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Beneath the mask: evaluating compliance with the guidelines for facemask use and bacteria contamination amongst healthcare workers with patient contacts at a Nigerian Tertiary Healthcare Facility

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Abstract

Healthcare workers (HCWs) are the first responders in healthcare facilities and are disproportionately exposed to infectious diseases. Facemask is a potential barrier to containing the spread of infectious droplets, aerosols and contaminated surfaces. This study isolated the bacterial contamination associated with using facemasks amongst HCWs interacting with patients. This research utilised the descriptive cross-sectional study design to obtain data from 161 HCWs selected through a multi-stage sampling technique. 2 mm × 2 mm of nose and mouth regions of facemasks were aseptically collected and cultured using standard methods. Antibiotic sensitivity tests were done using standard diagnostic kits. Most (61.5%) of HCWs were females, and 70.8% were between 20 and 39 years. 39.1%, 31.7%, 14.3% and 9.9% were nurses, doctors, health attendants and laboratory technicians, respectively. In this study, 62.7% and 49.7% had a good perception of WHO guidelines for using and removing facemasks, respectively. 74.5% of HCWs volunteered their used facemasks, and 25.6% had growth when cultured. The predominant bacteria isolates were *Enterobacter agglomerans* (62.5%), *Proteus stuarti* (28.1%) and *Morganella morganii* (9.4%) and 96.9% resistant to Augmentin and Ceftazidime, 93.8% were resistant to Cefuroxime and 87.5% were resistant to Cefixime with the highest zones of inhibition to Ofloxacin. Most HCWs have good knowledge but *fail to practice the appropriate guidelines for facemask use*. Facemasks harbour nosocomial organisms, and many of them are resistant to common antibiotics.

Keywords: *facemasks*; *drug-resistant bacteria*; *antimicrobial sensitivity tests*; *COVID-19*; *healthcare workers*

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Facemasks are simple and effective means of interrupting the transmission of infectious diseases, including viral haemorrhagic fevers, such as Marburg, Ebola and COVID-19 (1, 2). With the viral haemorrhagic fevers pandemics, the use of facemasks became a symbol of protection (3), and consistent use in the healthcare environment was advised in addition to other infection prevention and control (IPC) measures to reduce disease transmission (4, 5). When donned correctly, facemasks and respirators for respiratory aerosols provide a physical barrier between the mouth and nose of the user and the immediate environment, thereby protecting from airborne pathogen droplets, fomites and contaminants (2, 6, 7).

A facemask alone cannot provide adequate protection or source control even when used correctly. Other IPC measures include hand hygiene, physical distancing of at least one metre, avoiding touching one's face, respiratory etiquette, adequate ventilation in indoor settings, testing, contact tracing, quarantine and isolation. The application of composite measures is critical to prevent human-to-human transmission of SARS-CoV-2.

There are single-use and reusable facemasks, subdivided into face covers and surgical masks, based on the particle size and intended use (7–9). Before the COVID-19 pandemic, facemasks were used by healthcare workers (HCWs) to control the spread of infectious diseases, such as Influenza, Ebola and Middle East Respiratory Syndrome (4), with a significant protective effect (OR = 0.84; 95% CI = 0.71–0.99), which was more pronounced when the intervention duration was more than 2 weeks (OR = 0.76; 95% CI = 0.66–0.88) (10).

Microorganisms on the skin and upper respiratory tract are transferred to the facemask whilst wearing or

removing it or due to frequent manipulation (11). Bacterial contamination of the mask poses a significant risk when they are not used, removed or disposed of appropriately and can lead to hospital-acquired infections (12–14). Surgical masks were recommended for all HCWs, irrespective of their patients' COVID-19 status (2). The guidance recommends that all HCWs and caregivers wear a medical mask during patient care (2). The control of SARS-CoV-2 infection amongst HCWs is associated with using surgical facemasks in the healthcare environment (15). However, the correct use, removal and disposal of facemasks are essential to ensure their effectiveness and avoid any risk of increased transmission (2).

HCWs are at reduced infection incidence of COVID-19 when facemask is used and removed as prescribed by the World Health Organisation (16, 17). Facemasks protect healthy HCWs and reduce the transmission of infectious agents from fomites and infected individuals to the population (2). Before using a surgical facemask, the guidelines recommend that users ensure the mask is not damaged, covers the mouth and nose, is adjusted to the nose bridge and tied securely, and avoid touching the mask whilst wearing (2).

