Original Article

DOI: 10.17354/ijss/2016/54

Occurrence and Antimicrobial Susceptibility Pattern of Methicillin-resistant *Staphylococcus aureus* and Methicillin-resistant Coagulase-Negative Staphylococci Isolated from Different Clinical Specimens from the Patients Hospitalized in Teerthanker Mahaveer Medical College and Research Centre, Moradabad, India

Raees Ahmed[1], Sudhir Singh[2], Umar Farooq[3], Amit Kumar Bharti[1], Navdeep Kaur[1]

[1]Final Year Student, Department of Microbiology, Teerthanker Mahaveer Medical College and Research Centre, Moradabad, Uttar Pradesh, India, [2]Assistant Professor, Department of Microbiology, Teerthanker Mahaveer Medical College and Research Centre, Moradabad, Uttar Pradesh, India, [3]Head and Professor, Department of Microbiology, Teerthanker Mahaveer Medical College and Research Centre, Moradabad, Uttar Pradesh, India

Abstract

Background: Methicillin-resistant *Staphylococcus aureus* (MRSA) and methicillin-resistant coagulase-negative staphylococci (MRCoNS) have been reported a public health problem globally. MRSA and MRCoNS are the most important infectious agent of the nosocomial infection, which is a major problem particularly in developing nations including India, where the burden of infectious diseases are high, and healthcare providing facilities are low. Rising percentage in the antimicrobial resistance of the methicillin-resistant staphylococci to the available anti-staphylococcal antibiotics is a growing problem in the Indian scenario.

Objective: This study was conducted to determine the occurrence and antimicrobial sensitivity pattern of MRSA and MRCoNS isolated from different clinical specimens.

Materials and Methods: MRSA and MRCoNS were identified among 400 staphylococcal isolates, isolated from various clinical specimens. All the isolates were identified as per Clinical and Laboratory Standards Institute guidelines and antimicrobial susceptibility pattern was determined by Kirby-Bauer disc diffusion method.

Results: A total of 400 staphylococcal isolates were processed, of which 347 isolates (86.75%) were coagulase-positive *S. aureus* and 53 isolates (13.25%) were CoNS, tested by both slide and tube coagulase test. Among 347 coagulase-positive *S. aureus*, 148 (42.65%) were MRSA, whereas among 53 CoNS, 28 (52.83%) were MRCoNS. Among MRSA isolates maximum resistance was seen with co-trimoxazole (91.89%) and least with vancomycin (0%). Among MRCoNS isolates maximum resistance was seen with both penicillin and co-trimoxazole (100%) and least with vancomycin (0%).

Conclusion: It is concluded that to preserve the value of vancomycin for the treatment of life-threatening staphylococcal infections in future, there is need of regular surveillance of MRSA and MRCoNS which is necessary for the appropriate guideline of antimicrobial therapy and to avoid the use of powerful antibiotics as initial infections.

Key words: Methicillin-resistant coagulase-negative staphylococci, Methicillin-resistant *Staphylococcus aureus*, Nosocomial infection, Vancomycin

Access this article online

www.ijss-sn.com

Month of Submission : 12-2015
Month of Peer Review : 01-2016
Month of Acceptance : 01-2016
Month of Publishing : 02-2016

INTRODUCTION

Staphylococci are Gram-positive cocci, arranged in grape-like clusters. They are non-motile, non-sporing, occasionally capsulated, and are facultative anaerobes that grow better

Corresponding Author: Raees Ahmed, Department of Microbiology, Teerthanker Mahaveer Medical College and Research Centre, Moradabad, Uttar Pradesh, India. Phone: +91-9690133977. E-mail: drraeesahmed52@gmail.com

under aerobic than anaerobic conditions. Staphylococci are classified as coagulase-positive *Staphylococcus aureus* and coagulase-negative staphylococci (CoNS).[1]

S. aureus is one of the most important pathogen leading to cause diseases ranging from minor skin and soft tissue infections to life-threatening conditions.[2] CoNS previously considered as avirulent commensals have emerged as an important prevalent pathogen, especially as a cause of nosocomial infection.[3] Bloodstream infections are the major causes of CoNS with increased morbidity and mortality.[4]

The term methicillin-resistant *S. aureus* (MRSA) and methicillin-resistant CoNS (MRCoNS) are used for the *S. aureus* and CoNS respectively, leads to the methicillin-resistance but now refers to a multi-drug resistant group and are susceptible only to glycopeptide antibiotics such as vancomycin.[5]

