NASAL CARRIAGE OF STAPHYLOCOCCI IN HEALTH CARE WORKERS: ANTIMICROBIAL SUSCEPTIBILITY PROFILE

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ABSTRACT

One year prospective study was evaluated to ascertain the prevalence of nasal carriage of potentially pathogenic bacteria in health care workers and the antibiotic susceptibility profile. The bacterial strains were identified by conventional method and the antibiotic resistance was carried out by disc diffusion method. The prevalence of *Staphylococcus aureus*, coagulase negative staphylococci and methicillin resistant *Staphylococcus aureus* were 48%, 46% and 14% respectively. The antibiotic susceptibility pattern of these isolates revealed that *Staphylococcus aureus* were more resistant towards antibiotics than coagulase negative staphylococci. The most effective antibiotic for *S. aureus* was found to be vancomycin with 100% efficacy, then cephalothin 92%, ciprofloxacin 91%, amikacin 77 % and erythromycin 55%, ampicillin 11% and penicillin 3%. Coagulase negative staphylococci were 100% sensitive to vancomycin and cephalothin. Oxacillin showed 78% effectiveness; while ampicillin and penicillin, demonstrated 64% and 59% respectively. Doxycycline (93%), amikacin (93%), fusidic acid (90%) and erythromycin (92%) were effective antimicrobials.

Keywords: Nasal carriage of health care workers, *Staphylococcus aureus*, staphylococci, susceptibility profile of antimicrobial agents and drug resistance.

INTRODUCTION

One of the major ecological problems in a society is the problem of health-care facilities (hospitals, inpatient and outpatient departments). Hospital represents a special environment, serving health care to patients and as a work environment for medical and other staff. There are many risk factors (chemical, physical, biological and psychosocial), which can evoke many disorders and can damage the health of patients and staff (Brooks *et al*., 1995; Aghova *et al*., 1997). The microbiological factor is the most risky one for immuno-compromised patients because it has the potential to start nosocomial infections. All environments except those maintained under sterile conditions harbor microorganisms may be pathogenic. Hospitalized patients are unusually at high risk of infection because of their underlying diseased conditions, but their risk is increased when they are exposed to certain invasive procedures. If the patient is immuno-compromised, microorganisms that are not normally pathogenic are capable of causing disease (Noskova, 2004).

Staphylococci colonize skin and nasal mucosa as their normal inhabitants. Among staphylococci, *S. aureus* is the most virulent, and it is associated with a wide spectrum of diseases, including skin and soft tissue, systemic infections and exotoxin related diseases (Shittu *et al*., 2006; Tacconella *et al*., 1998). About 20% of the population is always colonized with *S. aureus*, 60% are intermittent carriers, and 20% never carry the organism (Peacock *et al*., 2001**;** Von Eiff *et al*., 2001).

Methicillin resistant *S. aureus* (MRSA) has been a major cause of nosocomial infections since the early 1960s (CDC, 2004) and since 1997 another type of MRSA, producing Pentone Valentine Leucocidin (PVL), has emerged in the community and it is associated with surgical infections, as well as with necrotizing pneumonia, in children and adolescents (Zetola *et al*., 2005). Other staphylococci called coagulase negative staphylococci (CoNS) are also pathogenic, when the host is compromised. CoNS are the most common pathogens in nosocomial blood stream infections. Methicillin resistant CoNS (MRCoNS) have also been found worldwide. Moreover, CoNS may transfer its resistance to MRSA (Sefani and Varaldo, 2003; Hurdle *et al*., 2005).

One of the important sources of staphylococci for nosocomial infection is nasal carriage among hospital personnel. Almost 25% of the health care workers are stable nasal carriers, and 30% to 50% of them also possess the bacteria on their hands. Occasionally, health care workers who carry *S. aureus* in their nares can cause outbreaks of surgical-site infections (Luzar *et al*., 1990; Cespedes *et al*., 2002). The present study was undertaken

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to investigate the nasal carriage of health care workers, with *S. aureus*, methicillin resistant *S. aureus* and coagulase negative staphylococci as well as the antibiotic susceptibility pattern of these isolates.

