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Original Research Article

Staphylococcus aureus: Nasal carriage in health care workers and in-patients with special reference to MRSA.

Running title: Staphylococcal carriagein a tertiary care hospital.

Abstract-

Study design: Cross sectional study

Place and duration of study: Department of Microbiology, Govt Medical College and Hospital Srinagar Kashmir. One year study (July 2013 to June 2014)

Methodology: Nasal swabs were taken from health care workers (HCWs) and in-patients and these were processed for the recovery of *Staphylococcus aureus* (*S. aureus*) and methicillin resistant *Staphylococcus aureus* (MRSA).Antimicrobial susceptibility of the isolatesto various antibiotics was performed as per Clinical Laboratory Standards Institute (CLSI) guidelines and D-test done to ascertain inducible or constitutive clindamycin resistance. Risk factors for their carriage were also analyzed.

Results: Higher isolation of *S. aureus* and of MRSA was seen in in-patients (47.1% and 32.7% respectively) as compared to HCWs (32.8% and 19.1% respectively).Significantresistance to clindamycin, erythromycin, ciprofloxacin, tetracycline and co-trimoxazole was seen in MRSA isolates recovered form in-patients. MRSA isolates had higher constitutive and inducible clindamycin resistance. Years of service and level of education in HCWs were significantly associated with MRSA carriage in them.

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Conclusion: Nasal carriage of *S. aureus* and MRSA is common in HCWs and in-patients in our hospital. Apart from periodic screening for MRSA carriage, strict adherence to existing infection control guidelines is mandatory.

Key words:HCWs, In-patients, MRSA

Introduction

Staphylococcus aureus is a major nosocomial pathogen, causing healthcare-associated infections worldwide. [1]Shortly after the introduction of penicillin, *S. aureus* strains resistant to the drug appeared on the horizon. [2,3] Methicillin was subsequently used to treat such infectionsbut again strains with acquired resistance to this antibiotic; methicillin-resistant *S. aureus* (MRSA) emerged.[4] Nasal colonization with *S. aureus* is a dynamic process; various factors being responsible for the gain and loss of carriage.Risk of subsequent infection in a person colonized with *S. aureus*as well as MRSA, increases with timeand remains persistently elevated. [5]

A causal relationship between *S. aureus* nasal carriage and subsequent infection is supported by the fact that many a times nasal and the infecting strain share the same genotype. Colonizing strains may thus serve as endogenous reservoirs for overt clinical infections or may spread to other patients. [6]Active surveillance for patients colonized with MRSA is recommended to prevent infections due to this pathogen in health care settings.Healthcare workers (HCWs) arealsoknown to carry pathogenic hospital strains in their nose and on skin, thus acting as vectors of transmission for both patients and other HCW's [5].

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Several studies worldwide have reported the rate of nasal carriage of *S. aureus* strains varying from 16.8% to 90%. [7-9]Emergence of MRSA strains, which are often multidrug-resistant, renders the treatment of suchinfections more challenging as options are limited.

The aim of this study was to describe the pattern of colonization with *Staphylococcus* especially MRSAamong HCWs and in-patients, in a leading tertiary care hospital of this north Indian state as well as to delineate the antibiogram of these isolates.

Material and methods

Nasal swabs were taken from in-patients (of all age groups) admitted in various wards and HCW's at Government Medical College and Hospital, Srinagar.A total of 736 samples were collected fromin patientsand health care personnel including doctors, nursing staff, sanitary attendants, laboratory technicians, canteen staff, laundry attendants and administrative staff.

Pre-moistened cotton swabs were introduced 2 cm into the nasal vestibule and rubbed along the walls of the nasal cavity. The swabs were transported within 2 hrs to the Microbiology laboratory of our hospital. These were streaked onto blood agar and mannitol salt agar (MSA) plates. The swabs were also put in Robertson's cooked meat broth (RCM) with high salt concentration (7.5%) to aid in the recovery of small number of *S. aureus*. The media plates were incubated aerobically at 35°C for 18-24 hrs and RCM tubes were incubated for 72hrs. In case the primary culture plates were sterile and RCM showed turbidity, it was sub-cultured on to the above mentioned media.