In the 1960s, methicillin was first introduced in human medicine for the treatment of infection caused by penicillin's resistant *S. aureus*.[6] In 1961, in England, the first MRSA emerged.[7]

Methicillin-resistance among *S. aureus* and CoNS is caused by the *mecA* gene which encodes an altered penicillin-binding protein 2a with a low affinity for beta-lactam antibiotics including the penicillinase-resistant penicillin. A genetic element in which *mecA* gene is located called the staphylococcal cassette chromosome.[8]

The factors responsible for the emergence of resistant forms of staphylococci includes widespread use of antibiotics, prolonged hospital stay, lack of awareness, receipt of antibiotics before visiting the hospital, etc.[9]

MRSA and MRCoNS are considered as the most important cause of hospital-acquired infection (HAI) as well as community acquired infection (CAI) causing a wide range of diseases, leads to the increased mortality, morbidity, the length of hospital stay along with increased financial burden.[10]

Outbreaks of hospital-acquired MRSA are typically the result of nosocomial transmission of MRSA from patient to patient and colonized healthcare workers act as the reservoir for the spread of MRSA to uncolonized susceptible patients. Outbreaks of community-acquired MRSA reported worldwide.[11]

The similar habitats are shared by MRSA and MRCoNS, both categories are colonizes to the anterior nares and different areas of skin and mucous membranes permanently or transiently may play an important role as agents of subsequent bacteremia and some other infections.[12] It reported by Centers for Disease Control and Prevention that skin infections can be caused by MRSA among healthy newborns so health-care workers should be aware.[13]

Nosocomial or HAIs includes surgical wound infections, ventilator associated pneumonia, bacteremia associated with intravenous devices and other prosthetic materials such as cerebrospinal fluid (CSF) shunts, prosthetic joints, and the vascular graft. CAIs includes infections affecting the skin and soft tissue (e.g., boils, impetigo, cellulitis, and myositis), toxin-mediated disease (e.g., food poisoning and toxic shock syndrome), bones and joints infections, infections related to deep sites (e.g., endocarditis, abscess formation in liver, spleen and other sites) and infections related to the urinary tract and lungs.[14]

The treatment of infection caused by staphylococci has become very complicated due to the increasing resistance to various antibiotics, emphasize the need for better control of MRSA and other resistant bacteria for appropriate treatment within healthcare settings.

MATERIALS AND METHODS

Study Design

The study was conducted in Department of Microbiology, Teerthanker Mahaveer Medical College and Research Centre, Moradabad from March 2015 to February 2016.

The study included those patients from whom staphylococci have been isolated among different clinical samples submitted to Microbiology Laboratory for culture and sensitivity and excluded the specimens were staphylococci isolates have been considered contamination due to Laboratory or skin flora.

Isolation and Identification of Clinical Specimens

A total of 400 staphylococci isolates were obtained from various clinical specimens including pus, blood, urine, high vaginal swab (HVS), and CSF.

All the clinical specimens were collected from the patients, submitted to the microbiology laboratory for the sample processing according to standard protocols and the antimicrobial sensitivity was determined according to Clinical Laboratory Standard Institute (CLSI) guidelines.

BacT/alert culture bottles were used for the collection of blood and body fluids that are loaded in BacT/Alert three-dimensional (3D) system according to the manufacturer instructions. On the detection of growth in the BacT/alert 3D system, further sample processing was done.

Inoculation of all the clinical specimens and positively detected samples from BacT/alert 3D system was performed primarily on their respective culture plates and incubated aerobically at 37°C for 24 h. Further identification was carried out by conventional methods including colony characteristics, Gram-staining, catalase test, slide and tube coagulase test, growth on mannitol salt agar.

Antimicrobial Susceptibility Testing

The antibiotic susceptibility pattern of all the confirmed *S. aureus* and CoNS were determined by Kirby-Bauer disc diffusion method against the following antibiotics as per CLSI guidelines: Penicillin (10 μg), erythromycin (15 μg), clindamycin (2 μg), co-trimoxazole (25 μg), tetracycline (30 μg), levofloxacin (5 μg), gentamycin (10 μg), vancomycin (30 μg), linezolid (15 μg), oxacillin (1 μg), ciprofloxacin (5 μg), cefalexin (30 μg), rifampicin (5 μg), chloramphenicol (30 μg), ampicillin (10 μg), amoxy/clavulanic acid (20/10 μg), teicoplanin (30 μg), amikacin (30 μg), tobramycin (10 μg), amp/sulbactam (10/10 μg), and cefotaxime (30 μg).

