

Prevalence of Risk Factors Associated with MRSA Nasal Carriage among HIV-Patients on HAART at a Tertiary Hospital in Niger Delta, Nigeria

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Abstract

Methicillin-resistant *Staphylococcus aureus* (MRSA) is said to be any strain of *Staphylococcus aureus* that has evolved, through the process of natural selection, resistance to beta-lactam antibiotics, which include the penicillin (methicillin, dicloxacillin, nafcillin, oxacillin, etc.) and the cephalosporins. Colonization of anterior nares of HIV positive patients with MRSA is a risk factor for a wide range of invasive infections. This study was intended to determine the prevalence of MRSA using PBP2' Latex agglutination test and the assessment of the percentage prevalence of some risk factors associated with *Staphylococcus aureus* nasal colonization of HIV positive patients. However, PBP2' Latex Agglutination Test showed that 32 (39.02%) isolates of *Staphylococcus aureus* were positive for PBP2'. Also, 56 (25.81%) singles, 158 (72.81%) married and 3 (1.38%) divorced HIV positive adults in this study and 3 (1.38%) singles, 32 (14.75%) married HIV positive adults were MRSA carriers. Obviously, this result trend was attributed to several factors including overcrowded settlements, personal and public hygiene, poverty and illiteracy. Therefore, patients with HIV infection should practice the best forms of personal and public hygiene and avoid hand sneezing to help control the rising incidence of MRSA.

Keywords: MRSA; PBP2'; HIV; Risk Factors; Niger Delta

Introduction

Methicillin-resistant *Staphylococcus aureus* (MRSA) is said to be any strain of *Staphylococcus aureus* that has evolved, through the process of natural selection, to gain resistance to beta-lactam antibiotics, which include the penicillin (methicillin, dicloxacillin, nafcillin, oxacillin, etc.) and the cephalosporins. *Staphylococcus aureus* (*S. aureus*) is an organism to which most HIV-infected individuals are susceptible to [1]. *S. aureus* is frequently found in the nostrils, respiratory tract and skin (especially, the skin folds of the groin). They are present as normal flora but when immunosuppression sets in due to certain disease conditions such as diabetes mellitus, HIV infection, leukemia and tuberculosis, etc., the organism deviates from its normal mode of commensalism and becomes pathogenic; causing several infections depending on the body region it finds itself. [2] Some of the diseases caused by *S. aureus* include sinusitis and abscesses. Antibiotics are the therapeutic agents for treating *S. aureus* and they had been effective globally, but this was short-lived by the emergence of methicillin-resistant strains, first described in 1961 in the United Kingdom as the superbug [3] and had been of great concern to medicine until date.

The Human Immunodeficiency Virus (HIV) is a lentivirus (a subgroup of retrovirus) that causes HIV infection and progresses to acquired immunodeficiency syndrome (AIDS). AIDS is a condition in humans in which progressive failure of the immune system allows life-threatening opportunistic infections. Infection with HIV occurs by the transfer of blood, semen, vaginal fluid,

pre-ejaculate, or breast milk. [4] Infection with MRSA has been observed with greater frequency among HIV-positive patients. MRSA is as easily spread by direct contact, most often via the hands of transiently colonized health workers.

Methicillin resistant *Staphylococcus aureus* have been on the rise in incidence. There have been several predisposing factors to MRSA infections which can be different for different societies because of their peculiarities in terrain, cultures, livelihood, awareness and economy. Some of the populations at risk of MRSA infection are people who are frequently in crowded places, especially with shared equipment and skin-to-skin contact. [5] This includes college students living in dormitories, women with frequent urinary tract or kidney infections due to infections in the bladder, people staying or working in a health care facility for an extended period of time, People who spend time in coastal waters where MRSA is present, [6] people who spend time in confined spaces with other people, including occupants of homeless shelters and warming centers, prison inmates, military recruits in basic training, and individuals who spend considerable time in changing rooms or

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gym. [7] Also, people with weak immune systems like HIV/AIDS, lupus, or cancer sufferers; transplant recipients, severe asthmatics, diabetics, intravenous drug users, users of quinolone antibiotics and the elderly, are predisposed to MRSA infection. Therefore, it is important to understand the prevalence pattern of MRSA along different risk baselines, for the formulation of public health care policies, and also for the provision of useful information on the global surveillance of this pathogen. All these justify the need for this study.

This study was aimed at determining the prevalence of risk factors associated with MRSA nasal colonization of HIV positive patients in a Tertiary Hospital in Rivers State.

Subjects and Methods

Study area

Consenting HIV positive subjects attending HIV clinic at the University of Port Harcourt Teaching Hospital located at Alakahia in Obio/Akpor Local Government Area of Rivers State were enrolled for a cross sectional study were used as subjects for this study. This study was conducted for duration of six months. The hospital is a tertiary hospital with the capacity of 500 beds and a referral health facility for the south-south of Nigeria.

