International Journal of Modern Science and Technology, 2018;3(2):41-46.
ISSN: 2456-0235.
www.ijmst.co

Research Article

Incidence and Evaluation of Methicillin-Resistant *Staphylococcus aureus* from Nasal Cavity of Students of Allied Healthcare

B. Bharathi[1,]*, V. Vinodhini[2]

[1]MMM College of Health Sciences, Mogappair, Chennai - 600037. India.
[2]Department of Microbiology, Madras Medical Mission, Mogappair, Chennai - 600037. India.

*Corresponding author's e-mail: bharathikarnan@gmail.com

Abstract

The present investigation deals with the incidence and evaluation of methicillin resistant *Staphylococcus aureus* (MRSA) nasal colonization and carriage among the students of allied health care. In this study, a total of 104 allied health care students were selected and nasal swabs were taken and was inoculated into appropriate media and the organisms were isolated and identified by cultural characteristics, microscopic examination and biochemical characteristics. The isolated *S. aureus* was subjected to act on five antibiotics namely methicillin, ciprofloxacin, erythromycin, pencillin and tetracycline by using Kirby-Bauer method. Among 104 students, 20 (19%) students showed positive result for *S. aureus*. Among them, *S. aureus* 9 (45%) showed positive for MRSA, 5 (25%) showed positive for methicillin intermediate *S. aureus* (MISA), and 6 (30%) showed positive for methicillin sensitive *S. aureus* (MSSA). Among gender, 16.67% MRSA and 40% MISA found in male; In female 83.34% MRSA, 60% MISA and 100% MSSA were seen. Among professional aspects, students of Cardio Pulmonary Perfusion Care Technology showed 33.34% MRSA and 20% MISA; students of Cardiac Technology were showed 16.67% MRSA , 20% MISA and 33.34% MSSA; students of Operation Theatre & Anesthesia Technology were showed 20% MISA and 11.12% MSSA; students of Dialysis Technology showed 33.34% MRSA and 20% MISA; students of Medical Sociology were showed 16.67% MRSA and 33.34% MSSA and the students from Physician Assistant were showed 20% MISA and 22.23% MSSA. There was no significant difference between the potential factors (gender and profession) and nasal carriage of MRSA, MISA and MSSA (P>0.05).

Keywords: Methicillin resistant; Methicillin Sensitive; Methicillin Intermediate; *Staphylococcus aureus.*

Introduction

Staphylococcus aureus has been recognized as an epidemiologically important pathogen. Despite antibiotic therapy, staphylococcal infections occur frequently in hospitalized patients and have severe consequences. It can act both as a human commensal, that persistently colonizes 20-30% of adult human population, and as an invasive pathogen [1]. *S. aureus* has outstanding ability to acquire resistance to antibiotics. Benzyl penicillin was no longer effective for treatment of most *S. aureus* infections within 10 years after its introduction for use because of the acquisition of plasmid encoded β-lactamase. Penicillin resistant *S. aureus* became pandemic throughout the late 1950s and early 1960s.

Methicillin is β-lactam antibiotic invented to treat penicillin resistant *S. aureus*. However, methicillin-resistant *S. aureus* (MRSA) was reported 2 years after the antibiotic was introduced in 1961 in the United Kingdom [2]. Treatment of MRSA infection with vancomycin can be complicated, due to its inconvenient route of administration. Methicillin-resistant *S. aureus* (MRSA) is any strain of *S. aureus* bacterium that is resistant to a large group of antibiotics called the beta-lactams. The bacterial call wall contains penicillin binding proteins (PBPs), which have an enzymatic role in the synthesis of peptidoglycan. Normally, PBPs have a high affinity for beta-lactam antibiotics, in MRSA this affinity is reduced resulting in antibiotic resistance. In MRSA, a low antibiotic affinity PBP known as

Received: 06.02.2018; Received after Revision: 15.02.2018; Accepted: 16.02.2018; Published: 28.02.2018

PBP2a is encoded by mecA gene [3]. Community-associated MRSA (CA-MRSA) strains differ from health care-associated (HA) MRSA strains in terms of epidemiology, microbiology, and clinical manifestations [4]. CA-MRSA strains are generally susceptible to most antibiotics, contain Staphylococcal chromosome cassette mecA type IV, produce the virulence factor Panton-Valentine Leukocidin, and cause mainly skin and soft tissue infections [5].

