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Antimicrobial susceptibility pattern of *Staphylococcus aureus*, and their nasal and throat carriage among food handlers at the Federal University of Technology, Owerri Nigeria

Emeakaroha[1], Maryjane Chioma[1], Nkwocha[1], Ihuoma Gertrude[1], Adieze[1], Nchekwube Chibuzo[2], Adieze[1], Ifechukwu E[1]*

[1]*Department of Microbiology, Federal University of Technology, Owerri, Nigeria*

[2]*Department of Human Kinetics and Health Education, University of Port Harcourt, Port Harcourt, Nigeria*

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Abstract

The frequency of *Staphylococcus aureus* carriage among healthy food handlers at the students' cafeteria at the Federal University of Technology, Owerri Nigeria was investigated. Nasal and throat swab samples were obtained from 54 food handlers, and analysed using standard microbiological methods. A total of 28 (51.9%) food handlers were positive for *S. aureus*. Twenty one of the food handlers (38.9%) harbor *S. aureus* in their nostrils, 11 (20.4%) in their throat, while 6(11.1%) harbor it in both their nostrils and throats. The exclusive colonization of the throat (20.4%) of the studied food handlers, demonstrated the importance of the throat as a site of colonization for *S. aureus*. Antimicrobial susceptibility of isolates shows that all the isolated *S. aureus* were susceptible to nitrofurantoin and cefuroxime, but resistant to penicillin, chloramphenicol, cotrimazole. The isolates were also 25%, 28.6% and 35.7% susceptible to ampicillin, amoxycillin and erythromycin, respectively. This study has further shown the need for routine regular screening of food handlers for both nasal and throat carriage of *S. aureus* so as to detect early and treat carriers in order to protect the general public from staphylococcal food poisoning. The high prevalence of antimicrobial resistance in *S. aureus* isolated from the healthy food handlers is of great public health concern, as it shows a growing problem of antimicrobial resistance in the community. This study thus, recommends an urgent formulation of a national policy on antibiotics by the Nigerian government for regulation and management of antibiotics use.

***Corresponding Author:** E. Ifechukwu ✉ ifechukwu.adieze@futo.edu.ng

Introduction

Staphylococcus aureus is part of the normal flora of human skin and nasal passages. It has been reported to colonize about 20% of the human population (Kluytmans, 1997). Unfortunately, it is an opportunistic organism that may cause infection under favourable circumstances, and are easily spread through direct contact. When in contact with food, particularly cooked moist protein-rich food, *Staphylococcus aureus* can grow and produce enterotoxins which cause food poisoning. Food poisoning has been reported, resulting from ingestion of preformed toxins in food with such enterotoxigenic strains of *Staphylococcus aureus* (Figueroa, 2002).

Enterotoxigenic strains of *Staphylococcus aureus* may exist on food handler's nose or skin, from where it may be transmitted to cooked food. When the food is not kept hot to destroy the organisms or refrigerated to keep them from multiplying, they become intoxication agent within a few hours. Thus healthy food handlers carrying enterotoxin-producing *S. aureus* can contaminate food, leading to food poisoning. Thus poor personal hygiene among the food handler is an important risk factor in food borne diseases.

Staphylococcal food poisoning accounts for 14–20% of outbreaks involving contaminated food in the USA (Mead *et al*,. 1999). Multidrug-resistant strains of Staphylococci have been reported with increasing frequency worldwide, these include isolates that are resistant to methicillin, lincosamides, macrolides, aminoglycosides, fluoroquinolones, or combinations of these antibiotics (Moellering, 1998; Lowy, 1998). These are major public health concern since the bacteria can be easily circulated in the environment. Multiple drug-resistant *S. aureus* have been frequently recovered from foodstuffs (Abulreesh and Organji, 2011) and nasal mucosa of humans (Acco *et al*., 2003). Community-acquired infections with *S. aureus* are also common (Lowy, 1998).

