https://www.banglajol.info/index.php/BJMM/index

Bangladesh Journal of Medical Microbiology

January 2023, Volume 17, Number 1, Page 29-33

ISSN (Print) 2070-1810

ISSN (Online) 2072-3105

Original Article ***Open Access***

Prevalence and Antibiotic Resistance Pattern of *Staphylococcus aureus* Isolated from Clinical Samples: A Cross-sectional Study

Noor-E-Jannat Tania[1], SM Shamsuzzaman[2], Aminul Islam[3], MD. Maminur Rahman[4], Khadijatul Kubra[5]

[1]Lecturer, Department of Microbiology, Dhaka Medical College, Dhaka, Bangladesh; [2]Professor and Head, Department of Microbiology, Dhaka Medical College, Dhaka, Bangladesh; [3]FCPS Part 2- trainee, Department of Endocrinology and Metabolism, Dhaka Medical College Hospital, Dhaka, Bangladesh; [4]Resident Medical Officer, Department of Paediatric Anaesthesiology and Surgical ICU, Bangladesh Shishu Hospital and Institute, Dhaka, Bangladesh; [5]Medical Officer, Officer on Special Duty (OSD), Directorate General of Health Services, Mohakhali, Dhaka, Bangladesh

Abstract

Background: *Staphylococcus aureus*, mainly a hospital acquired infection is responsible for many suppurative lesions and has demonstrated the ability of developing resistance to many antimicrobial agents leading to life threatening infections and long hospital stay. **Objective:** This study was aimed to determine the prevalence and antibiotic susceptibility profiles of *Staphylococcus aureus* in different clinical specimens isolated from hospital admitted patients. **Methodology:** This cross-sectional study was conducted from 1 January 2019 to 31 December 2019 in the Microbiology Department of Dhaka Medical College, Dhaka, Bangladesh. Pus, wound swab and blood samples were included in this study. Isolation and identification of Staphylococcus aureus was based on culture, microscopy and different biochemical tests. The antibiotic susceptibility test was done by disc diffusion method using Kirby-Bauer technique. **Results:** Among 275 clinical specimens 21.63% *Staphylococcus aureus* were isolated among which 21.93% were isolated from pus and wound swabs and 19.05% from blood samples. Most of the *Staphylococcus aureus* showed resistance to azithromycin and erythromycin (68.89%) followed by clindamycin (66.67%), ampicillin (40%), linezolid (31.11%), amikacin (26.67%) and teicoplanin (24.44%). **Conclusion:** In conclusion there is a high prevalence of *Staphylococcus aureus* in clinical samples of hospitalized patients and it has shown alarmingly resistance to many of common antimicrobials.

Keywords: Antibiotic; prevalence; resistance; susceptibility; *Staphylococcus aureus*

Bangladesh Journal of Medical Microbiology, January 2023;17 (1):29-33

Introduction

Staphylococcus aureus is an aerobic gram positive coccus and ubiquitous commensal that periodically lives on the skin and anterior nares of about one third of the healthy human population without causing illness[1,2]. Most *Staphylococcus aureus* infections occur in persons who are colonized with the organism.

Correspondence: Dr. Noor-E-Jannat Tania, Lecturer, Department of Microbiology, Dhaka Medical College, Dhaka, Bangladesh; Email: noorejannat87@gmail.com; Cell No.: +8801816531364;
ORCID: https://orcid.org/0009-0000-6833-9367

DOI: https://doi.org/10.3329/bjmm.v17i1.68265

Staphylococcus aureus carriage has long been known to be one of the most strongly associated risk factors for subsequent infection[3,4]. The organism also elaborates toxins that can cause specific diseases and likely participate in the pathogenesis of *staphylococcal* infection[5]. S*taphylococcus aureus* causes a wide variety of diseases that ranges from skin and soft tissue infections, pneumonia, bloodstream infections, osteomyelitis and endocarditis, as well as toxin-mediated syndromes like toxic shock and food poisoning[6,7].

Varying degree of antibiotics resistance towards *Staphylococcus aureus* may be due to production of β-lactamase enzyme responsible for inactivation of

β-lactam drugs, gene mutations and horizontal gene transfer and exposure to high selection pressure of antibiotics[8].

The rise of drug-resistant is a serious problem in the treatment and control of *Staphylococcal* infections[9]. The knowledge of antimicrobial susceptibility profile of *Staphylococcus aureus* in a particular area is important as this can contribute to rational choice and use of antimicrobial agents[10]. The aim of the present study was to determine the prevalence and antibiotic susceptibility profiles of *Staphylococcus aureus* in different clinical samples isolated from hospital admitted patients.