Previous studies elsewhere reported poor compliance with WHO guidelines on facemask use, removal and disposal recommendations despite users' good knowledge during the pandemic (18). The inappropriate use can increase the risk of infectious disease contamination and self-contamination amongst HCWs and the population (2). There is a lack of evidence on the level of awareness and compliance with the WHO and Nigeria's National Centre for Disease Control (NCDC) guidelines, hence the need to ascertain the perception and practices of HCWs on the occupational use of surgical facemasks and identify and characterise the bacterial pathotypes in the study area.

Objectives

This study ascertained compliance with and perceptions and practices regarding facemask use by HCWs with patients' contact, characterised and isolated pathogenic pathotypes from occupationally used facemasks and explored the risk of occupational hazards and healthcare-associated infections amongst patients in the study area.

Methods

This study was conducted in a Federal Government-owned tertiary healthcare facility (HCF) with 26 wards. The study's target population were HCWs with patient contacts (doctors, nurses, pharmacists, healthcare attendants, physiotherapists, dental assistants, laboratory technologists and scientists). In fulfilling its mandate, the tertiary HCF focuses on an integrated healthcare delivery approach emphasising comprehensive healthcare service to improve Nigerians' physical, mental and socio-economic well-being through preventive, promotive, diagnostic, therapeutic and rehabilitative services.

Research design

This study utilised a descriptive cross-sectional design, and study data were collected between January and February 2022.

Study population and inclusion and exclusion criteria

The sampling frame comprised medical doctors (n = 420), nurses (n = 540), health attendants (n = 210), pharmacists (n = 36), physiotherapists (n = 24) and laboratory scientists and technicians (n = 91). The HCWs with patient contact were selected by systematic sampling and enrolled in this study. At the same time, the administrative and eligible staff who were absent from work due to illness, injury and/or on official leave were excluded from the study.

Sample size

Fisher's formula for estimating a single proportion in cross-sectional studies was applied to determine the minimum sample size. The standard normal deviation was at a 95% confidence level, with prevalence at 88.75% (19) with an allowable margin of error of 5%. The calculated sample size was 153. The sample size was adjusted to 146, considering the total eligible population was 1,321 and less than 10,000 respondents. The minimum sample size was increased to 161 when adjusted for attrition or inappropriately filled questionnaires.

Sampling technique

A stratified sampling technique was employed. The distribution of the HCWs with patient contact – doctors, nurses, laboratory scientists and health attendants – was determined using the information obtained from the hospital registry using the proportion-to-size method. The systematic sampling technique selected a representative and proportional sample from each stratum. The process of field data collection is described as follows:

- **Stage one**: This study briefed respondents and enrolled eligible HCWs who consented to the study. This was followed by aseptically collecting their facemask and providing a replacement.
- **Stage two**: The pre-tested questionnaire was interviewer-administered.
- **Stage three**: Tagged used facemask with the corresponding questionnaire identification number.
- **Stage four**: The samples were transported to the medical microbiology and parasitology laboratory for culturing, microbial identification and antimicrobial sensitivity testing.

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Study questionnaire

The questionnaire was adapted from the study by Tadesse et al. (20) and refined with guides from the literature (21). The adapted questionnaire was subjected to face validity by an environmental health expert and two resident doctors (22). The questionnaire has four sections (A–D). Section A included questions on socio-demographic characteristics and wealth; Section B included questions on the perception of facemask use. Section C assessed the practice of facemask use, and Section D assessed the health hazards associated with mask use. The instrument was pretested in a tertiary HCF outside the study area.

The pretest administered 20 pieces of the data collection instrument to 20 HCWs (medical doctors, nurses, pharmacists, laboratory technologists and nursing assistants). The observations on the questions' sequencing and participants' difficulty in understanding some questions and similarly interpreted questions were addressed in plenary discussions, amended to reflect the pretest findings and finalised in English. The final draft of the instrument was administered to the study respondents in the study area.

Microbial characterisation and identification

The 2 mm × 2 mm of the nose and mouth area of the surgical facemasks were aseptically collected in Ziploc and transferred to the Laboratory. Each surgical facemask was cut with a sterilised scalpel, transferred into sterile bottles containing nutrient broth and incubated for about 24–48 h. The incubated organisms were inoculated (Fig. 1) into MacConkey Agar and further incubated for 12–24 h for growth. The growths observed were then gram-stained, the organisms were identified using the Microbact 12E kit, and the results were interpreted using the Microbact software (23).

