Methicillin Resistant *Staphylococcus aureus* nasal carriage among apparently healthy University students

Ahmed Olowo-okere
Usmanu Danfodiyo University
Maryam Umar
Usmanu Danfodiyo University
Mus'ab Ibrahim
Usmanu Danfodiyo University Faculty of Pharmaceutical Science
Adeiza Suleiman Shuaibu
Usmanu Danfodiyo University
Mustapha Usman
Nigerian Air Force Reference Hospital, Nigeria
Jamila Sani
Kaduna State University
Zakaria Nabti Larbi
University Setif 2
Abdourahamane Yacouba (abdourahamaneyacouba@yahoo.fr)
Universite Abdou Moumouni de Niamey Faculte des Sciences de la Sante https://orcid.org/0000-0002-0950-2205

Research

Keywords: MRSA, Nasal colonisation, Staphylococcus aureus, Nigeria

Posted Date: December 22nd, 2020

DOI: https://doi.org/10.21203/rs.3.rs-131734/v1

Abstract

Background Medical and paramedical **s**tudents are often exposed to MRSA colonization and infection during clinical postings. They may serve as reservoirs or vector and occasionally as victims of MRSA cross-contamination. This study was designed to determine the rate of MRSA nasal carriage among apparently healthy undergraduate medical and paramedical students of Usmanu Danfodiyo University Sokoto.

Methods A questionnaire was administered to collect demographic data and health history of the recruited participants. Swab sticks pre-moistened with sterile physiological saline was used to collect samples from the nasal cavities of the participants. The collected samples were processed using standard microbiological techniques. The presence of MRSA was determined using the Oxacillin resistance screening agar base test (ORSAB). The susceptibility of the MRSA isolates to commonly prescribed antibiotics was carried out using the disc diffusion method.

Result A total of 200 participants were recruited from medical and allied faculties. The participants comprise 120 clinical students and 80 pre-clinical students. The mean age of the study participants was 23.32 ± 1.76 years. Majority of the participants were males 119 (59.5%). Overall, 77 (38.5%) of the study participant were found to be nasally colonised with MRSA. The carrier rate was higher among the male (61.0%) and participants aged less than 20 years (79.2%). Equally, higher MRSA colonisation rate was observed among the students of faculties of medicine (27.3%) and nursing (22.1%) and predominantly among the clinical students (53.2%). Clinical students and students who visited to hospital more than four time in a month were 0.72 (95% CI, 0.394–1.328) and 0.61 (95% CI, 0.325–1.136) times more likely to carry MRSA, respectively. The MRSA isolates were highly resistant to all the tested antibiotics (72–100%).

Conclusion The MRSA nasal carriage rate among medical and paramedical students of Usmanu Danfodiyo University Sokoto is high. The finding of this study has important implication on public health. Thus, urgent steps should be taken to improve infection control practices in the study area.

Introduction

Staphylococcus aureus (*S. aureus*) is one of the pathogens of great concern due to its inherent virulence, its ability to cause various life-threatening infections and its capacity to adapt to different environmental condition [1]. It is a Gram-positive, facultative anaerobic bacterium, usually part of human body's microflora [2]. The bacterium is highly versatile and infectious opportunistic pathogen for humans and animals, responsible for a variety of infections, such as superficial lesions, toxic shock syndrome, systemic and a number of life-threatening diseases [3]. More worrisome is the methicillin resistant *S. aureus* (MRSA) because of its propensity for antibiotic resistance, exhibiting resistance to multiple classes of antimicrobial agent [4]. This has been classified as high priority pathogens requiring urgent global attention and action by the World Health Organization [5]. The total hospital cost or charge among

inpatients with MRSA was 1.12-6.25 times higher than that for patients with methicillin susceptible strains [4].

