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Knowledge of hand hygiene and evaluation of hand washing technique among nurses at the University of Nigeria Teaching Hospital

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Abstract

Background Healthcare worker's hands are route for cross-transmission of potentially harmful germs between patients in a healthcare facility. As hand washing is an established cost-effective measure for infection control, hand hygiene knowledge and compliance with the recommended steps are essential to control healthcare-associated infections (HCAI). We assessed the knowledge and practice of hand hygiene among nurses at the University of Nigeria Teaching Hospital (UNTH), Enugu.

Methods A cross-sectional study was carried out from 14th September to 24th December 2023 on all consenting nurses in UNTH. A modified World Health Organization (WHO) knowledge questionnaire structured to collect demographics and assess hand hygiene knowledge expressed as good(> 75%), moderately good(50–74%) and poor(< 50%) knowledge. Duration to completion of hand washing was timed while Glo germ gel with ultraviolet lamp were used to assess effectiveness of hand washing. Ineffective hand washing was graded as fair, poor, or very poor. The WHO checklist was used to assess steps in hand washing technique performed.

Result A total of 395 nurses participated in the study (mean age and standard deviation, 41.40 ± 8.82 years). Most were females (93.2%), married (80.8%), and functioned in the surgery department (38.5%). Moderately good knowledge of hand hygiene was demonstrated by 58.2% while effective hand washing occurred in 29.2% of them. Steps of hand washing technique most frequently missed were the use of towel to turn off faucet (94.3%), rubbing backs of fingers to opposing palms with fingers interlocked (89.8%), and wetting hands with water before applying soap(55.9%). Zones of hands not adequately washed were mainly the fingernails and perimeter of fingernails (38.4%), the palm (28.6%), and the dorsum of hand (22.9%). There was no significant difference in hand hygiene knowledge and effective hand washing across the different age groups, sex, nursing cadre, educational qualifications, and departments.

Conclusion Nurses at the UNTH had fair hand hygiene knowledge with the majority demonstrating ineffective hand washing; a finding suggesting sub-optimal infection prevention and control. Periodic hand hygiene training targeting nurses and other health personnel engaged in patient care while emphasizing frequently missed areas is paramount to improving hand hygiene knowledge and effectiveness.

Clinical Trial Number Not applicable.

Keywords Hand hygiene, Hand washing technique, Knowledge, Glo germ gel, Ultraviolet light

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Introduction

Health care associated infections (HCAIs) are frequent adverse events that compromise patient safety in health-care causing significant morbidity and mortality [1, 2]. In Europe alone up to 2.6 million HCAIs are reported to occur every year leading to more than 91,000 deaths while in the USA the annual incidence of HCAIs is about 1.7 million with 99,000 resultant deaths [3]. Although data is sparse, available evidence suggests that the incidence of HCAIs is high in Africa [1, 4]. The pooled point prevalence of HCAI in Africa is estimated to be 12.76%—about double that of the developed countries [5].

The transmission of these HCAIs commonly occurs via the hands by direct contact which can involve patient to patient, patient to healthcare worker, and, healthcare worker to patient transmission among others [6]. In most cases, healthcare worker's hands are responsible for transmitting micro-organisms from the source (a patient, healthcare worker, or surrounding environment) to a patient [7]. Several studies have also demonstrated a reduction in the incidence of HCAI following the institution of proper hand washing [2, 8–11]. Hence, the World Health Organization (WHO) has described hand hygiene as the undisputed single most effective infection control measure [7].

Despite the importance of hand hygiene in reducing rates of HCAI, the knowledge of hand hygiene among nurses and other healthcare workers has been reported to range from low to moderate levels with only a few having good or high levels of knowledge while mostly maintaining suboptimal compliance to hand hygiene practices [12–16]. Furthermore, a recent global survey of hand hygiene implementation in health care facilities across 90 countries comprising 46% WHO member states revealed that although high income countries were at either intermediate or advanced levels of implementation, low income countries were still at basic or inadequate levels [7].

To further strengthen hand hygiene, the WHO in 2009 introduced the concept of “five moments of hand hygiene” to reduce transmission of infection during patient care, thus reducing the burden of HCAI [7, 17]. Since then, many countries have adopted this model of hand hygiene, and its awareness raised with the emergence of coronavirus-19 (COVID-19) and its adverse health outcomes [18–21]. However, mere compliance with this model will not entirely achieve its targeted outcome especially if hand washing itself is not properly performed. For hand washing to be effective, it has to be performed following the sequential steps recommended by WHO [7]. These steps ensure that all parts of the hands are carefully rubbed during the hand washing process.

