatening infections caused by a group of drug-resistant bacteria are named as "ESKAPE" pathogens by the Infectious Diseases Society of America (IDSA), because they effectively escape the effects of antibacterial drugs.

Objectives: To find out the antibiotic susceptibility pattern of bacteria isolated from various specimens, with special reference to the ESKAPE bugs.

Methods: A retrospective study of one year was undertaken in this tertiary care hospital. Samples (pus/wound swabs, respiratory samples, blood cultures and urine samples) were processed as per standard techniques and bacteria identified by standard biochemical tests.

Antibiotic susceptibility (ABS) was done by the Kirby Bauer Disc Diffusion Method on Mueller Hinton Agar, according to CLSI guidelines.

Results: Maximum growth was seen from pus swabs (51.49%), followed by respiratory samples (35.66%). Overall Gram negative bacilli (GNB) isolated was 77% and GPC 23%. MDR was mainly seen with Proteus species (50%), followed by Acinetobacter species (48%) and Pseudomonas aeruginosa (46%). Staphylococcus aureus was the major Gram positive isolate in pus samples and enterococci in urine samples. Impenem susceptibility for all bacteria was more than 80%, except in some respiratory samples. Both MDR and carbapenem resistant bacteria increased in 2013, as compared to 2012. S. aureus showed 100% susceptibility to linezolid and 33.86% of all MRSA showed ICR. One VISA and four VRE were isolated. HLAR was seen in 23.96% enterococci.

Conclusion: Judicious use of antibiotics is the need of the day to control the spread of MDR "ESKAPE" bugs. There is also an urgent need to develop Antimicrobial Stewardship.

Keywords: ESKAPE bugs; Multidrug resistant (MDR) bacteria; IDSA

Introduction

"We’re not at the point where all antibiotics are useless, that’s overstating it. But there’s no question we have a problem with increasing bacterial resistance to current antibiotics." - Dr. Andrew Simor.

Antimicrobial Resistance (AMR) is present in all parts of the world. New resistance mechanisms emerge and spread globally. It is an increasingly serious threat to global public health that requires action across all government sectors and society. There is a warning for India by WHO, that antimicrobial resistance is reaching critical levels [1]. AMR is a problem worldwide, but is particularly worrying in India, where hospital standards are inconsistent and antibiotics are readily available over the counter at pharmacies. Antibiotic use is unnecessary or inappropriate in as many as 50% of cases and this creates unnecessary pressure for the selection of resistant species. Moreover, overuse and misuse of antimicrobial agents in humans, food, animals, agriculture and consumer products are also responsible for increase in AMR. Inadequate infection control practices add further to this problem [2,3].

Antibiotic exposure increases the risks of resistance of Carbapenem Resistant Enterobacteriaceae (CRE). Carbapenems increase the risk of resistance up to 15 fold and ESBL producing organisms and cephalosporins increase the risk up to 6 to 29 fold [4].

The most serious, life-threatening infections caused by a group of drug-resistant bacteria are named as "ESKAPE" pathogens by the Infectious Diseases Society of America (IDSA), because they effectively escape the effects of antibacterial drugs. The six "ESKAPE" bacteria are Enterococcus faecium (E), Staphylococcus aureus (S), Klebsiella pneumoniae (K), Acinetobacter baumannii (A), Pseudomonas aeruginosa (P) and Enterobacter species/Escherichia coli (E). These bugs are responsible for two thirds of all health care-associated infections (HAIs) [5], prompting IDSA to raise the alarm and label this threatening situation as "Bad Bugs, No Drugs" [6]. The latter microorganisms span over a wide range of microbial species such as methicillin resistant Staphylococcus aureus (MRSA) being healthcare-associated (HA-MRSA) or community-associated (CA-MRSA), vancomycin-intermediate or resistant S. aureus (VISA or VRSA), vancomycin-resistant enterococcus (VRE), the multidrug-resistant Acinetobacter spp. and Pseudomonas aeruginosa, extended spectrum-lactamase (ESBL)-producing Escherichia coli and Klebsiella spp., and carbapenem resistant enterobacteriaceae.

