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Antibiotic resistance patterns of strains of *Staphylococcus aureus* isolated from patients in three hospitals in Kumasi, Ghana

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Staphylococcus aureus **continues to offer challenges to medical science in the area of resistance to chemotherapeutic agents leading to treatment failures using common antibiotics. In this study,** ***S. aureus*** **isolated from patients from three hospitals in Kumasi, Ghana were tested for their sensitivity to some reference antibiotics using the Kirby-Bauer agar disc diffusion method. A total of 109** ***S. aureus*** **isolates were obtained from wound and nose swabs of 300 patients.** ***S. aureus*** **was isolated from 44% female and 56.0% male patients. Majority of the** ***S. aureus*** **isolates were identified in patients aged between 20 and 29 years, while those within the age group of 60 to 69 years recorded the least number of** ***S. aureus*** **isolates. Vancomycin had the highest susceptibility of 74.1% followed by ceftriaxone with 67.6%, erythromycin with 49.0%, ampicillin with 47.0% and gentamicin with 44.4%. Out of the 109** ***S. aureus*** **isolated from the three hospitals, 32.1% exhibited multiple drug resistance.**

Key words: Antibiotics, bacterial resistance, *Staphylococcus aureus*, sensitivity.

INTRODUCTION

In Ghana, *Staphylococcus aureus* is a common cause of human infections and is recognized as a pathogen of high public health significance (Newman et al., 2006). *S. aureus* is a normal inhabitant of the human skin and the anterior nares. In a healthy person, *S. aureus* is usually not a health concern, but an injury or poor hygiene can cause *S. aureus* infections (Brenda and Lee, 2008). It is also a serious opportunistic pathogen responsible for a number of infections in immuno-compromised individuals (Burnett et al., 1996). *S. aureus* has therefore emerged as one of the main important human pathogens, and has over the past decades, been a leading cause of hospital and community-acquired infections (Shittu and Johnson, 2006).

S. aureus is the most frequently occurring bacterial pathogen among clinical isolates from hospital inpatients and is the second most prevalent bacterial pathogen among clinical isolates from outpatients (Styers et al., 2006). According to Biedenbach et al. (2004), *S. aureus* is the most common cause of nosocomial bacteraemia in North America, Latin America and Europe. Tagoe et al. (2011) also found that 57.6% of all the pathogenic isolates causing hospital acquired infections in south eastern part of Ghana were *S. aureus.* Most cases of nosocomial infections are acquired through exposure to hands of health care workers after they have been transiently colonized with bacterial agents from their own reservoir or from contact with infected patients (Sheretz et al., 1996).

Attempts to control diseases caused by *S. aureus* through the use of antibiotics have resulted in increased prevalence of resistant strains of the organism (Levy, 2001; Crowder et al., 2006). Therefore, in order to effectively treat infections caused by *S. aureus*, culture

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Table 1. Distribution of *S. aureus* isolates among males and females in relation to specimen types.

Samples	Hospitals	Males	Females	Total no. of *S . aureus*
Blood (No = 1 50)	Tafo (No = 50)	0	0	0
	North Suntreso (No = 50)	0	0	
	Kumasi South (No = 50)	0	0	
Wound swabs (No = 150)	Tafo (No = 50)	11	5	53
	North Suntreso (No = 50)	12	7	
	Kumasi South (No = 50)	5	13	
Nose swabs (No = 150)	Tafo (No = 50)	8	6	56
	North Suntreso (No = 50)	12	6	
	Kumasi South (No = 50)	11	13	

and antibiotic sensitivity tests must first be determined. Once culture and sensitivity results confirm the type of bacterial infection and sensitivity pattern, treatment may be modified (Paterson, 2000). However, most health facilities in Ghana lack adequately resourced laboratories to culture and test the antibiotic sensitivity of bacteria causing infections. Even, where laboratory facilities are available, culture and sensitivity test results take 48 to 72 h to be ready (Newman et al., 2006). In many cases, sensitivity test may not be carried out at all due to lack of microbiologists and the extra cost it constitutes for the patients (Ohene, 1997). This study is intended to isolate *S. aureus* from patients in Kumasi South, North Suntreso and Tafo hospitals in Kumasi, Ghana and determine their susceptibility patterns to some common antibiotics used for the treatment of staphylococcal infections.

