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ORIGINAL ARTICLE

Methicillin-Resistant *Staphylococcus Aureus* Nasal Carriage among Health Care Workers in Surgery Department at a Tertiary Care Hospital in Egypt

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Key words:
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ABSTRACT

Background: *High rate of methicillin-resistant Staphylococcus aureus (MRSA) nasal carriage among health care workers (HCWs) represents a major risk factor for hospital acquired infections (HAIs).* ***Objectives:*** *Our objectives were to determine the rate of MRSA nasal carriage among HCWs in Surgery Department in our hospital, to investigate the antibiotic susceptibility pattern for MRSA isolates and to assess the effectiveness of mupirocin for eradication of MRSA.* ***Methodology:*** *A cross sectional study was conducted on 150 HCWs. Nasal swabs were collected for detection of MRSA isolates and their antimicrobial susceptibility pattern by standard bacteriological procedures.* ***Results:*** *The carriage rate of MRSA was 14.6%. Nurses showed a significantly higher carriage rate. Using mupirocin, 70% of MRSA carriers were decolonized.* ***Conclusion:*** *High rate of nasal carriage of MRSA among HCWs in our surgery department necessitate application of proper infection control measures.*

INTRODUCTION

Hospital acquired infections (HAIs) are one of the commonest problems in hospitals throughout the world. About 20% of surgical patients acquire at least one HAI. *Staphylococci* and *Enterococci* are major causes of these infections [1].

The prevalence of methicillin-resistant *Staphylococcus aureus* (MRSA) infections has increased dramatically over the past two decades. It has become endemic in many hospitals and is one of the commonest pathogens related to the outbreaks within the healthcare facilities [2]. In a recent study from Egypt, the prevalence of *Staphylococcus aureus* (*S. aureus*) was 46.5% of isolates collected from both patients and sources of infection, 69.9% of them were MRSA [3]. In another recent study from Egypt, the prevalence of MRSA was 84.6% of *S. aureus* isolates from patients [4]. These data suggest that MRSA represents a major problem in Egyptian hospitals

Nasal colonization is considered crucial in the pathogenesis of MRSA infection acting as the reservoir for infection. It has been reported that the rate of nasal carriage of *S. aureus* and MRSA among hospital personnel varying from 16.8% to 90% [5].

The risk of MRSA transmission via transiently colonized hands of permanent nasal MRSA carriers in health care workers (HCWs) to the patients or hospital environment is three to six times greater than non-carriers and transient carriers [6]. Poor infection control measures are usually caught up in both acquiring and transmitting MRSA by HCWs [7].

It has been recommended to apply regular surveillance and eradication of nasal *S. aureus* and MRSA in addition to standard precautions including, hand wash after visiting every patient, wearing protective mask when coming in contact with the patient harbouring MRSA as infection control policy for this organism [8].

Awareness of the rate of MRSA carriage and its antimicrobial susceptibility pattern in our locality is required for selection of the suitable empirical treatment for *S. aureus* infections [9].

METHODOLOGY

Study design:

A cross sectional study was conducted during the period from January to June 2018 in Surgery Department and Medical Microbiology and Immunology Department at Zagazig University Hospitals.

Ethical considerations: The study was approved by Institutional Review Board (IRB) Committee of Zagazig Faculty of Medicine. An informed consent form was signed by each participant.

Subjects

The study involved 150 HCWs including doctors, nurses, and others health care personnel. Their demographic data (name, age sex, working category,

duration of health care employment) were collected using questionnaires.

Exclusion criteria for the population under study were *S. aureus* infections (such as impetigo, skin and soft tissue infections or upper respiratory tract infection), fever, use of antibiotics, use of nasal medications and/or undergoing nasal surgery within the last three months.

Sample collection

Nasal swabs were collected from each participant. The cotton swab, moistured with normal saline, was applied into each nostril to a depth of about one cm and rotated 4–5 times in both directions [10]. Samples were transported to the laboratory of Medical Microbiology and Immunology Department within two hours of sampling.