Antimicrobial sensitivity tests

The antibiotic sensitivity (Fig. 2) was first achieved by inoculating the organisms into peptone water (standardised with the McFarland turbidity standard). Then, a diagnostic sensitivity test agar was prepared and flooded with the peptone water. The antibiotic disc was picked and placed aseptically into the agar, and incubation was done for another 12–24 h. After 24h, each dish was examined for the inhibition zones, and the antibiotic sensitivities were recorded.

Measurement of bacteria contamination

Bacterial contamination of the facemask was assessed using colony-forming units (cfu/100 mL), bacterial isolation and culturing of facemask swabs. The swab specimen from each facemask was streaked into MacConkey and blood agar, and the bacterial load was determined by measuring the cfu/100 mL.

Data quality control and analysis

The questionnaires were manually sorted, cleaned and organised, and responses were entered according to the identity assigned to each facemask. The laboratory analytical data (the isolated bacteria and antibiotic resistance) were also entered into the corresponding serial IDs. The data were analysed using the IBM Statistical Package for Social Sciences (SPSS) version 29 software.

Frequency distribution tables and charts were used to describe the variables at the univariate level. Knowledge of respondents' compliance with WHO guidelines in using facemasks was determined at the bivariate level with a *p*-value of <0.05. Wealth was a derived variable computed from the ownership or ownership of 21 household items. The predominant factor category through principal component analysis was applied to categorise respondents into poor, average and rich wealth groups (24).

Compliance was assessed using the five steps in the WHO recommendations on facemask use. A score of five was considered compliant, and less than five was non-compliant. The perception was assessed by a derived

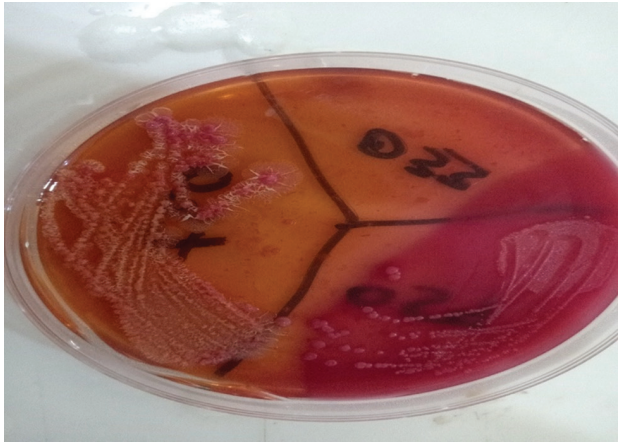

Fig. 1. A petri dish showing microbial growth.

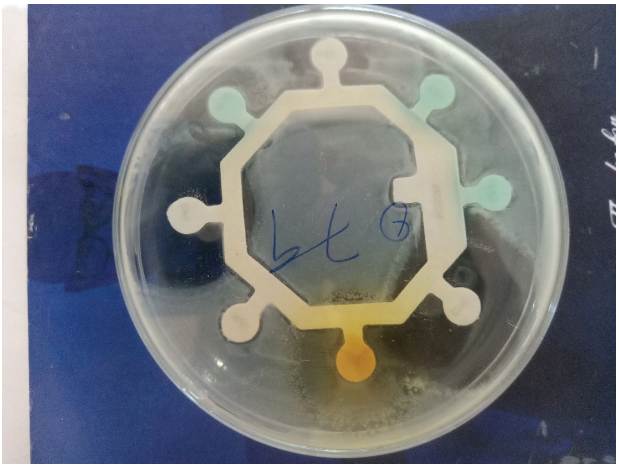

Fig. 2. Antimicrobial sensitivity test.

composite practice index that comprised 15 on facemask use. The median score was 12, and a score ≥12 was rated as a good perception and <12 as a poor perception. 14 questions were applied to determine practice, and the median score of 7 was used to dichotomise practice into good (≥7) and poor (<7) practice ratings. For all composite measure outcomes, correct responses were scored '1', and incorrect responses were rated '0'.

