

## Veterinarians' Perception, Knowledge and Practices of Hand Hygiene in Enugu State Southeast, Nigeria

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### Abstract

A cross-sectional survey utilizing questionnaire assessed veterinarians' awareness, attitudes and practices of hand hygiene (HH) in Enugu State Southeastern Nigeria. Data obtained were analyzed using chi-square on SPSS (version 15.0) at a significance level of  $P < 0.05$  to determine possible associations between variables and perceptions/knowledge about HH. Out of 294 respondents, 26.9% were familiar with the WHO's "5 moments of HH" model but majority knew the importance of the model. There was high compliance with HH after touching an animal (100%) and animal's surrounding (96%), and contact with body fluid (100%) but HH before touching an animal (52.5%) and performing clean procedures (58.5%) were practiced sub-optimally. Majority of the respondents often forgets to perform HH (61.9%) and prioritizes clinical tasks to HH when busy (65%). The attitudes/practices towards HH were generally negative. Minority knew that unclean veterinary personnel's hands are the main route of infection in the veterinary clinic (38.1%) and alcohol-based hand rubs are more effective on pathogens than other cleansing agents (23.1%). Majority of the respondents does not know when different HH techniques ought to be performed. The overall knowledge of HH by the respondents was moderate (55.4%). No significant association ( $P > 0.05$ ) was found between level of knowledge and gender, age, qualification, duration of practice and location. Poor knowledge of HH guidelines, unavailability and inaccessibility of HH facilities, and unavailability of reminders were the major barriers to compliance with appropriate HH practices. In conclusion, veterinarians' awareness and perception about HH in the study area is moderate while the practices are sub-optimal, thus the education of Nigerian veterinarians about HH and the teaching of the principles and practices of appropriate HH during veterinary schools are recommended.

**Keywords:** awareness; barrier; hand hygiene; practice; veterinarians

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### Introduction

The impact of healthcare-associated infections (HCAIs) includes outrageous increase in healthcare cost due to additional treatment, antimicrobial use, hospital stay and potential death (Mathur, 2011; Stull and Wesse, 2015). In veterinary healthcare, these complications not only affect practice reputation but also drastically affect animal welfare and often create emotional and financial distress for animal owners (Stull and Wesse, 2015). Nowadays, zoonotic multidrug-resistant organisms (MDROs) are the commonest causes of HCAIs in human and veterinary healthcare settings (Anderson, 2015). These organisms often colonize animal patients (especially the skin) and they are readily shed (from the skin and/or through dejections)

contaminating the immediate environment (Salman *et al.*, 2018). Animal owners colonized by these organisms are also potential vehicle for their transmission to veterinary clinics (Anderson, 2015). With their hands, veterinarians and veterinary support staffs frequently make contact with their patients (mostly the skin during physical examination and other routine procedures) and contaminated environment (Nakamura *et al.*, 2012; Morley, 2013; Anderson *et al.*, 2014). Quite often, veterinarians also make contact with their clients/animal owners (Morley, 2013; Anderson, 2015). Thus, hands of veterinarians are crucial vehicles for the transmission of organisms to their patients/clients thereby jeopardizing their safety (Anderson, 2015; Salman *et al.*, 2018). These individuals could potentially transmit HCAIs to the public resulting in further spread in human

and animal population. Veterinarians themselves could contract infectious diseases from their patients/clients if they practice sub-optimal HH (Anderson, 2015; Anderson and Wesse, 2016).

Increasing incidence of multidrug-resistant HCAs led to the intensified call on human/veterinary health workers to improve on basic hygiene practices (Tartari, 2017; Saito, 2018). Hand hygiene (HH) has been established the most effective infection prevention and control (IPC) measure that reduces the spread of HCAs/antimicrobial-resistant organisms in human and veterinary healthcare settings (WHO, 2015; Kingston *et al.*, 2017). HH is a simple, standardized, low-cost and universally applicable measure that breaks the cycle of HCAs transmission and it is based on solid scientific evidence (Morley, 2013; Anderson, 2015). The World Health Organization (WHO) issued guidelines for effective HH in order to curb the spread of AMROs/HCAs and ensure safety of patients, clients and practitioners (WHO, 2009; Cheng *et al.*, 2011; WHO, 2015); the organization has also continued to promote HH amongst human/veterinary health workers and the public with vast campaigns (WHO, 2015; Tartari *et al.*, 2017; Saito, 2018). Unfortunately, sub-optimal adherence/compliance to recommended HH procedures by human/veterinary health workers, have been reported in most countries (Boyce and Pittet, 2002; Anderson *et al.*, 2014; Kingston *et al.*, 2017). Studies reported compliance rates of 5-81% (average 40%) and 14-48% amongst human (Erasmus *et al.*, 2010) and veterinary (Wright *et al.*, 2008; Nakamura *et al.*, 2012; Shea and Shaw, 2012; Anderson *et al.*, 2014) health workers, respectively. This poor compliance has been attributed to complex and multifactorial barriers influenced by elements at both the organizational and individual levels (Mathur, 2011; Chavali *et al.*, 2014). This has resulted in increasing prevalence of HCAs in human and animal population with the African continent being the worst hit (Allegranzi *et al.*, 2011; Pittet, 2014; Ling *et al.*, 2015). Of all the barriers limiting adherence/compliance to recommended HH procedures, poor awareness/knowledge of the WHO's "Five Moments of HH" model has been identified as the most important (Maheshwari *et al.*, 2014; Khanal and Thapa, 2017). The model is evidenced-based and entails five calls for action that are universal in ensuring patient, practitioner and client safety (WHO, 2009; Saito *et al.*, 2018). It has been used in understanding, training, monitoring and improving HH practices among human/veterinary health workers (Anderson *et al.*, 2014; Kingston *et al.*, 2017). Multimodal programs which included ongoing education (about the WHO model and recommended HH procedures) of health workers have proved to be effective in sustaining improvements on HH practices in human and veterinary healthcare settings (Anderson *et al.*, 2014; Anderson and Wesse, 2016; Watson, 2016; Khanal and Thapa, 2017).