Sample processing:

The samples were cultured on Mannitol salt Agar (Oxoid, England) plates along with the positive control (*S aureus* ATCC 25923) and negative control (*Staphylococcus epidermidis* ATCC 12228) to be incubated at 37◦Cfor 48 hours. Mannitol-positive colonies were re-cultured on nutrient agar plates at 37◦C for 24 hours. Isolated colonies were identified by Gram stain and colonies suspected to be *S. aureus* were tested for catalase, coagulase and deoxyribonuclease (DNase) production by standard microbiological protocols [11]. Isolates that were catalase-positive, coagulase-positive and DNase-postive were considered *S. aureus.*

All isolates were tested for their antibiotic susceptibility by disc diffusion method on Müeller Hinton Agar (Oxoid, England) plates [12]. The antibiotics used were Amikacin (30µg), Azithromycin (15µg), Cefoxitin (30µg), Chloramephenicol (30µg), Ciprofloxacin (5µg), Clindamycin (2 µg), Gentamicin (10µg), Linezolid (15µg), Rifampicin (5µg), Teicoplanin (30µg), Tetracycline (30µg), Trimethoprim/ Sulphamethazol (1.25/23.75 µg) and Vancomycin (30 µg) (Oxoid, England). The antimicrobial susceptibility patterns were confirmed by Vitek-2 system with an AST-GP67 card (Biomérieux, USA). The used antibiotics included Ampicillin, Benzylpenicillin, Cefoxitin, Ciprofloxacin, Clindamycin, Erythromycin, Gentamycin, Levofloxacin, Linezolid, Moxifloxacin, Nitrofurantoin, Oxacillin, Quinupristin/ Dalfopristin, Rifampicin, Streptomycin, Tetracycline, Tigecycline, Trimethoprim/Sulphamethazol and Vancomycin.

Methicillin resistance was evaluated using cefoxitin disks (30µg). *MRSA* ATCC 33591 was taken as positive control while *MSSA* ATCC 25923 was taken as negative control. Zone sizes were interpreted according to Clinical and Laboratory Standards Institute (CLSI) guidelines: Isolates having zone size ≥ 22 against 30µg cefotixin disc were considered susceptible to Methicillin while isolates having zone size ≤ 22 against 30µg cefotixin disc were considered resistant [13]. The results were confirmed by Vitek-2 system where a cut off ≥4 ug/ml for oxacillin was considered resistant while, a positive screen for cefoxitin was considered resistant.

Management of nasal MRSA carriage:

Subjects proven to be nasal MRSA carriers were treated with mupirocin cream intranasally two times per day for five consecutive days [1]. After treatment, nasal swabs were collected again to confirm successful decolonization.

Statistical analysis

Statistical analyses were performed by the Statistical Package for Social Science (SPSS) version 11.0 (IBM, USA). Chi-square test was used where appropriate. P values of <0.05 were considered significant.

RESULTS

The current study detected the carriage rate of *S. aureus* to be (37/150) 24.7 % while the carriage rate of MRSA was (22/ 150) 14.6 %. Regarding risk factors for MRSA colonization (Table 1), nursing staff showed a significantly higher carriage rate of MRSA as compared to doctors and paramedical staff (*p=0.03*).

Table 1: Frequency of *S. aureus* and MRSA among HCWs according to their Demographic Characteristics (n=150)

Characteristics			*S. aureus*	MRSA	P value
Gender	**Female**	98	26	15	0.9
	Male	52	11	7	
Working category	**Doctor**	36	2	1	0.03
	Nurse	99	32	19	
	Paramedical staff	15	3	2	
Duration of health care employment	**<1 year**	16	2	1	0.98
	2-5 years	37	9	3	
	6-10 years	54	15	10	
	>10 years	43	11	8	

For antibiotic susceptibility testing (figure 1), all MRSA isolates were resistant to ampicillin, benzylpenicillin, cefoxitin and oxacillin. Low resistance pattern was noted towards vancomycin (4.55%), Quinupristin/Dalfopristin (9.09%), rifampicin (18.18%), clindamycin (22.73%) and ciprofloxacin (27.27%) while none of the isolates was resistant to teicoplanin, linezolid or tigecycline. They revealed variable resistances towards other tested antibiotics (31.82 to 81.82%).

Using intranasal mupirocin ointment 70 % of MRSA carriers were successfully decolonized by while 30% of them were still colonized with MRSA on re-examination.