The levels of crowding and hygiene in both hospital and household settings are important for the rate of transmission. Health care workers (HCWs) have been reported to have rates of *S. aureus* nasal carriage comparable to the general population in different cross-sectional studies [5], but the range of carrier rates is large possibly due to differences in the quality of sampling and culture techniques. Recent reports have revealed that *S. aureus* nasal carriage rates is higher among surgeons than among high risk patient groups [6], among physicians compared with other professionals in the society, and among nurses compared to other HCWs [7]. Medical students represent an important portion of the health care personnel, and they are at risk of being colonized with different pathogens, including *S. aureus*, and of spreading them to susceptible patients [8]. Some studies reported that nasal carriage rates of *S. aureus* increased with greater exposure of students to the hospital environment [9]. Thus, colonized individuals in frequent contact with the general community or health care environment may spread the bacteria to other community members or to susceptible patients respectively [10].

Materials and methods

Study population and sample collection

A total of 104 allied health science students were included in the study, aged between 17 and 21 years those who are going to be posted in the hospital in different labs and departments.

Nasal swabs were taken from both anterior nares of the students. Without contamination the swab was place in the culture medium namely Nutrient broth, Nutrient agar, Mannitol salt agar, Muller Hinton Agar [11].

Isolation and identification of bacteria

The swabs were subjected for isolation, identification and characterization of colonies by staining, culture and using 2 biochemical tests-catalase and coagulase tests. The cultural characteristics- architectural view of colony associated with colour, size and shape.

Antibiotic sensitivity test

Antibiotic sensitivity test performed on according to Clinical and Laboratory Standards Institute (CLSI, formerly NCCLS, 2012) procedures. The tested antibiotics were included: ciprofloxacin (5 µg), erythromycin (15 µg), methicillin (5 µg), penicillin-G (10 units) and tetracycline (30 µg) (HiMedia, India). *Staphylococci* were tested for antimicrobial drug susceptibility against 5 commonly used antibiotics belonging to different groups by disc diffusion method by Kirby-Bauer method. The antibiogram of isolates (*Staphylococcus spp*.) were determined on freshly prepared, dried up Muller Hinton agar using by the Kirby-Bauer disc diffusion method (Bauer *et al*, 1966). A measurement zone designed on sensitive, intermediate and resistant. Based on zones of inhibition, the results are interpreted using the criteria recommended by CLSI, isolates were classified as either sensitive (S), intermediate (I) or resistant (R). The isolates resistant to three or more antibiotics were classified as multi-drug resistant (MDR) strains.

Statistical analysis

The data analysis was done with IBM SPSS (Version-21) software. Frequency and percentage analysis has been carried out to summarize the data. Fisher's exact test has been done to find the association between potential factors with MRSA, MISA, and MSSA. All p-values were two-sided with, $p<0.05$ being considered statistically significant.

Results and discussion

Age, sex and professional distribution of the study participants

A total of 104 samples were collected from the nasal cavity of Allied health care students. About 20.19% were males and 79.81% were females, and they were aged between 17-21 with the mean and S.D. of 18.24±0.62. The demographic profile of the respondents was shown in table 1.

Isolation and identification of S. aureus

S. aureus was isolated and identified from the nasal swabs collected from the different professional students. The distribution of *S. aureus* was 19% among the 104 samples. The overall cultural, microscopic and biochemical characteristics of *S. aureus* were represented in table 2.

Table 1. Demographic profile of the respondents

Variables	No (%)
Gender	
Male	21 (20.19)
Female	83 (79.81)
Age*	18.24±0.62
Profession	
Cardio Pulmonary Perfusion Care Technology	5 (4.81)
Cardiac Technology	18 (17.31)
Operation Theatre & Anesthesia Technology	20 (19.23)
Dialysis Technology	19 (18.27)
Medical Sociology	12 (11.54)
Physician Assistant	20 (19.23)
Medical Lab Technology	10 (9.62)

*Mean±SD

Table 2. Cultural, microscopic and biochemical characteristics of *S. aureus*

Characteristics	Results	Interpretation
Cultural characteristics		
Nutrient agar	Small, circular and smooth raised yellow colonies	Presence of coagulase positive *S. aureus*
Mannitol salt agar	Small, circular, yellowish colonies with fermentation	
Microscopic examination		
Gram's staining	Gram positive cocci with grape like clusters	
Biochemical characteristics		
Catalase test	Positive	
Coagulase test	Positive	

In the present study, student nasal carriage rate of *S. aureus* was shown to be 19% (20 students) out of 104 students. This result is comparable to previous studies from different countries such as in Iran [12]. However, the carriage rate in our study was shown to be lower than what has been found in other studies. In Southwest Ethiopia, the overall frequency of isolation of *S. aureus* from nasal cavity of primary school children of Jimma town was found to be 47.74% (169/354) [13].