MATERIALS AND METHODS

The protocols for the study were approved by the individual Hospital's Ethics Committees and the patients' consent for the study was done. Clinical samples including wound swabs, nose swabs and blood samples were collected from 300 patients suspected to have bacterial infection at Kumasi South, North Suntreso and Tafo hospitals and cultured to isolate *S. aureus*. All the clinical samples collected at the hospitals were inoculated into a transport medium (cooked meat broth, Oxoid Basingstoke, UK) and incubated at 37°C for 72 h (Ajello et al., 2003).

The samples were then inoculated on plates of blood and Mannitol salt agar (Oxoid Basingstoke, UK). Suspected *S. aureus* colonies were isolated, Gram stained and identified through biochemical tests as described by Betty and colleagues (Forbes et al., 2007).

In vitro sensitivity tests of the *S. aureus* isolates against some reference antibiotics (ampicillin 10 µg, ceftriaxone 30 µg, gentamicin 10 µg, erythromycin 15 µg and vancomycin 30 µg (Oxoid, Basingstoke, UK) was carried out using the Kirby-Bauer agar disc diffusion method as recommended by the Clinical and Laboratory Standards Institute (2010). A standardized suspension of the isolated *S. aureus* was prepared by inoculating a colony into 10 ml peptone water and incubated at 37°C for 24 h. It was then diluted to 0.5 MacFarland turbidity standards. A sterile swab was dipped into the standardized inoculum and used to inoculate evenly the surface of already prepared Mueller-Hinton agar (Oxoid Basingstoke, UK). The agar was left for 15 min for the surface moisture to dry (Ajello et al., 2003). The antibiotic discs were applied to the surface of the inoculated agar plate using a disc dispenser (Oxoid 6-place, 90 mm) and incubated for 18 h at 37°C (Lalitha, 2004). The zones of inhibition for each antibiotic was measured in millimeters and compared with values provided by the Clinical and Laboratory Standards Institute (CLSI, 2010). *S. aureus* (ATCC 25923) was used as positive control.

The mean diameter of zone of growth-inhibition observed was measured and compared with the reference data provided by the Clinical and Laboratory Standards Institute (CLSI, 2010).

Statistical analysis

Data obtained in this study were statistically analyzed using Graph Pad prism version 5.0 (GraphPad Software, San Diego, CA, USA) and Microsoft excel 2010 edition. Two-way ANOVA was used to compare the means. $P<0.05$ was considered significant.

RESULTS

Results from the study showed 48.6% *S. aureus* from wound swabs and 51.4% were from nose swabs. The occurrence of *S. aureus* in the samples according to gender as shown in Table 1. The *S. aureus* isolates were

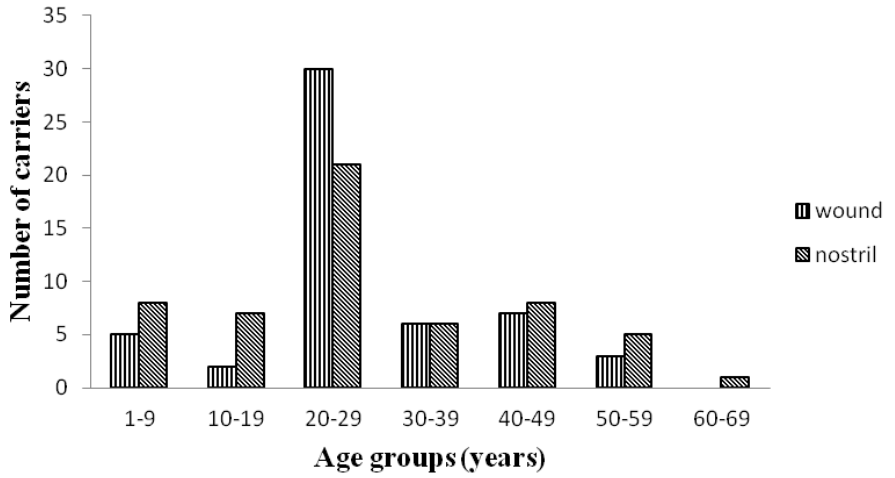

Figure 1. The number of *S. aureus* isolated in relation to age (years) of patients.