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Gram positive, catalase positivecocci were classified as *S. aureus* on the basis of colony characteristics on blood agar, growth on MSA, slide and tube coagulase positivity, DNAase and phosphatase tests as well as bacitracin resistance and lysostaphin sensitivity. Antibiotic susceptibility testing was done for all the confirmed *S. aureus* isolates by Kirby Bauer disk diffusion method on Muller Hinton agar according to Clinical Laboratory Standard Institute (CLSI) 2013 guidelines, with zone diameters measured in millimeters. [10]Antibiotic discs used included penicillin (10 units), vancomycin (30 µg), teicoplanin (30 µg), linezolid (30 µg), gentamicin (10 µg), amikacin (30 µg), clindamycin (2 µg), erythromycin (15 µg), trimethoprim-sulfamethoxaxazole (1.25/23.75 µg), ciprofloxacin (5 µg) and tetracycline (30 µg). Zone of inhibition around the discs was interpreted as sensitive, intermediate or resistant as per CLSI guidelines.[10] Methicillin resistance was evaluated by using cefoxitin(30 µg) discs. D-test to look for constitutive or inducible clindamycin resistance was done as per CLSI guidelines [10]*S. aureus* ATCC 25923 was used as a quality control strain for the disc diffusion test.

Ethical clearance for the study was sought from the institute's ethical clearance committee and written consent was taken from HCW's as well as in-patients. Details of the in-patients and HCWs such as age, gender, antibiotic intake in the previous 3 months, were noted on a pre-prepared proforma. Apart from these, years of service, level of education(for HCWs) and duration of hospital stay,history of prior hospitalization (last I year) and the place of admission, at the time of taking the nasal swab (for in-patients) was also recorded. Findings were analyzed using descriptive and analytical statistics using SPSS version 16 software.*P*-value of <0.05 was taken as significant.

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All the discs, media and control strains were procured from Himedia Laboratories Pvt. Ltd., Mumbai.

Results

A total of 310 (42.1%) isolates of *S. aureus* were recovered from the 736 nasal swabs collected from 480 in-patients and 256 healthcare workers (HCWs). Of the 310 *S. aureus* isolates, 226 (47.1%) were from in-patients whereas 84 (32.8%) were from HCWs. Methicillin resistance was seen in 74 (32.7%) *S. aureus* isolates recovered from in-patients and 16 (19.1%) *S. aureus* isolates recovered from HCWs. Table 1. The overall prevalence of methicillin resistant *S. aureus* (MRSA) was 29.0% (n=90).

A total of 32 (24.8%) *S. aureus* isolates recovered from in-patients showed constitutive clindamycin resistance (MLS_{BC} phenotype) whereas 19 (14.7%) showed inducible clindamycin resistance, i.e. D-test positive (MLS_{Bi} phenotype). MS phenotype B (D-test negative) was seen in 78 isolates. Among *S. aureus* isolates recovered from HCWs, 17 (21.8%)depicted constitutive clindamycin resistance (MLS_{BC} phenotype), whereas 7 (9%)were D-test positive (MLS_{Bi} phenotype).MS phenotype B (D-test negative) was seen in 54 isolates. MRSA isolates recovered from both in-patients and HCWs depicted higher constitutive and inducible clindamycin resistance. Table 2

MRSA were isolated more from male patients (n=41, 55.4%) than female patients (n=33, 44.6%). Higher isolation of MRSA was seen in patients belonging to the age group of 50-59 years (n=26, 35.1%).Specimens received from patients housed in the surgical intensive care unit (SICCU) yielded higher number of MRSA isolates (n=29, 39.2%), followed by plastic surgery ward (n=19, 25.7%).Prior history of hospitalization (last one year) was seen in 12 (16.2%) patients from whom MRSA were recovered