Without prejudice to other routes of transmission, transmission of MRSA is mainly via person-to person contact. The in-patients and hospital staff are the main reservoirs of *S. aureus* with squamous epithelium of anterior nares as the main ecological niche and most colonized site in human body [6]. Of the general population, 1.5% are asymptomatic nasal carriers of MRSA and the prevalence among health care workers is about 3 times higher [7]. A 1.8% MRSA nasal colonization rate has been reported among healthcare workers in the United States and Europe [8]. Similarly, among healthcare workers in India, a 7.5% MRSA nasal carriage rate has been documented particularly among the nursing staff [9]. In Nigeria, a 13.6% rate of MRSA has been documented among healthcare workers with higher preponderance among clinical staff than the non-clinical staff [10].

Students are often neglected component of healthcare workforce worldwide, undergoing training and rendering non-essential services during clinical posting. They are at the interface between healthcare facilities and communities [7]. These students are exposed to patients and other healthcare workers during their clinical rotation thus predisposing them to colonization and infection with MRSA. Because of their limited knowledge and consciousness of infection control practices, they may serve as reservoirs or vector and occasionally as victims of MRSA cross-contamination [7]. Moreover, they can be one of the major sources of transmission during contact with non-medical students and other members of the public in the community, if infection control measures are not complied.

The MRSA colonization predisposes the carriers to higher risk of subsequent infections [11,12]. Additionally, colonized individuals have been demonstrated to be essential link in the transmission chain of MRSA in hospitals [13]. Thus, understanding and control of the spread of MRSA is an important strategy for reduction of inter-patient MRSA transmission and horizontal transmission between the hospitals and communities. While the rate of colonization among hospital personnel has been extensively studied in Nigeria [14,15]. In Sokoto Nigeria, the rate of nasal carriage of MRSA among students studying medical and allied courses in Sokoto is currently unknown. In the present study, we aimed to determine the rate of MRSA nasal carriage among undergraduate medical and paramedical students of Usmanu Danfodiyo University Sokoto, Nigeria.

Materials And Methods

Population Study

This study was conducted among undergraduate medical and paramedical students of Usmanu Danfodiyo University Sokoto (UDUS), Nigeria. The University has three campuses with medical and paramedical students sharing hostel facilities within the Usman Danfodiyo University Teaching Hospital (UDUTH) complex. The students are routinely posted on clinical posting from the third year of their study to observe and learn basic clinical skills within the teaching hospital. These students are often exposed to

patients and other healthcare workers during their clinical rotation thus predisposing them to colonization and infection with MRSA.

Study design and participant recruitment

This comparative study was carried out among medical and paramedical students (Pharmacy, Nursing, Medical Laboratory Science and Radiography) of Usmanu Danfodiyo University, Sokoto. Eligible participants were pre-clinical (Undergraduates, UG 1-3) and clinical (UG 4 to 5). The participants were sampled using a simple random sampling technique. Eligible participants were recruited after briefing them on the objectives of the study and assuring them that the procedure for sample collection does not pose any hazard to their health.

Data collection

A questionnaire was administered to collect demographic data and health history of the participants. Data collected include: age, year of study, gender, any underlying disease Condition, hospitalization in the past one year, skin infections, antibiotic use in the past four weeks prior to sample collection, habitual behaviour such as nose-picking, more than four times a month visit to the hospital.

Selection criteria

Students from the five medical and allied faculties with no apparent respiratory diseases who consented to participate in this study were included. Students that do not give consent and also those having apparent respiratory diseases such as running nose, bronchitis, etc were excluded from the study.

Sampling and sample collection

Convenient sampling technique was employed. Commercially available swab sticks pre-moistened with sterile physiological saline was used to collect samples from the anterior nare of nasal cavities of the participants. The collected samples were transported within an hour of collection in an ice pack to the Microbiology Laboratory of the Faculty of Pharmaceutical Sciences for culturing and further analysis.

