Pattern of bacterial colonization of health care personnel at a reference hospital in North- eastern Nigeria.

Iragbogie A Imoudu[1], Musa G Zirami[2], Abdu B Zamo[3], Igho E Idiodemise[4], Ladi M Mahmoud[2], Hassan Sambo[5], Ibrahim U Abdul[6]

Abstract

Background: Health care personnel (HCP) play a significant role in the spread of healthcare-associated infections. This study was conducted to determine the prevalence and pattern of bacterial colonization of HCP at the Federal Medical Centre (FMC), Azare.

Methods: A cross sectional survey of health workers was conducted from 1st to 31st October, 2019. Swabs were taken from the hands and naso-pharynx of the subjects, processed and results analyzed.

Results: Eighty-two HCP [64 (78%) males and 18(22%) females] were recruited. The prevalence of bacterial colonization of HCP was 70.7%. The naso-pharyngeal carriage rate was 52.4 per 100 HCP and isolates included Escherichia *coli*, Staphylococcus *aureus*, Staphylococcus *epidermidis*, Klebsiella *spp*, α-Streptococcus and Haemophilus *influenza.* The carriage rate of hands was 10.1 per 100 HCP composed of Escherichia *coli*, Staphylococcus *aureus*, Staphylococcus *epidermidis*, and Klebsiella *spp*. Doctors accounted for 20.0% of those without a positive swab culture and nurses accounted for 44.0% of this figure. The naso-pharynx was the most likely site to be colonized by bacteria (χ^2 =112.4, df=24, P< 0.001). All the isolates were resistant to amoxicillin+ clavulanic acid, and all except 9.7% of Staphylococcus *aureus* isolates were resistant to both ceftriaxone and cefixime. Two (10.0%) of Escherichia *coli* isolates were sensitive to erythromycin.

Conclusion: There was a high colonization rate by bacteria as well as a high hand carriage rate of Escherichia *coli* by HCP in FMC Azare. Resistance to commonly used antimicrobials was also prevalent among the isolates.

Keywords: Health care, Personnel, Bacterial colonization, Naso-pharynx, Hands, Azare

Date received: 1 July 2020; accepted: 1 October 2020

Highland Med Res J 2020;20(2):24-29

Introduction

A select group of health care personnel (HCP) who make direct and frequent contact with patients may become reservoirs and spreaders of infectious diseases. They are known to play a significant role in the spread of healthcare-associated infections (formally known as nosocomial infections).[1] These healthcare-associated infections (HAIs) have become globally important as a cause of increased morbidity and mortality, they have also become essential economically.[2] The prevalence of HAI in low income countries is estimated to be about 15.5 per 100 patients with annual economic costs ranging from 5.7 to 31.5 billion dollars in the United States alone.[3,4] Mortality estimates from HAI range between 10.8% – 28.4%. [5]

[1]Department of Paediatrics, Federal Medical Centre, Azare, Bauchi state. [2]Department of Nursing Services, Federal Medical Centre, Azare, Bauchi state. [3]Department of Pathology, Federal Medical Centre, Azare, Bauchi state. [4]Department of Pharmaceutical Services, Federal Medical Centre, Azare, Bauchi state. [5]Department of Environmental Health, Federal Medical Centre, Azare, Bauchi state. [6]Department of Administration, Federal Medical Centre, Azare, Bauchi state.

All correspondences to:
Iragbogie A. Imoudu
E-mail: tomhe164@yahoo.com.

The pattern and carriage rate of bacteria by HCP has been described around the world with figures ranging from 42 – 88% been previously quoted as carriage rates and with isolated organisms including Staphylococcus *aureus*, Haemophylus *influenza,* Escherichia *coli* and Streptococcus *pneumomiae* amongst others.[6,7] The pattern and carriage rate of bacteria by HCP have also been described in a few Nigerian studies.[8-11] In a study conducted in Southern Nigeria in 2013,the researchers found a carriage rate of 80% in the hands and nares of a cross section of frontline health care personnel. [8] Another study reported a carriage rate of 53% in the hands of health care personnel in the North-central part of the country.[11] However, to the best of our knowledge similar studies had not been conducted in this part of Nigeria. Moreover, the few Nigerian studies on this subject are limited in scope given that they had small sample sizes and isolation of bacteria was done mainly from a single site. In addition, none had samples cultured from the naso-pharynx. Hence knowledge of the pattern and carriage rate of bacterial isolates among HCP in the Federal Medical Centre (FMC), Azare would fill the data gap that exists in this context. It would also serve as a valuable resource for physicians and managers within the facility.