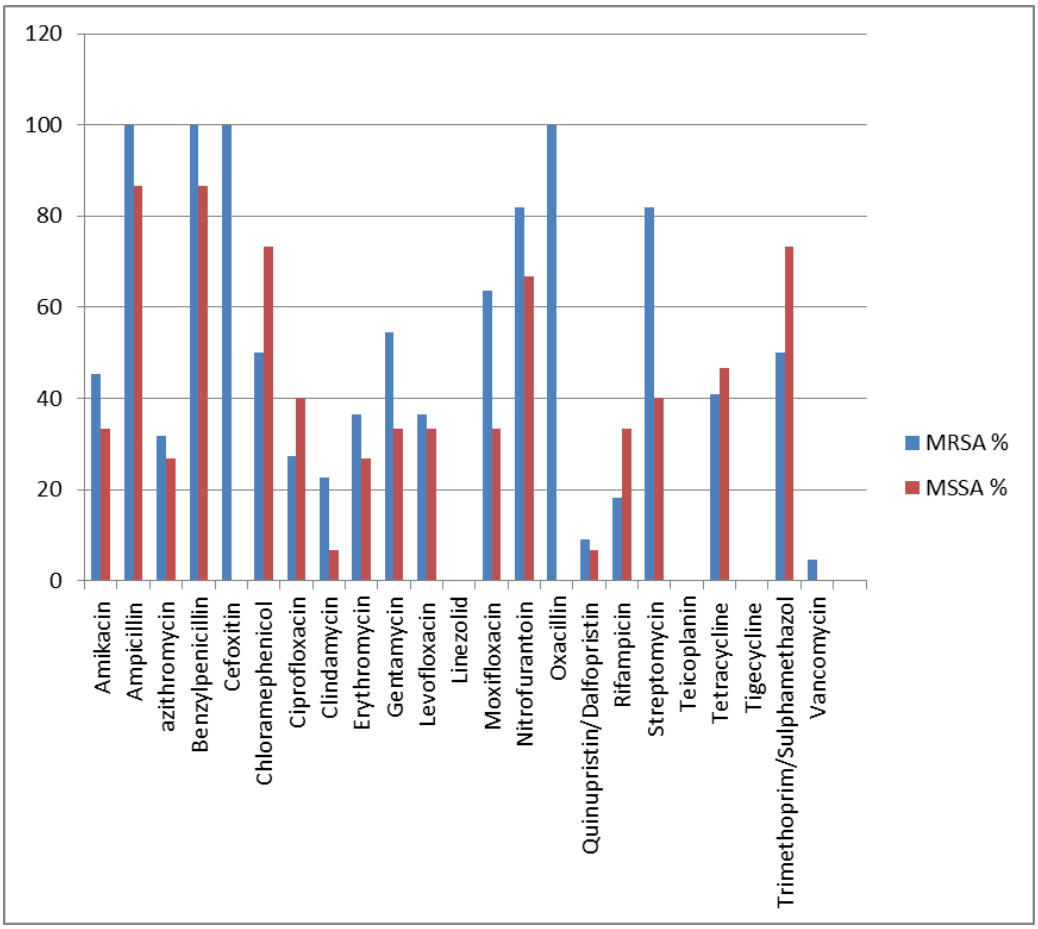

Fig. 1: Percentage of antibiotic resistance among MRSA and Methicillin-sensitive *Staphylococcus aureus* (MSSA) isolated from HCW

DISCUSSION

S. aureus is a frequent cause of hospital and community acquired infections. MRSA is considered one of the commonest causes of HAI and a major factor contributing to failure of antimicrobial therapy [14].

In hospitals, where misuse of broad- spectrum antibiotics is a common malpractice, there is a huge probability that Methicillin resistant strains of *S. aureus* may develop, and thus lead to a carrier state not only among the patients but also among the health care providers [15].Our study was concerned with the Surgery Department because researches clearly designate the highest percentage of MRSA nasal carriage to HCWs in surgical departments owing to the greater potential for infections [16, 17]. HCWs are incriminated as the main sources and disseminators of MRSA infections not only in hospitals but also in the community [18]. MRSA nasal colonization rate among healthcare workers has been found to be much more than in the community members[19]. Detection of colonized HCWs and assessing the associated risk factors of colonization is an essential step for controlling the spread of MRSA infections in hospitals [20]. So, this study was conducted to detect the nasal carriage rate of *S. aureus* and MRSA among HCWs in Surgery department of our hospital.