(CRE) [7,8]. Thus, surveillance and revealing the antimicrobial profile as well as monitoring and determining the changing trends of resistance among these pathogens at different periods of time provides essential valuable information to the clinicians, hospital infection control committee and also to epidemiologists, for the containment of this problem [9,10].

*Corresponding author: Anuradha S De, Professor, Department of Microbiology, L.T.M. Medical College and Hospital, Sion, Mumbai, India, Tel: +91 9892147781, E-mail: dr_anuradhade@yahoo.com

Received May 01, 2015; Accepted May 20, 2015; Published May 27, 2015


Copyright: © 2015 Anuradha S De, et al. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.
Therefore the present study was undertaken to reveal and reflect on antimicrobial resistance among commonly encountered bacteria recovered in this tertiary care hospital during one year period, with special reference to the ESKAPE bugs.

Materials and Methods

A retrospective study of one year (January-December 2013) was undertaken in this tertiary care hospital. Samples comprised of pus/wound swabs (6112), respiratory samples (2465), blood cultures (5931) and urine (4818). All the above samples were processed as per standard techniques and bacteria identified by standard biochemical tests [11].

Antibiotic susceptibility (ABS) was done by the Kirby Bauer Disc Diffusion Method on Mueller Hinton Agar, according to CLSI guidelines. For Acinetobacter species, tigecycline disc and colistin MIC strip were also put up. For Pseudomonas aeruginosa, colistin disc was also put up. For Streptococcus species, ABS was put up on blood agar. Vancomycin susceptibility for S. aureus and Streptococcus species were done by E-strip (HiMedia). For S. aureus, inducible clindamycin resistance (ICR) was done by D-test. For enterococci, high level aminoglycoside resistance (HLAR) detection was performed using gentamycin (120 µg) and streptomycin (300 µg) discs [12].

Results

Maximum growth was seen from pus/wound swabs, i.e. 51.49% (3147/6112), followed by 35.66% (879/2465) from respiratory samples, 14.16% (840/5931) from blood cultures and 14.43% (695/4818) from urine samples. Overall growth of Gram negative bacilli (GNB) was 77.1% and Gram positive cocci (GPC) were 22.9%. GNB in pus and respiratory samples was 78.03% and 75.43% respectively and GPC in these samples were 21.97% and 24.57% respectively. GNB was isolated maximum from urine samples to the tune of 91.08% and only 8.92% was GPC. In blood cultures, GPC was slightly more than in other samples, i.e. 37.5%, though GNB also predominated (62.5%).

Table 1 shows overall bacteria isolated from different samples. Table 2 shows type of growth from different samples taken from each specialty. Figures 1-3 show% antibiotic susceptibility pattern of GNB and Enterococcus species. Figure 4 shows prevalence of Multidrug resistant (MDR) Gram negative bacilli (GNB) in 2013. MDR-GNB was maximum seen in Proteus species (50.79%), followed by Acinetobacter species (48.76%) and Pseudomonas aeruginosa (46.14%).

Overall imipenem susceptibility was >80%, except for Pseudomonas aeruginosa (65.38%) and Enterobacter species (58%) in respiratory samples. All isolates from urine samples showed 100% susceptibility to imipenem. For blood culture isolates, imipenem susceptibility of Acinetobacter species and Enterobacter species were 96.23% and 88.89% respectively. All other GNB from blood cultures were 100% susceptible to imipenem.

All Enterobacteriaceae from urine samples showed 100% susceptibility to netilmicin, whereas in Acinetobacter species and Pseudomonas aeruginosa, susceptibility to netilmicin was 90% and 33.33% respectively. Netilmicin susceptibility of Acinetobacter species and Pseudomonas aeruginosa in other samples varied from 33-45% and 14-43% respectively. Netilmicin susceptibility of all Enterobacteriaceae from pus samples was between 12-22%, except in E. coli, where it was 65.75%. In respiratory samples, the same was between 11-32% and in blood cultures it was from 5-11%.