Results

Socio-demographic characteristics of respondents

This study showed that 61.5% (*n* = 99) of the HCWs were female, 70.8% (*n* = 114) were aged between 20 and 39 years, 56.5% (*n* = 91) had tertiary education, 64.0% (*n* = 103) had >5 years of work experience and 34.2% (*n* = 55) were classified as average in wealth status (Table 1). Amongst the respondents were 39.1% (*n* = 63) nurses, 31.7% (*n* = 51) medical doctors, 14.3% (*n* = 23) health attendants, 9.9% (*n* = 16) laboratory technicians, 2.5% (*n* = 4) pharmacists and 2.5% (*n* = 4) physiotherapists.

Table 1. Sociodemographic characteristics of respondents (*n* = 161)

Variables	Frequency	Percent
Age categories		
20–39	114	70.8
40–59	47	29.2
Sex		
Male	62	38.5
Female	99	61.5
Highest education		
Secondary	8	5
Tertiary	91	56.5
Postgraduate	62	38.5
Experience (years)		
≤ 5	58	36
> 5	103	64
Wealth status		
Poor	53	32.9
Average	55	34.2
Rich	53	32.9

The knowledge of respondents on guidelines for the use and removal of facemasks

This study showed that 79.5% (*n* = 128) were aware of (1) sanitary hand disinfection before using a facemask and (2) covering the mouth and nose with a mask and ensuring there are no gaps between the face and the mask. Also, 77.0% (*n* = 124) knew about avoiding touching the mask whilst using it or cleaning hands with alcohol-based hand rub or soap and water if they do, and 80.7% (*n* = 130) were knowledgeable about replacing facemask with new ones when damp and non-reuse of single-use masks. 83.9% (*n* = 135) of the HCWs knew how to remove the facemask from behind and discard it immediately in a sanitary bin before cleaning their hands with alcohol-based disinfectants or soap and water. In summary, only 67.1% (*n* = 108) of HCWs had good knowledge level, whilst 32.9% (*n* = 33) exhibited poor knowledge of the WHO guidelines for using and removing soiled facemasks (Table 2).

The perception and practice of respondents to the use of facemasks

In this study, 91.9% (*n* = 148) perceived that the use of a facemask prevents infectious diseases, 98.8% perceived that hand washing before and after facemask use prevents microbial contamination and 67.1% (*n* = 108) of HCWs thought that it is only necessary to wear a mask when one is infected with COVID-19; 85.7% thought that facemask only protects against COVID-19, whilst 91.3% (*n* = 147) thought that wearing a facemask frequently is one of the ways of reducing airborne infection. Additionally, 80.7% (*n* = 130) and 90.7% (*n* = 146) of respondents were aware of the correct steps in using a facemask and using a facemask protects against COVID-19 whilst on duty, respectively. 88.8% (*n* = 143) of the HCWs perceived that used facemasks should be disposed of sanitarily to protect against the transmission of viruses or other pathogens (Table 3). This study showed that 62.7% (*n* = 101) of HCWs had a good perception, whilst 37.3% (*n* = 60) had a poor perception rating.

The use of facemasks in practice by HCWs

This study showed that 2.5% (*n* = 4) of HCWs do not cover their nose and mouth appropriately when they wear facemasks, 1.2% (*n* = 2) do not wear a facemask at all times whilst on duty and 69.6% (*n* = 112) of HCWs pull down their facemasks to speak with clients/patients whilst on duty. Also, 31.7% (*n* = 51) always coughed or sneezed into their facemask, whilst 52.8% (*n* = 85) always changed facemasks when damp. In addition, 42.9% (*n* = 69) of HCWs do not wear facemasks for more than 4 h at a time (Table 4). As shown in Table 5, only 60.2% (*n* = 97) of HCWs reuse single-use facemasks, only 55.9% (*n* = 90) disinfect their hands before using facemasks and 47.2% (76) do not wash their hands after removing used facemasks. Additionally, 86.3% (*n* = 139) preferred single-use facemasks, whilst 13.7% (*n* = 22) preferred reusable facemasks. The composite practice index revealed that only 49.7% (*n* = 80) of HCWs had good practice, whilst 50.3% (*n* = 81) had poor practice.