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whereas history of antibiotic intake in the last three months was noted in 23 (31.1%) patients,most common of which were fluoroquinolones (n=8) followed by co-trimoxazole (n=5), macrolides (n=4), cephalosporins (n=4), aminoglycosides and inhibitor combination (n=3) and inhibitor combination (n=3). Details of the HCWs from whom *S.aureus* was isolated are given in table 3. Higher carriage of MRSA (n=4, 25%) was seen in HCWs working in the SICCU. As with in-patients, more MRSA were recovered from male HCWs, 10 (62.5%). Nasal swabs taken from HCWs in the age group of 30-50 years yielded more MRSA isolates, 11 (68.8%). Those who had been working in the hospital from the last 1-4 years were found to have more MRSA carriage, 8 (50%). Nasal carriage of MRSA was more in HCWs who were college graduates, 11 (68.8%). Two (12.5%) HCWs had taken fluoroquinolonesin the last three months. MRSA carriage was seen more in nurses, 9 (56.3%)and doctors (12.5%).

Results of the antimicrobial susceptibility testing are given in table 4 and 5. Higher resistance to the antibiotics tested was seen in *S. aureus* isolates in general and MRSA isolates in particular recovered from both HCWs and in-patients. Hundred percent isolates of MRSA recovered from both the groups were resistant to penicillin, whereas all the isolates were uniformly sensitive to linezolid, teicoplanin and vancomycin. High resistance to MRSA isolates recovered from HCWs was seen to erythromycin (81.3%), ciprofloxacin (75%), co-trimoxazole (68.8%) tetracycline and clindamycin (62.5% each). On the other hand significant resistance among MRSA isolates recovered from in-patients was seen to erythromycin (91.9%), co-trimoxazole (85.1%), clindamycin (83.3%), tetracycline (82.4%) and ciprofloxacin (79.7%).

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Table 1: Distribution of MSSA and MRSA isolates among in-patients and health care workers.

	MSSA (n=220)	MRSA (n=90)	Total (n=310)	*P*-value
In-patients	125 (56.8%)	74 (32.7%)	199 (64.2%)	<0.05
Healthcare workers	95 (43.2%)	16 (19.1%)	111 (35.8%)	

Table 2: Pattern of clindamycin resistance in *S. aureus* isolates recovered from in-patients and HCWs

In-patients				
	Clindamycin resistant MSSA (n=67)	Clindamycin resistant MRSA (n=62)	Total (n=129)	
$MLSB_c$	11 (16.4)	21 (33.9)	32 (24.8)	Fischer exact test=1.00
$MLSB_i$	6 (8.9)	13 (21)	19 (14.7)	
HCWs				
	Clindamycin resistant MSSA (n=68)	Clindamycin resistant MRSA (n=10)	Total (n=78)	
$MLSB_c$	13 (19.1)	4 (40)	17 (21.8)	Fischer exact test=1.00
$MLSB_i$	5 (7.4)	2 (20)	7 (9)	

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Table 3: Details of the health care workers from whom *S. aureus* were recovered

Characteristic	MSSA carriage (n=95)	MRSA carriage (n=16)	*P*-value
Gender			
Male	56 (59)	10 (62.5)	0.99
Female	39 (41.0)	6 (37.5)	
Age (years)			
<30	28 (29.5)	2 (12.5)	0.29
30-50	47 (49.5)	11 (68.8)	
>50	20 (21.0)	3 (18.7)	
Years of service			
1-4	18 (18.9)	8 (50)	0.01
6-9	42 (44.2)	6 (37.5)	
≥10	35 (36.8)	2 (12.5)	
Level of education			
Under graduate	11 (11.6)	1 (6.3)	0.03
Graduate	33 (34.7)	11 (68.8)	
Post graduate	51 (53.7)	4 (25)	
Antibiotic intake in the last 3 months			
Present	21 (22.1)	2 (12.5)	0.58
Absent	74 (77.9)	14 (87.5)	
Occupation			
Doctor	18 (18.9)	2 (12.5)	0.07
Nurse	26 (27.4)	9 (56.3)	
Nursing orderlies	15 (15.8)	3 (18.8)	
Sanitary attendants	12 (12.6)	1 (6.3)	
Laundry attendants	6 (6.3)	0	
Canteen staff	4 (4.2)	0	
Laboratory staff	8 (8.4)	1 (6.3)	
Administrative staff	6 (6.3)	0	

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Table 4: Antimicrobial susceptibility profile of *S.aureus* isolates recovered form in-patients.