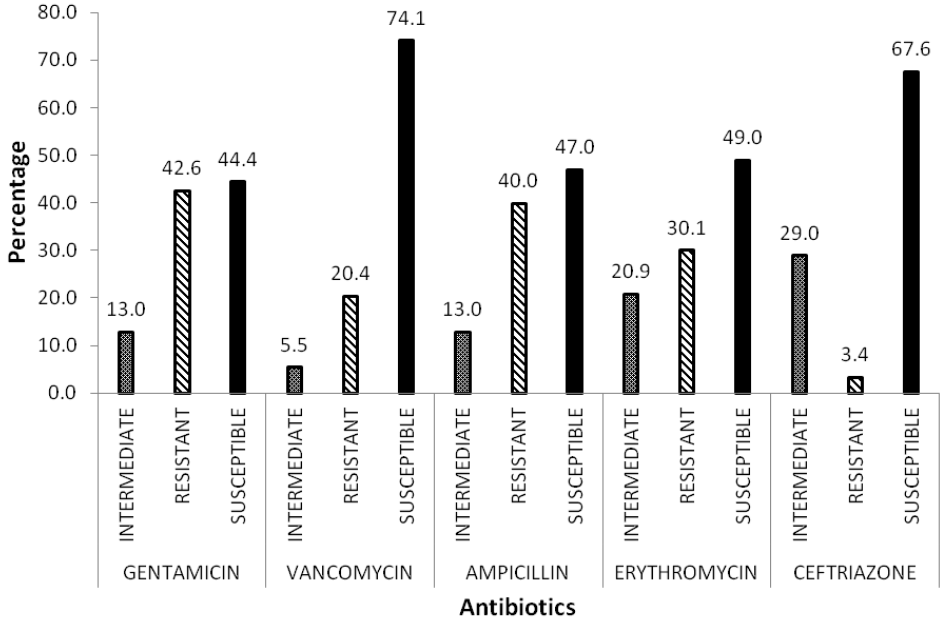

Figure 2. Antibiotic sensitivity patterns of *S. aureus* isolates to reference antibiotics determined by Kirby-Bauer agar disc diffusion method and the mean zones of inhibition when compared with the values provided by the Clinical and Laboratory Standards Institute (CLSI, 2010).

from 44% of the female and 56.0% male samples. *S. aureus* occurred more frequently between the ages of 20 and 29 years, whilst 60 to 69 years age group registered the least number of *S. aureus* isolates (Figure 1).

Antibiotic sensitivity patterns of *S. aureus* isolates

S. aureus isolates showed variable susceptibility to the antibiotics tested. Vancomycin recorded the highest susceptibility of 74.1% followed by ceftriaxone with 67.6%, erythromycin with 49.0%, ampicillin with 47.0% and gentamicin with 44.4%. Resistance to vancomycin, ceftriaxone erythromycin, ampicillin and gentamicin were 20.4, 3.4, 30.1, 40.0 and 42.6.0%, respectively (Figure 2). The *S. aureus* isolates exhibited intermediate resistance of 29.0% to ceftriaxone, 13.0% to ampicillin, 20.9% to erythromycin, 13.0% gentamicin and 5.5% to vancomycin