Methodology

Study Settings and Population: This cross-sectional study was conducted from 1 January 2019 to 31 December 2019 in the Microbiology Department of Dhaka Medical College, Dhaka, Bangladesh.

Sample Collection Procedure: Samples were collected from pus, wound swab and blood of clinically suspected infected patients of inpatient departments of Dhaka Medical College Hospital or were received in the microbiology department for culture and sensitivity after taking informed written consent irrespective of age, sex and antibiotic intake. Patient who did not give consent were excluded from this study.

Isolation and Identification: Wound swab and pus samples were inoculated in blood agar and MacConkey agar media and incubated at 37°C aerobically for 24 hours. Incubated plates were then examined for the presence of colonies of bacteria. Primary blood culture was done in Trypticase soya broth (TSB) for 24 hours and then subculture was done in blood agar and MacConkey agar media and incubated at 37°C aerobically for 24 hours.

Microscopic Examination: Smears were prepared from culture plates and stained by Gram's stain as per standard procedure. Then were examined under microscope for presence of gram positive or gram negative organisms[11].

Biochemical test: Among isolated gram positive cocci, *Staphylococcus aureus* was identified by catalase test, coagulase test (slide and tube method), colony morphology, hemolytic property, pigment production and mannitol fermentation test in mannitol salt agar media as per standard methods[12].

Antimicrobial susceptibility tests: All the *Staphylococcus aureus* isolates were tested for antimicrobial susceptibility testing by disc diffusion method on Mueller Hinton agar using Kirby-Bauer technique[13]. Antibiotic discs used for sensitivity tests were Azithromycin, Clindamycin, Erythromycin, Linezolid, Ampicillin, Novobiocin, Teicoplanin, Amikacin.

Statistical Analysis: Statistical analyses was performed with SPSS software, versions 22.0 (IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY: IBM Corp.). Continuous data that were normally distributed were summarized in terms of the mean, standard deviation, median, minimum, maximum and number of observations. Categorical or discrete data were summarized in terms of frequency counts and percentages. When values are missing, the denominator was stated. Chi-square test was used for comparison of categorical variables. Every effort was made to obtain missing data. A two-sided P value of less than 0.05 was considered to indicate statistical significance.

Ethical Clearance: All procedures of the present study were carried out in accordance with the principles for human investigations (i.e., Helsinki Declaration) and also with the ethical guidelines of the Institutional research ethics. Formal ethics approval was granted by the Research Review Committee (RRC) of Department of Microbiology and Ethical Review Committee (ERC) of Dhaka Medical College, Dhaka, Bangladesh (Reference number: MEU-DMC/ECC/2019/171). Participants in the study were informed about the procedure and purpose of the study and confidentiality of information provided. All participants consented willingly to be a part of the study during the data collection periods. All data were collected anonymously and analyzed using the coding system.

Results

A total 275 samples were included in the present study. Among them 230 pus and wound swabs and 45 blood samples. From the 275 samples 208 (75.6%) were culture positive. Culture yielded growth in 187 (81.30%) pus and wound swabs and 21 (46.67%) blood samples (Table 1).

Table 1: Culture Positivity Among Various Clinical Samples (n= 275)

Samples	Culture Positive	Culture Negative	Total
Pus and wound swabs	187 (81.3%)	43 (18.7%)	230 (100.0%)
Blood	21 (46.7%)	24 (53.3%)	45 (100.0%)
Total	**208 (75.6%)**	**67 (24.4%)**	**275 (100.0%)**

Out of 187 pus and wound swabs samples 41 (21.93%) Staphylococcus aureus was isolated followed by 4(19.05%) from 21 blood samples (Table 2).

Table 2: Distribution of *Staphylococcus aureus* Isolated from Culture Positive Samples (n=208)

Samples	Culture Positive	Culture Negative	Total
Pus and wound swabs	41 (21.93%)	146 (78.07%)	187 (100.0%)
Blood	4 (19.05%)	17 (80.95%)	21 (100.0%)
Total	**45 (21.63%)**	**163 (78.37%)**	**208 (100.0%)**

Staphylococcus aureus showed higher resistance to azithromycin and erythromycin (68.89%) followed by clindamycin (66.67%), ampicillin (40%), linezolid (31.11%), amikacin (26.67%) and teicoplanin (24.44%). All (100%) isolated *Staphylococcus aureus* were sensitive to novobiocin (Table 3).