The anterior nares are considered to be the primary colonization site, and approximately 30% of healthy people carry this bacterium (Kluytmans *et al*., 1997). The human throat is less well studied as a carriage site, particularly in Nigeria.

The carriage of enterotoxigenic *S. aureus* by food handlers is an important source of staphylococcal food contamination in restaurants and fast food outlets (Colombari *et al*., 2007). Therefore it is important to screen for *S. aureus* carriage among food handlers in order to ascertain the epidemiology, pattern of antibiotic susceptibility and to prevent possible food contamination by them that may result in food poisoning. This will also help develop preventive measures as well as treatment possibilities.

The severe consequences of infection with *S. aureus* heighten the importance of its prevention and the need for regular investigation of isolated *S. aureus* susceptibility to antibacterial agents.

The aim of this study therefore was to assess the prevalence of nasal and throat carriage of *S. aureus* among healthy food handlers in the students' cafeterias at the Federal University of Technology, Owerri, and to determine the antibiotics susceptibility pattern of the isolated *S. aureus* to commonly used antibiotics.

Materials and methods

Study area

The study was carried out at Federal University of Technology, Owerri Imo State, Nigeria, located between latitude 5°27´ 50.23˝ N and longitude 7°02´ 49.33˝E

Sample collection

Nasal and throat swabs were collected aseptically from fifty four (54) apparently healthy food handlers aged between 18-43 years, by rolling sterile normal saline moistened cotton tip of applicator swab sticks in each consenting food handler's nostrils and throat, respectively. The swab sticks were immediately and carefully returned to their sterile containers and sealed, then labeled and immediately taken to the laboratory in ice box for analysis.

Ethical Consideration

Informed consent was requested and granted by the food handlers investigated. The essence of the study was explained to them and their consent sought. On understanding the study, candidates freely granted their informed consent.

Exclusion criteria

A structured questionnaire was used for the collection of information on age, sex, antibiotics usage in the previous one month of each food handler, as well as presence of inflammatory nasal congestion and throat irritation. Candidates that used antibiotics within the previous one month prior to sampling and those with symptoms as inflammatory nasal congestion and throat irritation were excluded from the study.

Isolation and identification of S. aureus

Nasal and throat swabs obtained from each food handler were inoculated onto Blood agar and mannitol salt agar plates and incubated at 37°C for 24 hours. Isolated colonies per swab sample showing typical colonial morphology of *S. aureus*, β–hemolysis on blood agar plates and yellow colonies on mannitol salt agar were subjected to Gram staining, catalase test and coagulase test following standard microbiological procedures. Isolates that were Gram positive, coagulase and catalase positive, were identified and selected as *S. aureus*. Identified isolates were then stored on nutrient agar slants at 4°C till further tests.

Antimicrobial susceptibility test

Antimicrobial susceptibility test was performed on Mueller Hinton agar (Oxoid, Hampshire UK) using agar disc diffusion technique (Bauer *et al.*, 1966). Susceptibility of *S. aureus* isolates to eight (8) commonly used antimicrobials were tested. These are penicillin (10 units), erythromycin (15μg), chloramphenicol (30μg), nitrofurantoin (15μg), cefuroxime (30μg), ampicillin (10μg), amoxicillin (30μg), and cotrimazole (30μg). The susceptibility of isolates to antibiotics was interpreted according to the Clinical and Laboratory Standards Institute (2007).

Results

The results showed the *S. aureus* was isolated from food handlers in 12 (80%) of the 15 cafeteria examined, and from 28 (51.85%) of the 54 food handlers examined (Table 1). of the 54 food handlers examined, 21 (38.9%) harbor *S. aureus* in their nostrils only, 11 (20.4%) in their throat only and 6 (11.1%) in their nostrils and throat (Table 2).

The distribution of the 54 studied food handlers shows that 25 are males while 29 are females. The prevalence of *S. aureus* colonization among the studied population, showed that 11 (44.0%) of the 25 male food handlers, and 17 (58.6%) of the 29 females are colonized by *S. aureus* (Table 3).