MATERIAL AND METHODS

The study (April, 2006 – March, 2007) was carried in pathology laboratory of Children Hospital Complex, Multan. A sample of one hundred and twenty nine was screened for their nasal carriage from various wards and administrative site and hospital staff.

Cultivation and identification

Specimens were collected from the anterior nares with sterile dry cotton swabs (Becton Dickinson Culturette Systems, Sparks, Md.). The swab was circled in both nostrils consecutively and inoculated on 5% sheep blood agar, chocolate agar and MacConkey agar (OXOID). Sheep blood agar and MacConkey agar were incubated at 37°C for 24-48 hours, while chocolate agar was incubated in the candle extinction jar at 37°C for 24-48 hours. Well-isolated colonies were initially Gram-stained and then biochemically characterized according to Bergey's Manual of Determinative Bacteriology (9th edition). For Gram-negative bacteria MICROBACT ^{TM} 24E (OXOID) was used for identification and for Gram-positive various tests were applied. The colonies were identified on the basis of colony morphology (β-hemolytic – clear zone around colonies on blood agar), microscopy and confirmatory biochemical tests such as catalase, DNase and coagulase tests (Collin *et al*., 1998).

Antibiotic susceptibility testing

Standardized Kirby-Bauer disc diffusion method (Bauer *et al*., 1966) was performed on Mueller-Hinton agar. Single isolated colonies were selected and inoculated in Mueller-Hinton broth and placed in incubator for 24 hours at 37^{o}C. When its turbidity is comparable to 0.5 McFarland turbidity standards, then these plates were inoculated with each broth culture and left to dry before the application of antibiotic discs. The plates were inverted and incubated at 35-37°C for 18-24 hours. Zone sizes of each antimicrobial agent was interpreted, reporting the organism as 'Resistant', 'Intermediate' and 'Sensitive' (susceptible).

RESULTS

Prevalence of various microorganisms in health care workers

Among 129 samples, 112 (86.8%) samples were positive for at least one of the staphylococcal species. Nine specimens (6.9%) contained two different species, and one contained *K. pneumoniae* along with staphylococci. Nasal carriage of staphylococci was 93.8%; comprising of 48.06% *S. aureus* and 45.7% CoNS (table 1).

Table 1: Distribution of nasal staphylococci among health care workers

Micro organism	Prevalence	
	n*	%
Staphylococci	121	93.8
Staphylococcus aureus	62	48.06
Methicillin resistant *Staphylococcus aureus*	18	13.95
Coagulase negative staphylococci	59	45.7

*Number of isolates

Resistance pattern against antibiotics

Ninety percent of *S. aureus* and 34% CoNS isolates were resistant to atleast one antibiotic. Whereas 15% and 9% were resistant to two antibiotics, *S. aureus* and CoNS respectively. Fourty five percent *S. aureus* and 13% of CoNS were found resistant to 3 or more antibiotics (fig. 1).

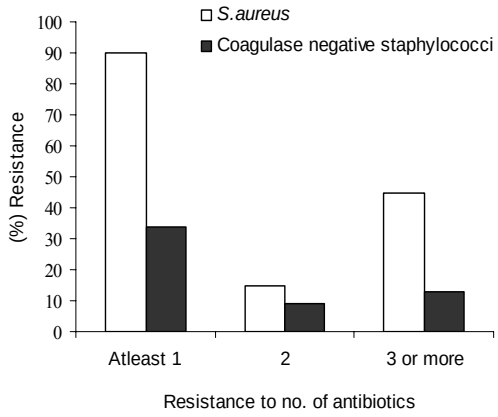

Fig. 1: Prevalence of multidrug resistant *S. aureus* and coagulase negative staphylococci.

Sixty-two strains of *S. aureus* were fully susceptible to vancomycin. Cephalothin was the second most effective drug against these isolates (92% sensitivity). Ciprofloxacin, doxycycline, amikacin, oxacillin and fusidic acid were found to be effective antimicrobials with 90%, 81%, 74%, 70% and 70% sensitivity respectively. Erythromycin showed 55% efficacy; while ampicillin and penicillin demonstrated only 11% and 3% efficacy respectively (fig. 2)

Sensitivity pattern of all 59 isolated strains of coagulase negative staphylococci showed that there was no isolate resistant to vancomycin, ciprofloxacin and cephalothin. Doxycycline, amikacin, fusidic acid and erythromycin were found to be effective antimicrobials with efficacy, 93%, 93%, 90% and 92% respectively. Seventy-eight isolates were found sensitive with oxacillin, while

ampicillin and penicillin demonstrated 64% and 59% sensitivity respectively (fig. 3).