Table 3: Antimicrobial Resistance Pattern of Isolated *Staphylococcus aureus* from Clinical Samples (n=45)

Antimicrobial drugs	Frequency	Percent
Azithromycin	31	68.89
Erythromycin	31	68.89
Clindamycin	30	66.67
Ampicillin	18	40.0
Linezolid	14	31.11
Amikacin	12	26.67
Teicoplanin	11	24.44
Novobiocin	0	0.00

Discussion

Staphylococcus aureus is the most frequently occurring bacterial pathogen among clinical samples from hospital inpatients in the United States and is the second most prevalent bacterial pathogen among outpatients[14]. *Staphylococcus aureus* bacteremia was associated with a long duration of hospital stay, high treatment cost and increased risk of mortality, compared with bacteremia by any other pathogen and a significant economic burden on health care systems[15].

In the present study, 45 (21.63 %) *Staphylococcus aureus* were isolated from clinical samples. This finding was almost similar to the related study in India who reported that 18.70% *Staphylococcus aureus* were isolated in their studies[16]. Another study showed that 33.3% *Staphylococcus aureu*s were isolated in their studies[17]. This divergence might be due to the difference in types of samples, difference in sample size and number of hospital surveyed, season of collecting samples and medication taken before sampling[18]. In our study, maximum (21.93%) *Staphylococcus aureus* were isolated from pus and wound swabs which concurs with a previous study (29.4%)[19]. Antimicrobial agents have been used extensively to combat *Staphylococcus aureus* infections but the increasing level of resistance of *Staphylococcus aureus* to many antibiotics is complicating the treatment of serious infections caused by this pathogen[20].

In the present study, 68.89% *Staphylococcus aureus* showed resistance to erythromycin. This result was similar to the related previous study[21]. Another study showed that 46.3% erythromycin resistance for *Staphylococcus aureus*[22].The rate of erythromycin resistance varies greatly in different countries which may reflect on the difference in selective pressure of antibiotics and infection control policies[23].

In this current study, 68.89 % *Staphylococcus aureus* showed resistance to azithromycin. A previous study found 49.2% resistance[24]. In our study, 66.67% *Staphylococcus aureus* showed resistance to clindamycin. Two previous studies found 77.3% and 40.7% clindamycin resistance respectively[25,26].

In the present study, 40% *Staphylococcus aureus* showed resistance to ampicillin. This result was similar to the study of Turutoglu et al[27]. Another study observed that 100% *Staphylococcus aureus* showed resistance to ampicillin. The higher resistance of *Staphylococcus aureus* to ampicillin may be attributed to the fact that it is the frequently used antibiotic for the treatment of skin and nasal infections[28].

In this current study, 31.11% *Staphylococcus aureus* showed resistance to linezolid. This result was in agreement with the study of Amr et al[29]. Garcia et al[30] showed that linezolid resistance probably develops on exposure.

Many factors are responsible for the differences in the antibiotic resistance profile such as various geographic regions, local infection preventive measures implemented, antibiotic prescribing guidelines and epidemiology of the studied strains themselves[31].

Antibiotic resistance usually occurs in Bangladesh and other developing countries as a result of some incidences including the use of antibiotics without performing AST and the inappropriate prescribing of antibiotics, unethical practices of health professionals, unqualified drug sellers offering alternative drugs when the prescribed drugs are unavailable and the uncontrolled use of antibiotic in agriculture and livestock[24,25].

There are some limitations of the study. The incidence of *Staphylococcus aureus* infection and its complications has increased sharply in recent years because of the increased frequency of invasive procedures, increased numbers of immunocompromised patients and increased resistance of *Staphylococcus aureus* strains to available antibiotics. This changing epidemiology of *Staphylococcus aureus* infection, in combination with the inherent virulence of the pathogen, is driving an urgent need for improved strategies and better antibiotics to prevent and treat *Staphylococcus aureus* infection and its complications.

Conclusion

Staphylococcus aureus is a particularly complex, virulent and successful pathogen. There is a higher risk of acquiring multidrug resistant *Staphylococcus aureus* infection in hospital admitted patients. The chronic misuse and overuse of antibiotics in community level have deteriorated the drug-resistant problem. We should cautious of prescribing antibiotics with accurate dose and duration after culture and sensitivity reports are available. Policies need to be adopted in order to stop an increasing resistance of *Staphylococcus aureus* to different antibiotics due to high cost and time in developing new antibiotics. The clinical isolates of hospitalized patients exhibit a relatively high prevalence of *Staphylococcus aureus* which is an alarming issue and significant economic burden on health care systems.