Muller-Hinton agar used to perform all antimicrobial susceptibility tests, and the interpretation criteria were taken according to National Committee for Clinical Laboratory Standard (NCCLS).

Detection of MRSA and MR CoNS

Oxacillin (1 μg) disc diffusion method

The test was performed by Kirby-Bauer disc diffusion method by using 1 μg of oxacillin disc on Muller-Hinton agar plate incubated at 35-37°C for 24 h at. The interpretation criteria were taken according to (NCCLS) guidelines. If a zone of inhibition was <10 mm or any discernible growth within a zone of inhibition was used as an indicator for methicillin-resistant and ≥13 mm zone of diameter was indicative for methicillin susceptible.

Cefoxitin (30 μg) disc diffusion test

The isolated samples were subjected to cefoxitin disc diffusion test by using 30 μg discs. A suspension, equivalent to 0.5 McFarland standard was prepared from each strain. Then, a swab was taken and dipped into the suspension and lawn culture was done on MHA plate after that plate was incubated at 37°C for 18-24 h and zone of inhibition was measured.

An inhibition zone diameter of ≤21 mm was considered as cefoxitin resistant reported as methicillin-resistant and ≥22 mm was reported as cefoxitin sensitive indicating methicillin-sensitive.

Statistical Analysis

The data were recorded and analyzed using Microsoft Excel (2007 Version). Results are presented in frequency (number) and percentage (%).

RESULTS

In our study, 400 staphylococcal isolates were collected from various clinical specimens among the patients hospitalized in Teerthanker Mahaveer Medical College and Research Centre, Moradabad, Uttar Pradesh, India.

The highest percentage of staphylococcal isolates was obtained from pus samples (38%), followed by blood (33.5%), urine (24%), HVS (3%), and CSF (2%) (Figure 1) (Table 1).

Out of 400 staphylococcal isolates tested, 347 isolates (86.75%) were coagulase positive *S. aureus* and 53 isolates (13.25%) were CoNS, tested by slide and tube coagulase test. Among 347 coagulase positive *S. aureus*, 148 (42.65%) were methicillin-resistant, and among 53 CoNS, 28 (52.83%) were methicillin-resistant.

The occurrence of MRSA and MRCoNS were significantly variable among different clinical samples. Among 148 MRSA isolates highest percentage was obtained from blood 43.24% (64/148), followed by pus 35.13% (52/148), urine 18.24% (27/148), CSF 2.70% (4/148), and HVS 0.67% (1/148). Among 28 MRCoNS highest percentage was obtained from blood 46.42% (13/28), followed by pus 25% (7/28), urine 24% (6/28), and HVS 3.57% (1/28) (Figure 2) (Table 2).

Among 148 MRSA isolates, 72 (48.65%) were from male patients and 76 (51.35%) were from female patients. Among 72 MRSA isolated from male patients, maximum 27 (37.5%) were obtained from 0 to 10 age group whereas, among 76 MRSA isolated from female patients, maximum 24 (31.58%) were obtained from 21 to 30 age group.

Out of 28 MRCoNS isolates, 9 (32.14%) were from male patients and 19 (67.85%) were from female patients. Among 9 MRCoNS isolated from male patients, maximum 3 (33.33%) belonged to (0-10) age group whereas, among 19 MRCoNS isolated from female patients, maximum 6 (31.58%) belonged to (0-10) age group (Figure 3) (Table 3).

MRSA and MRCoNS isolates show different antimicrobial susceptibility pattern against agents of different classes.

Table 1: Distribution of staphylococcal isolates from different clinical specimens

Clinical specimens	Number of staphylococcal isolates	Percentage
Pus	152	38
Blood	134	33.5
Urine	96	24
HVS	12	3
CSF	6	2
Total	400	100

HVS: High vaginal swab, CSF: Cerebrospinal fluid

Table 2: Isolation of coagulase positive and coagulase negative staphylococci from various clinical specimens

Clinical specimens	Number of *S. aureus*	MRSA *n* (%)	MSSA *n* (%)	Number of CoNS	MRCoNS *n* (%)	MSCoNS *n* (%)
Pus	137	52 (35.13)	85 (42.75)	15	7 (25)	8 (32)
Blood	113	64 (43.24)	49 (24.62)	21	13 (46.42)	8 (32)
Urine	83	27 (18.24)	56 (28.14)	13	7 (25)	6 (24)
HVS	8	1 (0.67)	7 (3.52)	4	1 (3.57)	3 (12)
CSF	6	4 (2.70)	2 (1.01)	0	0 (00)	0 (00)
Total	347	148 (42.65)	199 (57.35)	53	28 (52.83)	25 (47.17)