This study found the rate of nasal carriage of *S. aureus* to be (37/150) 24.7 % among HCWs which is similar to results reported by a previous studies in Eygpt [21, 22]. Different rates have been reported in different studies internationally (14% to 45% %) [23-26]. This wide range between different studies is related to variations in sample size, microbiological technique of sampling, culture and identification, local infection control measures and the local prevalence of *Staph* infections.

The carriage rate of MRSA was (22/ 150) 14.6 % in the present study. Rates comparable to this have been previously reported from Egypt [21,22]. However, it is higher than internationally reported rates (~5%) [23-27]. This high rate of MRSA nasal carriage can be related to a number of causes. High prevalence of MRSA among patient increases the risk of exposure among the participating HCWs. Suboptimal infection control practices increases the risk of transmission of MRSA between patients and HCWs. These include; lack of active surveillance cultures to identify colonized patients, incompliance of HCWs with hand hygiene and deficient use of protective barrier equipment. Also, it was suggested that screening of HCWs for MRSA is to be done before starting the daily work to avoid detection of short-term, transient MRSA carriage that may occur during a work shift [28] which may be another factor contributing to high MRSA rate in this study.

As our study included HCWs from the Surgery department, the potential risk of MRSA transmission from the HCWs to the patients and surgical wound infection complicating the treatment and recovery, cannot be overlooked.

In this study, nursing staff showed a comparatively higher carriage rate of MRSA as compared to surgeons and paramedical staff which could be explained by the fact that the nursing staff had more frequent patient contact. Also this could indicate better infection control practice implemented by the doctors.

Few antibiotics, including vancomycin, teicoplanin, linezolid, Quinupristin/Dalfopristin and tigecyclin, are available to treat MRSA and they are used as our last resorts[29-33]. However, there are numerous reports worldwide which shows that resistance patterns to these antibiotics are rising [34, 35]. So, in the current study we determined antibiotic susceptibility pattern of the isolates in an attempt to formulate efficient antibiotic policy and infection control programme.

In the current study, antibiotic susceptibility testing of MRSA isolates revealed variable resistances towards most of the tested antimicrobials (31.82 to 81.82%). Low resistance pattern was noted towards rifampicin (18.18%), clindamycin (22.73%) and ciprofloxacin (27.27%), indicating that these antibiotics might be an alternative for empirical therapy of MRSA infections at our hospital. Resistant to vancomycin was 4.55% and to Quinupristin/Dalfopristin was 9.09% which gives a strong alarm about emerging resistance to the reserved drugs that are considered last line of defense. Luckily, none of the MRSA isolates was resistant to teicoplanin, linezolid or tigecycline.

Mupirocin nasal ointment is considered the best choice for decolonization of nasal carriage. It is used for temporarily eradicating *S. aureus* from nose. When applied intranasally, twice daily for five consecutive days, the elimination rates is about 90% [36, 37].

In our study 70 % of MRSA carriers were successfully decolonized by using intranasal mupirocin ointment while 30% of them were still colonized with MRSA on re-examination. This could be explained by mupirocin resistance [38, 39]. Another suggested explanation is extra -nasal colonization with MRSA e.g. in the throat or on the skin which could act as an alternative reservoir for the organism [40].

CONCLUSION & RECOMMENDATIONS

Unless this misuse of antibiotics is controlled in an optimum range and the sterile and sanitary measures are taken by the doctors and the authorities; we may experience a medical crisis. As a result of which the existing antibiotics will no longer be able to fight MRSA infections. Effective precautionary measures should be brought about immediately to prevent an outbreak of MRSA infection in the healthcare setup. These may include increasing awareness among the healthcare workers, medical students and the patients to regularly wash their hands and ensuring proper sanitation as well. The use of the broad spectrum Antibiotics should be decreased to minimum, in order to prevent the evolution of such resistant strains of bacteria. Moreover, the healthcare providers and medical students should follow the necessary protocol to avoid nasal carriage by using masks, gloves and gowns. Those having nasal carriage of MRSA should be adequately treated using antimicrobials like Mupirocin, taking in consideration that follow up is mandatory to ensure the eradication of nasal carriage of MRSA. Continuous surveillance will reduce the burden of treatment cost on to the patients and community.

Conflicts of interest:
The authors declare no conflicts of interest.

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