This study was conducted with a view to determining the prevalence and pattern of bacterial colonization of the naso-pharynx and hands of frontline

HCP. We also determined the sensitivity patterns of the isolates.

Methods

Study Area

The study was conducted at the Federal Medical Centre Azare, Bauchi state. The centre is a tertiary facility which serves as a referral hospital for the populations of Bauchi, Yobe and Jigawa states of Northern Nigeria.

Study Design

The study was a cross sectional survey of health workers (i.e. doctors, nurses and health assistants) who make direct contact with patients.

Ethical Approval

Approval was sought for and obtained from the Research Ethics and review committee of the hospital in advance of the commencement of the study.

Sampling / Sample Collection

Given the characteristics of our study population, the purposive sampling technique was applied in this study. All doctors, nurses and health assistants who were present and gave written informed consent during the times of recruitment were recruited until the desired sample size was acquired. The sample size was calculated with the formula[12] $n = z^2pq/d^2$ where; n= desired sample size, z= standard normal deviation, p = prevalence, q= 1-p and d= degree of accuracy. The initial calculated sample size was 138. However, applying finite population correction, a minimum sample size of 81.7 was determined. Nonetheless, 82 HCP were recruited. The study was conducted over a 4 week period from 1st to 31st October, 2019. During this period, twice weekly visits were made by the investigators to four randomly selected units (units were selected by balloting) of the hospital: the special care baby unit (SCBU), the main operating theatre (MOT), the male surgical ward (MSW), and the female surgical ward (FSW).

The investigators then administer a structured questionnaire which contained questions on the unit the personnel was deployed, gender, and designation. The microbiology results for each of the anatomical sites studied were also entered into the questionnaire. Every single questionnaire was assigned a code number which was replicated on the specimen containers and unique to each subject. Swabs were then taken (using sterile swab sticks dampened in sterile 0.9% saline) from the web between the middle and ring fingers of the right hand, the right index finger tip, the left palm, the left thumb tip as well as the naso-pharynx. All these were done only after a verbal explanation of the processes to the study subject. For the nasopharyngeal swabs, the subjects were asked to cough while the swab was placed gently on the naso-pharynx. All the swab sticks were then labeled appropriately using code numbers assigned to each subject and written on the result form for the subject. The swab sticks were then transferred immediately to the microbiology laboratory of the hospital (FMC) Azare for immediate processing by an investigator who is a medical laboratory scientist specializing in micro-biology. The sample transportation was done in an Amies transport medium and analysis was done by inoculation.

The collected specimens were cultured on chocolate and MacKonkey agars. The chocolate agar was incubated in a canister jar while the MacKonkey agar was incubated aerobically with 10% CO_2. Both agar plates were incubated at 37°C for 24 – 48 hours. The isolates were identified using biochemical tests and subjected to drug sensitivity testing.

Data Analysis

Collected data was analyzed with the statistical package for social sciences (SPSS) version 20.0. Presentation of data was done in prose, tables, proportions and percentages. Categorical variables were compared with the chi – square test, a P – value < 0.05 was regarded as been statistically significant.

Results

Eighty-two (82) HCP were recruited into the study, 58 of them had one or more positive bacterial cultures giving a prevalence of 70.7%.