Knowledge about HH is crucial for veterinarians because they are anticipated as key animal healthcare providers to take prominent roles in IPC programmes in veterinary healthcare systems and as educators of their clients/the public about HH (Anderson, 2015; Pires and Pittet, 2017); thus they are supposed to remain informed,

trained and motivated (Pires and Pittet, 2017; Saito *et al.*, 2018). In addition, veterinarians have ethical and legal responsibilities to prevent the spread of infectious diseases among animals (Morley, 2013; Bergstrom and Gronlund, 2014). HH practices by health workers are associated with their knowledge and perceptions (Mathur, 2011; Salman *et al.*, 2018). Therefore assessing the veterinarians' perception and level of knowledge/awareness about and practices of HH is crucial for identifying gaps in knowledge, determining the level of compliance to recommended HH practices, development of effective HH policies/practices in veterinary hospitals, and improvement and implementation of appropriate remedies in veterinary schools' curricula (Anderson *et al.*, 2014). This will subsequently result in behavioral change and lead to more appropriate HH practices (Saito *et al.*, 2018). With proper veterinary health worker (VHW) behaviour and compliance with evidence-based HH guidelines, veterinary HCAs may be unnecessary adverse events as they are preventable (Ling *et al.*, 2015; Pires and Pittet, 2017).

In available literature, there are several reports (Nair *et al.*, 2014; Diwan *et al.*, 2016; Kingston *et al.*, 2017; Salman *et al.*, 2018) on perception/understanding and practices of HH among medical/allied health workers in many parts of the world, including in Nigeria (Segun *et al.*, 2013; Shobowale *et al.*, 2015; McFubara *et al.*, 2017); but studies regarding the perception/level of awareness and practices of HH among veterinary personnel (VP) are scanty and were only conducted in the United States (Wright *et al.*, 2008; Nakamura *et al.*, 2012; Shea and Shaw, 2012) and Canada (Anderson *et al.*, 2014; Anderson and Wesse, 2016). In Nigeria, Veterinary Medicine is a 6-years full-time degree programme during which courses on Public Health and Preventive Medicine are taught. These courses have been taught for several years but there has not been any assessment of Nigerian veterinarians' knowledge about the WHO HH guidelines. On individual basis, HH practices taught formally/informally at early stages of life may not be enough for appropriate HH during veterinary clinical practice. Thus most Nigerian veterinarians may not be knowledgeable about HH and therefore may be practicing HH sub-optimally. This sort of practice increases the problem of veterinary HCAs in the country. Consequently, this could result in increased incidence of HCAs among animals and humans in the country. Till date, no study has evaluated the Nigerian veterinarians' understanding of the concept and practices of HH. This study was therefore undertaken to assess the perception/level of knowledge, attitude and practices of HH amongst veterinarians in Enugu State, Southeast Nigeria.

## Materials and Methods

### *Study area and population*

The study was done in Enugu State, Southeastern Nigeria. Geographically, the state is at coordinates approximately 6° 30' N 7° 30' E and is made up of 17 Local Government Areas (L. G. As) namely: Aninri, Awgu, Enugu East, Enugu North, Enugu South, Ezeagu, Igbo Eriti,

Igbo Eze North, Igbo Eze South, Isi Uzo, Nkanu East, Uzouwani, Nkanu West, Nsukka, Oji River, Udenu and Udi, the Enugu South, Enugu North and Enugu East L. G. As made up Enugu township which is the State Capital Territory. Nsukka L. G. A. comprised Nsukka town with a University Veterinary Teaching Hospital and other smaller towns. Enugu and Nsukka are geographically located at coordinates approximately 6° 27' 9.60" N 7° 30' 37.20" E and 6° 51' 24" N 7° 23' 45" E, respectively. They are the two most populated towns in Enugu State, with population of about 722,664 and 309,633, respectively (NPC, 2007). The study population comprised veterinarians who graduated from veterinary schools in Nigeria and are teaching and/or practicing in government- and/or privately-owned veterinary clinic in Enugu State. Those veterinarians in privately-owned clinics often handle the animals themselves partly due to lack of veterinary support staffs while those in government clinics (teaching and resident doctors) attend clinical call duty during which they handle their patients with or without the support staffs and/or clinical students on rotation.

#### *Ethical approval*

Ethical approval was not necessary for this study. However, the study was conducted in accordance with the code of ethics of the World Medical Association Declaration of Helsinki (WMA, 2013). Informed consent was obtained from all participants involved in the study and no identifiable data reported.

#### *Study design and sampling procedure*

This is a quantitative descriptive survey aimed to assess the awareness/level of knowledge and practices of HH amongst veterinarians. Between March and June, 2018, a questionnaire-based cross-sectional study was conducted among teaching and/or practicing veterinarians in Enugu and Nsukka which were purposively selected because majority of veterinarians in the state are based in these towns. A sample size of 384 participants from the two towns was estimated using the method of Thrushfield (1997):

$$n = 1.96^2 \times P_{\text{exp}} (1 - P_{\text{exp}}) / d^2$$

Where n = sample size,  $P_{\text{exp}}$  = expected proportion of knowledge about HH which was assumed to be 50% and d = desired absolute precision level which was assumed to be 5%. Participation implied consent and was voluntary and anonymous.

#### *Data collection*

Information about the level of awareness, practices, and barriers of HH including the socio-demographic characteristics of the respondents were collected using a self-administered questionnaire. The questionnaire was developed following a literature review of comparable studies (Nair *et al.*, 2014; ; Maheshwari *et al.*, 2014; Kingston *et al.*, 2017) which assessed the awareness, attitudes and practices of HH, and barriers to adherence to the current WHO (2009) and Centers for Disease Control and Prevention (2002) HH guidelines. The survey comprised 53 questions: 5 questions on demographics, 37 on awareness of HH, 24 on practices of HH, and 17 on

hand-rubbing using alcohol-based hand rubs (ABHR) and barriers to compliance with HH guidelines with Likert scale, multiple choice and 'yes' or 'no' questions. Almost all questions were closed questions with pre-specified answered options (Kingston *et al.*, 2017). However, there was a question where the respondents were meant to define the full meaning of the acronym "ESKAPE" and 2 questions where the respondents could choose the option "others" and respond in their own words. The questionnaire was validated by two experienced researchers and a pilot study on 10 veterinarians. The participants were given opportunity to ask questions after completion of the survey and they were provided with relevant HH information.