Antibiotic	MSSA (n=125)		MRSA (n=74)		P-value
	Sensitive n (%)	Resistant n (%)	Sensitive n (%)	Resistant n (%)	
Penicillin	2 (1.6)	123 (98.4)	0	74 (100)	-
Cefoxitin	125 (100)	0	0	74 (100)	-
Clindamycin	58 (46.4)	67 (53.6)	12 (16.2)	62 (83.8)	<0.001
Erythromycin	32 (25.6)	93 (74.4)	6 (8.1)	68 (91.9)	0.004
Ciprofloxacin	51 (40.8)	74 (59.2)	15 (20.3)	59 (79.7)	0.005
Tetracycline	42 (33.6)	83 (66.4)	13 (17.6)	61 (82.4)	0.023
Amikacin	47 (37.6)	78 (62.4)	21 (28.4)	53 (71.6)	0.242
Gentamicin	41 (32.8)	84 (67.2)	18 (24.3)	56 (75.7)	0.269
Co-trimoxazole	86 (68.8)	39 (31.2)	11 (14.9)	63 (85.1)	<0.001
Linezolid	125 (100)	0	74 (100)	0	-
Vancomycin	125 (100)	0	74 (100)	0	-
Teicoplanin	125 (100)	0	74 (100)	0	-

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Table 5: Antimicrobial susceptibility profile of *S. aureus* isolates recovered form health care workers.

Antibiotic	MSSA (n=95)		MRSA (n=16)		p-value
	Sensitive n (%)	Resistant n (%)	Sensitive n (%)	Resistant n (%)	
Penicillin	0	95 (100)	0	16 (100)	-
Cefoxitin	95 (100)	0	0	16 (100)	-
Clindamycin	27 (28.4)	68 (71.6)	6 (37.5)	10 (62.5)	0.66
Erythromycin	16 (16.8)	79 (83.2)	3 (18.8)	13 (81.3)	0.86
Ciprofloxacin	46 (48.4)	49 (51.6)	4 (25)	12 (75)	0.141
Tetracycline	44 (46.3)	51 (53.7)	6 (37.5)	10 (62.5)	0.701
Amikacin	32 (33.7)	63 (66.3)	8 (50)	8 (50)	0.329
Gentamicin	28 (29.5)	67 (70.5)	8 (50)	8 (50)	0.182
Co-trimoxazole	48 (50.5)	47 (49.5)	5 (31.3)	11 (68.8)	0.247
Linezolid	95 (100)	0	16 (100)	0	-
Vancomycin	95 (100)	0	16 (100)	0	-
Teicoplanin	95 (100)	0	16 (100)	0	-

Discussion

The current study highlights the carriage of *S. aureus* in HCWs and in-patients in our hospital. Higher isolation of *S. aureus* and of MRSA was seen from in-patients (47.1% and 32.7% respectively) in our study as compared to HCWs (32.8% and 19.1% respectively).Data available from India suggests that MRSA carriage rates are nearly 15.6% in in-patients and range from 1.8 to 25% amongst health-care workers in various

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hospital settings. [11] Al-Abdli et al. [12] studied the frequency of *S. aureus* carriage among HCWs in 10 different hospitals in Libya and found the prevalence to be 47.5%; out of which 21.4% were MRSA.On the other hand, higher carriage rates of *S. aureus* were reported in Yemen (85%) and Nigeria (52.5%). [13,14]These difference can be attributed to factors like sample size, quality of sample collected, culture techniques used, population studied, geographical area and accompanying risk factors that contribute to the dynamics of *S. aureus* and MRSA carriage.