The result of the antimicrobial sensitivity pattern of *S. aureus* isolates from food handlers shows that, all isolates (100%) were susceptible to nitrofurantoin and cefuroxime, but resistant to penicillin, chloramphenicol and cotrimazole. Seven of the isolates (25%) and 8 (28.6%) isolates were susceptible to ampicillin and amoxicillin respectively, while 10 (35.7%) were susceptible to erythromycin (Table 4).

Table 1. Prevalence of *S. aureus* among food-handlers working in cafeterias.

Cafeteria ID	CAF 01	CAF 02	CAF 03	CAF 04	CAF 05	CAF 06	CAF 07	CAF 08	CAF 09	CAF 10	CAF 11	CAF 12	CAF 13	CAF 14	CAF 15	Total
Subjects examined	4	5	3	4	3	5	4	3	3	4	4	3	3	3	3	54
S. aureus n (%)	3 (75.0)	3 (60.0)	1 (33.3)	3 (75.0)	2 (66.7)	3 (60.0)	3 (75.0)	1 (33.3)	0 (0)	3 (75.0)	0 (0)	0 (0)	2 (66.7)	2 (66.7)	2 (66.7)	28 (51.85%)

Table 2. The prevalence of *S. aureus* in the nostrils and throats of food handlers working in cafeterias (n=54).

Cafeteria ID	CAF01	CAF02	CAF03	CAF04	CAF05	CAF06	CAF07	CAF08	CAF09	CAF10	CAF11	CAF12	CAF13	CAF14	CAF15	Total (%)
Subjects with *S. aureus* in nostrils	3	1	1	2	0	3	2	1	0	3	0	0	1	2	2	21 (38.9)
Subjects with *S. aureus* in throat	1	2	0	1	2	0	2	0	0	2	0	0	1	0	0	11 (20.4)
Subjects with *S. aureus* in nostrils and throat	1	1	0	1	0	0	1	0	0	2	0	0	0	0	0	6 (11.1)

Table 3. Prevalence of *S. aureus* colonization among the food handlers of differences gender.

Sex	Population sampled	Prevalence	%
Male	25	11	44.0
Female	29	17	58.6
Total	54	28	51.9

Table 4. Antimicrobial sensitivity pattern of *S. aureus* isolates from food handlers.

Antimicrobials	Susceptible (%)	Resistant (%)
Erythromycin	10 (35.7)	18 (64.3)
Penicillin	0 (0)	28 (100)
Ampicillin	7 (25)	21 (75)
Chloramphenicol	0 (0)	28 (100)
Amoxycillin	8 (28.6)	20 (71.4)
Nitrofurantoin	28 (100)	0 (0)
Cefuroxime	28 (100)	0 (0)
Cotrimazole	0 (0)	28 (100)

Discussion

Nasal and throat carriage of *Staphylococcus aureus* among food handlers in students' cafeterias at the Federal University of Technology, Owerri was assessed. *Staphylococcus aureus* is an opportunistic pathogen for both human and livestock population, and is one of the most frequent etiological sources of hospital and community infections. It is a common colonizer of the skin and nose has become one of the most successful adaptable human pathogens. Although food handlers represent a section of the healthy population in the community, their carriage of *S. aureus* reported (David *et al.*, 2006; Sampathukumar, 2007; Hotu *et al.*, 2007) to have remarkable ability to acquire antibiotic resistance contributing to its emergence as an important pathogen in a variety of setting, is a great cause of public health concern. This is because healthy carriers of *S. aureus* strains play an important role in its dissemination in the hospitals and community (Hamdan-Partida *et al.*, 2010).