#### *Data analysis*

Data were analysed using SPSS version 15.0. Descriptive statistics (frequencies and percentages) were calculated. An overall knowledge score was evaluated by calculating the total percentages (each counts one point; possible answers ranged from 0-37) of correct answers for the HH concept-based questions. Knowledge/awareness score  $\geq 75\%$  was considered good knowledge, 50%-74% moderate knowledge, and  $< 50\%$  as poor knowledge (Nair *et al.*, 2014; Maheshwari *et al.*, 2014; Salman *et al.*, 2018). Chi-square ( $\chi^2$ ) was used to determine possible association between variables and the awareness/knowledge about HH. Values of  $P < 0.05$  were considered significant. Pilot study data was not included in the final analysis.

## **Results**

#### *Socio-demographic characteristics of respondents*

Out of 400 veterinarians given the survey, 294 (73.5% response rate) returned sufficiently-filled survey. Of the 294 respondents, majority were males (215, 73%) and between the ages of 25 and 35 years (182, 62%) (Table 1). One hundred and fifty-five (52.7%) were based in Enugu and 139 (47%) were teaching and/or practicing in Nsukka. Majority of the respondents (191; 65%) had master's degree while 24 (8%) were doctorate degree holders. Fifty-one percent of the respondents have practiced veterinary medicine for more than 5 years.

#### *Perceptions/Level of knowledge possessed by respondents about hand hygiene*

The overall awareness/knowledge level about HH was 55.3% (Table 2). Minority (26.9%) of the respondents agreed that they are familiar with or have heard about the WHO's "5 Moments of HH" model. In order to prevent transmission of pathogens to animals, all the respondents correctly knew that HH should be done before handling an animal, before a clean/aseptic procedure and after eating/drinking/smoking at work. Majority also correctly knew that performing HH before handling an animal that had surgery in the last 48 hours (95.9%) is important for preventing animal infection but not after exposure to immediate surroundings of a sick animal (88.1%). All the respondents correctly knew that a VHW would not get infected if HH is performed after handling an animal, before eating/drinking/smoking at work and after contact with urine or faeces of an animal.

Table 1. Sociodemographic characteristics of the respondents

Variable	Frequency	Percentage (%)
Sex	n = 294	
Male	215	73
Female	79	27
Age		
25-35	182	62
36-45	91	31
46 and above	21	7
Qualification		
First Degree	79	27
Masters	191	65
Doctorate	24	8
Years of practice		
Less than 1	32	11
1-5	112	38
More than 5	150	51
Location		
Enugu	139	47.3
Nsukka	155	52.7

Almost all the respondents equally knew that for VP to protect themselves from infections, HH should be performed after exposure to the surroundings of a sick animal (95.9%) and after removal of hand gloves (92.2%).

Regarding survivability of pathogenic organisms in the environment, majority wrongly perceived that *Escherichia coli* and *Klebsiella pneumoniae* survives longer in the environment than vancomycin-resistant enterococci (VRE) (0%) and methicillin-resistant staphylococci (MRS) (35%). Only a respondent (0.3%) was able to correctly define the acronym "ESKAPE". Less than one-third (58.2%) of the respondents agreed they knew the difference between patient zone and healthcare area. Minority of the respondents knew that unclean hands of a veterinary personnel (VP) is the main route of transmission of pathogens/antimicrobial-resistant organisms between animals, clients and veterinary practitioners (38.1%), sick animals are the most frequent source of pathogens in veterinary health-care (31%), and an animal can become septic if attending VP's hands are unclean (23.1%).

With regards to knowledge about HH techniques, majority (88.1%) of the respondents claimed that they knew the difference between hand washing (HW) and hand rubbing (HR) but only 54.1% correctly knew that HR cleanses the hand more rapidly than HW. Less than half (41.8%) of the respondents correctly knew that HR does not cause skin dryness more than HW while less than one-third (23.1%) correctly perceived that HR is more effective against pathogens than HW. Eighty-one percent correctly knew that HW and HR were not recommended to be performed in sequence and wearing of gloves does not preclude HW. None of the respondents knew the number of steps involved in appropriate HW procedure and the minimal time needed to perform effective HR. Minority of the respondents knew that HR should be done before examining an animal physically (41.8%) and before injecting an animal (38.1%). Minority of the respondents equally knew that HW is required after removing animal excreta (35%) and when managing diarrhoea associated with *Clostridium difficile* (4.1%). Half (50%) of the

respondents wrongly perceived that regular use of hand creams increases the likelihood of colonization of hands by microorganisms whereas above two-third knew that artificial fingernails (69%) and damaged skin (73.1%) increases hand colonization by pathogens. Less than one-third (23.1%) of the respondents rightly believed that wearing hand jewellery increase microbial colonization of the hands.

Age, gender, qualification, duration of practice and location did not exert any influence ( $P > 0.05$ ) on the awareness of respondents about HH.

#### *Attitudes and practices of hand hygiene by veterinarians*

Less than half (41.8%) of the respondents indicated that they have sufficient knowledge about HH whereas above half (54.1%) reported that they always adhere to appropriate HH practices (Table 3).

Pertaining compliance to the "5 moments of HH" model, all the respondents reported that they perform HH after touching an animal and after contact with body fluids from animals whereas less than two-third indicated that they always perform HH before handling an animal (52.4%) and performing clean or aseptic technique (58.5%). A considerable minority (4%) of the respondents reported that they do not always perform hand HH after touching an animal's surrounding.