Culturing, Isolation and identification

Each swab collected from nasal cavities was inoculated into Petri-dishes containing mannitol salt agar (Oxoid Limited, UK) and incubated at 37°C for 24 hours. Bacterial isolates that grew on the mannitol salt agar were subjected to Gram staining, catalase and coagulase test as described [16]. The identity of the isolates was confirmed by Microgen™ Staph-ID System kit (Microgen, Surrey, UK). The *S. aureus* isolates were inoculated unto Oxacillin resistant screening agar (ORSAB) plate (Oxoid, UK) and the resultant isolates after overnight culture were regarded as MRSA and the cultures were preserved in agar slant.

Antibiotic susceptibility test

The isolates were subjected to antibiotic susceptibility using the disc diffusion method according to the Clinical and Laboratory Standards Institute (CLSI) guidelines [17]. The disc of antibiotics used includes those recommended by the CLSI and/or those most commonly used locally for empirical treatment of *Staphylococcus aureus* infections. This includes amoxicillin-clavulanate (30µg), ciprofloxacin (5µg), gentamycin (30µg), chloramphenicol (30µg), azithromycin (15µg), trimethoprim/sulphamethoxazole (25µg). Interpretation of results as susceptible, intermediate or resistant was carried out according to the criteria recommended by the CLSI guideline.

Statistical analyses

Statistical analysis was performed using SPSS v20 (IBM Corporation). Pearson's χ^2 test or Fisher's exact test was used for data comparison. Multivariable logistic regression was performed to estimate risk of MRSA carriage. Independent variables with p-value ≤ 0.2 in the bivariate analysis were included in a multivariable model. At 95% confidence interval, $p < 0.05$ was considered as statistically significant.

Result

Socio-demographic characteristics of the study participants

A total number of 200 students participated in this study (Table 1). Forty participants each (20.0%) were sourced from each of the five medical related faculties. The participants comprise 120 (60.0%) clinical students carrying out clinical rotation at various departments in the hospital and 80 (40.0%) pre-clinical students who have not yet been exposed to clinical posting. The mean age of the study participants was 23.32 ± 1.76 years (Range,19–30) Majority of the participants were males 119 (59.5%) with a male to female ratio of 1.47 to 1. Out of the 200 participants recruited for this study, 9 (4.5%) were hospitalized within the last six months, 46 (23.0%) have used antibiotics in the last four weeks and 79 (39.5%) have visited hospitals more than four times for various reasons within the last one month. 54 (27.0%) of the participants admitted having habitual behaviour such as nose-picking.

Table 1
Demographic and Clinical Characteristics of Participants

	Number of participants
Gender	81
Female	119
Male	
Age (years)	159
20–24	40
25–29	1
>30	
Faculties/departments	40
Medicine	40
Med. Lab. Science	40
Nursing	40
Pharmacy	40
Radiography	
Level of study	120
Clinical	80
Pre-clinical	
Any underlying disease condition	196
No	4
Yes	
Hospitalization in the past one year	191
No	9
Yes	
Antibiotic use for the past four weeks	154
No	46
Yes	

	Number of participants
Visit to hospital more than four times in a month	121
No	79
Yes	
Habitual behaviour (nose-picking)	146
No	54
Yes	

MRSA Carriage Among Study Participants

Overall, 77 (38.5%) of the 200-study participants were found to be colonised with MRSA. The carrier rate was higher among the male (61.0%) than the female (39.0%) participants (Table 2). Equally, higher MRSA colonisation rate was observed among the participants aged less than 20 years (79.2%). Comparison of nasal carriage rates across different faculties showed that medical (27.3%) and nursing (22.1%) students had the highest colonisation rate. Also, the colonisation rate was higher among the clinical students (53.2%) compared to their pre-clinical counterparts (46.8). However, statistical comparison revealed that no significant difference ($p > 0.05$) was observed between the colonisation rates and the various stratified parameters, despite different prevalence percentages.

Table 2
Predictors of MRSA carriage, among study population.