The predictors of facemask use perception

The binary logistic regression showed that being married (0.032) and compliance with WHO guidelines on the use of facemasks (<0.001) were predictors of HCWs'

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Table 2. Knowledge of WHO guidelines on how to use and remove facemask

WHO guideline statements (*N* = 161)	Yes *n* (%)	No *n* (%)	Not sure *n* (%)
Before putting on a mask, clean your hands with an alcohol-based hand rub or soap and water	128 (79.5)	13 (8.1)	20 (12.4)
Cover your mouth and nose with a mask and make sure there are no gaps between your face and the mask	128 (79.5)	15 (9.3)	18 (11.2)
Avoid touching the mask whilst using it; if you do, clean your hands with an alcohol-based hand rub or soap and water	124 (77.0)	14 (8.7)	23 (14.3)
Replace the mask with a new one as soon as it is damp and do not reuse single-use masks	130 (80.7)	10 (6.2)	21 (13.0)
To remove the mask: remove it from behind (do not touch the front of the mask); discard it immediately in a closed bin; clean hands with an alcohol-based hand rub or soap and water	135 (83.9)	11 (6.8)	15 (9.3)
Compliance with WHO guidelines on the steps to use facemasks	108 (67.1)	13 (8.1)	20 (12.4)

Table 3. Perception of respondents on the use of facemasks

Description of variables (*N* = 161)	Correct responses *n* (%)	Incorrect responses *n* (%)
Aware of the correct steps to follow in using a facemask	130 (80.7)	31 (19.3)
Facemasks are very effective in preventing infectious droplets from spreading	144 (89.4)	17 (10.6)
The use of facemask prevents communicable diseases	148 (91.9)	13 (8.1)
Does hand washing before and after facemask use prevent microbial contamination	159 (98.8)	2 (1.2)
It is important to wear a facemask when one is infected with COVID-19	108 (67.1)	53 (32.9)
Facemask only protects against COVID-19	138 (85.7)	20 (16.3)
Wearing a facemask frequently is one of the ways of reducing airborne infection	147 (91.3)	14 (8.7)
It is necessary to change the facemask before going to another patient	108 (67.1)	53 (32.9)
Necessary to wear a facemask when in contact with a patient	146 (90.7)	15 (9.3)
Necessary to wear a facemask as I am afraid of getting COVID-19	122 (75.8)	39 (24.2)
Facemasks should be put on and taken off as carefully as possible	142 (88.2)	19 (11.8)
Using a facemask is important to tackle COVID-19 and other respiratory infectious diseases	146 (90.7)	15 (9.3)
I wear a facemask since it protects me and my clients/patients whilst on duty	146 (90.7)	15 (9.3)
Even all healthcare workers must use a facemask whilst in their duty posts	150 (93.2)	11 (6.8)
Used facemasks should be disposed of carefully as they promote virus and other communicable disease transmissions	143 (88.8)	18 (11.2)

perception for the use of facemasks. Additionally, HCWs with tertiary education and postgraduate educational qualifications were about 5 and 12 times more likely to have a good perception of using facemasks (Table 6).

Similarly, the highest education (0.019) and postgraduate education (0.013) subset, in addition to nurse (0.031), health attendant (0.015) and laboratory technician (0.011) subsets of professions, were predictors of HCWs' use of facemasks in practice. Additionally, HCWs who had tertiary education, postgraduate educational qualifications, Islamic religion, compliance with the WHO guidelines and laboratory technician vocation in healthcare facilities were about 5, 14, 1.6, 19.7 and 3.9 times more likely to exhibit good practice in the use of facemasks, respectively (Table 7).

Microbial isolates and antimicrobial sensitivity tests

In this study, only 32 (25.6%) of the used facemasks collected (125) had growth when cultured, whilst 93 (74.4%) had no growth. Of the 32 used facemasks that had growth, the bacteria isolates identified were *Enterobacter agglomerans (20, 62.5%)*, *Proteus stuarti (9, 28.1%)* and *Morganella morganii (3, 9.4%)*.

Out of the 32 bacteria cultured, 18.8% were resistant to Ofloxacin, 96.9% were resistant to Augmentationin, 59.4% were resistant to Nitrofurantoin, 43.8% were resistant to Ciprofloxacin, 96.9% were resistant to Ceftazidime, 93.8% were resistant to Cefuroxime, 34.4% were resistant to Gentamicin and 87.5% were resistant to Cefixime (Fig. 3).