Less than two-third (58.2%) of the respondents reported that they do perform HH often despite the frequency, slightly above half (54.1%) reported that they do perform HH in emergency cases despite its cumbersome while 31% reported that they are usually not worried about performing HH whenever gloves were worn. Almost all (99.3%) the respondents indicated that they use reusable cloth towel to dry their hands after washing. More than one-third (65%) opined that when busy performing clinical tasks should be prioritized to HH, 26.9% agreed they are always reluctant asking others to perform HH, 76.6% reported that they feel guilty when they omit HH (76.9%) while 73.1% indicated they feel frustrated when HH is omitted by others.

A minor proportion (4.1%) of the respondents believed that staffs in their clinic have been properly trained or instructed in HH and close to two-third (61.9%) agreed that they sometimes do miss HH due to forgetfulness. All the respondents agreed that HH is essential part of a veterinarian's role and that they are responsible for educating clients and support staffs in their clinic about HH. They equally agreed that appropriate HH prevents

vetterinary HCAs and almost all (98.3%) agreed that appropriate HH helps in curbing antimicrobial resistance. Majority agreed that regular enrolment in HH training is crucial for every veterinarian (88.1%) but above two-third (69%) reported that time pressure limits them from enrolling/involving in HH courses/training. Majority (73.1%) indicated that they would like to be trained on HH.

Table 2. Perception/Level of knowledge possessed by veterinarians in the study area about hand hygiene

Concept	Correct response	Frequency	Percentage (%)
		n = 294	
Overall knowledge of hand hygiene	Correct answers	163	55.4
Familiar with or have heard about World Health Organization's "Five Moments of Hand Hygiene"	Yes	79	26.9
Know the full meaning of the acronym "ESKAPE"	<i>Enterococcus faecium, Staphylococcus aureus, Klebsiella pneumoniae, Acinetobacter baumannii, Pseudomonas aeruginosa</i> and <i>Enterobacter</i>	1	0.3
Know the difference between patient zone and healthcare area	Yes (patient zone - a patient's intact skin and its/his/her immediate surroundings colonized by the patient flora; healthcare area - containing all other surfaces)	171	58.2
Main route of transmission of antimicrobial-resistant organism between animal patients, clients and veterinary practitioners	Unclean veterinary personnel's hand	112	38.1
Sick animals are the most frequent source of pathogens in veterinary health care	Yes	91	31
An animal can become septic if the attending veterinary personnel's hands are unclean	Yes	68	23.1
Organisms that survive for weeks in human and animal environment			
<i>Clostridium difficile</i>	Yes	103	35
Methicillin-resistant staphylococci	Yes	103	35
Vancomycin-resistant enterococci	Yes	0	0
<i>Escherichia coli</i>	No	56	19
<i>Klebsiella pneumoniae</i>	No	12	4.1
Scenarios in which hand hygiene prevents transmission of pathogens to animals			
Before handling any animal	Yes	294	100
Before a clean/aseptic procedure	Yes	294	100
Before handling an animal that had surgery in the last 48 hours	Yes	282	95.9
After eating/drinking/smoking at work	Yes	294	100
After exposure to immediate surroundings of a sick animal	No	35	11.9
Scenarios in which hand hygiene prevents transmission of pathogens to veterinary personnel			
After handling an animal	Yes	294	100
After exposure to the surroundings of a sick animal	Yes	282	95.9
Before eating/drinking/ smoking at work	Yes	294	100
After removal of hand gloves	Yes	271	92.2
After contact with urine or faeces of an animal	Yes	294	100
Hand hygiene techniques			
Know the difference between hand washing and rubbing	Yes	259	88.1
Hand rubbing cleanses the hand more rapidly than hand washing	Yes	159	54.1
Hand rubbing causes skin dryness more than hand washing	No	123	41.8
Hand rubbing is more effective against pathogens than hand washing	Yes	68	23.1
The number of World Health Organization's recommended steps in appropriate hand washing	Seven	0	0
The World Health Organization recommended that hand washing and hand rubbing should be performed in sequence	No	238	81
Minimal time needed for alcohol-based hand rub to kill pathogens on a person's hands	20 seconds	0	0
Wearing gloves replaces hand washing practice	No	238	81
Appropriate method of hand hygiene in different clinical scenarios			
Before physical examination (taking vital signs, palpation) of an animal	Rubbing	123	41.8
Before injecting an animal	Rubbing	112	38.1
After removing animal excreta	Washing	103	35
After removing examination gloves	Rubbing or Washing	159	54.1
After cleaning an in-patient or sick animal's cage or pen	Rubbing	191	65
After visible exposure to animal blood	Washing	171	58.2
Managing <i>Clostridium difficile</i> -associated diarrhoea	Washing	12	4.1
Factors associated with increased colonization of veterinary healthcare worker's hands by pathogens			
Wearing hand jewelry	Yes	68	23.1
Damaged skin	Yes	215	73.1
Artificial fingernails	Yes	203	69
Regular use of a hand cream	No	147	50

Table 3. Practices and attitudes of hand hygiene by veterinarians

Attitudes, Behaviours and Practices	Frequency	Percentage (%)
	n = 294	
Adhere to correct hand hygiene practices at all times	159	54.1
Sufficiently knowledgeable about hand hygiene	123	41.8
Five moments of hand hygiene		
i. Perform hand hygiene before handling an animal	154	52.4
ii. Perform hand hygiene before a clean or aseptic technique (such as injecting an animal, vaccinating an animal, shaving an animal)	172	58.5
iii. Perform hand hygiene after touching an animal	294	100
iv. Always perform hand hygiene after contact with body fluids from animals	294	100
v. Always perform hand hygiene after touching an animal's surrounding	282	96
Perform hand hygiene in emergency cases despite its cumbersomeness	159	54.1
More important to perform my task than to perform hand hygiene when busy	191	65
Not worried about performing hand hygiene whenever gloves are worn	91	31
Dry hands with cloth towels after washing	292	99.3
Feel frustrated when others omit hand hygiene	215	73.1
Reluctant asking others to engage in hand hygiene	79	26.9
Staffs in my/our clinic have been properly trained/instructed in hand hygiene during their training	12	4.1
Feel guilty when hand hygiene is omitted	226	76.9
Miss hand hygiene sometimes due to forgetfulness	182	61.9
Hand hygiene is essential part of a veterinarian's role	294	100
Education of clients and other staffs in my/our clinic about hand hygiene is part of my role as a veterinarian	294	100
Perform hand hygiene often despite the frequency	171	58.2
Appropriate hand hygiene prevents veterinary healthcare-associated infections	294	100
Regular enrolment in hand hygiene training is crucial for every veterinarian	259	88.1
Appropriate hand hygiene helps in curbing antimicrobial resistance	289	98.3
Time pressure limits me from enrolling/involving in hand hygiene courses	203	69
Would like to be trained on hand hygiene	215	73.1