In this study, it was observed that 28 (51.9%) of the 54 food handlers examined harboured *S. aureus* in either their nose or throat, or in both. Although *S. aureus* causes severe infections it is very important to note that it is also a member of the normal flora of the nasal cavity, and about one-third of the U.S. population are carriers of *S. aureus (*Kuehnert *et al.*, 2006). *S. aureus* has also been isolated from restaurant workers in many other studies e.g. in a study conducted among restaurant workers from Kuwait City; it was found that *S. aureus* and coagulase-negative *staphylococci* (CNS) were isolated from the hands of food handlers in 50 restaurants in Kuwait City (Udo *et al.,*1999). The 51.9% food handlers colonized by *S. aureus* in this study was found to be similar to 53.3% food handler's hands found by Wolde *et al.* (2016) to be positive for *S. aureus*. Other previous studies have also recorded varied percentages of colonization. This was attributed to the ecological differences of the study population (Dagnew *et al.*, 2012). Dagnew *et al.*, 2012 reported the isolation rate of 20.5% from the nasal cultures of food handlers studied, while Mulat *et al.* (2012), reported 20.5% food handlers as positive for nasal carriage of *S. aureus*. In a study implemented in Jigjiga University, Ethiopia, among food handlers in university students cafeteria, it was also found that 53.3% of food handlers were positive for *S. aureus* isolates from nails swab (Atif *et al*,.2006). While these other studies reported *S. aureus* isolated from either hands, nails or nasal swabs of food handlers, this present study assayed for and reported *S. aureus* from the nasal and throat swabs of food handlers.

It is important to screen healthy population of food handlers routinely for *S. aureus*. However, this screening for *S. aureus* strains has been traditionally restricted to the nares (Cole *et al.*, 2001; Kluytmans *et al.*, 1997; Peacock *et al.*, 2001). This study showed that 20.4% of the studied food handlers have their throat exclusively colonized by *S. aureus,* demonstrating the importance of the throat as a common site of colonization for *S. aureus*. As observed in this study, several studies has also shown that the throat of individuals may be exclusively colonized and that such individuals would be missed on screenings limited to the anterior nares (Mertz *et al.*, 2007, Meurman *et al.*, 2005; Small *et al.*, 2007; Widmer *et al.*, 2008).

The comparatively higher level of colonization of the nares to the throat observed in this study could be because the nasal regions are the major reservoir of *S. aureus* (Appelbaum, 2007; Koziol-Montewka, 2006). Similar findings had also been reported (Kuehnert *et al*., 2006; Uemura *et al*., 2004). This ability of the nasal passages to harbour *S. aureus* results from a combination of a weakened or defective host immunity and the bacterium's ability to evade host innate immunity (Quinn, 2007). Contrary to higher level of colonization of the nares, the works of Nilsson and Ripa (2006) and Hamdan-Partida *et al.* (2010) had reported that the presence of *S. aureus* is more frequent in the throat than in the nares.

The rate of susceptibility of the isolated bacteria to different antimicrobials tested is shown in Table 4. Nitrofurantoin and cefuroxime were found to be most effective against the isolates with susceptibility rate of 100% respectively, while penicillin, chloramphenicol and cotrimazole with 0% susceptibility were found to be the least effective antimicrobials. This provides information on the likely antibiotics of choice useful for the treatment of infection from *S. aureus* in the study area. However, as observed by (Udo *et al*., 2009) food handlers represent a section of the healthy population in the community, besides working in restaurants, the detection of high prevalence of antibiotic resistance in *S. aureus* isolated from them also highlights the growing problem of antibiotic resistance in the community. The high resistance of isolates from the present study to commonly used antibiotics could be attributed to wide spread indiscriminate usage and abuse of antibiotics. It has been reported that penicillins are the most misused antibiotics amongst Nigerian communities (Olayemi *et al*., 2010), this reflected in their susceptibility pattern in this study.

The high resistance to commonly used antibiotics contrasts greatly with the high sensitivity to nitrofurantoin and cefuroxime, which are less frequently used compared to penicillin, chloramphenicol, cotrimazole and ampicillin, collaborating the relationship between antibiotics usage and level of its resistance.

Also the observed susceptibility to nitrofurantoin and cefuroxime could be as a result of nitrofurantoin's broad mechanism of action on bacteria which is likely responsible for the low development of resistance to it, and cefuroxime's high stability in the presence of beta-lactamases.