Acknowledgements
We are thankful to all the teachers and staff of Microbiology department, Dhaka Medical College, Dhaka.

Conflict of Interest
There is no conflict of interest.

Financial Disclosure
This study was partially funded by Bangladesh Medical Research Council (BMRC).

Authors' contributions
Noor-E-Jannat Tania conceived and designed the study, analyzed the data, interpreted the results, and wrote up the draft manuscript. SM Shamsuzzaman contributed to the analysis of the data, interpretation of the results and critically reviewing the manuscript. Aminul Islam contributed to the data analysis and manuscript writing. Maminur Rahman involved in the manuscript review and editing. Khadijatul Kubra involved in the manuscript review and editing. All authors read and approved the final manuscript.

Data Availability
Any inquiries regarding supporting data availability of this study should be directed to the corresponding author and are available from the corresponding author on reasonable request.

Ethics Approval and Consent to Participate
Ethical approval for the study was obtained from the Institutional Review Board. As this was a retrospective study the written informed consent was not obtained from all study participants. All methods were performed in accordance with the relevant guidelines and regulations.

How to cite this article: Tania NEJ, Shamsuzzaman SM, Islam A, Rahman MM, Kubra K. Prevalence and Antibiotic Resistance Pattern of Staphylococcus aureus Isolated from Clinical Samples: A Cross-sectional Study. Bangladesh J Med Microbiol, 2023;17(1):29-33

Article Info
Received: 7 August 2022
Accepted: 24 December 2022
Published: 1 January 2023

References

1. Chambers HF, DeLeo FR. Waves of resistance: Staphylococcus aureus in the antibiotic era. Nat Rev Microbiol 2009;7(9):629-41.
2. Monsen T, Olofsson C, Rönnmark M, Wiström J. Clonal spread of staphylococci among patients with peritonitis associated with continuous ambulatory peritoneal dialysis. Kidney Int 2000;57(2):613-8.
3. Von Eiff C, Becker K, Machka K, Stammer H, Peters G. Nasal carriage as a source of Staphylococcus aureus bacteremia. N Engl J Med 2001;344(1):11-6.
4. Miles AA, Williams RE, Clayton-gooper B. The Carriage of Staphylococcus (pyogenes) aureus in Man and its relation to Wound Infection. J Pathol Bacteriol 1944;56(4):513-24.
5. Faden H, Lesse AJ, Trask J, et al. Importance of colonization site in the current epidemic of staphylococcal skin abscesses. Pediatrics 2010;125(3):e618-24.
6. Perez-Vazquez M, Vindel A, Marcos C, et al. Spread of invasive Spanish Staphylococcus aureus spa-type t067 associated with a high prevalence of the aminoglycoside-modifying enzyme gene ant (4′)-Ia and the efflux pump genes msrA/msrB. J antimicrob chemother 2009;63(1):21-31.
7. Diekema DJ, Pfaller MA, Schmitz FJ, et al. Survey of infections due to Staphylococcus species: frequency of occurrence and antimicrobial susceptibility of isolates collected in the United States, Canada, Latin America, Europe, and the Western Pacific region for the SENTRY Antimicrobial Surveillance Program, 1997–1999. Clin Infect Dis 2001;32(Supplement_2):S114-32.
8. Baumert N, von Eiff C, Schaaff F, Peters G, Proctor RA, Sahl HG. Physiology and antibiotic susceptibility of Staphylococcus aureus small colony variants. Microb drug resist 2002;8(4):253-60.
9. Lee MC, Rios AM, Aten MF, Mejias A, Cavuoti D, McCracken Jr GH, et al. Management and outcome of children with skin and soft tissue abscesses caused by community-acquired methicillin-resistant *Staphylococcus aureus*. Pediatr Infect Dis J 2004;23(2):123-7.
10. Shittu AO, Udo EE, Lin J. Phenotypic and molecular characterization of Staphylococcus aureus isolates expressing low-and high-level mupirocin resistance in Nigeria and South