Table 4. Person-specific practice of respondents to the use of facemasks

Description of variables (*N* = 161)	Never *n* (%)	Sometimes *n* (%)	Often *n* (%)	Always *n* (%)
Does your facemask cover your nose and mouth completely when you wear it?	4 (2.5)	16 (19.9)	38 (23.6)	103 (64.0)
Do you wear it all the time when you are in the hospital?	2 (1.2)	23 (14.3)	51 (31.7)	85 (52.8)
Do you pull your mask down to talk to people or patients?	49 (30.4)	86 (53.4)	19 (11.8)	7 (4.3)
Do you maintain social distance whilst wearing your mask?	15 (9.3)	64 (39.8)	44 (27.3)	38 (23.6)
Do you ask patients to always wear their masks when you speak to them?	7 (4.3)	43 (26.7)	39 (24.2)	72 (44.7)
Do you cough or sneeze into your facemask?	14 (8.7)	60 (37.3)	36 (22.4)	51 (31.7)
Do you often misplace your mask and wear it inside out after previously taking it off	97 (60.2)	41 (25.5)	17 (10.6)	6 (3.7)
Do you change your mask when it is damp?	7 (4.3)	19 (11.8)	50 (31.1)	85 (52.8)
Do you remove the mask from the face touching only the bands	15 (9.3)	35 (21.7)	50 (31.1)	61 (37.9)
Do you wear your facemask for more than 4 h?	8 (4.9)	36 (22.4)	48 (29.8)	69 (42.9)

Table 5. Preference of respondents on the use of facemasks

Description of variables (*N* = 161)	Yes *n* (%)	No *n* (%)
Do you reuse a single-use facemask	64 (39.8)	97 (60.2)
Do you wash your hands before using your facemask	90 (55.9)	71 (44.1)
Do you wash your hands after using your facemask	85 (52.8)	76 (47.2)
What kinds of masks do you prefer:		
a) Single-use facemask	139 (86.3)	-
b) Reusable facemask	22 (13.7)	-

Discussion

The study's findings revealed a significant proportion of females in the workforce who are relatively young and have higher educational qualifications. Also, the HCWs were predominantly nurses and doctors and economically advantaged. These are useful indicators for healthcare planning and policy development, bearing the associated brain drain in the studied workforce. Before the study, health education and promotional activities on the efficacy and the process for using and removing facemasks were coordinated by the NCDC in Nigeria. This was aimed at reducing the incidence of infectious disease morbidity and mortality amongst HCWs, especially the first responders in emergency wards. This included periodic interactive discussions, radio jingles, playlets and electronic and hard copies of promotional materials, including posters and leaflets, which were shared and aired at intervals in media houses.

Most of the respondents had a good perception of facemask use in contrast to poor practice on the use of facemasks in their workplaces, in congruence with studies with findings amongst university students in Vietnam (25), Nigeria amongst HCWs (19) and amongst Chinese university students (26). The increase in knowledge was associated with rigorous campaigns to promote compliance for using and removing facemasks amongst the population against COVID-19. However, this study's findings were in contrast to those of Kumar et al. (27) in India and Tadesse et al. (20) in Ethiopia amongst HCWs, where positive attitudes and moderate to poor knowledge and practice were evident regarding the use of facemasks to prevent infectious disease transmission. However, the WHO recommends that all HCWs in healthcare facilities should wear facemasks continuously throughout the entire shift for potential protection from infectious diseases (4, 28). Besides, the logistics and non-supply of personal protective equipment consumables may also be responsible for poor practices, as there were limited supplies in the store at the time of the study.

Enterobacter agglomerans, *Proteus stuarti* and *Morganella morganii* were isolated and characterised from the used facemasks samples. *Enterobacter agglomerans* is a pathogenic gram-negative bacillus found in faeces, plants and soil. At the same time, *Proteus stuarti* is a pathogenic gram-negative bacillus found in water, soil and sewage, and *Morganella morganii* is a pathogenic gram-negative bacillus found in faeces. This revealed the possibility of cross-contamination of the facemasks by unwashed hands and the hospital environment, as these organisms are commonly associated with nosocomial infections. A similar study by Akpoka et al. (29) identified *Peptococcus*, *Pseudomonas* and *Staphylococcus*, which are also commonly associated with nosocomial infections. The microbes were attributed to the regular interaction resulting from coughing, talking and sneezing of HCWs and constant handling of hospital equipment (29). Besides, Delanghe et al. (11) identified *Streptococcus* and *Staphylococcus* spp. on used facemasks after 4 h of use (11). However, the difference in microbial isolates may be attributed to different study locations and diversity.