#### *Barriers of and approaches to improve hand hygiene among veterinarians in the study area*

Minority (15%) of the respondents reported that they have had formal training on HH and 4.1% claimed they had training on HH in the past 3 years. Majority of the respondents reported that there is neither a poster displaying the WHO HH recommendations (85%) nor an infection notice board (87%) in their clinic. Close to half of the respondents (45.9%) reported that the current location of HW facilities in their clinic is inconvenient. The reasons for poor HH compliance cited by the respondents were, in rank of decreasing frequency: lack of knowledge of recommended guidelines/protocol (65%), poor access to hand washing facilities (58.2%), non-availability of ABHR (45.9%), non-availability of soap and water (38.1%), lack of role models among colleagues/superiors (23.1%), frequent wearing of gloves and gowns by practitioners (19%), irritation and dryness caused by HW agents (15%), and understaffing and overcrowding (11.9%). The respondents cited antiseptic (35%) as the most commonly used HW agent followed by liquid soap and detergent (26.9%), soap bar and ABHR (8.2%).

Barriers to the use of ABHR reported by the respondents in rank of decreasing frequency: lack of availability (35.7%), skin sensitivity (8.2%) and time (4.1%). A considerable minority (26.9%) indicated that there is no barrier to the use of ABHR in their clinic. Personal protection (41.8%) ranked first as single most important

influencer on the use of ABHR followed by prevention of cross infection (35%), convenience (15%) and infection control policy (11.9%). Majority of the respondents opined that training and education of veterinarians and veterinary support staffs (69%), display of instructions demonstrating correct HW techniques in the clinic (58.4%), provision of accessible ABHR and soap dispensers (54.4%) were the most effective approaches to improve HH compliance among veterinarians while minority (35%) of them suggested that motivation of staffs would have effect on compliance to HH by veterinarians.

#### **Discussion**

The health and economic burden of multidrug-resistant HCAs is outrageous thus, veterinarians (as key animal healthcare providers) have been urged to hold the responsibility of HH (principally targeted to reduce HCAs and spread of AMR) in veterinary practice area (Anderson *et al.*, 2014; Pires and Pittet, 2017). The results obtained from this study showed that the overall level of awareness or knowledge about HH amongst veterinarians in the study area is moderate. This could be attributed to the fact that minority of the respondents had heard about the "5 moments of HH" model. The model aims to increase self-efficacy among practitioners by giving unambiguous advice about when to incorporate HH into complex care tasks (WHO, 2009; Kingston *et al.*, 2017). The finding of low

familiarity about the model in this study suggested that there is little or no WHO multimodal HH education/awareness campaign program going on in the study area. It also suggested that the Nigerian veterinary schools' curricula might be deficient with regards to concepts of appropriate HH. Despite the low familiarity with the "5 moments of HH" model, the respondents exhibited good knowledge about the importance/timing of some components of the model such as performing HH before handling any animal, before performing a clean/aseptic procedure, after contact with urine or faeces of an animal, after handling an animal and after exposure to the surroundings of a sick animal. This high knowledge about importance of the model's components may be due to personal experiences, motivations, instructional initiatives, influence of other staffs among other reasons. A similar finding was reported by Anderson and Wesse (2016) among veterinary clinic personnel in Canada.

The emergence of "personal protection" as the single most important positive influencer of HH practice among the respondents in this study implies that these veterinarians strive to protect themselves from risk more traditionally associated with certain aspects of care such as contact with body fluid (Kingston *et al.*, 2017). This may also explain the high compliance to some components of the "5 moments of HH" model such as after touching an animal and after touching body fluids from animal (100%) and after touching an animal's surroundings (96%), and high level of knowledge about the scenarios during which HH prevents transmission of pathogens. However, some of the respondents might have self-reported a high rate of personal compliance, but it has been noted that HH beliefs, knowledge and practices do not always correlate (Jeong and Kim, 2016; Kingston *et al.*, 2017). Despite 35% of the respondents identifying "prevention of cross infection" as the single most important positive influencer of HH practice and almost all exhibiting high knowledge of the importance/timing of HH, 47.6% were non-compliant with HH "before handling an animal", 41.5% "before performing a clean or aseptic procedure (such as vaccinating an animal, injecting an animal)" and 4% "after touching the surrounding of an animal". This suggested that some of these veterinarians may perceive less risk associated with these indications and may not realize the potential of veterinary HCAI transmission associated with these animal encounters (Kingston *et al.*, 2017). While there are no existing recommendations to perform HH before administration of vaccine to animals, HH is recommended before administration of injections (Anderson *et al.*, 2014). By video observation, Anderson *et al.* (2014) reported 3% and 26% compliance to HH before and after animal contact which is lesser than 52.4% and 96% recorded in the hereby study, respectively. Anderson *et al.* (2014) also reported that unnecessary or mistimed contact with animals (such as petting of animals at the end of appointment and immediately after performing HH) resulted in missed opportunity with compliance among veterinarians. It has been suggested that these unnecessary contacts with animals should be avoided especially if individuals are not ready to comply with appropriate HH (Anderson *et al.*, 2014). The finding of non-compliance by some veterinarians in this study calls for concern because it has been proven that the

veterinary hospital environment can contribute significantly to disease transmission (Anderson, 2015). The potential high infection-risk areas in the veterinary clinic environment are the patient zone (animal's intact skin and its immediate surroundings colonized by the flora) and healthcare area (containing all other surfaces) (Kirk *et al.*, 2016). Unfortunately, less than one-third of the respondents in this study actually knew the difference between a patient zone and healthcare area.