Antibiotic sensitivity pattern

The coagulase-positive *Staphylococci* isolates showed variable antibiotic sensitivity pattern towards 5 antibiotics. Among 20 isolates, 9 were resistant to methicillin (MRSA), 5 were intermediate to methicillin (MISA), and 6 were sensitive to methicillin (MSSA) (Table 3). In Iran in 2008, the nasal screening identified 186 (31%) *S. aureus* carriers out of 600 HCWs, of the 186 nasal carriers of *S. aureus*, 154 (82.8%) carried MSSA and 32 (17.2%) carried MRSA [12]. The antibiotic resistance pattern towards *S. aureus* was summarized in table 4. The antibiotic sensitivity pattern of MRSA, MISA and MSSA towards 4 other antibacterial antibiotics are represented in table 5.

Table 3. Prevalence of nasal carriage of *Staphylococcus aureus* towards Methicillin antibiotic

S. aureus	Frequency	Percentage
Resistant (MRSA)	9	45
Intermediate (MISA)	5	25
Sensitive (MSSA)	6	30
Total	20	100

Table 4. Antibiotic resistant pattern towards *Staphylococcus aureus*

Antibiotics	*S. aureus*		
	R%	I%	S%
Methicillin	9(45)	5(25)	6(30)
Ciprofloxacin	7(35)	7(35)	6(30)
Erythromycin	7(35)	4(20)	9(45)
Penicillin-G	20(100)	-	-
Tetracycline	1(5)	3(15)	16(80)

Among 9 isolates of MRSA - 33.34% resistant, 33.34% intermediate and 33.34%

sensitive towards ciprofloxacin; 44.45% resistant, 44.45% intermediate and 11.12% sensitive towards erythromycin, 100% resistant towards penicillin-G and 11.12% resistant, 22.23% intermediate and 66.67% sensitive towards tetracycline. Among 5 isolates of MISA - 40% resistant, 40% intermediate and 20% sensitive showed towards ciprofloxacin; 40% resistant and 60% sensitive showed towards erythromycin; 100% resistant showed towards penicillin-G and 100% sensitive showed towards tetracycline. Among 6 isolates of MSSA - 33.34% resistant, 33.34% intermediate and 33.34% sensitive towards ciprofloxacin; 16.67% resistant and 83.34% sensitive towards erythromycin; 100% resistant showed towards penicillin-G and 16.67% intermediate, 83.34% sensitive towards tetracycline. This study shows that the nasal carriage of *S. aureus* (MSSA, MISA & MRSA) insignificantly associated to gender and profession of the students (p=0.23 and p=0.80) similar to the studies of Mollelama *et al*., 2010 [14]. Likewise, the study conducted in Iran, among HCWs showed that there was no significant difference between the sexes (p=0.247), age (p=0.817), and years of health care service (p=0.15) between those with nasal carriage of MRSA and MSSA [15].

Table 6 showed the results of potential factors for nasal carriage of MRSA, MISA and MSSA. Among gender, 16.67% MRSA and 40% MISA found in male; in female 83.34% MRSA, 60% MISA and 100% MSSA were seen. There was no significant association between the potential factors (gender and profession) and nasal carriage of MRSA, MISA and MSSA (p>0.05).

Table 5. Antibiotic sensitivity pattern of MRSA, MISA and MSSA

Antibiotics	MRSA (9)			MISA (5)			MSSA (6)		
	R%	I%	S%	R%	I%	S%	R%	I%	S%
Ciprofloxacin	3(33.34)	3(33.34)	3(33.34)	2(40)	2(40)	1(20)	2(33.34)	2(33.34)	2(33.34)
Erythromycin	4(44.45)	4(44.45)	1(11.12)	2(40)	-	3(60)	1(16.67)	-	5(83.34)
Penicillin-G	9(100)	-	-	5(100)	-	-	6(100)	-	-
Tetracycline	1(11.12)	2(22.23)	6(66.67)	-	-	5(100)	-	1(16.67)	5(83.34)

Table 6. Potential factors for nasal carriage of MRSA, MISA and MSSA among Allied healthcare students

Variable	Carrier status			p-value
	MRSA , n (%)	MISA, n (%)	MSSA, n (%)	
Gender				
Male	1(16.67)	2(40)	-	0.23
Female	5(83.34)	3(60)	9(100)	
Professional				
Cardio pulmonary Perfusion Care Technology	2(33.34)	1(20)	-	0.80
Cardiac Technology	1(16.67)	1(20)	3(33.34)	
Operation Theatre & Anesthesia Technology	-	1(20)	1(11.12)	
Dialysis Technology	2(33.34)	1(20)	-	
Medical Sociology	1(16.67)	-	3(33.34)	
Physician Assistant	-	1(20)	2(22.23)	

Conclusions

This study revealed the prevalence of nasal carriage of *S. aureus* strains in allied health care students with MRSA, MISA & MSSA. The high frequency of *S. aureus* carriage (persistent & intermittent) found in this study among the students who are going to be posted in different

departments of hospital represent a risk for the health care personnel to susceptible patients and to other individuals in the community. The present study demonstrates that allied health care students from this geographical area asymptomatically carry MRSA strains persistently, with the threat of spreading then both to community and hospital environment. Studies addressed to determine the duration of CA-MRSA carriage, transmissibility, attack rates, and eradication strategies are required to clarify the role of health care workers including allied health-care students, as reservoirs of these strains in health care facilities. Actions should be taken to create awareness for the emergency and transmission of these strains to minimum by making the use of well-established hygienic precautions.