MRSA were isolated more from male in-patients (55.4%) as well as HCWs (62.5%) in our study. This is in accordance to what was seen by Tenguria R et al. [15]where the authors found higher prevalence of methicillin resistance in *S aureus* isolates recovered from male patients. Shibabaw et al. [16] in their study reported similar findings where higher numbers of MRSA were recovered from male HCWs (17.5%). Higher isolation of *S. aureus* from male HCWs was also seen by Shakya B et al. [17]Al-Humaidan et al. [18]Rongpharpi et al. [19] in their respective studies.

In the present study higher number of MRSA isolates were recovered from in-patients in the age group of 50-59 yrs; 35.1% and HCWs in the age group of 30-50 yrs; 68.8%.Our results are comparable to those reported by Tenguria R et al.[15]where authors found MRSA carriage of 30% among in-patients in the age group of 50-59 yrsand Al-Humaidan et al. [18] where preponderance of MRSA carriage in the age group of 30-50 yrs (20%) was seen among HCWs.

Specimens obtained from patients (39.2%) and HCWs(25%) in the SICCU yielded higher number of MRSA isolates in our study.This is in contrast to what was reported by Mohajeri P et al. [20] where high MRSA carriage rate was seen in the infant wards (80%) followed by intensive care unit (47.4%). On the other hand, Khanal et al. [21] in their study reported MRSA carriage in 28.6% of the HCWs working in ICU. Pan et

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al. [22] also reported high isolation of MRSA (38.1%) from HCWs working in the ICU. Askarian et al. [1] in a study carried out in Iran, reported higher prevalence of nasal carriage of MRSA in HCWs working in the surgical ward. Whereas the carriage rate of MRSA was highest among the staff working in the orthopedics department in a study carried out in the northeastern part of our country. [19]

Admission of critically ill patients in SICCU that have to undergo invasive monitoring and receive broad spectrum antibiotics as empirical therapyplaces them at a higher risk of being infected with MDR pathogens. Nasal carriage of MRSA among HCWs involved in the care of such patients can serve as a source of infection in them if proper infection control practices are not followed. Routine surveillance of HCWs in high dependency areas of the hospital like ICUs and surgical wards for nasal carriage of MRSA and its eradication should be carried out, to reduce the risk of transmission and subsequent infections in patients.

Prior history of hospitalization (last 1 year) and antibiotic intake (last 3 months)was seen in 16.2% and 31.1% of in-patients respectively from whom MRSA were recovered.On the other hand 12.5% HCWs from whom MRSA were recovered had taken antibiotics in the last 3 months.However no significant association was found between these variables and MRSA carriage either in HCWs or in-patients. This is in contrast to what was reported by Rongpharpi et al. [19] where the investigators found a significant association between antibiotic intake and MRSA isolation among HCWs.

We found a significant isolation of MRSA; ($P<0.05$) from HCWs with < 5 year of service record (50%). This could be attributed to the lack of knowledge and experience regarding proper infection control practices in them, compared to more senior staff that is well versed with basic infection control measures. Our results are comparable to those seen by other investigators. [1,16]Interestingly with regards to level of education of the

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HCWs we found significant isolation of MRSA from those who were college graduates ($P<0.05$) in our study. The greatest challenge for the success of established infection control protocols is strict compliance rather than novelty hence continuedtraining and capacity buildingof newer recruits in the field of health careshould be done at regular intervals and their active participation sought in this regard. This can prove to be a simple and cost effective method of preventing transmission of drug resistant bacteria (e.g. MRSA)especially in patients with open wounds admitted to surgical units.

Highest carriage of MRSA was seen in nurses (56.3%) and doctors (12.5%) in our study,which could be due to their frequent contact with patients. Many studies conducted across the globe have reported more MRSA carriage rates among nurses and doctors. [1,12,16,18,19,21]