Variables	MRSA carriage (n, %)					
	NO	YES	OR(95% IC)	p value∗	aOR(95% CI)	p value
Gender				0.7258		NA
Female	51(41.5)	30(39.0)	1			
Male	72(58.5)	47(61.0)	1.10(0.620–1.985)			
Age				0.2548		NA
(19,25]	111(90.2)	73(94.8)	1			
(25,30]	12(09.8)	4(05.2)	0.50(0.157–1.632)			
Visit to hospital more than four time in a month				0.0577		0.1232
No	68(55.3)	53(68.8)	1		1	
YES	55(44.7)	24(31.2)	0.559(0.307–1.019)		0.61(0.325–1.136)	
Hospitalization in the past one year				0.98387		NA
No	114(92.7)	77(100.0)	1			
Yes	9(07.3)	0	9.4e-08(0)			
Antibiotics use in the past four weeks				0.42976		NA
No	97(78.9)	57(74.0)	1			
YES	26(21.1)	20(26.0)	1.30(0.670–2.554)			
Level of study				0.124		0.2956
Preclinical	44(35.8)	36(46.8)	1		1	
Clinical	79(64.2)	41(53.2)	0.63(0.355–1.132)		0.72(0.394–1.328)	

∗variables with $p \leq 0.2$ were included in the saturated multivariable regression model.

p-values are only shown for variables included in the multivariable regression model. For variables not included we show p = NA (Not Applicable). OR: odds ratio; aOR: adjusted odds ratio; 95% CI:

Predictors Of MRSA Carriage Among Study Population

In bivariate analysis, no significant difference ($p > 0.05$) was found between MRSA carriage and the various stratified parameters.

In multivariate analysis, clinical students and students who visited to hospital more than four time in a month were 0.72 (95% CI, 0.394–1.328) and 0.61 (95% CI, 0.325–1.136) times more likely to carry MRSA. However, no significant difference ($p > 0.05$) was observed between the colonisation rates and these parameters. (Table 2)

Antimicrobial Susceptibility Pattern Of MRSA Isolates

The MRSA isolates were highly resistant to all the tested antibiotics (Fig. 1). Highest resistance rate was observed against trimethoprim/sulphamethoxazole (100%), chloramphenicol (96.8%) and amoxicillin/clavulanic acid (94.1%). The least resistance rate was observed against gentamicin.

Discussion

Methicillin resistant *S. aureus* is an important pathogen in both community and hospital settings. Individuals nasally colonised with MRSA are more prone to self-contamination and eventually infections due to MRSA than un-colonised individuals [11]. This study determined MRSA nasal colonization rate among undergraduate students of medical and allied faculties in a tertiary education institution in Sokoto, Nigeria. Results from this study showed that the overall nasal carriage rate of MRSA in the study area was 38.5%. Our finding is comparable to the 18.3–42.3% MRSA prevalence reported in a systematic review of MRSA in Nigeria [15]. Different carriage rates have been reported by other researchers. For example, 45.9% in Ecuador [18], 31.0% in Malaysia [19], 18.7% in Saudi Arabia [20] and 3.1% in South Korea [21]. In another study, none of the medical students investigated were found to be nasally colonised with MRSA [22]. Comparatively, a lower rate has been reported among non-medical students [23, 24]. The varying prevalence rate reported in various studies could be attributed to differences in hygiene practices and infection control and prevention policies in the various study centres. The higher MRSA colonisation rate reported in this study may be as a result of vertical transmission in over-crowded student's hostels. Students in Nigeria mostly reside in overcrowded hostels [25, 26]. Crowded environment has been lined with higher MRSA colonisation, vertical transmission and infections [27].

Though no statistically significant difference was observed between gender and colonisation rate, a MRSA carriage observed in this study was higher among the males than the females. Previously published studies have documented be significant statistical association between MRSA nasal carriage rate and age and gender of study participants. The higher colonisation rate reported among the males may be due to low hand hygiene behaviour prevalent among the males [28]. A more positive attitude and compliance with hand hygiene has been documented among the females than the males. Males are thus

more susceptible to MRSA colonisation than the female. Contact sport and other outdoor games may further facilitate the transmission of the infections among the males than the females [28].