Africa. BMC Infect Dis 2009;9(1):1-9.
11. Arioli V, Berti M, Candiani G. Activity of teicoplanin in localized experimental infections in rats. J Hosp Infect 1986;7:91-9.
12. Cheesbrough M. Microscopical techniques used in Microbiology, culturing bacterial pathogens, biochemical tests to identify bacteria. In: Cheesbrough M. (editor). Dist. Lab. Pract. Trop. Ctries. Part 2, 2nd ed, Cambridge University Press, India 2009; pp. 35-70.
13. Bauer AW. Antibiotic susceptibility testing by a standardized single disc method. Am J clin pathol 1966;45:149-58.
14. Styers D, Sheehan DJ, Hogan P, Sahm DF. Laboratory-based surveillance of current antimicrobial resistance patterns and trends among Staphylococcus aureus: 2005 status in the United States. Ann Clin Microbiol Antimicrob 2006;5(1):1-9.
15. Shorr A, Lodise T. Burden of Methicillin-resistant Staphylococcus aureus on healthcare cost and resource utilization. ISMR Update 2006;1(2):1-2.
16. Ahmad MK, Asrar A. Prevalence of methicillin resistant Staphylococcus aureus in pyogenic community and hospital acquired skin and soft tissues infections. J Pak Med Assoc 2014; 64(8): 892-5
17.ElSayed N, Ashour M, Amine AEK. Vancomycin resistance among Staphylococcus aureus isolates in a rural setting, Egypt. Germs 2018; 8(3): 134.
18.Al-Bassam WW, Kazar AA.The isolation and characterization of Proteus mirabilis from different clinical samples. J Biotechno ReN 2013; 7: 24-30.
19.Zerfie T, Moges T, Mucheye G. Staphylococcus aureus and its Antimicrobial Susceptibility Pattern in Patients, Nasal carriage of Health Personnel, and objects at Dessie referral hospital, Northern Ethiopia. Global J Medical Res Microbiol Patho 2014;14:1-5.
20.Wang SH, Khan Y, Hines L, Mediavilla JR, Zhang L, Chen L, Hoet A, et al. Methicillin-resistant Staphylococcus aureus sequence type 239-III, Ohio, USA, 2007–2009. Emerg Infect Dis 2012;18(10):1557.
21.Taz KA, Jobayer M, Shamsuzzaman SM. Nasal Colonization of Methicillin Resistant Staphylococcus aureus among Healthcare Providers in a Tertiary Care Hospital, Bangladesh. Mymensingh Med J 2019;28(3):627-33.
22.Lin Q, Sun H, Yao K, Cai J, Ren Y, Chi Y. The prevalence, antibiotic resistance and biofilm formation of Staphylococcus aureus in bulk ready-to-eat foods. Biomolecules 2019;9(10):524.
23. Kim HB, Lee B, Jang HC, Kim SH, Kang CI, Choi YJ, et al. A high frequency of macrolide-lincosamide-streptogramin resistance determinants in Staphylococcus aureus isolated in South Korea. Microb Drug Resist 2004;10(3):248-54.
24. Emaneini M, Eslampour MA, Sedaghat H, Aligholi M, Jabalameli F, Shahsavan S, et al. Characterization of Phenotypic and Genotypic inducible Macrolide Resistance in Staphylococciin Tehran, Iran. J Chemother 2009;21(5):595-7.
25. Turutoglu HU, Ercelik S, Ozturk D. Antibiotic resistance of Staphylococcus aureus and coagulase-negative staphylococci isolated from bovine mastitis. Bull Vet Inst Pulawy 2006;50(1):41.
26. Savariraj WR, Ravindran NB, Kannan P, Paramasivam R, Senthilkumar TM, Kumarasamy P, et al. Prevalence, antimicrobial susceptibility and virulence genes of Staphylococcus aureus isolated from pork meat in retail outlets in India. J Food Saf 2019;39(1):e12589.
27. Amr GE, Al Gammal S. Emergence of vancomycin resistant Staphylococcus aureus isolated from patients in ICUs of Zagazig University Hospitals. Egypt J Med Microbiol 2017;26(2).
28. García MS, De la Torre MÁ, Morales G, Peláez B, Tolón MJ, Domingo S, et al. Clinical outbreak of linezolid-resistant Staphylococcus aureus in an intensive care unit. Jama 2010;303(22):2260-4.
29. Dhanalakshmi TA, Umapathy BL, Mohan DR. Prevalence of Methicillin, Vancomycin and Multidrug Resistance among Staphylococcus aureus. J Clin Diagn Res 2012;6(6).
30. Okeke IN, Lamikanra A, Edelman R. Socioeconomic and behavioral factors leading to acquired bacterial resistance to antibiotics in developing countries. Emerg Infect Dis 1999;5(1):18.
31. Mamun KZ, Tabassum S, Shears P, Hart CA. A survey of antimicrobial prescribing and dispensing practices in rural Bangladesh. Mymensingh Med J 2006;15(1):81-4.