Piperacillin-tazobactam susceptibility of Acinetobacter species and Pseudomonas aeruginosa from blood cultures was 58.5% and 64% respectively. From urine samples, the same was 50% and 27%.

<table>
<thead>
<tr>
<th>Bacteria (Total No.)</th>
<th>Pus No. (%)</th>
<th>Respiratory No. (%)</th>
<th>Blood Culture No. (%)</th>
<th>Urine No. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acinetobacter species (1247)</td>
<td>684 (54.85)</td>
<td>287 (23.02)</td>
<td>216 (17.32)</td>
<td>60</td>
</tr>
<tr>
<td>Pseudomonas aeruginosa (1415)</td>
<td>1111 (78.52)</td>
<td>156 (11.00)</td>
<td>66</td>
<td>82</td>
</tr>
<tr>
<td>Escherichia coli (807)</td>
<td>420 (52.04)</td>
<td>40</td>
<td>39</td>
<td>308 (38.17)</td>
</tr>
<tr>
<td>Klebsiella pneumoniae (473)</td>
<td>209 (44.19)</td>
<td>106 (22.41)</td>
<td>61</td>
<td>97 (20.51)</td>
</tr>
<tr>
<td>Enterobacter species (535)</td>
<td>308 (57.57)</td>
<td>50</td>
<td>104 (19.44)</td>
<td>73</td>
</tr>
<tr>
<td>Proteus species (189)</td>
<td>156 (82.54)</td>
<td>14</td>
<td>07</td>
<td>12</td>
</tr>
<tr>
<td>Citrobacter species (31)</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>01</td>
</tr>
<tr>
<td>Salmonella typhi (16)</td>
<td>-</td>
<td>-</td>
<td>16</td>
<td>-</td>
</tr>
<tr>
<td>Serratia marcescens (01)</td>
<td>01</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Other nonfermenters (06)</td>
<td>-</td>
<td>-</td>
<td>06</td>
<td>-</td>
</tr>
<tr>
<td>Methicillin Sensitive Staphylococcus aureus (MSSA) (659)</td>
<td>414 (62.82)</td>
<td>27</td>
<td>206 (31.26)</td>
<td>12</td>
</tr>
<tr>
<td>Methicillin Resistant Staphylococcus aureus (MRSA) (436)</td>
<td>361 (82.80)</td>
<td>15</td>
<td>58 (13.30)</td>
<td>02</td>
</tr>
<tr>
<td>Enterococcus species (104)</td>
<td>20</td>
<td>10</td>
<td>31 (29.81)</td>
<td>43 (41.35)</td>
</tr>
<tr>
<td>Streptococcus species (209)</td>
<td>21</td>
<td>164 (78.47)</td>
<td>20</td>
<td>04</td>
</tr>
<tr>
<td>Coagulase negative Staphylococcus aureus (CONS) (01)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>01</td>
</tr>
</tbody>
</table>

Table 1: Overall bacteria isolated from different samples.

<table>
<thead>
<tr>
<th>Year</th>
<th>Gram negative bacilli (No.)</th>
<th>Total MDR No. (%)</th>
<th>Total Carbapenem resistant No. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>Enterobacteriaceae (2951)</td>
<td>723 (24.50)</td>
<td>05 (0.17)</td>
</tr>
<tr>
<td></td>
<td>Non-fermenters (3043)</td>
<td>1653 (54.32)</td>
<td>32 (1.05)</td>
</tr>
<tr>
<td></td>
<td>Total (5994)</td>
<td>2376 (39.64)</td>
<td>37 (0.62)</td>
</tr>
<tr>
<td>2013</td>
<td>Enterobacteriaceae (2312)</td>
<td>719 (31.10)</td>
<td>59 (2.55)</td>
</tr>
<tr>
<td></td>
<td>Nonfermenters (2814)</td>
<td>1392 (49.47)</td>
<td>163 (5.79)</td>
</tr>
<tr>
<td></td>
<td>Total (5126)</td>
<td>2111 (41.18)</td>
<td>222 (4.33)</td>
</tr>
</tbody>
</table>

Table 2: Multidrug Resistant Gram negative bacilli (MDR-GNB) and Carbapenem resistant (CR) bacteria isolated in 2012 and 2013.
showed more MDRs (49.47% - 1392/2814) than enterobacteriaceae (31.1% - 719/2312). Carbapenem resistant (CR) Gram negative bacilli in 2013 was 4.33% (222/5126), of which CR in nonfermenting GNB was 5.79% (163/2814) and in enterobacteriaceae CR was 2.55% (59/2312).