Inclusion criteria

People living with HIV within the age bracket 11 years and above, who had been on antiretroviral drugs for six months and above, were included into this study, both male and female.

Exclusion criteria

Children (under 11 years) and adult HIV positive subjects who were not on antiretroviral drugs, patients who were on antibiotic treatment for any bacterial infection during the time of data collection were excluded in this study.

Sample collection

Nasal Swab samples were collected from the anterior nares of consenting HIV positive patients who were attending the University of Port Harcourt Teaching Hospital, HIV Clinic. Samples were collected from Adults. Any consenting participant who visited the clinic from January 2016 through June 2016 was enrolled in the study. A total of 217 study participants were recruited. From each participant, specimen for *Staphylococcus aureus* culture was collected from the anterior nares, using sterile distilled water aseptically moistened sterile swab. Moistened sterile swab sticks were inserted into the nostrils 1-2 cm inside, swabbing it in clockwise direction for 3-4 times. The swabs were immediately transported to the Medical Microbiology and Parasitology Laboratory of the University of Port Harcourt Teaching Hospital for analysis.

Questionnaire

A short structured questionnaire was administered to each participant to obtain demographic and other data, as well as pertinent data from patient's records.

Consent

An informed, written consent was obtained from each participant after explanation of the purpose of the study and were ensured strict confidentiality. They were given the option of not to participate in the study if they wanted.

Ethical clearance

Ethical approval was also obtained from the ethics committee of the University of Port Harcourt Teaching Hospital where this study was carried out.

Results

In this study, as described in Table 1, PBP2' Latex Agglutination Test was carried out on 82 *Staphylococcus aureus* confirmed isolates. This test was used as a confirmatory test for MRSA. Thirty-two isolates (39.02%) of *Staphylococcus aureus* were positive for PBP2' and 50 (60.98%) isolates of *Staphylococcus aureus* were negative for PBP2'. Table 2 contains a detailed summary of the demographic parameters of HIV positive subjects in this study. Here-in, there were 56 (25.81%) singles, 158 (72.81%) married and 3 (1.38%) divorced HIV positive adults in this study and 3 (1.38%) singles, 32 (14.75%) married HIV positive adults were MRSA carriers. Out of the 11 HIV positive adults enrolled in this study who have been previously hospitalized within 6 months before the study, 3 (1.38%) were MRSA carriers. From the 206 non-hospitalized HIV patients, 32 (14.75%) were MRSA carriers. Also, out of the 193 HIV patients that usually cover their nose while sneezing, 32 of them were MRSA carriers while from the 28 HIV patients that do not cover their nose, 3 were MRSA carriers. Similarly, out of 8 HIV patients that always pick their nose, 3 (1.38%) were MRSA carriers and from the 209 that don't pick their noses, 32 (14.75%) were MRSA carriers. Additionally, 39 skilled HIV patients, 129 unskilled and 49 professionals were enrolled. Seven (3.23%) skilled, 19 (8.76%) unskilled and 9 (4.15%) professionals are MRSA carriers. The result showed no statistical significance of these variables with the isolation of MRSA in HIV positive subjects in this study. Then, out of the 11 HIV positive adults enrolled in this study who had been previously hospitalized within 6 months before the study, 3 (1.38%) were MRSA carriers. From the 206 non-hospitalized HIV patients, 32 (14.75%) were MRSA carriers. From the 193 HIV patients that usually cover their nose while sneezing, 32 of them were MRSA carriers while from the 28 HIV patients that do not cover their nose, 3 were MRSA carriers. Out of the 35 HIV positive adults with primary level of education, 6 (2.76%) were MRSA carriers. One Hundred and Twelve (112) were enrolled at secondary level out of which 13 (5.99%) were MRSA carriers. For tertiary level, 65 were enrolled and 15 (6.91) were MRSA carriers. From the 5 with non-formal education, only one (1) was MRSA carrier. Based on living condition, 19 (Rural), 48 (Urban) and 150 (Sub-urban) HIV patients were enrolled in this study and 3 (1.38%) Rural, 9 (4.15%) Urban and 23 (10.60%) sub-urban HIV positive were MRSA carriers. There is no statistical significance in the isolation of MRSA based on living conditions ($P=0.355$). Nevertheless, out of the 14 HIV patients that keep long nails, 2 (0.92%) were MRSA carriers while out of

the 203 patients that don't keep nails, 33 (15.21%) were MRSA carriers. Similarly, out of 8 HIV patients that always pick their nose, 3 (1.38%) were MRSA carriers and from the 209 that don't pick their noses, 32 (14.75%) were MRSA carriers. Additionally, 39 skilled HIV patients, 129 unskilled and 49 professionals were enrolled. Seven (3.23%) skilled, 19 (8.76%) unskilled and 9 (4.15%) professionals are MRSA carriers. The result showed no statistical significance of these variables with the isolation of MRSA in HIV positive subjects in this study.