Among the studied groups, higher prevalence rate was observed among the clinical students. This result was comparable with reports of several other researchers [21]. The higher prevalence observed among the clinical students may be due to higher exposure of the clinical students to nasal colonisation during clinical posting. Similarly, this could account for higher colonisation rate observed among the medical and nursing students compared to their pharmacy and laboratory science counterparts, since these students visit hospital more frequently during clinical posting, have longer stay in the hospital environment and have more contact time with the patients and other healthcare professionals. An association has been established between the exposure to healthcare settings and colonization with MRSA among medical students [29]. Though, no significant statistical association was found between more than four visit to hospital a month and MRSA colonisation rate, frequent hospital visit has been shown to be significantly associated with MRSA colonisation rate [18].

In this study, significant statistical association was not found between the nasal MRSA carriage rate and recent hospitalization and antibiotic use. In another centre in Nigeria, strong correlation has been established between these factors [30].

The high resistance (72–100%) of the isolates to commonly prescribed anti-staphylococci antibiotics is not surprising. MRSA isolates are known to be highly resistant to several important antibiotics. A systematic review has reported that Nigerian MRSA isolates are highly resistant to commonly prescribed, orally available antibiotics [15]. Antibiotics overuse, often inappropriately and without prescription, is a common drug use problem in Nigeria [31]. This overuse drives selection pressure which often results in antibiotic induced gene expression, and emergence of multidrug resistant bacteria [32]. Genomic analysis of a MRSA strain revealed that it contains about 29 genes associated with antibiotic resistance [33].

This study is limited by a number of factors. Majorly, the investigations are mainly phenotypic. This is common to studies in resource-limited settings such as Africa. Investigation of molecular basis of the observed resistance is the focus of our future studies. Also, for the same reason as above, the resistance of the MRSA strains as tested against a limited number of antibiotics.

Conclusion

The MRSA nasal carriage rate among medical and paramedical students of Usmanu Danfodiyo University Sokoto is high. The finding of this study has important implication on public health. Thus, urgent steps should be taken to improve infection control practices in the study area.

Declarations

Ethical approval and consent to participate

The approval to conduct this study was granted by the Sokoto State Ministry of Health (Reference number: SMH/2019/1280/V). Informed consent was also sought from the study participants after carefully briefing them on the objective of the study. Student who declined consent to participate were excluded from the study.

Data availability

All relevant raw data are available on:

https://doi.org/10.6084/m9.figshare.13394231.v1

Competing interests

No competing interests were disclosed.

Funding

Not applicable

Authors' contributions:

This study was conceived and designed by A.O. The experiment was conducted by MU and MI. AO, A.Y and L.Z.N analysed, interpreted the data. the first draft of this manuscript was written by A.O and revised by all authors. All authors have read and approved the final manuscript.

Acknowledgements

Not applicable

References

1. World Bank. Drug-Resistant Infections: A Threat to Our Economic Future (Discussion Draft). World Bank Rep. 2016;2:1–132.
2. Hodges NA. Hugo and Russell's Pharmaceutical Microbiology. 7th ed. Denyer S, Hodges NA, Sean P. Gorman, editors. United Kingdom: Blackwell Publishing company; 2004.
3. Olowo-Okere A, Atata RF, Abass A, Adeiza Suleiman Shuaibu UHY, Nuhu Tanko. Incidence and Antibiotic Susceptibility Profile of Staphylococcus aureus Isolates from Wounds of Patients at Specialist Hospital , Sokoto , Nigeria. J Med Bacteriol. 2017;6:44–50.
4. Zhen X, Lundborg CS, Sun X, Hu X, Dong H. Economic burden of antibiotic resistance in ESKAPE organisms : a systematic review. Antimicrob Resist Infect Contro. Antimicrobial Resistance & Infection Control; 2019;8:1–23.
5. WHO. Global priority list of antibiotic-resistant bacteria to guide research, discovery, and development of new antibiotics. 2017.