Over all higher resistance to the various antibiotics tested was seen in MRSA isolates recovered from both HCWs and in-patients in our study. Significant resistance among MRSA isolates recovered from in-patients was seen to clindamycin, erythromycin, ciprofloxacin, tetracycline and co-trimoxazole ($P<0.05$). Various studies in our country and across the world have reported high resistance rates to various anti-Staphylococcal antibiotics. [1,12,15,19,20] Constitutive and inducible clindamycin resistance was seen more in MRSA than methicillin sensitive *S. aureus* (MSSA). These resistance patterns can be detected by simple and inexpensive tests like D-test which should be incorporated in the susceptibility testing of these organisms routinely. Our results are similar to those seen by Fomda et al. [23] where the authors reported significantly higher constitutive and inducible resistance to clindamycin in MRSA isolates. Results similar to ours have been reported previously as well. [24,25]

Our study has certain limitations to it. We did not investigate the persistence of MRSA carriage and its relation to subsequent infection in the admitted patients.

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Relatedness of the recovered MRSA isolates from in-patients as well as HCWs was not looked into, which could provide valuable insight into the infection control practices being followed in our hospital.

Conclusion

The results of this study demonstrate that nasal carriage of MRSA is common among health care professionals and in-patients in our hospital. Since these isolates are highly resistant to common antibiotics,continuous monitoring of their susceptibility profiles cannot be over emphasized. The hospital staff and in-patients should be screened for MRSA and appropriate treatment measures instituted. All HCWs should as a matter of routine, be educated and trained about infection control practices and maintenance of hygiene. Since the antibiotic armamentarium for the treatment of infections due to these pathogens is limited, we need to focus on simple and basic infection control practices that can go a long way in reducing nosocomial infections.

References

1. Askarian M, Zeinalzadeh A, JaponiA, Alborzi A, Memish ZA Prevalence of nasal carriage of methicillin-resistant *Staphylococcus aureus* and its antibiotic susceptibility pattern in healthcare workers at Namazi Hospital, Shiraz, Iran. International Journal of Infectious Diseases 2009; 13:e241-47
2. Shehabel-Din SA, El-Shafey E, El-Hadidy M, El-Din BA, El- Hadidy M, Zaghloul H. Methicillin-resistant *Staphylococcus aureus*: a problem in the burns unit. Egypt J PlastReconstrSurg 2003; 27:1-10.

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3. Korn GP, Martino MD, Mimica IM, Mimica LJ, Chiavone PA, Musolino LR. High frequency of colonization and absence of identifiable risk factors for methicillin-resistant *Staphylococcus aureus* (MRSA) in intensive care units in Brazil. Braz J Infect Dis 2001; 5:1-7.
4. Enright MC, Robinson DA, Randle G, Feil EJ, Grundmann H, Spratt BG. The evolutionary history of methicillin-resistant *Staphylococcus aureus* (MRSA). ProcNatlAcadSci USA 2002; 99:7687-92.
5. Gupta K, Martinello RA, Young M, Strymish J, Cho K, et al. MRSA nasal carriage patterns and the subsequent risk of conversion betweenpatterns, infection, and death. PLoS ONE. 2013;8(1):e53674. doi:10.1371/journal.pone.0053674
6. Wertheim HF, Melles DC, Vos MC, van Leeuwen W, van Belkum A, Verbrugh HA, et al. The role of nasal carriage in *Staphylococcus aureus* infections. *Lancet Infect Dis.* 2005;5(12):751-62.
7. Bolyard EA, Tablan OC, Williams WW, Pearson ML, Shapiro CN, Deitchmann SD. Guideline for infection control in health care personnel, 1998. Hospital Infection Control Practices Advisory Committee. Infect Control HospEpidemiol 1998; 19:407-63.
8. Goyal R, Das S, Mathur M. Colonisation of methicillin-resistant *Staphylococcus aureus* among health care workers in a tertiary care hospital of Delhi. Indian J Med Sci 2002; 56:321-24
9. Alghaithy AA, Bilal NE, Gedebou M, Weily AH. Nasal carriage and antibiotic resistance of *Staphylococcus aureus* isolates from hospital and non-hospital personnel in Abha, Saudi Arabia. Trans R Soc Trop Med Hyg 2000;94:504-07
10. CLSI. Performance Standards for Antimicrobial Susceptibility Testing;Twenty-Third Informational Supplement. CLSI document M100-S23. Wayne, PA: Clinical and Laboratory Standards Institute; 2013