MRSA: Methicillin-resistant *Staphylococcus aureus*, MRCoNS: Methicillin-resistant coagulase-negative staphylococci, HVS: High vaginal swab, CSF: Cerebrospinal fluid

Table 3: Age and sex distribution of MRSA and MRCoNS isolates

Age group	Total number of MRSA	Male	Female	Male-female ratio	Total number of MRCoNS	Male	Female	Male-female ratio
0-10	48	27	21	9:7	9	3	6	1:2
11-20	27	12	15	4:5	3	1	2	1:2
21-30	36	12	24	1:2	7	2	5	2:5
31-40	9	3	6	1:2	2	0	2	0:2
41-50	10	6	4	3:2	2	1	1	1:1
51-60	9	6	3	2:1	3	1	2	1:2
61-70	7	5	2	5:2	1	1	0	1:0
71-80	2	1	1	1:1	1	0	1	0:1
Total	148	72	76	18:19	28	9	19	1:2

MRSA: Methicillin-resistant *Staphylococcus aureus*, MRCoNS: Methicillin-resistant coagulase-negative staphylococci, HVS: High vaginal swab, CSF: Cerebrospinal fluid

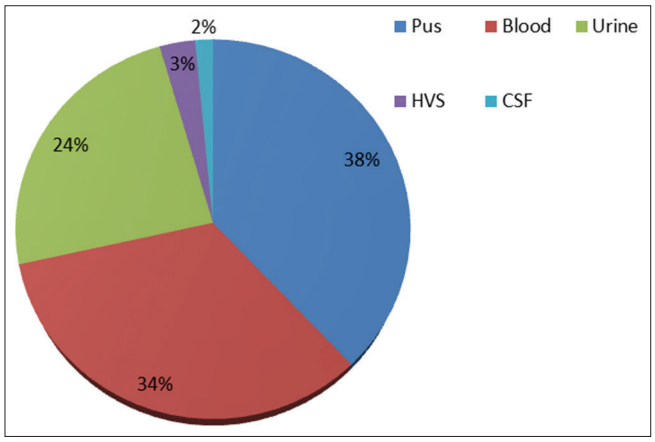

Figure 1: Distribution of staphylococci among different clinical specimens

It was observed that MRSA isolated from various clinical samples show highly variable drug resistant pattern whereas nearly similar drug resistant was shown by MRCoNS.

Among MRSA isolates maximum resistance was seen with co-trimoxazole (91.89%), followed by penicillin-G (89.19%) and least with vancomycin (0%), followed by linezolid (5.40%). Among MRCoNS isolates maximum resistance was seen with both penicillin-G and co-trimoxazole (100%), followed by amoxicillin (89.28%) and least with vancomycin (0%), followed by teicoplanin (10.71%) (Figure 4) (Table 4).

Table 4: Antimicrobial resistance pattern of MRSA and MRCoNS isolates

Antibiotics	MRSA (*n*=148)	MRSA (%)	MRCoNS (*n*=28)	MRCoNS (%)
Co-trimoxazole	136	91.89	28	100
Penicillin-G	132	89.19	28	100
Amoxicillin	132	89.19	25	89.28
Cefalexin	128	86.40	24	85.71
Ampicillin	127	85.87	25	89.28
Amoxy/clavulanic acid	121	81.67	24	85.71
Ciprofloxacin	116	78.38	21	75
Erythromycin	109	73.65	24	85.17
Ofloxacin	104	70.27	16	57.14
Levofloxacin	93	62.84	20	71.43
Gentamycin	88	59.46	16	57.14
Cefotaxime	80	54.05	21	75
Amp/Sulbactam	76	51.35	24	85.71
Clindamycin	71	47.97	20	71.43
Chloramphenicol	65	43.91	16	57.14
Tetracyclin	64	43.24	13	46.42
Tobramycin	53	35.81	23	82.14
Refampicin	40	27.03	16	57.14
Amikacin	24	16.22	11	39.28
Teicoplanin	15	10.13	3	10.71
Linezolid	8	5.40	5	17.86
Vancomycin	0	00	0	00

MRSA: Methicillin-resistant *Staphylococcus aureus*, MRCoNS: Methicillin-resistant Coagulase-Negative staphylococci

DISCUSSION

Among hospitalized patients *S. aureus* has been noted as the most important causative agent of wound infection.