Table 1: PBP2' latex agglutination test result.

Latex Agglutination Test Result	Frequency (%)
PBP2' Positive (MRSA) Isolates	32 (39.02)
PBP2' Negative (MSSA) Isolates	50 (60.98)
Total	82 (100)

Table 2: Distribution of demographic parameters of the study.

Variables	MRSA Positive Patients	Patients, n (%)
Sex		
Female	24 (11.06)	152 (70.05)
Male	11 (5.06)	65 (29.95)
Marital Status		
Single	3 (1.38)	56 (25.81)
Married	32 (14.75)	158 (72.81)
Divorced	0	3 (1.38)
Hospitalization		
Yes	3 (1.38)	11 (5.07)
No	32 (14.75)	206 (94.93)
Use Of Invasive Device		
Yes	0	2 (0.92)
No	32 (14.75)	215 (99.08)
Level Of Education		
Primary	6 (2.76)	35 (16.13)
Secondary	13 (5.99)	112 (51.62)
Tertiary	15 (6.91)	65 (29.95)
No formal education	1 (0.46)	5 (2.30)
Underlying Diseases		
Yes	5 (2.30)	8 (3.69)
No	30 (13.82)	209 (96.31)
Living Condition		
Rural	3 (1.38)	19 (8.76)
Urban	9 (4.15)	48 (22.12)
Sub-Urban	23 (10.60)	150 (69.12)
Hand Covering While Sneezing		
Yes	32 (14.75)	193 (88.94)
No	3 (1.38)	24 (11.06)
Keeping Long Nails		
Yes	2 (0.92)	14 (6.45)
No	33 (15.21)	203 (93.55)
Picking Of Nose		
Always	3 (1.38)	8 (3.69)
Occasionally	32 (14.75)	209 (96.31)
Occupation		
Skilled	7 (3.23)	39 (17.97)
Unskilled	19 (8.76)	129 (59.45)
Professional	9 (4.15%)	49 (22.58)

Discussion

PBP2' (penicillin binding protein 2a - PBP2a) is the expressed *Staphylococcus aureus* antigens, the active site of PBP2a, used for the analysis of the crystal structure of drug targets in most

betalactam inhibitors, which is responsible for the expression of resistance in MRSA is a good detection technique for MRSA. Consequently, according to Lemma et al.,^[8] methicillin resistant species must contain the mec A gene which produces a protein known as the penicillin binding protein 2a (PBP2a), that has low affinity for the binding of most beta-lactam antibiotics to its target site.

However, this result was not in agreement with the results of many other studies that had shown more than 80% of these MRSA infections originating from *Staphylococcus aureus* nasal colonization. It has also been shown that MRSA can be transmitted from nasal nares to other parts of the body and to other individuals directly or indirectly.^[2,8,9]

Similarly, a glance at the demographic indices evaluated in this study as detailed in Table 2, revealed that, the sex distribution of MRSA among the study subjects, had more percentage of females acquiring MRSA in their nasal cavity than males in the ratio of 11.06:5.06 percent. This study's prevalence was not comparable with that obtained by Odu and Konko.^[10] Although the both studies agreed with the fact that, female sex had more MRSA colonization than males. Nevertheless, there was observed a significant difference in the carriage rate of MRSA between the two genders as was also observed from the report of Grundmann et al.^[11]

Statistically, there was observed a significant odd ratio between the married and unmarried folks as regarding acquiring MRSA infection [Table 3]. However, there was observed no statistical significance in the trend of MRSA detection in the nasal nares of HIV patients based on sex, living condition, use of invasive device, hospital status, education status, occupation, nose picking, hand sneezing and nail cutting [Table 3]. Therefore, long nails are not a factor which could be responsible for the transmission of MRSA among people living with HIV/AIDS.

Table 3: Statistical evaluation of the risk factors to MRSA colonization among HIV patients.