Figure 5 shows% antibiotic susceptibility pattern of Staphylococcus aureus (MSSA and MRSA). S. aureus showed 100% susceptibility to linezolid and only one Vancomycin Intermediate Resistant S. aureus (VISA) was recovered from blood culture. Netilmycin susceptibility of MRSA from urine samples and blood cultures were 100% and 88% respectively, whereas netilmycin susceptibility of MRSA from pus and respiratory samples were <66%. All Streptococcus species isolated from all sampled showed 100% susceptibility to linezolid and vancomycin.

Overall Inducible Clindamycin Resistance (ICR) in S. aureus was 18.57% (207/1115). ICR encountered in MRSA was 33.86% (149/440) and in MSSA it was 8.59% (58/675). Vancomycin In 2013, four (3.74%) Vancomycin Resistant Enterococci (VRE) were isolated – three from respiratory samples and one from blood culture. High Level Aminoglycoside resistance (HLAR) was seen in 23.36% enterococci (25/107) in 2013.

Discussion
In 2011, the theme of World Health Day was “Antimicrobial resistance: no action today, no cure tomorrow”, and WHO published a six-point policy package to assist countries with tools to combat antimicrobial resistance. In 2014, WHO published its first global report on surveillance of antimicrobial resistance, with data provided by 114 countries [1]. The global emergence of antimicrobial resistance constitutes serious human and public health burdens, especially due to limited availability of treatment options. Such resistance poses morbid and mortal threats with challenges in the treatment of patients infected with such pathogens, as well as the infection control tolls associated with these resistant microorganisms [5,13].

Escherichia coli isolates from patients were mostly from cases of uncomplicated primary UTI. Other isolates from cases of UTI were from catheterized patients (Table 2). All the isolates were presumed pathogens in an established infectious process, as all urinary isolates with colony count >105 cfu/ml and with symptoms of UTI were selected for antibiotic susceptibility testing. Similarly, all patients with positive blood cultures were clinically diagnosed as sepsis with at least 2-3 positive biochemical markers of sepsis. All respiratory samples were endotracheal secretions from patients on ventilator in Intensive Care Units (ICUs) and sputum samples from wards (Table 2). Pus/wound
Pseudomonas aeruginosa and Proteus species were isolated from pus/wound swabs (82.54%), hospital acquired, as all the patients were admitted in this hospital for thoracic wounds and also from burn patients. The infections were swabs were from patients having infection of post-surgical abdominal or thoracic wounds and also from burn patients. The infections were hospital acquired, as all the patients were admitted in this hospital for more than 48 hours.

In the present study, amongst Gram negative bacilli, maximum Proteus species was isolated from pus/wound swabs (82.54%), followed by Pseudomonas aeruginosa (78.52%), Enterobacter species (57.57%), Acinetobacter species (54.85%) and Escherichia coli (52.04%). Escherichia coli was predominant in urine (38.17%), followed by Klebsiella pneumoniae (20.51%). Amongst Gram positive cocci, maximum Enterococcus species was isolated from urine (41.35%), followed by from blood cultures (29.81%). Staphylococcus aureus was the major Gram positive isolate in pus/wound swabs, with MRSA being 82.8%. Streptococcus species was predominantly seen in respiratory samples (78.47%) (Table 1).

Enterococcus showed very high susceptibility to vancomycin, ranging from 96.77 to 100%, except in respiratory samples, where it was 70% (Figure 3B). Only four Vancomycin Resistant Enterococci (VRE) strains were detected in 2013. Zouin et al. have also observed 99.6% to 100% susceptibility to vancomycin and they detected seven VRE [14]. Rare and sporadic vancomycin resistant strains in enterococci are encountered. The prevalence of VRE in India, varies from 1.4 to 8% in few studies [15-18], but one study from Mumbai reported a prevalence of 23% [19].