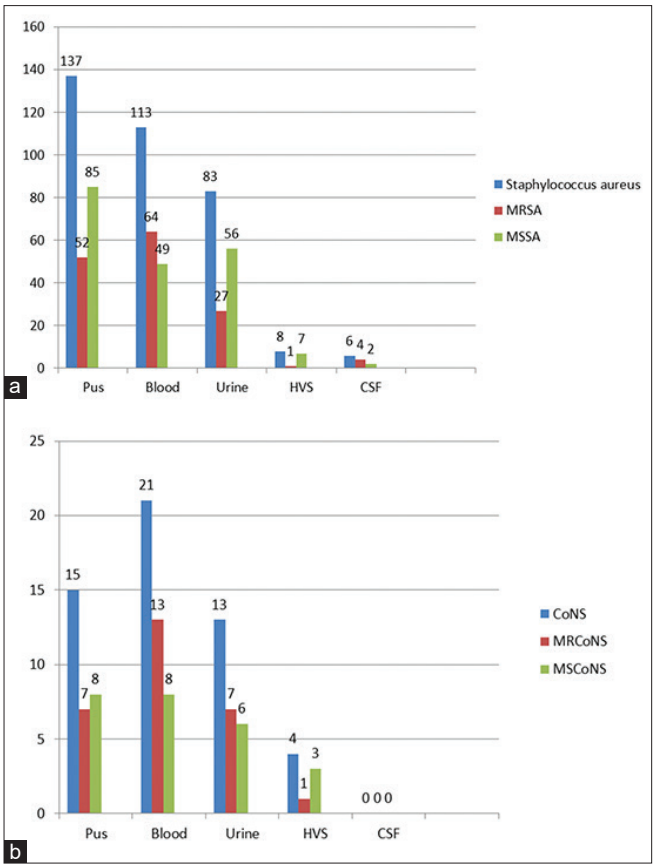

Figure 2: (a) Isolation of coagulase positive staphylococci from different clinical specimens, (b) isolation of coagulase negative staphylococci from different clinical specimens

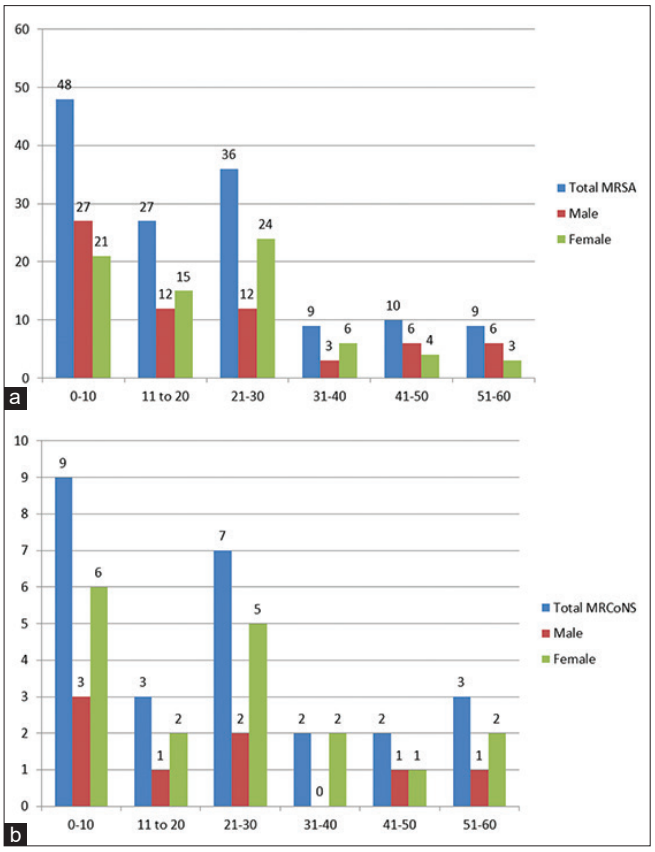

Figure 3: (a) Age and sex distribution of methicillin-resistant *Staphylococcus aureus* isolates, (b) age and sex distribution of methicillin-resistant coagulase-negative staphylococci isolates