Risk Factors	Odds ratio	P-value	95% Confidence Interval	Comment
Gender	1.12	0.8402	0.5131 to 2.446	Not Significant
Marriage	4.741	0.0063	1.393 to 16.137	Significant
Hospital Status	5.438	0.0581	1.050 to 28.158	Not Significant
Use of Invasive Device	1.129	1	0.053 to 24.082	Not Significant
Education	0.773	0.5924	0.0837 to 7.132	Not Significant
Disease Condition	9.944	0.0033	2.257 to 43.818	Significant
Living Condition	1.053	1	0.2899 to 3.829	Not Significant
Hand Sneezing	1.383	0.7738	0.3891 to 4.914	Not Significant
Nail Status	0.859	1	0.1835 to 4.017	Not Significant
Nose Picking	2.213	0.3038	0.4112 to 11.91	Not Significant
Occupation	1.266	0.6191	0.4888 to 3.281	Not Significant

Likewise, sneezing into ones hand could be advanced as a vehicle for the transmission of MRSA from one person to another, even though it was statistically not significant in this study. This could be achieved during handshakes with people, which can result in the transfer of the pathogen from one person to another. Worse still, it could be the case of a health worker, who may be transferring the sneezed pathogen from a seemingly healthy person to the very sick, aged, neonate, wounded, or immunosuppressed patient, as he/she comes in close contact with them.

On a precautionary note, even though this study observed no significance in the living conditions of patients with respect to MRSA colonization in subjects, it showed that 10.6% of subjects living in sub-urban environments had MRSA colonization of their nasal nares, which was more than the 4.14% MRSA nasal colonization observed among urban dwellers and the 1.38% observed for the rural dwellers who participated in this study. This could be due to overcrowding. Overcrowded rooms and homes are typical hallmark of most semi-urban slums and because of the influx of people to urban areas.^[5,6] According to Aaron et al.,^[4] poverty is a major underlining factor behind the general impact of HIV/AIDS to the various sectors of human life. This is because, rural-urban drift induced stress on the accommodation needs of urban towns and sub-bubs. Therefore, residents of these overcrowded homes who do not have the financial strength to acquire build or rent a decent accommodation in the towns and cities where they have drifted to for greener pastures, resort to attach with friends and relatives who may also have had family until they are financially buoyant to do so. This kind of MRSA transmission/colonization could be worrisome as the persons involved may have inadequate resources to treat such infection and may continue the chain of transmission within the community.

With more persons living in a room, the rate of transmission will increase. Thus, people living in crowded urban/semi-urban slums, would have an increased likelihood of contracting MRSA compared to those living in well planned spacious environments. Likewise, for literacy; there is no increased likelihood of risk for persons living with HIV/AIDS depending on their degree of education. According to Aaron et al.,^[4] it is important for those living with HIV/AIDS to acquire appropriate knowledge to prevent underlining infections that may undermine their immune stability. Thus, MRSA detection in patients living with HIV/AIDS from this study had shown that it is not dependent on the level of education attained but basically ones attitude towards hygiene and general public health issues prevailing at the time may be predisposing factors.

Societal relationships based on family circles have been the main pillar of the society and the source of most public health challenges bedeviling most societies today. A quick review of the information deduced from the marital status data group, showed that, being married alone increases the probability of being an MRSA nasal carrier for people living with HIV/AIDS as it appeared to be one of the predisposing factors to nasal carriage of MRSA among the studied population while divorcees showed no sign of nasal carriage of MRSA.

The above fact to a large extent could be thought provoking, as reasons proposed would tease the head and amuse the brain. Nevertheless, we would like to restrict our discussion to the interactions existing within the family fold. Firstly, knowing that the ecological niches of *Staphylococcus aureus* are the anterior nares,^[2] this result may have arisen from the day to day romantic body fondling existing between married couples in the family, which may thus bring about transfer of microorganisms, like MRSA, from one body site to another. This type of transmission of MRSA through contact was reported by Seguin et al. and also from animal to man. Secondly, with marital love obligations and discussions a routine custom for this group of people, it is expected that they exhibit close contact at most times with each other and thus, talk, inhale and exhale almost directly opposite each other's nostrils, thereby creating a conducive environment that would encourage the transfer of the colonizing microorganisms from the mouth and nostrils of one person to another. Thirdly, the act of kissing during romantic engagements could also be another means of introducing microbes from the buccal cavity flora into the nasal cavity and could be a ready source of transmission of MRSA from one person to another.

Conclusion

It was observed among many other demographic indices that, marriage and disease condition were statistically significant while, sneezing into one's hands, keeping long nails and unskilled manpower were not statistically significant risks factors for MRSA nasal colonization among people living with HIV/AIDS. Therefore, adequate public enlightenment on the possible modes of transmission of MRSA in our society should be carried out by all public health stakeholders with much emphasis on the adoption of regular hand washing as a routine attitude. Good personal hygiene should be encouraged by all strata of leadership in the society to help reduce MRSA transmission.

Authors Contributions

Study design and conception (JPA, NEG and AUU): Sample collection, processing and data collation (JPA): Oversight on all stages of the research (NEG and AM): All authors read and approved the final manuscript.

Conflict of Interest

All authors disclose that there was no conflict of interest.

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