High level aminoglycoside resistance (HLAR) detected was 23.36% in this study. Indian studies have reported a prevalence ofHLAR, ranging from 7.8% to as high as 56% [20-23]. Zouin et al. detected HLAR in E. faecalis and E. faecium being, respectively, 19% and 39% against gentamicin and 36% and 26% against streptomycin [14].

In India, the incidence of MRSA is increasing, with prevalence rates varying from 23.6% to as high as 59.3% [24-26]. Out of total MRSA isolated in this study, 82.8% were from pus samples (Table 1). MRSA from blood cultures showed 57% and 53.5% susceptibility to gentamicin and ciprofloxacin. All other first line antibiotics showed very less susceptibility (Figure 5B). Vancomycin, which was regarded as the drug of choice for the MRSA infections, is showing early signs of emerging resistance. Hopefully, only one VISA was isolated in this study and no VRSA was encountered. Meticillin resistant Staphylococcus aureus (MRSA), though was relatively high in this study but vancomycin maintained uniform activity.

Penicillin and erythromycin susceptibility of MSSA were 8.25% and 14.56% in blood cultures. Gentamicin and ciprofloxacin susceptibility of MSSA were good, being >74% and >49% respectively but in respiratory samples, ciprofloxacin susceptibility was 0% (Figure 5A). Macrolide and clindamycin increasing rates of resistance is being noted in S. pneumoniae, group A streptococci, S. aureus and viridans streptococci in the recent years. Inducible Clindamycin Resistance encountered in MRSA and MSSA was 33.86% and 8.59% in the present study (Table 3).

Drug-resistant Acinetobacter baumannii has the distinction of simultaneously being a National Institute of Allergy and Infectious Diseases (NIAID) Category C pathogen and one of the six most dangerous MDR bacteria amongst the ESKAPE bugs. It accounts for 6% of Gram negative infections in intensive care facilities in the USA, with mortality rates as high as 54% having been reported by the IDSA [27]. In an USA study, isolation of MDR acinetobacter soared from 6.7% in 1993 to 29.9% by 2004, emphasizing the need for newer and better drugs [10].

The overall susceptibility of Acinetobacter spp. to the vast majority of antimicrobial agents is very low (Figure 1A). Since MDR A. baumannii is being encountered with increasing frequency in the hospitals, the use of fluoroquinolones is not advisable as a long-term treatment strategy. In this study, ciprofloxacin susceptibility of Acinetobacter spp. From blood cultures was 53.7% but in all other samples, ciprofloxacin susceptibility was <17% (Figure 1A). Overall imipenem susceptibility was >80% in the present study. Araj et al. have reported a remarkable resistance encountered against imipenem (increased from 1% in 2000/1 to 70% in 2010/11). The susceptibility rates against doripenem, meropenem and imipenem, were only 38.9%, 36.1% and 16.7%, respectively [28].

Tigecycline being one of the few remaining effective drugs, 98% of the Acinetobacter spp. analyzed by El Herte et al. during 2006-2007 were susceptible [29], and this rate is maintained till date. Acinetobacter spp. susceptibility to tigecycline was also 98% in this study. Colistin susceptibility was 100%.

With respect to P. aeruginosa, their susceptibilities to the different antimicrobial agents show fluctuations, generally within 46% to 72%, with susceptibility slightly higher in isolates from blood cultures (Figure 1B). Susceptibility of first line antibiotics to isolates from pus samples was <38%. Overall ceftazidime susceptibility was <34%, with only 0.64% ceftazidime susceptibility in isolates from respiratory samples (Figure 1B). Imipenem susceptibility of Pseudomonas aeruginosa was 65.38% in respiratory samples and 89% in pus samples, whereas in blood cultures and urine samples, imipenem susceptibility was 100% each. Araj et al. have reported susceptibility rates against doripenem, meropenem and imipenem, to be 65%, 47.5% and 27.5%, respectively [10].