Conclusion

The result of this study has further shown the need for routine regular screening of food handlers for both nasal and throat carriage of *S. aureus* so as to detect early and treat carriers in order to protect students and the general public from staphylococcal food poisoning and the spread of resistant *S. aureus* strains in the community. This study suggests an urgent formulation of a national policy on antibiotics by the Nigerian government for proper regulation and management of antibiotics use. Nigeria has a high rate of antibiotic misuse as well as high prevalence of self-medication use (Sapkota *et al*., 2010).

References

Abulreesh HH, Organji SR. 2011. The prevalence of multidrug-resistant staphylococci in food and the environment of Makkah, Saudi Arabia. Research Journal of Microbiology **6,** 510-523.

Acco M, Ferreira FS, Henriques JAP, Tondo EC. 2003. Identification of multiple strains of *Staphylococcus aureus* colonizing nasal mucosa of food handlers. Journal of Food Microbiology **20,** 489-493.

Appelbaum PC. 2007. Reduced glycopeptides susceptibility in methicillin-resistant *Staphylococcus aureus* (MRSA). International Journal of Antimicrobial Agents **30,** 398-408.

Atif A, Tariq Z, Aiman M. 2006. Bacteriological and Serological Survey of Infectious Diseases among Food Handlers in Makkah. Annals of Saudi medicine **26,** 141- 144.

Bauer AW, Kirby WM, Sherris JC, Turch M. 1966. Antibiotic susceptibility testing by standard single disk method. American Journal of Clinical Pathology. **45,** 493-496.

Clinical and Laboratory Standards Institute. 2007. Performance standards for antimicrobial susceptibility testing; fifteenth informational supplement. CLSI document M100-S15. Clinical and Laboratory Standards Institute, Wayne PA.

Cole AM, Tahk S, Oren A, Yoshioka D, Kim Y, Park A, Ganz T. 2001. Determinants of *Staphylococcus aureus* nasal carriage. Clinical and diagnostic laboratory immunology **8,** 1064-1069.

Colombari V, Mayer MD, Laicini ZM, Mamizuka E, Franco BD, Destro MT, Landgrave M. 2007. Foodborne outbreak caused by *Staphylococcus aureus*: phenotypic and genotypic characterization of strains of food and human sources. Journal of Food Protection **70,** 489-493.

Dagnew M, Tiruneh M, Moges F, Tekeste Z. 2012. Survey of nasal carriage of *Staphylococcus aureus* and intestinal parasites among food handlers working at Gondar University, Northwest Ethiopia. Biomed central Public Health **12,** 1471-2458.

David MD, Kearus AM, Gossain S, Ganner M, Holmes A. 2006. Community–associated methicillin–resistant *Staphylococcus aureus*: nosocomial transmission in a neonatal unit. Journal of Hospital Infection **64,** 244-250.

Figueroa G, Navarrete P, Caro M, Troncoso M, Faundez G. 2002. Carriage of Enterotoxigenic *Staphylococcus aureus* in Food Handlers. Revista Medica de Chile **130,** 859-864.

Hamdan-Partida A, Sainz-Espun˜es T, Bustos-Martínez J. 2010. Characterization and persistence of *Staphylococcus aureus* strains isolated from the anterior nares and throats of healthy carriers in a Mexican community. Journal of Clinical Microbiology **48,** 1701-1705.

Hotu B, Ellenbogen C, Hayden MK, Aroutcheva A, Rice TW, Weinstein RA. 2007. Community–associated methicillin–resistant *Staphylococcus aureus* skin and soft tissue infections at a public hospital: do public housing and incarceration amplify transmission? Archives of Internal Medicine **167,** 1026-1033.

Kluytmans J, van Belkum A, Verbrugh H. 1997. Nasal carriage of *Staphylococcus aureus*: epidemiology, underlying mechanisms, and associated risks. Clinical Microbiology Reviews **10,** 505520.