6. Graber CJ. Route of transmission of Staphylococcus aureus. Lancet Infect Dis. The Author(s). Published by Elsevier Ltd. This is an Open Access article under the CC BY-NC-ND license; 2017;17:124–5.
7. Albrich WC, Harbarth S, Bern H. Health-care workers : source , vector , or victim of MRSA ? Lancet Infect Dis. 2008;8:289–301.
8. Dulon M, Peters C, Schablon A, Nienhaus A. MRSA carriage among healthcare workers in non-outbreak settings in Europe and the United States : a systematic review. BMC Infect Dis. 2014;14:363.
9. Singh N, Mohanty S, Panda SS, Sahoo S, Pattnaik D, Jena J. Methicillin resistant Staphylococcus aureus (MRSA) carriage among health care workers in a tertiary care hospital in Bhubaneswar. Int J Community Med Public Health. 2018;5:3276–82.
10. Egwuatu TO, Oduyebo OO. Prevalence and Risk Factors for Carriage of Methicillin-Resistant Staphylococcus aureus (MRSA) among Healthcare workers in a tertiary Prevalence and Risk Factors for Carriage of Methicillin-Resistant Staphylococcus aureus (MRSA) among Healthcare worke. IOSR J Dent Med Sci. 2013;8:9–13.
11. Stenehjem E, Rimland D. MRSA nasal colonization burden and risk of MRSA infection. Am J Infect Control. 2013;41:405–10.
12. Shuaibu SA, Onaolapo, Josiah Ademola Olayinka BO. Nasal Colonization as a Risk Factor for Staphylococcal Infection: a Systematic Review and Meta-Analysis. Niger J Microbiol. 2018;32:4220–35.
13. Ike B, Ugwu MC, Ikegbunam MN, Nwobodo D, Ejikeugwu C, Gugu T, et al. Prevalence , Antibiogram and Molecular Characterization of Comunity-Acquired Methicillin-Resistant Staphylococcus aureus in in Awka, Anambra Nigeria Blessing. Open Microbiol J. 2016;10:211–21.
14. Fadeyi A, Bolaji B, Oyedepo OO, Adesiyun OO. Methicilin Resistant Staphylococcus aureus Carriage amongst Healthcare Workers of the Critical Care Units in a Nigerian Hospital Methicilin Resistant Staphylococcus aureus Carriage amongst Healthcare Workers of the Critical Care Units in a Nigerian Hospit. Am J Infect Dis. 2010;6:18–23.
15. Abubakar U, Sulaiman SAS. Prevalence , trend and antimicrobial susceptibility of Methicillin Resistant Staphylococcus aureus in Nigeria : a systematic review. J Infect Public Health. King Saud Bin Abdulaziz University for Health Sciences; 2018;11:763–70.
16. Cowan T, Steel K. Cowan and Steel manual for the identification of medically important bacteria. 3rd ed. BARROW GI, FELTHAM RKA, editors. New York: Cambridge University Press; 1993.
17. CLSI. M100S Performance Standards for Antimicrobial Susceptibility Testing. 26TH, editor. Wayne, PA 19087 USA; 2019.
18. Villacrés-granda I, Coral-almeida M, Cifuentes SG. Antibiotic susceptibility pro fi le and prevalence of mec A and lukS-PV / lukF-PV genes in Staphylococcus aureus isolated from nasal and pharyngeal sources of medical students in Ecuador. Infect Drug Resist. 2019;12:2553–60.
19. Irfan N, Mohd B, Hlaing SS, Myint T, Emran NA, Lin Z, et al. Nasal Carriage of. Asian J Pharm. 2016;2016:10–1.