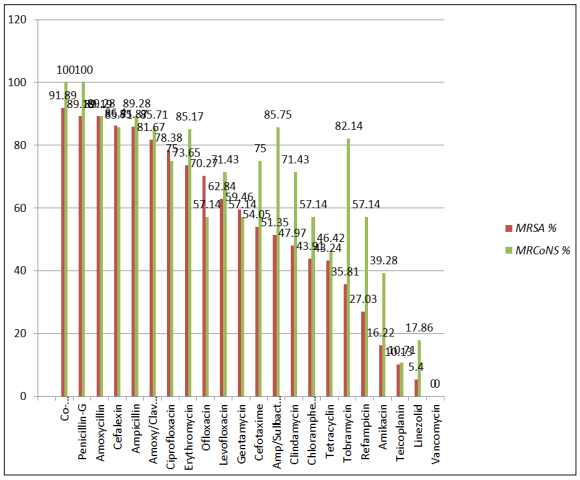

Figure 4: Antimicrobial resistance pattern of methicillin-resistant *Staphylococcus aureus* and methicillin-resistant coagulase-negative staphylococci isolates

CoNS are a group of an opportunistic pathogen that causes a wide range of diseases in hospitalized patients.[15]

The growing concern in the Indian scenario about the rapid increasements in the resistance of *S. aureus* and CoNS to various antimicrobial agents. MRSA and MRCoNS have been recognized as the predominant pathogen among hospitalized patients with increased morbidity and mortality.[16]

The earlier studies were reported to MRSA of concern but during 1970s it become clear that the occurrence of methicillin resistance was higher in CoNS (MRCoNS) than in *S. aureus* (MRSA),[17] in our study it has become true in a continuous manner. The present study shows low occurrence rate of MRSA, which is 42.65% than MRCoNS which is 52.83% reported that methicillin resistance seen in CoNS (MRCoNS) was higher than *S. aureus* (MRSA).

The occurrence of MRSA in different regions of India varies according to the INSAR (Indian Network of Surveillance of Antimicrobial Resistance) group,[18] a multi-hospital based study in various part of India shown that the overall MRSA occurrence in India was 42% in 2008 and 40% in 2009.

In a study at Aligarh, India[19] it was shown that 35.1% of *S. aureus* and 22.5% of CoNS isolates were resistant to methicillin which is low as compared to our study. Anila A. Mathew has reported an occurrence rate of MRSA of

about 34% in the clinical specimen and occurrence rate of MRSA in Eastern U.P. and AIIMS in New Delhi, were 54.85% and 44% respectively.[20] In our study MRSA was 42.65% which is accordance with the similar findings of MRSA in AIIMS, New Delhi.

Few studies from India has reported slightly higher occurrence rate of MRSA as compared to our study such as 46% by Arora *et al.*,[21] from Amritsar, 48.72% by Deepa *et al.*,[22] from Mysore, South India, 51.6% by Vidhani *et al.*,[23] from New Delhi, 54.85% by Anupurba *et al.*, from Banaras Hindu University.[24]

In another study in Nagpur in November-1999 to October-2000, the rate of MRSA was 19.5% which is low as compared to this study.[9] MRCoNS in our study was 52.83% which is average than other studies from India, ranging from 22.5 to 73.5%.[25]

This variation in the occurrence of methicillin resistance among staphylococci is due to the various factors as the availability of healthcare facilities in a particular hospital, implementation, and monitoring of infection control policy, antimicrobial therapy that play a different role from hospital to hospital.

The occurrence of MRSA and MRCoNS were noted variable among different clinical specimens. Out of 148 MRSA and 28 MRCoNS, the highest percentage of MRSA 43.24% (64/148) and MRCoNS 46.42% (13/28) were obtained from blood. The similar findings also reported by Anbumani at Chennai,[26] according to which maximum isolates of MRSA were from blood specimen compared to pus. Our study shows that females are more susceptible to MRSA and MRCoNS infections than males.

In the present study, MRSA and MRCoNS represents variable drug resistant pattern. MRSA isolates shows the highest resistance to co-trimoxazole (91.89%) followed by penicillin-G (89.19%), whereas MRCoNS isolates shows the highest resistance to both penicillin-G and co-trimoxazole (100%). All tested MRSA and MRCoNS shows no resistance to vancomycin. These results agreed with many other studies in the world mentioned that vancomycin was the first drug of choice to methicillin-resistant staphylococci for example in the study done by Von Eiff *et al.*,[27] and by Calderon-Jaimes *et al.*[28]

Most of the MRSA and MRCoNS showed multidrug resistance that makes difficult to treat the infection. Hence, it is necessary to evaluate the drug resistant pattern against MRSA and MRCoNS for controlling the nosocomial infections in an effective manner.