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Table 6. Binary logistic regression on the perception of facemask use by healthcare workers

Variables	B Coefficient	Odd ratio	95% CI		*P*
			Lower	Upper	
Gender					
Male (Ref)					
Female	0.124	1.132	0.393	3.263	0.818
Highest education					0.089
Secondary education (Ref)					
Tertiary education	1.727	5.623	0.441	71.673	0.184
Postgraduate education	2.552	12.838	0.913	180.491	0.058
Marital status					
Single (Ref)					
Married	-1.447	0.235	0.063	0.882	0.032*
Ethnicity					0.493
Hausa(Ref)					
Igbo	-0.665	0.514	0.023	11.277	0.673
Yoruba	-1.533	0.216	0.013	3.473	0.279
Others	-1.726	0.178	0.005	6.660	0.350
Religion					
Christianity (Ref)					
Islamic	0.497	1.644	0.411	6.571	0.482
Compliance with WHO guidelines					
No compliance (Ref)					
Compliance	2.981	19.714	6.811	57.065	<0.001*
Experience (years)					
1–5 (Ref)					
>5	0.064	1.066	0.395	2.881	0.899
Period of work daily (hours)					0.966
1–4 h (ref)					
5–8 h	-0.250	0.779	0.119	5.081	0.794
>8 h	-0.201	0.818	0.096	6.992	0.854
Professions					0.250
Doctor (Ref)					
Nurse	-0.373	0.689	0.198	2.395	0.557
Health attendant	0.119	1.126	0.224	5.672	0.886
Pharmacist	-1.997	0.136	0.008	2.313	0.168
Physiotherapist	-1.005	0.366	0.022	6.051	0.483
Lab technician	1.376	3.961	0.696	22.542	0.121
Constant	-0.617	0.540			0.757

Key: * = $P < 0.05$.

The microbial isolates showed various levels of resistance to Ofloxacin, Agmentin, Nitrofurantoin, Ciprofloxacin, Ceftazidime, Cefuroxime, Gentamicin and Cefixime, indicative of resistance to commonly used antimicrobial agents. This heightened the risk of nosocomial infections in HCWs, visitors and patients in healthcare facilities.

The one-time-use masks were initially designed to filter droplets that could potentially carry germs exhaled from the mouth and nose and protect the human respiratory system from microscopic airborne particles associated with respiratory conditions. The HCWs who complied with WHO guidelines on using, removing and disposing facemasks recorded no growths compared to the isolated microbes. This confirmed the potency of the guidelines in IPC of infectious and nosocomial infections in healthcare settings.

Handwashing at critical periods, irrespective of patient pressure, is also important in prevention, and the facilities are required to be provided at all points of care within healthcare facilities (30–33). The isolated organisms

Table 7. Binary logistic regression on the practice of facemask use by healthcare workers

Variables	B Coefficient	Odd ratio	95% CI		*P*
			Lower	Upper	
Gender					
Male (Ref)					
Female	0.612	1.844	0.800	4.252	0.151
Highest education					0.019*
Secondary education (Ref)					
Tertiary education	1.790	5.988	0.815	43.997	0.079
Postgraduate education	2.662	14.324	1.756	116.846	0.013*
Marital status					
Single (Ref)					
Married	-0.301	0.740	0.285	1.921	0.536
Ethnicity					0.562
Hausa(Ref)					
Igbo	-0.102	0.903	0.066	12.398	0.939
Yoruba	0.071	1.073	0.102	11.314	0.953
Others	1.374	3.952	0.205	76.028	0.362
Religion					
Christianity (Ref)					
Islamic	0.671	1.956	0.660	5.804	0.226
Compliance with WHO guidelines					
No compliance (Ref)					
Compliance	0.251	1.286	0.579	2.855	0.537
Experience (years)					
1–5 (Ref)					
>5	0.364	1.439	0.629	3.294	0.389
Period of work daily (hours)					0.907
1–4 h (Ref)					
5–8 h	-0.014	0.986	0.223	4.361	0.985
>8 h	0.220	1.247	0.227	6.854	0.800
Professions					0.059
Doctor (Ref)					
Nurse	1.105	3.018	1.108	8.217	0.031*
Health attendant	1.690	5.418	1.385	21.195	0.015*
Pharmacist	0.049	1.050	0.086	12.797	0.970
Physiotherapist	-0.067	0.935	0.066	13.160	0.960
Lab technician	1.761	5.820	1.493	22.685	0.011*
Constant	-3.679	0.025			0.034

Key: * = $P < 0.05$.