20. Zakai SA. Prevalence of methicillin-resistant Staphylococcus aureus nasal colonization among medical students in Jeddah, Saudi Arabia. Saudi Med J. 2015;36:807–12.
21. Baek YS, Dds SB, Dds YY. Higher nasal carriage rate of methicillin-resistant Staphylococcus aureus among dental students who have clinical experience. J Am Dent Assoc. Elsevier Inc; 2016;12:1–6.
22. Wong JL, Siti-Azrin AH, Mohd-Fadhli K, Siti-Asma H. Low prevalence of Staphylococcus aureus colonization among dental students in a teaching hospital in Malaysia. Trop Biomed. 2018;35:246–51.
23. Akerele J, Obasuyi O, Omede D. Prevalence of Methicillin-Resistant Staphylococcus aureus among Healthy Residents of Ekosodin Community in Benin-City , Nigeria. Trop J Pharm Res. 2015;14:1495–9.
24. Hogan B, Rakotozandrindrainy R, Al-emran H, Dekker D, Hahn A, Jaeger A, et al. Prevalence of nasal colonisation by resistant Staphylococcus aureus among healthcare workers and students in Madagascar. BMC Infect Dis. BMC Infectious Diseases; 2016;16:1–9.
25. Aluko OE. The Assessment of Housing Situation among Students in the University of Lagos. Arica Res Rev. 2011;5:104–18.
26. Jimoh FO, Adovi AV, Olugbenga OO, Akeem BO, Oluseyi AE. Off-Campus Living Among Ekiti State University Students in Southwestern Nigeria : Health and Policy Implications. J Health Environ Res. 2018;4:77–83.
27. Beltrán MA, García H, Couso M, Gallo MD, Lettieri A, Barna P V. Relationship between Overcrowding , Other Markers of Poverty and Community Acquired Methicillin Resistant Staphylococcus aureus. J Infect Dis Ther. 2018;6.
28. Humphreys H, Fitzpatick F, Harvey BJ. Gender differences in rates of carriage and bloodstream infection caused by methicillin-resistant Staphylococcus aureus. Are they real, do they matter and why? Clin Infect Dis. 2015;61:1708–14.
29. Arachchige J, Sampath A, Pilapitiya S, Kumbukgolla W. The relationship between the exposure to healthcare settings and colonization with methicillin-resistant Staphylococcus aureus among medical students. GERMS. 2020;10:34–43.
30. Ayepola OO, Taiwo SO, Anifowose A, Onile-ere O. Nasal Carriage of Staphylococcus aureus and Associated Risk Factors among Students in a Nigerian University. Acta Sci Microbiol. 2018;1:6–8.
31. Badger-emeka LI, Emeka PM. Evaluation of the extent and reasons for increased non-prescription antibiotics use in a University town, Nsukka Nigeria. Int J Health Sci. 2018;12.
32. Ventola CL. The Antibiotic Resistance Crisis Part 1 : Causes and Threats. Pharm Ther. 2015;40:277–83.
33. Ali MS, Isa NM, Abedelrhman FM, Alyas TB, Mohammed SE, Ahmed AE, et al. Genomic analysis of methicillin-resistant Staphylococcus aureus strain SO-1977 from Sudan. BMC Microbiol. BMC Microbiology; 2019;19:1–9.

Figures

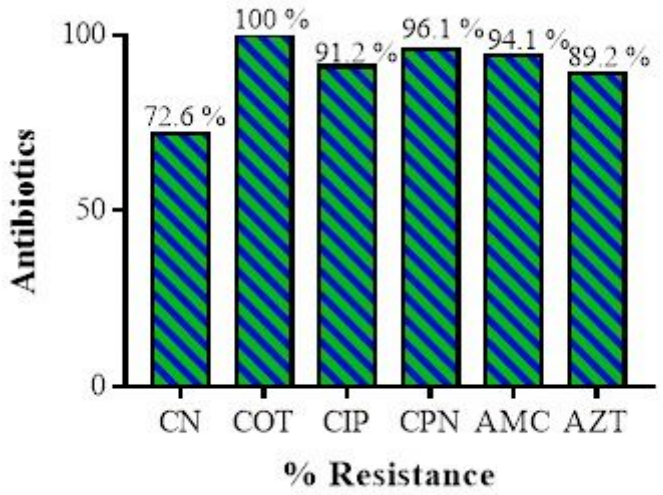

Figure 1

Antibiotics susceptibility profile of the MRSA isolates