Table 1. General characteristics of study subjects

Characteristics	No. of subjects	Bacterial Isolates		
	N= 82 (%)	Present (%)	Absent (%)	P-value
Gender				
Male	64 (78.0)	43 (52.4)	21 (25.6)	0.14
Female	18 (22.0)	14 (17.1)	4 (4.9)	
Designation				
Doctor	18 (22.0)	13 (15.9)	5 (6.1)	0.10
Nurse	36 (43.9)	25 (30.5)	11 (13.4)	
Health assistant	28 (34.1)	19 23.2	9 (11.0)	
Ward				
Male Surgical Ward	19 (23.2)	10 (12.2)	9 (11.0)	0.25
Female Surgical Ward	20 (24.4)	16 (19.5)	4 (4.9)	
Main Operating Theatre	25 (30.5)	19 (23.2)	6 (7.3)	
Special Care Baby Unit	18 (22.0)	12 (14.6)	6 (7.3)	

The naso-pharyngeal carriage rate was 52.4 per 100 HCP, while the carriage rate of hands was 10.1 per 100 HCP. Seventy-six (18.5%) of the 410 swabs collected had positive culture results. Sixty-four HCP (78%) were males and 18 (22%) were females. Nurses constituted the largest number of subjects, making up 43.9% of the total number. In terms of units, the Main Operating Theatre accounted for 25 (30.5%) of the total HCP recruited into the study. Table 1 shows the general characteristics of the study subjects.

Table 2 displays the distribution of bacterial isolates by gender, profession and source. Twenty-two (88.0%) of

Table 2. Distribution of bacterial isolates by gender, profession and source

Characteristics	Escherichia coli (%)	Staphylococcus aureus (%)	Staphylococcus epidermidis (%)	Klebsiella spp. (%)	α- Streptococcus (%)	Haemophilus influenza (%)	No isolate (%)	P-value
Gender								
Male	13(76.5)	21(67.7)	7(87.5)	2(66.7)	0(0.0)	1(33.3)	22(88.0)	0.14
Female	4(23.5)	10(32.3)	1(12.5)	1(33.3)	1(100)	2(66.7)	3(12.0)	
Profession								
Doctor	3(17.6)	7(8.5)	1(12.5)	0(0.0)	0(0)	2(66.7)	5(20.0)	0.10
Nurse	9(52.9)	13(15.9)	3(37.5)	2(66.7)	0(0)	1(33.3)	11(44.0)	
Health assistant	5(29.4)	11(35.5)	4(50.0)	1(33.3)	1(100)	0(0)	9(36.0)	
Source								
Right hand (middle web)	6(26.2)	8(22.9)	2(20.0)	0(0.0)	0(0.0)	0(0.0)	66(19.8)	<0.001
Right hand (Index finger tip)	3(13.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	79(23.6)	
Left palm	4(17.4)	2(5.7)	1(10.0)	1(25.0)	0(0.0)	0(0.0)	74(22.1)	
Left thumb tip	3(13.0)	1(2.9)	0(0.0)	2(50.0)	0(0.0)	0(0.0)	76(22.8)	
Nasopharynx	7(30.4)	24(68.6)	7(70.0)	1(25.0)	1(100)	3(100)	39(11.7)	

Table 3. Distribution of bacterial isolates by units

Units	Escherichia coli	Staphylococcus aureus	Staphylococcus epidermidis	Klebsiella spp.	α - Streptococcus	Haemophilus influenza	No isolate
Male Surgical Ward n=19(%)	4(21.1)	4(21.1)	1(5.3)	0(0.0)	0(0.0)	0(0.0)	10(52.6)
Female Surgical Ward n=20(%)	5(25.0)	8(40.0)	2(10.0)	2(10.0)	0(0.0)	1(5.0)	4(20.0)
Main Operating Theatre n=25(%)	4(16.0)	11(44.0)	4(16.0)	0(0.0)	0(0.0)	1(4.0)	5(20.0)
Special Care Baby Unit n=18(%)	4(22.2)	8(44.4)	1(5.6)	1(5.6)	1(5.6)	1(5.6)	6(33.3)