Conflicts of interest

The authors declare no conflict of interest.

Acknowledgment

We gratefully thank the management and Principal of the College of Health Sciences to give permission for the collection of nasal samples from the students for the study purpose. Greatful thanks goes to the students who are involved in this study.

References

[1] Kluytmans JA, Wertheim HF. Nasal carriage of *Staphylococcus aureus* and prevention of nosocomial infections. Infection. 2005;B33(1):3-8.

[2] Raygada JL, Levine DP. Managing CA-MRSA infections: current and emerging options. Journal of Infections and Medicine. 2009;26:49-58.

[3] Silvana M, Emmanuel R, Carols C. Prevalence of *Staphylococcus aureus* introduced into intensive care units of a university hospital. Brazilian Journal of Infectious Diseases. 2005;9:1-12.

[4] Millar BC, Loughrev A, Elborn JS, Moore JE. Proposed definitions of community-associated methicillin-resistant *Staphylococcus aureus* (CA-MRSA). Journal of Hospital Infection. 2005;67:109-13.

[5] Johnson A, Pearson A, Duckworth G. Surveillance and epidemiology of MRSA bacteraemia in the UK. Journal of Antimicrobial Chemotherapy. 2005;56:455-462.

[6] Schwarzkopf R, Takemoto RC, Immerman I, Slover JD, Bosco JA. Prevalence of Staphylococcus aureus colonization in orthopaedic surgeons and their patients: a prospective cohort controlled study. Journal of Bone and Joint Surgery America. 2010;92(9):1815-1819.

[7] Elie-Turenne MC, Fernandes H, Mediavilla JR, Rosenthal M, Mathema B, Singh A, Cohen TR, Pawar KA, Shahidi H, Kreiswirth BN. Prevalence and characteristics of *Staphylococcus aureus* colonization among healthcare professionals in an urban teaching hospital. Infection Control and Hospital Epidemiology. 2005;31(6):574-580.

[8] Benedikt H, Raphael R, Hassan AE, Denise D, Andreas H. Prevalence of nasal colonisation by methicillin-sensitive and methicillin-resistant *Staphylococcus aureus* among healthcare workers and students in Madagascar. BMC Infect Dis. 2016;16:420. doi:10.1186/s12879-016-1733-6.

[9] Stubbs E, Pegler M, Vickery A, Harbour C. Nasal carriage of Staphylococcus aureus in Australian (pre-clinical and clinical) medical students. Journal of Hospital Infection. 1994;27:127-134.

[10] Carre N, Herbreteau N, Askeur N, Dabas JB, Sillam F, Pinchon C. Outbreak of skin infections due to *Staphylococcus aureus* carrying Panton-Valentine Leukocidin genes in pupils and their relatives. Medecine et Maladies Infectieuses. 2011;41:364-371.

[11] Dougherty L, Lister S. The Royal Marsden Hospital Manual of Clinical Nursing Procedures (6th ed). Blackwell Publishing, Oxford; 2004.

[12] Mollema FP, Richardus JH, Behrendt M, Vaessen N, Lodder W, Hendriks W, Verbrugh HA, Vos MC. Transmission of methicillin-resistant *Staphylococcus aureus* to household contacts. Journal of Clinical Microbiology. 2010;48(1):202-207

[13] Tekalign K, Ketema B. Prevalence and antibiotic susceptibility pattern of methicillin-resistant *Staphylococcus aureus* (MRSA) among primary school

children and prisoners in Jimma Town, Southwest Ethiopia. Annals of Clinical Microbiology and Antimicrobials. 2013;12:11.

[14] El Aila NA, Al Laham NA, Ayesh BM. Nasal carriage of methicillin resistant Staphylococcus aureus among health care workers at Al Shifa hospital in Gaza Strip. BMC Infect Dis. 2017;17(1):28. doi:10.1186/s12879-016-2139-1.

[15] Mollema FP, Richardus JH, Behrendt M, Vaessen N, Lodder W, Hendriks W, Verbrugh HA, Vos MC. Transmission of methicillin-resistant *Staphylococcus aureus* to household contacts. Journal of Clinical Microbiology. 2010;48(1):202-207.

****