CONCLUSION

In our study, it is concluded that in our hospital the occurrence of methicillin resistance is higher in both *S. aureus* and CoNS that is worrisome in the present therapeutic scenario. Females are more susceptible to both MRSA and MRCoNS infections as compared to males.

According to our study, most of the MRSA and MRCoNS isolates shows the high level of resistance against widely used antimicrobial agents. Although both MRSA and MRCoNS show no resistance to vancomycin.

Vancomycin is the first drug of choice for the treatment of infections caused by MRSA and MRCoNS and to preserve its value we should avoid the use of vancomycin as initial treatment and save it for the treatment of life-threatening infections caused by staphylococci. Linezolid and teicoplanin also show low resistance to both MRSA and MRCoNS so they can also play an important role in the treatment of staphylococcal infections.

In this study, both MRSA and MRCoNS shows higher resistance to co-trimoxazole, penicillin-G, amoxicillin, cefalexin, ampicillin so these are less effective in the treatment of MRSA and MRCoNS infections.

As of multidrug-resistant nature of both MRSA and MRCoNS, the infection control committee of the hospital should want to recommend continuous surveillance of hospital-associated infection and want to take strict infection control policy to eradicate infections caused by MRSA and MRCoNS.

REFERENCES

1. Collee JG, RS Miles, Watt B. Test for the identification of Bacteria. In: Collee JG, Fraser AG, Marmion BP, Simmons A, editors. Mackie and McCarteny Practical Medical Microbiology. 14th ed. New York: Churchill Livingstone; 1996. p. 131-49.
2. Koneman EW, Winn WC, Allen SD. Gram positive cocci, Part 1: Staphylococci and related gram positive cocci. In: Koneman's Color an Atlas and Textbook of Diagnostic Microbiology. 6th ed. Baltimore: Lippincott Williams and Wilkins; 2006. p. 694-71.
3. Pfaller MA, Herwaldt LA. Laboratory, clinical, and epidemiological aspects of coagulase-negative Staphylococci. Clin Microbiol Rev 1988;1:281-99.
4. Wisplinghoff H, Bischoff T, Tallent SM, Seifert H, Wenzel RP, Edmond MB. Nosocomial bloodstream infections in US hospitals: Analysis of 24,179 cases from a prospective nationwide surveillance study. Clin Infect Dis 2004;39:309-17.
5. de Almeida Silva H, Steffen Abdallah VO, Carneiro CL, Gontijo PP. Infection and colonization by *Staphylococcus aureus* in a high risk nursery of a Brazilian teaching hospital. Braz J Infect Dis 2003;7:381-6.
6. Cookson B, Schmitz F, Fluit A. Introduction. In: Fluit AC, Schmitz FJ, editors. MRSA. Current Prospectives. Wymondham: Caister Academic Press; 2003.
7. Zhang HZ, Hackbarth CJ, Chansky KM, Chambers HF. A proteolytic transmembrane signaling pathway and resistance to beta-lactams in Staphylococci. Science 2001;291:1962-5.