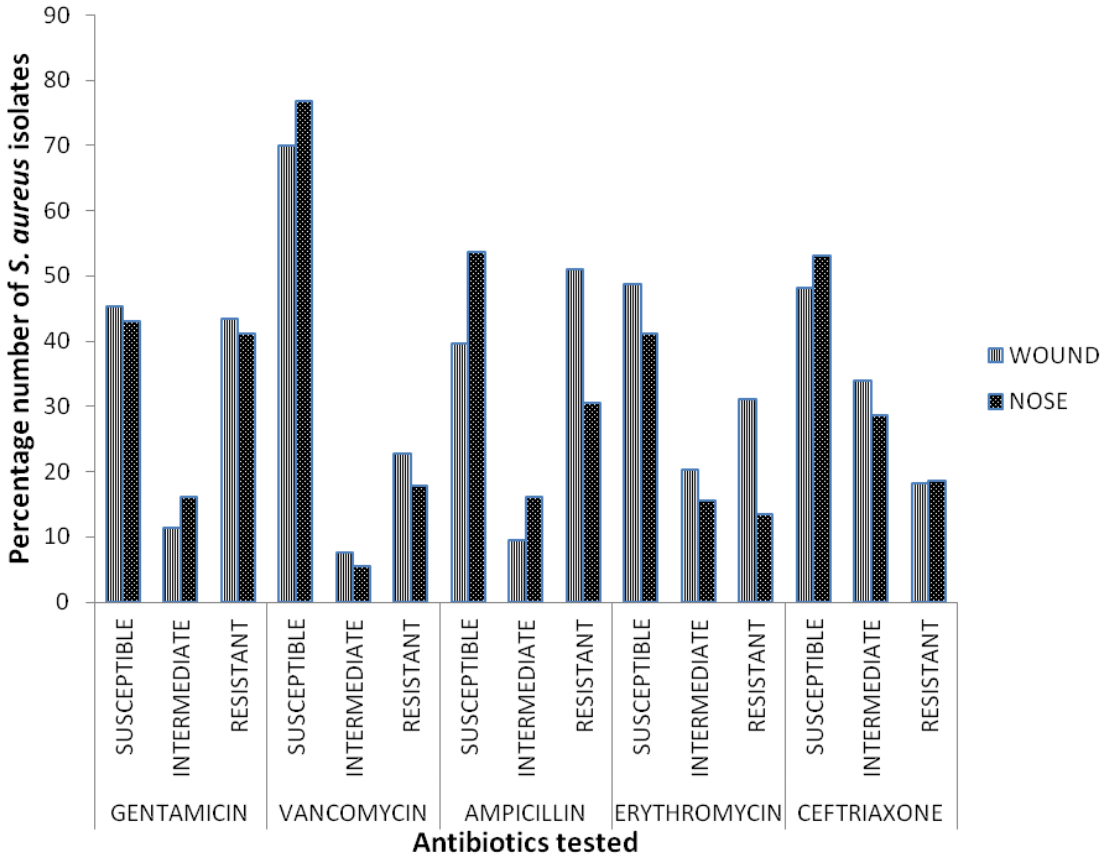

Figure 3. Antibiotic susceptibility patterns of *S. aureus* isolates from wound and nose swabs determined by Kirby-Bauer agar disc diffusion method and the mean zones of inhibition when compared with the values provided by the Clinical and Laboratory Standards Institute (CLSI, 2010).

based on comparison with the values provided by the Clinical and Laboratory Standards Institute (CLSI, 2010).

Antibiotic susceptibility patterns of wound and nose isolates of *S. aureus*

The wound and nose isolates of *S. aureus* were sensitive to vancomycin with susceptibilities of 69.9 and 76.8%, respectively.

Generally, the number of the *S. aureus* isolates from both wound and nose swabs that showed resistance to gentamicin, ampicillin, erythromycin and ceftriaxone were slightly high (Figure 3).

Out of the 109 *S. aureus* isolated from the three hospitals, 35 (32.1%) exhibited resistance to at least three different classes of antibiotics, that is, showing multiple drug resistance (Table 2).

DISCUSSION

S. aureus was isolated in nose (37.3%) and wound swabs (35.3%) but not in blood samples. The high yield of *S. aureus* from nose swabs confirms the nostrils as a habitat for the organism (Prescott, 2002) and could therefore be one of the major sources of *S. aureus* infection. There was no significant difference between the number of nose swabs and wound swabs that yielded *S. aureus*.

From the results, no patient had *S. aureus* in the blood, an indication that none of the patients recruited for the study had bacteraemia. Blood is sterile in healthy persons and the presence of *S. aureus* is normally an indication of bacteraemia and possible sepsis (Mylonakis and Calderwood, 2001). Some of the risk factors for bacteraemia include old age, immunosuppression, chemotherapy and invasive procedures (Newman et al., 2006).

More males had *S. aureus* than females even though there was no significant difference. This observation is corroborated by Manal et al. (2006) who also reported a higher percentage of *S. aureus* isolates (64.4%) in male patients from a Saudi Arabian hospital. There was a significant difference of *S. aureus* isolates among the various age groups with the 20 to 29 years group

Table 2. Multiple-drug resistant (MDR)* pattern of *S. aureus* isolates determined by Kirby-Bauer agar disc diffusion method and mean zones of inhibition when compared with the values provided by the Clinical and Laboratory Standards Institute (CLSI, 2010).