(*Enterobacter agglomerans*, *Proteus stuarti*, *Morganella morganii*) are all gram-negative enteric organisms that majorly follow the faecal route of transmission, are implicated as aetiological agents of nosocomial infection and are multi-drug resistant, which could significantly contribute to morbidity and mortality of HCWs.

The married status and compliance should be targeted to promote positive perception, perhaps because they are more likely to contract or transmit infections in HCFs and at home. The need to minimise overall risk has the increased potential for spreading infections to close family members and the need to protect their largely vulnerable populations. In addition, marriage status might be linked to specific behavioural patterns or lifestyle factors influencing infectious disease transmission. At the same time, the highest education, especially additional postgraduate education, nurses, health attendants and laboratory technicians, is predictors of the facemask use practice amongst HCWs and should strategically be focussed on promoting positive behaviour.

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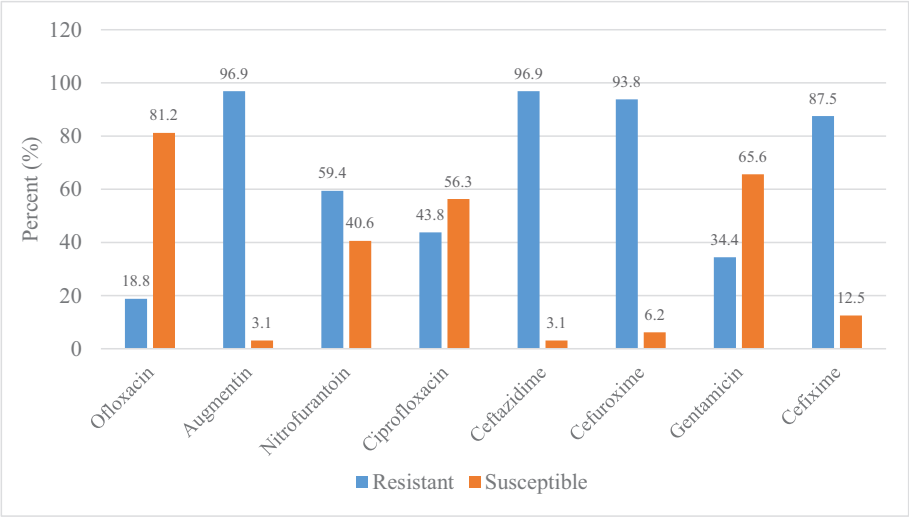

Fig. 3. Antimicrobial sensitivity tests.

First, this study identified the need for HCWs to be educated on the use of facemasks, to follow WHO-recommended guidelines and to remove facemasks to prevent self-contamination and nosocomial infections. Second, this study identified pathogens resistant to antibiotics, which need to be monitored within healthcare facilities and the environment. Future research can be conducted to determine the inventory of facilities required by HCWs to comply with the IPC guidelines, including the use, removal and disposal of facemasks within the sociocultural barriers amongst HCWs in Nigeria.

Limitations

The results showed that respondents with poor knowledge and no compliance with WHO guidelines on the use of facemask recorded a lower growth percentage (7.4%) than those with good knowledge and compliance (25.9%). It is essential to note that MacConkey agar, a selective and distinct bacterial culture medium designed to isolate Gram-negative and enteric bacteria preferentially, was employed in isolating these pathogens. This limited the study's full scale and breadth and may have accounted for the 'discordance', as the cultured facemasks that yielded no growth may have borne other gram-positive and potentially more clinically relevant pathobionts, which would have been isolated.

Conclusions

Compliance with WHO guidelines for the use, removal and disposal of used facemasks is good in preventing infectious and nosocomial infections. Although most respondents have a good perception of the importance of using facemasks in occupational use, their practice could be improved. It needs to be improved since the bacterial isolates suggest inadequate hand hygiene. Therefore, knowledge about appropriate guidelines on the use, removal and safe disposal of used facemasks should be included in the training and continuous capacity building of HCWs to significantly decrease the risks associated with potential contamination and nosocomial infections.

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Conflict of interest and funding

This research received no specific grant from funding agencies in the public, commercial or not-for-profit sectors. The authors report no conflict of interest.

Ethics statement

Ethical permission (IPH/OAU/12/1898) was obtained from the Obafemi Awolowo University health ethics and research committe, and verbal consent was obtained from the respondent after a detailed explanation of the scope of the research. No harm was done to respondents, and the confidentiality of the information provided was assured.

Data availability

The datasets used and analysed during the current study are available from the corresponding author upon reasonable request.

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