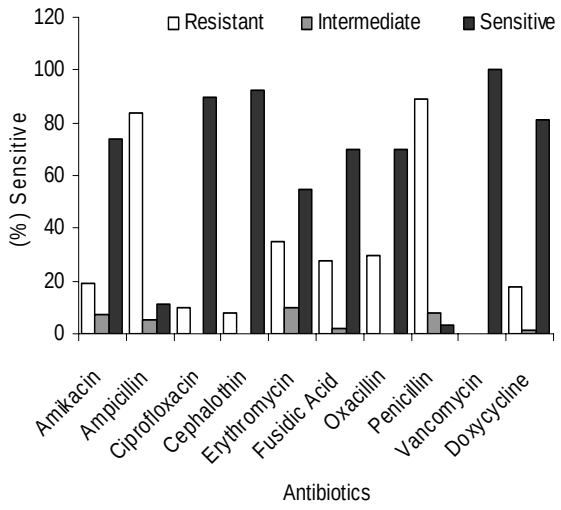

Fig. 2: Antimicrobial sensitivity pattern of nasal *S. aureus* against various antibiotics.

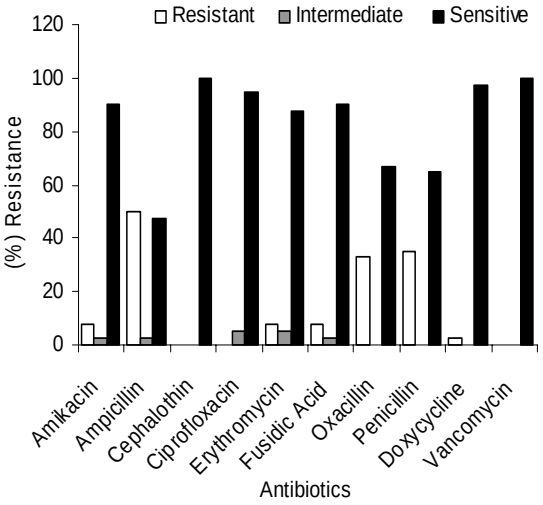

Fig. 3: Antimicrobial sensitivity pattern of nasal coagulase negative staphylococci against various antibiotics

DISCUSSION

During the present study nasal carriage of staphylococci varied among different people. In general, nasal carriage rates among hospital personnel and patient (60-70%) are much higher than those in community carriers (30-50%) (Lowy, 1998). In present study the prevalence of *S. aureus* carriage was 48%; out of these 29% were MRSA and CoNS carriage rate was 46%. Akoua and co-workers (2004) conducted a similar study and reported the carriage rate of *S. aureus* 45.4%, out of these 38.7% strains were resistant to methicillin, whereas Alghaithy and co-workers reported 26.1% *S. aureus* carriage and out of which 18.3% were MRSA positive. In different reports *S. aureus* carriage was 27.5% and 34.9% in health care workers (Tejero *et al*., 1991; Yazgi *et al*., 2003). In a local study 49.5% *S. aureus* carriage was reported, although slightly higher but closer to the present study (Ashiq, 1989).

Resistance towards antibiotics is associated with an increase in disease severity, which increases period of hospitalization, high mortality and increasing treatment costs, including a need for use of alternative drugs. The selection and spread of resistant organisms in developing countries, can led to complex socioeconomic behavioral antecedents and misuse of antibiotics by health professionals, unskilled practitioners, layman, poor drug quality and unhygienic conditions for spread of resistant bacteria, and inadequate surveillance (Isturiz and Carbon, 2000; Ogeer-Gyles, 2006).