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11. Ray P, Singh R.Methicillin-resistant *Staphylococcus aureus* carriage screening in intensive care. Indian J Crit Care Med. 2013; 17(4):205-06
12. Al-Abdli NE and Baiu SH. Nasal carriage of *Staphylococcus* in health care workers in Benghazi Hospitals. American Journal of Microbiological Research. 2014; 2 (4):110-12
13. Abdelmonem MO. Nasal Carriage of *Staphylococcus aureus* among healthcare workers in Althawra Hospital, Taiz City,Republic of Yemen. Aust J Basic &Appl Sci.2012; 6:417-24.
14. Fadeyi A, Bolaji BO, Oyedepo OO: Methicilin resistant *Staphylococcus aureus*carriage amongst healthcare workers of the critical care units in a Nigerian hospital. Am J Infect Dis.2010; 6(1):18-23.
15. Tenguriaa R, Bhat J, Irfan M and Fomda B. Nasal carriage of MRSA and its antimicrobial susceptibility pattern in healthy individuals and hospitalized patients INT J CURR SCI 2013; 6:e70-77
16. Shibabaw A, Abebe T and Mihret A. Nasal carriage rate of methicillin resistant *Staphylococcus aureus* among Dessie Referral Hospital Health Care Workers,Dessie, Northeast Ethiopia. Antimicrobial Resistance and Infection Control 2013; 2:25
17. Shakya B, Shrestha S, Mitra T. Nasal carriage rate of methicillin resistant *Staphylococcus aureus* among at National Medical College Teaching Hospital, Birgunj, Nepal. Nepal Med Coll J. 2010; 12(1):26-29.
18. Al-Humaidan OS, El-Kersh TA, Al-Akeel RA. Risk factors of nasal carriage of *Staphylococcus aureus* and methicillin-resistant *Staphylococcus aureus* among health care staff in a teaching hospital in central Saudi Arabia Saudi Med J. 2015; 36(9):1084-90

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19. Rongpharpi SR, Hazarika NK, KalitaH. The prevalence of nasal carriage of *Staphylococcus Aureus* among healthcare workers at a tertiary care hospital in Assam with special reference to MRSA.Journal of Clinical and Diagnostic Research. 2013;7(2):257-60
20. Mohajeri P, Izadi B,Rezaei M, Farahani A. Frequency distribution of hospital-acquired MRSA nasal carriage among hospitalized patients in west of IranJundishapur Journal of Microbiology. 2013; 6(6):e9076.
21. Khanal R, Sah P, Lamichhane P, Lamsal A, Upadhaya S and Pahwa VK. Nasal carriage of methicillin resistant *Staphylococcus aureus* among health care workers at a tertiary care hospital in Western Nepal. Antimicrobial Resistance and Infection Control 2015; 4:39 DOI 10.1186/s13756-015-0082-3
22. Pan A, Lorenzotti S, Ferrari L, Granata L, Signorini L, Carnevale G. Low rates of nasal colonization with methicillin-resistant *Staphylococcus aureus* among staff members of an Italian hospital. Infect Control HospEpidemiol. 2006; 27(2):218-20.
23. FomdaBA, Peer MA, Zahoor D, Thokar MA, Nasir RA. Phenotypic detection of constitutive and inducible clindamycin resistance in clinical isolates of *Staphylococcus aureus* and coagulase negative *Staphylococcus* on routine susceptibility Plate J. Commun. Dis. 2010;42(1):19-26
24. Gadepalli R, Dhawan B, Mohanty S, Kapil A, Das BK, Chaudhry R. Inducible clindamycin resistance in clinical isolates of *Staphylococcus aureus*. Indian J Med Res.2006; 123:571-73
25. Ajantha GS, Kulkarni RD, Shetty J, Shubhada C, Jain P. Phenotypic detection of inducible clindamycin resistance among *Staphylococcus aureus* isolates by using the lower limit of recommended inter-disk distance. Indian J PatholMicrobiol. 2008; 51:376-78.