E. coli isolates have been showing increasing resistance against most cephalosporins, fluoroquinolones and aminoglycosides. In this study, cefotaxime and ciprofloxacin susceptibility of E. coli was <24% and <42% respectively in all samples. Amikacin susceptibility was good in isolates from blood cultures (92.31%) but amikacin susceptibility of urinary isolates of E. coli was only 55% [27]. In an USA study, isolation of MDR E. coli was only 55% in respiratory samples, susceptibility of E. coli to first line antibiotics was <13%, (Figure 2A). A relatively high and stable susceptibility are maintained for nitrofurantoin in urinary isolates and it was 85% in this study. Overall imipenem susceptibility was >86%, with 100% susceptibility in isolates from urine samples and blood cultures. However, piperacillin-tazobactam susceptibility of E. coli was <21% in all samples, except in pus samples, where it was 54.79%.

Klebsiella pneumoniae showed increasing resistance to all first line antibiotics. Amoxycillin/ clavulanic acid showed 100% resistance for E. coli and Klebsiella spp. in all samples, except in blood cultures, where susceptibility was only 8.2% and 2.56% respectively (Figure 2B).
these virulent organisms. Antibiotics which are currently in use to treat *Escherichia coli* spp. and *Salmonella* spp. are also being encountered in *S. typhi* but in this study, no resistance to third generation cephalosporins or fluoroquinolones was recovered from blood cultures were susceptible to *S. typhi* and trimethoprim/sulfamethoxazole (43%-100%). In this study, 16 isolates of *K. pneumoniae* were resistant to ampicillin (65% to 100%) and carbapenem (2.4-52%) in *K. pneumoniae*, over a period of 10 years [30].

Nitrofurantoin susceptibility of *K. pneumoniae* in urinary isolates was 80% in this study but amikacin susceptibility was <51%, cefotaxime and ciprofloxacin susceptibility were only 23% each and amoxicillin-clavulanic acid susceptibility was 0% (Figure 2B). A study of urinary tract infections with *K. pneumoniae* in children from Pakistan has shown less than 30% susceptibility to cephaporsins and 31% to ciprofloxacin and amoxicillin-clavulanic acid. Piperacillin-tazobactam and meropenem were the most effective drugs [31].

Susceptibility of *Enterobacter* species to cefotaxime, piperacillin and amoxicillin-clavulanic acid was <26%, <17% and <8% respectively. Even ciprofloxacin susceptibility was <58% but amikacin susceptibility was better in respiratory samples (72%) and blood cultures (67.31%) (Figure 3A). Piperacillin/tazobactam susceptibility of *Enterobacter* species was about 26% in pus and urine samples, whereas in respiratory samples and blood cultures the same was 46% and 51.85% respectively. Imipenem susceptibility of *Enterobacter* species was >88% in all samples, except in respiratory samples, where it was 58%.

Since 1989, outbreaks caused by strains of *S. typhi* resistant to chloramphenicol, ampicillin and trimethoprim/ sulfamethoxazole have been reported in many developing countries, especially Pakistan and India [32]. *S. typhi* has maintained uniform susceptibility to ampicillin, cefotaxime, ciprofloxacin and trimethoprim/sulfamethoxazole till 2004. Thereafter, few resistant strains started to emerge with variable susceptibility to ampicillin (65% to 100%) and trimethoprim/sulfamethoxazole (43%-100%). In this study, 16 strains of *S. typhi* recovered from blood cultures were susceptible to ampicillin, cefotaxime, trimethoprim/sulfamethoxazole, nalidixic acid, ciprofloxacin and chloramphenicol. Resistance to quinolones is also being encountered in Salmonella spp. but in this study, no *S. typhi* resistance to third generation cephaporsins or fluorquinolones was detected.