X^2= 16.96, df= 18, P= 0.25

Table 4. Sensitivity pattern of bacterial isolates

Bacterial isolates	Nitrofurantoin	Ofloxacin	Ciprofloxacin	Amoxycillin + clavulanic acid	Ceftazidime	Cefuroxime	Gentamycin	Ceftriaxone/ Cefixime	Erythromycin
Escherichia coli (%)	13 (76.5)	11 (65.7)	11(65.7)	0(0.0)	0(0.0)	0(0.0)	7(41.2)	0(0.0)	2(11.8)
Staphylococcus aureus (%)	3 (9.7)	23 (74.2)	21(67.7)	0(0.0)	1(3.2)	4(12.9)	13(41.9)	3(9.7)	12(38.7)
Staphylococcus epidermidis (%)	0 (0.0)	6 (75)	6(75)	0(0.0)	0(0.0)	0(0.0)	2(25)	0(0.0)	4(50.0)
Klebsiellaspp (%)	2 (66.7)	2 (66.7)	2(66.7)	0(0.0)	1(33.3)	1(33.3)	2(66.7)	0(0.0)	0(0.0)
α- Streptococcus (%)	0 (0.0)	1(100)	1(100)	0(0.0)	0(0.0)	1(100)	1(100)	0(0.0)	0(0.0)
Haemophilus influenzae (%)	3 (100)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	1(33.3)	0(0.0)	0(0.0)

Some organisms were sensitive to more than one antibiotic

those without a positive bacterial culture were males while 12.0% were females. Doctors accounted for 5 (20.0%) of those without a positive culture result and nurses accounted for 44.0% of this figure. It also shows that 24 (68.6%)of Staphylococcus *aureus* isolates were obtained from the naso-pharynx. The naso-pharynx was the most likely site to be colonized by bacteria (χ^2 =112.4, df=24, P < 0.001).

The distribution of bacterial isolates by unit is outlined on Table 3. It shows that 33.3% of HCP in the SCBU had no bacterial organism cultured from their specimens while 44.4% had swabs that grew Staphylococcus *aureus.* Eleven (44.0%) HCP at the MOT also grew Staphylococcus *aureus* while 16.0% were positive for Escherichia *coli.* Table 4 shows the sensitivity pattern of the isolates. All the isolates were resistant to amoxicillin+ clavulanic acid, and all except 9.7% of Staphylococcus *aureus* isolates were resistant to both ceftriaxone and cefixime. Two (10.0%) of Escherichia *coli* isolates were sensitive to erythromycin.

Discussion

We found a high prevalence of bacterial colonization of the naso-pharynx and hands of HCP, with the naso-pharynx being the most frequently colonized. Staphylococcus *aureus* occurred most frequently in the naso-pharynx, and Escherichia *coli* was the most predominant in the hands. The quinolones (ciprofloxacin and ofloxacin) showed the most invitro potency against the bacterial isolates.

The prevalence of bacterial carriage in this study of 70.7% is lower than that observed in Uyo, south-south, Nigeria (80.0%).[8] It is also lower than the prevalence of 98.1% reported in Taiwan in 2017.[13] However, it is higher than figures from India and Europe.[14,15] The discrepancies in prevalence figures may be due to differences in sample size, source of samples (i.e., hands and nasal swabs vs. hands only etc.), categories of patient contacts of the HCP and culture techniques. Nevertheless, our finding provides a reference point for the facility and this part of Nigeria on the prevalence of bacterial colonization of HCP.

The naso-pharynx was the most frequently colonized in comparison to any of the 4 aspects of the hands that we studied. This is akin to findings from another Nigerian study and from multiple studies carried out around the world.[8,9,16,18] The most commonly cultured organism in this study was Staphylococcus *aureus,* this is in conformity with findings globally.[2,8,13,14,18] It is noteworthy that Staphylococcus *aureus* is part of the normal flora in human nares and as such nasal carriage is innocuous in the healthy. Nevertheless, given that the naso-pharynx was a site of colonization in our subjects who were all HCP there is the possibility that HAI may arise from the carriage of these organisms.[10]

Escherichia *coli* was the most predominant bacterial agent in the hands of HCP in our study, this finding does not match reports from other studies.[8,19,20] The reason for the relatively high hand carriage rate of Escherichia *coli* in this study is not evident. However, one could speculate that poor adherence to the principles of standard precautions especially as it relates to hand hygiene and probably housekeeping in this group of HCP may explain this finding.