It is worrisome that a minor proportion (11.8%) of respondents in this study cited "infection control policy" as the single most important influencer to use ABHR (sanitizers). ABHR rapidly inactivate a variety of potentially harmful microorganisms and in all WHO HH policies, the use of ABHR is recommended as the "gold standard" for HH in human/veterinary healthcare settings (WHO, 2009; Kingston *et al.*, 2017). It is a matter of concern that respondents in this study did not identify "safety of the patients" nor "evidence-based practice" as positive influencers for the use of ABHR. This suggested that veterinarians in the study area perhaps do not know/consider that their patients' safety should be paramount during clinical practice. The major reason why the WHO developed evidence-based models ("5 moments of HH" and procedural HH practices) is to prevent transmission of HCAI to patients thereby ensuring their safety (Kingston *et al.*, 2017). These findings further prove that these veterinarians do not have adequate knowledge about HH and are practicing HH sub-optimally thereby worsening the problem of cross-transmission of pathogens between animals and humans.

It is disconcerting that most respondents in this study do not know the appropriate HH technique to employ in different clinical tasks/scenarios such as prior to physical examination of an animal, injecting an animal, and managing *Clostridium-difficile*-associated diarrhoea (Nair *et al.*, 2013; Maheshwari *et al.*, 2014; Anderson *et al.*, 2014; Kingston *et al.*, 2017). It is equally disturbing that only two-third of respondents in this study knew that HR and HW are the appropriate techniques of HH after cleaning a sick animal's surrounding and after visible exposure to animal blood, respectively (WHO, 2009; Nair *et al.*, 2013; Maheshwari *et al.*, 2014). This finding puts a doubt to the response of 54.1% and 41.8% of respondents who claimed that they adhere to correct HH practices at all times and have sufficient knowledge about HH, respectively. Although HH using ABHR is recommended for routine HH in healthcare settings, HW with soap and water is recommended when the hands are visibly soiled or when an alcohol-resistant pathogen (such as non-enveloped viruses e.g. canine parvovirus, and *Clostridium* species) may be present (Anderson *et al.*, 2014). ABHR is contraindicated when managing patients with *Clostridium difficile*-associated diarrhoea (Kingston *et al.*, 2017). Displaying of posters specifying contraindications for the use of ABHR in veterinary clinics should be an important component of future educational campaign or intervention in the study area (Anderson *et al.*, 2014).

The acronym "ESKAPE" (*Enterococcus faecium*, *Staphylococcus aureus*, *Klebsiella pneumoniae*, *Acinetobacter baumannii*, *Pseudomonas aeruginosa* and *Enterobacter*) are

“high priority” pathogens that pose threat to human and animal health against which the WHO has continued to urge human/veterinary health workers to step up their IPC practices (particularly HH) thereby controlling the spread of these organisms (WHO, 2017). Unfortunately, only a respondent in this study correctly knew the full meaning of the acronym and none of the respondents knew that VRE ranks first among organisms that survive for long time in the environment followed by MRS (Mathur, 2011). This finding suggested that veterinarians in the study area are deficient in knowledge about problematic pathogens that are easily spread in the hospital environment. This finding calls for intensified training of these veterinarians on HH from a “One-Health” perspective because these organisms are the commonest causes of HCAs. It raises serious concern that less than one-third of the respondents in this study knew that unclean hands of VP are the main source of pathogens in veterinary clinic and an animal could become septic if attending VP’s hands are unclean. The WHO has through awareness campaigns urged health-care providers to perform HH in order to prevent patients (especially those that had surgery) from developing sepsis (Saito *et al.*, 2018). Encouragingly, almost all the respondents knew that HH should be performed before handling an animal that had surgery in the last 48 hours.

It calls for serious concern that close to one third (31%) of respondents in this study reported that they do not worry about performing HH whenever gloves were worn and 19% identified frequent wearing of gloves and gowns by practitioners as reason for non-compliance to appropriate HH. After glove removal, 39% compliance to HH was observed among veterinarians (Anderson *et al.*, 2014) while 82.3% VP self-reported that HH is important after glove removal (Anderson and Wesse, 2016). It has been noted that glove use may be misconstrued as a substitute for HH (Anderson *et al.*, 2014). Although gloves are useful in preventing hand contamination from patients and/or objects, studies have shown that HH following glove removal is very important because gloves are imperfect barrier owing to the fact that they could have preexisting defect or unnoticed damage during use as well as potential for contamination of the hands during removal since they are often worn for “dirty” procedures (Anderson *et al.*, 2014; Hinkin *et al.*, 2014). For gowns, long sleeves have been reported to interfere with HH (scrubbing) at the wrist level and therefore should be avoided (Anderson *et al.*, 2014; Bouwera *et al.*, 2017).

Even more worrisome is that none of the respondents in this study knew that the WHO recommended seven unambiguous steps to perform effective HW (Cheng *et al.*, 2011; Nair *et al.*, 2013; Maheshwari *et al.*, 2014). This suggested that these veterinarians may not be performing HW appropriately. It is crucial to use appropriate technique during HH in order to ensure that all parts of the hands come in contact with the product used and are adequately decontaminated (Anderson *et al.*, 2014). Studies showed that base of the thumbs, back of the hands, between the fingers and beneath the fingernails are the areas likely to be missed if the recommended steps are not followed during HH (Anderson *et al.*, 2014). In future HH training programmes for Nigerian veterinary personnel, emphasis

should be made on these parts of the hands most often missed during HH.