Resistance to carbapenems remains problematic in *Acinetobacter* spp. and *Pseudomonas aeruginosa*, and has also started emerging in *E. coli* and *K. pneumoniae*. Very few options remain for the treatment of these virulent organisms. Antibiotics which are currently in use to treat carbapenem resistant *Enterobacteriaceae* (CRE) infections include aminoglycosides, polymyxins, tigecycline, fosfomycin and temocillin [4]. Fortunately, overall carbapenem resistance in this study was only 4.33% but overall multidrug resistant bacteria was 41.18%. Tigecycline and colistin maintains excellent activity against most ESBL and carbapenem resistant bacteria.

One must be aware of the resistant flora which is being generated due to the rampant use of the higher generation antibiotics. Most often we fail to differentiate colonization from infection and needlessly prescribe those antibiotics, which were meant to be used as reserve drugs. The organisms that are not inhibited by the cephaporsins, consequently overgrow, with varying potential, to cause infections and the association between the cephaporsin usage and the emergence of multiple drug-resistant organisms has been proved [33].

Clinico-microbiologic cum hospital infection control committee meetings should be regularly organized in hospitals, for increasing the awareness on the local sensitivity patterns, to guide the rational use of antibiotics, especially their empirical use. Antibiotic prescriptions should be reviewed by microbiologists/infectious disease specialists before their administration to the patients [34].

This hospital has an active Hospital Infection Control Committee (HICC), which regularly takes rounds in the different wards and Intensive Care Units (ICUs) and also monthly meetings of HICC with all the committee members are held to discuss indiscriminate antibiotic use.

It has been proposed by the Directorate General Health Services of the Government of India that the sale of antibiotics Over the Counter (OTC) without proper prescriptions, should be stopped.

Practical application of the principles of the rational antibiotic therapy should be included in the medical/dental undergraduate curriculum. Most of the hospitals in India do not have a standardized antibiotic policy or a constant infection surveillance program. This institute has an effective antibiotic policy, which are reviewed from time to time according to the situation.

### Conclusion

Simple measures such as hand washing and barrier precautions can significantly reduce the spread of ESKAPE bugs. As these are multidrug resistant, they might pose a therapeutic challenge to the clinicians as well as microbiologists. Timely implementation of proper infection control practices reduce, eliminate and prevent establishment of these bugs. Judicious use of antibiotics is the need of the day to control the spread of MDR “ESKAPE” bugs. Physicians should be aware of the local epidemiology of antimicrobial resistance to properly guide the initial therapy.

<table>
<thead>
<tr>
<th>Year</th>
<th>Gram positive cocci (No.)</th>
<th>Total ICR &amp; VISA No. (%)</th>
<th>Total VRE &amp; HLAR No. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>MRSA (693)</td>
<td>50 (7.22)</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>MSSA (1225)</td>
<td>55 (4.49)</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Enterococcus species (224)</td>
<td>-</td>
<td>2 VRE (0.89)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>10 HLAR (4.46)</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>105/1918 (5.47)</td>
<td></td>
</tr>
<tr>
<td>2013</td>
<td>MRSA (440)</td>
<td>149 (33.86)/0/1 VISA(0.23)</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>MSSA (675)</td>
<td>58 (8.59)</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Enterococcus (107)</td>
<td>-</td>
<td>4 VRE (3.74)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>25 HLAR (23.36)</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>207/1115 (18.57)</td>
<td></td>
</tr>
</tbody>
</table>

Table 3: Inducible clindamycin resistance (ICR), Vancomycin Resistant Enterococci (VRE) and High Level Aminoglycoside resistance (HLAR) in 2012 and 2013.
A strict antibiotic policy should be followed in every hospital which restricts the use of the broad spectrum agents (especially the third-generation cephalosporins). The cephalosporins should only be used as reserve drugs, in the fluoroquinolone resistant cases, with evidence based indications only. The reserve drugs such as vancomycin or those which are used against the resistance to the carbapenems, like polymyxin B and E (colistin), tigecycline and fosfomycin should never be used indiscriminately.

Most of these resistance problems are attributed to uncontrolled use of antimicrobial agents. Therefore, there is an urgent need to develop antimicrobial stewardship, to curb this threat [34].

References