The isolates in the present study showed high resistance rate to most of the tested antimicrobial agents except for the quinolones (ciprofloxacin and ofloxacin). This is similar to reports from several studies.[9,18,21,22] Conversely, a Kenyan study found a higher susceptibility to ceftazidime.[23] The high rate of bacterial resistance may be due to several prevalent factors in our environment; i.e., lack of rational use of antimicrobials by prescribers, lack of appropriate regulations in the sale of antimicrobials, lack of compliance to dosing regimens by patients, use of these agents in farm animals and poor surveillance and antimicrobial susceptibility testing.[24]

This study has provided an insight into the prevalence and pattern of antimicrobial colonization of HCP in FMC Azare. It has also outlined the sensitivity patterns of the isolates. These findings would be of immense usefulness to clinicians especially in the management of HAI. However, a larger study involving subjects from all wards and units of the hospital and/or multiple hospitals would have ensured a more robust outcome and may allow for generalization of the findings. More so, the application of phenotypic and molecular characterization as well as genotyping of the isolates would have greatly enhanced the micro-biological aspects of this study.

Conclusion

Our findings implied a high colonization rate of HCP by bacteria. It also underlined the high carriage rate of Escherichia *coli* on the hands. In addition, there was evidence that resistance to commonly used antimicrobials is prevalent among the isolates. There is the need for continuous training on infection prevention and control as well as on adherence to the centre's infection prevention and control policies and guidelines especially as it relates to hand hygiene, cough etiquette and housekeeping. Improved surveillance of nosocomial infections and education of prescribers on the rational use of antimicrobials are also recommended.

Financial support and disclosure

The study was funded by the management of the Federal Medical Centre, Azare, Bauchi state.

Acknowledgements
The authors wish to thank the HCP and the management at the Federal Medical Centre, Azare, Nigeria for their support through all the various stages of this study.

Conflict of interests
The authors declare that there was no conflict of interests involved in this research.