Studies have shown that bacteria are transferred from hands to surfaces much more readily when hands remain wet, thus hand drying (HD) has been established an important component of HH (Kampf *et al.*, 2004). Reusable cloth towel potentially act as a formite between individual users and thus not recommended for HD in healthcare setting (Patrick *et al.*, 1997; Anderson *et al.*, 2014). Unfortunately, 99.3% of the respondents in this study reported that they use reusable cloth towel for HD. This further proves that veterinarians in the study area are performing HH sub-optimally. The recommended material for use in HD after HW in human/veterinary healthcare setting is single-use disposable hand towel (Anderson *et al.*, 2014). It is also recommended that after HD, the disposable towel should be used to open faucets of taps and door knobs so as to avoid recontamination of the dried hand (Bouwera *et al.*, 2017). Elsewhere, 1% of veterinary clinic personnel performed HD after HW using disposable towel while 23% used reusable cloth towel (Anderson *et al.*, 2014) indicating that these VP adhere to recommended HW guidelines better than respondents in this study. During educational campaigns and training of VP in Nigeria, information on appropriate HD techniques and ways of preventing recontamination of hands from water faucets should be emphasized (Anderson *et al.*, 2014).

Although in the minority, it calls for concern that 21% of the respondents in this study wrongly perceived that HW and HR are recommended to be performed in sequence. HR is performed as a standalone technique and is not combined with any other approach to HH (Kingston *et al.*, 2017). The use of ABHR after HW is not necessary and is not recommended (Anderson *et al.*, 2014). In fact, it has been reported that this practice can potentially curb contact time (reducing the effect of cleansing agent on microorganisms) and may result in additional damage to the skin which can lead to increased carriage of pathogens on the hands and reluctance to perform HH subsequently due to discomfort (Anderson *et al.*, 2014).

With regards to the advantages of the different HH techniques, only 54.1% of respondents in this study correctly knew that HR cleanses the hands more rapidly than HW while majority incorrectly believed that HR causes skin dryness more than HW which is more effective against pathogens. Kampf *et al.* (2004) reported that simply rinsing hands alone with water can remove some superficial skin cells and loosely-adherent bacteria through mechanical action. In clinical setting, the use of soap (either antimicrobial or non-antimicrobial depending on the specific situation) is recommended but reports also showed that if hands are not adequately dried after rinsing alone, the risk of pathogen transmission may even be increased (Patrick *et al.*, 1997; Anderson *et al.*, 2014). Contrarily, rubbing of hands with ABHR (which is antimicrobial in nature) results in rapid deactivation of various types of microorganisms and evaporates soon afterwards with no need of drying (Anderson *et al.*, 2014). Thus ABHR are recommended for day to day hand decontamination (Kingston *et al.*, 2017).



Of all the factors that can increase the likelihood of colonization of a VHWS hands asked in this study, “wearing of hand jewelry” was the least identified (23.1%). The issue of whether a HCW should wear ring or not remains unresolved because, no study has yet shown an effect of rings on pathogen transmission via hands in the clinical setting (Boyce and Pittet, 2002; Anderson *et al.*, 2014). However, hand jewellerys have been shown to increase bacterial load on the hands (Anderson *et al.*, 2014). Those jewellerys worn at the wrist (such as bracelets and watches) could potentially interfere with HW (scrubbing) and sanitizing at the wrist level (Boyce and Pittet, 2002). Nevertheless, some infection control guidelines recommended removal of hand jewellerys (particularly those that are elaborately designed or made from materials that absorb liquid and cannot be adequately cleaned if contaminated) prior to contact with patient or HH (Anderson *et al.*, 2014). As identified by majority in this study, artificial fingernails are not to be worn by practitioners because they are reservoirs for microorganisms (Mathur, 2011). Half of the respondents in this study do not know that the use of hand cream does not increase the likelihood of hand colonization by microorganisms (Nair *et al.*, 2013; Maheshwari *et al.*, 2014). This further indicated the need for urgent training of Nigerian veterinarians about HH in order to reduce the spread of MDROs and HCAs.

The most frequently identified barrier to the use of ABHR in this study was lack of availability. As reported by most respondents in this study, antiseptics, liquid soap and detergents are frequently used products for HH in most veterinary clinics in the study area. It has been noted that there is high likelihood that clinics without ABHR will have poor infection control culture (Anderson *et al.*, 2014). Unfortunately too, close to half of the respondents in this study reported that the location of HW facilities in their clinic is inconvenient and an inconveniently-placed (hidden) HW facility has been associated with reduced compliance (Pires and Pittet, 2017). For best practices, HH products (ABHR, running water, soaps) must be available at the point-of-care (POC) (where the animal, VP, and the provision of care or treatment come together) within arms-reach without leaving the animal’s zone (Kirk *et al.*, 2016). This will not only promote and facilitate HH but also prevent the potential spread of microbes that may occur if an individual is forced to move to another area to find a HH station (Mathur, 2011; Anderson *et al.*, 2014). Encouragingly, majority of the respondents in this study recognized that provision of accessible HH products would enhance compliance to HH practices.

Skin sensitivity ranked second among barriers to the use of ABHR in this study. Evidences showed that ABHR causes less dermatological issue than soap/detergents/antiseptics but 32.5% of Irish nursing students also cited skin sensitivity as a barrier to the use of ABHR (Kingston *et al.*, 2017). Circulation of counterfeit products, including ABHR, is a major public health problem in Nigeria. These counterfeit ABHR can potentially cause skin sensitivity and damage. Thus, it has been suggested that there may be scope to review the current ABHR products while continuously ensuring that the WHO guidelines are followed and product selection optimized (Kingston *et al.*, 2017).