Koziol-Montewka M, Szczepanok A, Baranowicz I, Joewiak L, Ksiazek A, Kaczor D. 2006. The investigation of *Staphylococcus aureus* and coagulase-negative staphylococcal nasal carriage among patients undergoing haemogialysis. Microbiological Research **161,** 281-287.

Kuehnert MJ, Deanna K, Hill HA. 2006. Prevalence of *Staphylococcus aureus* Nasal Colonization in the United States. Journal of Infectious Diseases **193,** 172-179.

Lowry FD. 1998. *Staphylococcus aureus* Infection. New England Journal of Medicine **339,** 520-532.

Mead PS, Slutsker L, Dietz V, McCaig LF, Bresee JS, Shapiro C, Griffin PM, Tauxe RV. 1999. Food-related illness and death in the United States. Emerging Infectious Diseases **5,** 607-625.

Mertz D, Frei R, Jaussi B, Tietz A, Stebler C, Fluckinger U, Widmer AF. 2007. Throat swabs are necessary to reliably detect carriers of *Staphylococcus aureus*. Clinical Infectious Diseases **45,** 475-477.

Meurman O, Routamaa M, Peltonen R. 2005. Screening for methicillin-resistant *Staphylococcus aureus*: which anatomical sites to culture? Journal of Hospital Infection **61,** 351-353.

Nilsson P, Ripa T. 2006. *Staphylococcus aureus* throat colonization is more frequent than colonization in the anterior nares. Journal of Clinical Microbiology **44,** 3334-3339.

Olayemi OJ, Olayinka BO, Musa AI. 2010. Evaluation of antibiotic self-Medication Pattern amongst undergraduate students of Ahmadu Bello University (Main Campus), Zaria. Research Journal of Applied Sciences, Engineering and Technology **2,** 35-38.

Peacock SJ, de Silva I, Lowy FD. 2001. What determines nasal carriage of *Staphylococcus aureus*? Trends in Microbiology **9,** 605-610.

Quinn GA, Cole AM. 2007. Suppression of innate immunity by a nasal carriage strain of *Staphylococcus aureus* increases its colonization on nasal epithelium. Immunology **122,** 80-9.

Sampathukumar P. 2007. Methicillin-Resistant *Staphylococcus aureus*: The latest Health Scare. Mayo Clinic Proceedings **82,** 1403-1467.

Sapkota AR, Coker ME, Rosenberg Goldstein RE, Atkinson NL, Sweet SJ, Sopeju PO, Ojo MT, Otivhia E, Ayepola OO, Olajuyigbe OO. 2010. Self-medication with antibiotics for the treatment of menstrual symptoms in Southwest Nigeria: a cross-sectional study. Biomed central Public Health **10,** 610. DOI: 10.1186/1471-2458-10-610.

Small H, Casey AL, Elliott TSJ, Rollason J, Ball S. 2007. The oral cavity an overlooked site for MRSA screening and subsequent decolonization therapy? Journal of Infection **55,** 378-383.

Udo EE, Al-Mufti S, Albert MJ. 2009. The prevalence of antimicrobial resistance and carriage of virulence genes in *Staphylococcus aureus* isolated from food handlers in Kuwait city restaurants. Biomed central Research Notes **2,** 108.

Uemura E, Kakinohana S, Higa N, Toma C, Nakasone N. 2004. Comparative characterization of *Staphylococcus aureus* isolates from Throats and Nose of Healthy Volunteers. Japanese Journal of Infectious Diseases **57,** 21-24.

Widmer AF, Mertz D, Frei R. 2008. Necessity of screening of both the nose and the throat to detect methicillin-resistant *Staphylococcus aureus* colonization in patients upon admission to an intensive care unit. Journal of Clinical Microbiology **46,** 835.

Wolde T, Abate M, Mehari L. 2016. Prevalence and antibiotics resistance pattern of *Staphylococcus aureus* among food handlers of Jigjiga University student's cafeteria, International Journal of Scientific Research Engineering Technology **2,** 38-41.