References

1. Albrich WC, Harbarth S. Health-care workers: source, vector or victim of MRSA? Lancet Infect Dis. 2008; 8: 289-301.
2. Peters C, Dulon M, Nienhaus A, Schablon A. Occupational infection risk with multidrug-resistant organisms in Health personnel- A systematic review. Int J Environ Res Public Health. 2019; 16: 1983. doi: 10.3390/ijerph16111983.
3. Allegranzi B, Nejad SB, Combescure C, Graafmans W, Donaldson L. Burden of endemic health-care-associated infections in developing countries: systemic review and meta-analysis. Lancet. 2011; 377 (9761): 228-41.
4. Schmidt RN, Hunt S, Stapp M. The budgetary impacts of hospital-acquired infections. Journal of Business and Behavioral Sciences. 2019; 31(1): 25-35.
5. Koch AM, Nilsen RM, Eriksen HM, Cox RJ, Harthug S. Mortality related to hospital-associated infections in a tertiary hospital; repeated cross-sectional studies between 2004-2011. Antimicrob Resist Infect Control. 2015; 4: 57.
6. Visalachy S, Palraj KK, Kopula SS, Sekar U. Carriage of multidrug resistant bacteria on frequently contacted surfaces and hands of health care workers. J Clin Diagn Res. 2016; 10 (5): 18-20.doi. 10.7860/JCDR/2016/19692.7772.
7. Raina MacIntyre C, Chughtai AA, Zhang Y, Seale H, Yang P, Chen J, et al. Viral and bacterial upper respiratory tract infection in hospital health care workers overtime and associated with symptoms. BMC Infectious Diseases. 2017; 17: 553. Doi. 10.1186/s12879-017-2649-5.
8. Edem EN, Onwuezobe IA, Ochang EA, Etok CA, James IS. Antibiogram of bacterial isolates from the anterior nares and hands of healthcare workers in University of Uyo Teaching Hospital (UUTH) Uyo, Akwa Ibom state, Nigeria. J Bacteriol Parasitol. 2013; 4: 168. doi: 10.4172/2155-9597.1000168.
9. Mahmoud AM, Albadawy HS, Bolis SM, Bilal NE, Ahmed AO, Ibrahim ME. Inducible clindamycin resistance and nasal carriage rates of staphylococcus aureus among health care workers and community members. Afri Health Sci. 2015; 15(3): 861-7.
10. Kumar P, Shukla I, Varshney S. Nasal screening of health care workers for nasal carriage of coagulase positive MRSA and prevalence of nasal colonization with Staphylococcus aureus. Biology and Medicine. 2010; 3: 182-6.
11. Ewaoche IS, Otu-Bassey IB, Umeh EU. Frequency of bacterial species associated with nosocomial infection among health care personnel in Nigeria. J Microbiol Exp. 2017; 5 (6): 00171.DOI: 10.15406/jmen.2017.05.00171.
12. Charan J, Biswas T. How to calculate sample size for different study designs in medical research. Indian J Psychol Med 2013; 35 (2): 121-6.
13. Chang CH, Chen SY, Lu JJ, Chang CJ, Chang Y, Hsieh PH. Nasal colonization and bacterial contamination of mobile phones carried by medical staff in the operating room. PLoS ONE. 2017; 12 (5): e0175811.
14. Visalachy S, Palraj KK, Kopula SS, Sekar U. Carriage of multidrug resistant bacteria on frequently contacted surfaces and hands of health care workers. Journal of Clinical and Diagnostic Research. 2016; 10(6): 18-20.
15. March A, Aschbacher R, Sleghel F, Soelva G, Kaczor M, Migliavacca R, et al. Colonization of residents and staff of an Italian long-term care facility and an adjacent acute care hospital geriatric unit by multidrug-resistant bacteria. New Microbiologica. 2017; 40(4): 258-63.
16. Castro A, Komora N, Ferreira V, Lira A, Mota M, Silva J, et al. Prevalence of Staphylococcus aureus from nares and hands on health care professional in a Portuguese hospital. Journal of Applied Microbiology. 2016; 121: 831-9.
17. Chakowa G, Samutela MT, Kwenda G, Mulundu G, Mwansa J, Hang'ombe BM, et al. Scientific African. 2019; 5: 1-9. Available from: http://doi.org/10.1016/j.sciaf.2019.e00105. (Accessed February 28 2020).
18. Fracaroli IFL, Andrade de Oliveira S, Marziale MHP. Bacterial colonization and antimicrobial resistance in healthcare workers: an integrative review. Acta Paul Enferm. 2017; 30(6): 651-7.
19. Matuka DO, Binta B, Carman HA, Singh T. Staphylococcus aureus and Escherichia coli levels on the hands of theatre staff in three hospitals in Johannesburg, South Africa, before and after hand washing. S Afr Med J. 2018; 108 (6): 474-6.
20. Ranweer, Parihar G, Singh NP, Jyotsna C. Prevalence of microbes on hands of health care workers in surgical intensive care unit at a tertiary care hospital. Int J Curr Microbiol App Sci. 2019; 8(3): 1105-11.
21. Patel M, Waites KB, Moser SA, Cloud GA, Hoesley CJ. Prevalence of inducible clindamycin resistance among community- and hospital- associated

Staphylococcus aureus isolates. J Clin Microbial. 2006; 44(7): 2481-4.
22. Ssemogerere L, Sendagire C, Mbabazi C, Namungoma Y, Oketayot AN, Namuyonga J, et al. Hand colonization with gram-negative organisms of healthcare workers accessing the cardiac intensive care unit: A cross- sectional study at the Uganda Heart Institute. Crit Care Res Pract. 2019; 9: 2019: 6081954. doi: 10.1155/2019/6081954.ecollection 2019.
23. Ngumi ZW. Nosocomial infections at Keyatta National Hospital Intensive-care unit in Nairobi, Kenya. Dermatology. 2006; 212(suppl 1): 4-7.
24. Ayukekbong JA, Ntemgwa M, Atabe AN. The threat of antimicrobial resistance in developing countries: causes and control strategies. Antimicrob Resist Infect Control. 2017; 6: 47.