Hospital	No. of MDR *S. aureus*		Total no. of MDR *S. aureus*	Total no. of *S. aureus* isolates	Percentage of MDR
	Wound	Nose			
Kumasi South	5	3	8	42	19.0
North Suntreso	11	3	14	37	37.8
Tafo	8	5	13	30	43.3
Total	24	11	35	109	32.1

*Multiple drug resistance (MDR) is defined as resistance of organism (bacteria) to at least three different antibiotics.

recording the highest carriers (51 patients). The highnumber of isolates of *S. aureus* in this age group could be due to the level of contamination arising from the habitat of the patients, low personal hygiene and poor health education which still persists in many African countries (Agwu et al., 2006).

S. aureus exhibits remarkable versatility in its susceptibility towards antibiotics and the capability of this bacterium to cause human diseases has not diminished even with the availability of antibiotics (Obiazi et al., 2007). In this study, the susceptibility of the *S. aureus* isolates to gentamicin, vancomycin, ampicillin, erythromycin and ceftriaxone were 44.4, 74.1, 47.0, 49.0 and 67.6% respectively. This trend of susceptibility is similar to a report by Reshma et al. (2007) but contrary to another report by Obiazi et al. (2007) who observed higher susceptibility of *S. aureus* to the antibiotics mentioned above. All the antibiotics used in this study except vancomycin and ceftriazone were considered to be ineffective against *S. aureus*. Vancomycin is not recommended for the management of *S. aureus* infections in public hospitals by the Ghana National Drugs Programme (GNDP, 2004). The use and subsequent abuse of this antibiotic by patients is therefore limited and could be the reason why vancomycin was active against the *S. aureus* isolates.

The isolates from both wound and nose exhibited similar intermediate resistance to gentamicin, ampicillin and erythromycin. However, many of the isolates showed intermediate resistance to ceftriaxone from both sites (Figure 3).

The number of resistant isolates from wounds were 31.1% to erythromycin, 50.9% to ampicillin, 43.4% to gentamicin and 18.2% to ceftriaxone, whereas 18.5% of those isolated from the nose were resistant to ceftriaxone, 41.0% to gentamicin, 13.3% to erythromycin and 30.4% showed resistance to ampicillin (Figure 3). Considering the results above, *S. aureus* has developed resistance to most of the older, less expensive antibiotics used in the treatment of infections. These inexpensive antibiotics are widely available to patients in pharmacies without prescription from authorized health personnel (Newman et al., 2006) and this leads to indiscriminate use which promotes selective pressure favouring the emergence of resistant bacteria (Levy, 2001). Not only are these resistant bacterial strains potential causes of recurrent infections but they are also reservoirs of resistance genes that could be transferred to other pathogens. For this reason, the antibiotic susceptibility trends seen with the *S. aureus* isolates may also occur with other bacterial pathogens.

Multiple-drug resistance among *S. aureus* isolates did not vary much from one hospital to another (Table 2). Kumasi South hospital recorded a multiple-drug resistance of 19.0% among the *S. aureus* isolates. North Suntreso hospital had 37.8% of the *S. aureus* being multiple-drug resistant, while Tafo hospital had 43.3% multiple-drug resistant *S. aureus* isolates. The overall multiple-drug resistance among the 109 *S. aureus* isolates was 32.1%. The multiple-drug resistance values in this study are lower than the findings of Newman et al. (2006) who reported that the multiple-drug resistance of *S. aureus* isolated in nine regions of Ghana was 42.3%.

The presence of multiple-drug resistant strains of *S. aureus* among the isolates may be attributed to antibiotic misuse arising from self-medication in suspected bacterial infections (Newman et al., 2006). Self-medication prevents early reporting of patients to hospitals at the onset of disease symptoms, except where complications had occurred, also, some other factors such as unnecessary prescriptions and substandard antibiotics. And hence there is a need to monitor the resistance and susceptibility patterns of pathogenic bacteria in patients suffering from bacterial infections from other parts of the country. Also, antibiotic sensitivity tests should be conducted on isolates from patients suffering from bacterial infections before antibiotics are prescribed.

Conclusion

S. aureus was isolated from nose and wound swabs but not from blood samples. The age group of 20 to 29 years recorded the highest number of *S. aureus* carriers. Over 30% of the *S. aureus* isolated were resistant to ampicillin and gentamicin and 32.1% of the isolates exhibited multi-

drug resistance to at least three of the antibiotics used.

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