ABHR has been shown to significantly reduce the time taken for HH (Kingston *et al.*, 2017). It is therefore worrisome that 4.1% of respondents in this study identified “time” as a barrier to the use of ABHR and almost two-third (65%) had the opinion that clinical task supersede HH when busy. This wrong perceptions and attitude may be why less than two-third of the respondents frequently performs HH during or in absence of emergency cases. It has been noted that individuals who believes that HH takes longer than is truly required may be less likely to attempt HH at all when busy (Anderson and Wesse, 2016). Nakamura *et al.* (2012) reported that 72% of veterinary support staffs cited being too busy as the most prominent reason for not performing HH. The WHO Guidelines on HH recommended 40-60 seconds for complete HW (from wetting hands to completion of drying) and 20-30s for completion of HR using sanitizers (WHO, 2009; Anderson *et al.*, 2014). Thus, the time burden to perform appropriate HH is not too onerous therefore Nigerian veterinarians should endeavour to comply with the recommendations (Kingston *et al.*, 2017). ABHR is the primary recommendation for routine HH as it takes less time, causes less skin damage and can easily be used at the point of care even when a sink is not available, saves water and generates less waste because disposable towels are not required for HD (Anderson *et al.*, 2014). Therefore, it is worrying that majority of the respondents in this study wrongly thought that HW is more effective than HR. Elsewhere, a 21% increase in compliance to HH was reported following a multimodal educational campaign in a veterinary teaching hospital in which the use of foaming ABHR was emphasized (Anderson *et al.*, 2014).

In this study, 26.9% of the respondents cited “no barrier” to the use of ABHR. This suggested that negligence on the part of some veterinarians in the study area affects compliance to recommended HH procedures (Kingston *et al.*, 2017). It may also suggest that these individuals have excellent HH compliance which has been reported to be highly unlikely among VP (Anderson *et al.*, 2014). Therefore, this perceived lack of barriers may partly be due to lack of awareness of when different HH techniques ought to be performed (Anderson and Wesse, 2016; Kingston *et al.*, 2017). This is the most probable reason because almost all the respondents in this study had never had formal training on HH nor had any HH training in the past 3 years. It may also be due to deficient curricula of the Nigerian veterinary schools on HH concepts and/or poor awareness campaign on HH in the study area. In addition, as indicated by majority of respondents in this study, there are no WHO recommended HH procedure or infection control posters/notice boards displayed in most veterinary clinics in the study area. HH posters/notice boards are considered a reasonable “first step” in human/veterinary healthcare facilities especially in facilities that may be resistant to more involved active interventions due to lack of a strong infection control culture or other reasons (Anderson *et al.*, 2014). This is because posters/notice boards are a commonly used type of intervention for promoting a wide variety of ideas and behaviours in many settings and they are often incorporated into multimodal interventions for improving HH compliance in healthcare

facilities (Mathur, 2011; Anderson *et al.*, 2014). Interestingly, more than half of the respondents in this study recognized that displaying instructions on correct HH techniques in the clinic can facilitate and promote compliance to HH practices. The lack of reminders in the veterinary clinics in the study area could also explain why close to two-third of the respondents sometimes miss HH due to forgetfulness. Anderson and Wesse (2016) suggested that to combat the problem of forgetfulness by veterinarians to perform HH, there is need to make HH a pervasive component of the clinic culture thereby going beyond reminders (written, verbal or other forms), in this way HH becomes habitual and does not need to be consciously reminded. Moreover, veterinarians should always remember to perform HH as they are frequently seen as clinic leaders, knowing that their attitude and behaviours are likely to be more influential than others (Anderson, 2015; Anderson and Wesse, 2016).

Lack of association between the variables (age, gender, qualification, year of practice and location) and awareness/knowledge of respondents in this study about HH may be because the respondents were similarly not exposed to the WHO HH model in the veterinary schools. This suggested that knowledge was a function of focused training on HH and not gender, age, qualification, year of practice or location. This study did not assess the association between the variables and compliance (practice) to recommended HH guidelines because of high likelihood of inflation of self-compliance (Anderson and Wesse, 2016).

Veterinarians are key animal healthcare providers thus they are expected to be trained in order to lead in IPC programs in veterinary healthcare systems (Morley, 2013; Saito *et al.*, 2018). Interestingly, more than half of the respondents in this study believed that staffs in their clinic are not well trained on HH and majority indicated that they would like to be trained on HH. By taking advantage of these optimistic views and other positive attitudes (such as appropriate HH helps in curbing AMR, HH is essential part of a veterinarian's role, feel guilty when HH is omitted, and education of their staffs and clients is part of a veterinarian's role) by majority in this study, the Federal Ministry of Health in collaboration with the Veterinary Council of Nigeria, Veterinary hospital administrations and other stakeholders should provide strategies on how they should intensify education of veterinary/allied animal health workers on the WHO HH Guidelines. These veterinarians would likely be receptive to the training since majority opined that training and education of VP will facilitate compliance to HH guidelines in their clinics.

This study highlighted an area where availability of literature is limited. The survey was anonymous and voluntary thus the likelihood of the respondents giving socially desirable answers was reduced. The study population is practicing/teaching veterinarians thus providing a better estimate of their knowledge about HH after graduation from veterinary schools. The data were collected from participants approached randomly therefore they may not account for the differences in the population. There is possibility of bias since the study is self-reported and some participants could inflate self-compliance (Anderson *et al.*, 2014). It is also possible that veterinarians with greater interest in infection control or who were more

comfortable with their current practices would be more willing to participate (Anderson and Wesse, 2016). Thus, generalization of the result to all veterinarians in Nigeria should be done with caution since only Enugu State was sampled. Despite the identified limitations of the findings, this study could be useful in improving compliance to HH guidelines in veterinary settings in Nigeria.

## Conclusions

The overall perception/awareness of veterinarians in Enugu State, Southeastern Nigeria about HH is moderate. This is attributed to lack of education/training on HH and absence of established IPC programmes and campaign on awareness of HH in the country. Consequently, veterinarians in the study area are practicing HH sub-optimally, thereby increasing the problem of veterinary HCAs. Thus, there is urgent need for intensified education/training of veterinarians in Nigeria on HH and the teaching of the concepts and practices of appropriate HH should begin during the Veterinary schools.

## Conflict of Interest

The authors declare that there are no conflicts of interest related to this article.

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