Majority of the staphylococci were multi-drug resistant and these multi-drug resistance patterns been documented already (DeLencastre *et al*., 2000; Gale *et al*., 2000). The penicillins were found to be very active against Gram-positive and Gram-negative cocci. In the present study rate of resistance against penicillin and ampicillin was highest. Overall more than 80% resistance against penicillin and ampicillin was observed in *S. aureus* and 37% in CoNS. Dimitrov *et al*., (2003) found 90% resistant strains, while Tejero and his coworkers (1991) reported 98.3% resistant isolates in their studies. Methicillin, the first semi-synthetic penicillinase-resistant antibiotic, was introduced in 1961 to target strains of penicillinase-producing *S. aureus* (Lowy, 2003; Woodford, 2005). In present study 29% of the *S. aureus* and 22% of CoNS isolates were found to be resistant to methicillin. Busato and his co-workers (2006) reported 19% resistant *S. aureus* strains in 1996 and 12% resistant *S. aureus* strains in 1999. On the other hand Guchu and his coworkers (2007) found 100% effectiveness for *S. aureus* and 23.5% methicillin resistant CoNS. In a retrospective study Jones and co-workers (1989), reported the percentage of oxacillin-resistant CoNS varied from 35 to 77%, with an average of 51%, similar to the National Nosocomial Infection Surveillance data (Schaberg *et al*., 1991).

The overall resistance among these isolates against cephalothin was 8% and ciprofloxacin was 10% in *S. aureus,* while CoNS were 100% sensitive to these antibiotics. Cephalothin proved to be relatively more effective antimicrobial than other ß-lactam antibiotics. The development of *S. aureus* resistance to ciprofloxacin might be due to previous antimicrobial therapy. Moreover, wide use of ciprofloxacin has resulted in a steady increase in incidence of fluoroquinolone resistant staphylococci, especially among clinical isolates (Hooper,

2002; Lowy, 2003). Hoiby and co-workers (1997) demonstrated that ciprofloxacin therapy rapidly increased the proportion of coagulase-negative staphylococcal strains, colonizing the nares and skin that were resistant to both ciprofloxacin and methicillin.

Fusidic acid is a typical narrow spectrum antibiotic for treatment of *S. aureus* infections. The incidence of fusidic acid resistance in this study was 8% for CoNS and 28% for *S. aureus*, as 11% resistance was documented against *S. aureus* isolated from hospital personnel (Yazgi *et al*., 2003). Erythromycin, a macrolide targeting the bacterial 50S ribosomal subunit, effectively inhibits protein synthesis (Maranan, 1997). The overall resistance shown by *S. aureus* strains isolated in this study was 35% and 10% of the strains were showing intermediate sensitivity. Varying resistance profiles (9.3%, 16.5% and 18%) had been reported in different studies (Paul *et al.,* 1982; Yazgi *et al*., 2003; Choi *et al*., 2006). The higher resistance of the isolates against these commonly used antibiotics could be attributed to many factors like misuse and or overuse of antibiotics. Antibiotic use provides selective pressure favoring resistant bacterial strains. Inappropriate use increases the risk for selection and dissemination of antibiotic-resistant bacteria, which are placed at competitive advantage. Therefore, the drugs, which are more commonly used, are generally inexpensive, and popular broad-spectrum agent lead to development of bacterial resistance in developing countries (Hogi *et al*., 1998; Schito, 2006). Moreover the injudicious use of the antibiotics in Pakistani hospitals and communities, lead to easy availability of antibiotics without prescriptions, as well as enhanced chances of emergence resistant strains. Lack of public awareness has further deteriorated the situation in Pakistan (Haneef and Khan, 1990).

CONCLUSION

The present study indicated high incidence of nasal carriage of Staphylococci among health care workers. It also demonstrated that health personnel are at high risk of infection and can be a potential source of nosocomial pathogens like *S. aureus*. Therefore, continuous surveillance and improvement of hygiene standards in hospitals should be adopted.

ACKNOWLEDGEMENT

This study was a part of M. Phil. Research. The work was supported by Bahauddin Zakariya University, Multan by providing substantial resources to carry out this project. Authors are thankful to the staff members of Children Hospital Complex, Multan for providing laboratory facilities and technical guidance for successful completion of this work.

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