8. Hanssen AM, Kjeldsen G, Sollid JV. Local variants of staphylococcal cassette chromosome mec in sporadic mathicillin resistant *Staphylococcus aureus* and methicillin resistant coagulase-negative Staphylococci: Evidence of horizontal gene transfer? Antimicrob Agents Chemother 2004;48:285-96.
9. Rajaduraipandi K, Mani KR, Panneerselvam K, Mani M, Bhaskar M, Manikandan P. Prevalence and antimicrobial susceptibility pattern of methicillin resistant *Staphylococcus aureus*: A multicentre study. Indian J Med Microbiol 2006;24:34-8.
10. Cosgrove SE, Sakoulas G, Perencevich EN, Schwaber MJ, Karchmer AW, Carmeli Y. Comparison of mortality associated with methicillin-resistant and methicillin-susceptible *Staphylococcus aureus* bacteremia: A meta-analysis. Clin Infect Dis 2003;36:53-9.
11. Rice LB. Antimicrobial resistance in gram-positive bacteria. Am J Med 2006;119 6 Suppl 1:S11-9.
12. Costa SF, Miceli MH, Anaissie EJ. Mucosa or skin as source of coagulase-negative staphylococcal bacteraemia? Lancet Infect Dis 2004;4:278-86.
13. From the Centers for Disease Control and Prevention: Morbidity and Mortality Weekly Report, Community-Associated Methicillin-Resistant *Staphylococcus aureus* Infection Among Healthy Newbirns-Chicago and Los Angeles County, 2004. JAMA 2006;296:36-8.
14. Peacock SJ. Staphylococcus. In: Murray PR, Bureau S, Koster J, Vandenberg L, Pengilley Z, editors. Topley & Wilson's Microbiology & Microbial Infections. 10th ed. London: Hodder Arnold; 2005. p. 769-70.
15. Koksal F, Yasar H, Samasti M. Antibiotic resistant patterns of coagulase-negative Staphylococcus strains from blood cultures of septicemic in Turkey Microbiol Res 2007;16:31-4.
16. Vogelaers D. MRSA: Total war or tolerance? Nephrol Dial Transplant 2006;21:837-8.
17. Joseph JF, Harvin AM. History and evolution in antibiotic resistance in coagulase negative staphylococci: Susceptibility profile of new anti-staphylococcal agents. Ther Clin Risk Manag 2007;3:1143-52.
18. Indian Network for Surveillance of Antimicrobial Resistance (INSAR) Group, India. Methicillin resistant *Staphylococcus aureus* (MRSA) in India: Prevalence & susceptibility pattern. Indian J Med Res 2013;137:363-9.
19. Dar JA, Thoker MA, Khan JA, Ali A, Khan MA, Rizwan M, *et al.* Molecular epidemiology of clinical and carrier strains of methicillin resistant *Staphylococcus aureus* (MRSA) in the hospital settings of north India. Ann Clin Microbiol Antimicrob 2006;5:22.
20. Tyagi A, Kapil A, Singh P. Incidence of methicillin resistant *Staphylococcus aureus* (MRSA) in pus samples at a tertiary care hospital, AIIMS, New Delhi. J Indian Acad Clin Med 2008;9:33-5.
21. Arora S, Devi P, Arora U, Devi B. Prevalence of Methicillin-resistant S. aureus (MRSA) in a tertiary care hospital in Northern India. (MRSA Surveillance Study Group). J Postgrad Med 1996;42:1-3.
22. Deepa S, Amruta Kumari B, Venkatesha D. Increasing Trends of Methicillin Resistant Coagulase Negative Staphylococcus in Neonatal Septicaemia- A study in a Tertiary Care Hopital, Mysore, South India. Indan J of Health Sci 2010;9:11.
23. Vidhani S, Mehndiratta PL, Mathur MD, Study of methicillin resistant S. aureus (MRSA) isolates from high risk patents. Indian J Med Microbiol 2001;19:13-6.
24. Anupurba S, Sen MR, Nath G, Sharma BM, Gulti AK, Mohapatra TM. Prevalence of methicillin resistant staphylococcus aureus in a tertiary refferal hospital in eastern U.P. Indian J Med Microbiol 2003;21:49-51.
25. Khadri H, Alzohairy M, Prevalence and antibiotic susceptibility pattern of methicillin-resistant and coagulase-negative Staphylococci in a tertiary care hospital in India. Int J Medicine Medical Science 2010;2:116-120.
26. Anbumani N, Kalyani J, Mallika M. Prevalence of Methicillin-resistant Staphylococcus aureus in Tertiary refferal hospital in Chennai, South India. Indian J for the practising doctor,2006. Vol3, No4.
27. Von Eiff C, Reinert RR, Kresken M, Brauers J, Hafner D, Peters G. Nationwide German multicenter study on prevalence of antibiotic resistance in staphylococcal bloodstream isolates and comparative *in vitro* activities of quinuvities-dalfopristin. J Clin Microbiol 2000;38:2819-23.
28. Calderon-Jaimes E, Monteros LE, Avila-Beltran R. Epidemiology of drug resistance: The case of *Staphylococcus aureus* and coagulase-negative staphylococci infections. Salud Publica Mex 2002;44:108-12.

How to cite this article: Ahmed R, Singh S, Farooq U, Bharti AK, Kaur N. Occurrence and Antimicrobial Susceptibility Pattern of Methicillin-resistant *Staphylococcus Aureus* and Methicillin-resistant Coagulase-Negative Staphylococci Isolated from Different Clinical Specimens from the Patients Hospitalized in Teerthanker Mahaveer Medical College and Research Centre, Moradabad, India. Int J Sci Stud 2016;3(11):41-47.

Source of Support: Nil, **Conflict of Interest:** None declared.