This study aimed to assess the knowledge of hand hygiene among nurses at the University of Nigeria

Teaching Hospital, Ituku/Ozalla, Enugu likewise their hand washing technique to determine its effectiveness, and identify zones of the hand inadequately washed after hand washing with soap. This is particularly important because although literature exists describing hand hygiene knowledge among health workers in sub-Saharan Africa, this knowledge has been seen to vary within and across regions [22, 23]. Furthermore, there is a paucity of data describing hand washing techniques among health workers particularly nurses who form a major health workforce population in Nigeria and it is known that all components of hand hygiene are desired to be at an acceptable standard to achieve clean safe hands necessary to reduce transmission of HCAI.

Methods

Study area

The study area was the University of Nigeria Teaching Hospital (UNTH), Ituku/Ozalla, Enugu Nigeria. A foremost teaching hospital in Nigeria with a bed capacity of over 500 beds. UNTH renders both general and specialized medical and surgical services as well as obstetrics and gynaecology, and paediatrics services.

Study design

This was a cross-sectional study carried out from 14th September to 24th December 2023. Data was collected from eligible participants on the day the participants were evaluated. Where both completion of questionnaire and evaluation of the observed hand washing technique were not possible on the same day, one was postponed to another day as arranged with the participant. Completion of the knowledge questionnaire was routinely done first while observation of the hand wash technique was the component deferred to a later date which was within 72 h of submitting a completed question (typically on the day after).

Study population

A total of 576 nurses representing all the clinical nurses working at UNTH Ituku/Ozalla site were the target population. However, 395 representing a participation rate of 68.6% were eventually recruited as some nurses were on different kinds of leave including sick leave, and could not be reached and some declined consent. Every effort was however made to ensure that all nurses working during the period of this study were recruited by approaching their service area during the different work shift hours.

Inclusion criteria

Nurses working at the wards, clinics, and other areas provided they make contact with patients, were eligible to participate.

Exclusion criteria

Nurses in administrative positions and who do not attend to patients were excluded.

Sample size determination

Sample size was not be calculated as this was a population study. As such all nurses in the clinical areas totaling 576 were eligible for the study.

Sampling technique

We recruited all eligible nurses provided they were available physically and gave consent. The sample size for this research study was three hundred and ninety-five (395) nurses.

Study instrument

A questionnaire (Additional file 1) titled "Knowledge of Hand Hygiene and Evaluation of Hand Washing Technique among Nurses at the University of Nigeria Teaching Hospital, Ituku/Ozalla, Enugu" was used as the instrument for data collection. It was slightly modified from the WHO "Hand hygiene knowledge questionnaire for health care workers" (Additional file 2). This modification was necessary for adaptation to the local context and for the nurses specifically who were the target population being studied. Hand washing evaluation form (Additional file 3) was used to indicate the steps of hand washing applied and those missed while the "Hand zone" (Fig. 1) was used to indicate parts of the hands that were not adequately washed.

Data collection methods

The questionnaire contained 10 questions addressing training in hand hygiene, source and route of infection transmission, moments of hand hygiene, hand rub and hand washing, and risk of colonization of hands with microbes. Five of the questions have options that require Yes or No answers; three questions have options requiring choosing one correct answer among the options; one question has options requiring True or False answers and another has options requiring choosing the correct answer for each of the options. Of the 10 stem questions, 8 are knowledge testing questions while 2 are fact finding questions about the nurse. The 8 knowledge testing questions altogether generate 25 answers. Scores were expressed in percentages. The knowledge score level was grouped as good (score 75% and above), moderately good or fair (score 50–74%) and poor (score below 50%).

Handwashing

Prior to the commencement of the study, four health professionals who served as research assistants were trained, and a pilot trial for the observation and scoring technique for handwashing was carried. Handwashing was done under running water by each nurse and the physical observation of the steps of handwashing was carried out with the technique scored using the WHO steps of hand washing as a benchmark. These steps include:

1. Wet hands with water
2. Apply enough soap to cover all hand surfaces.

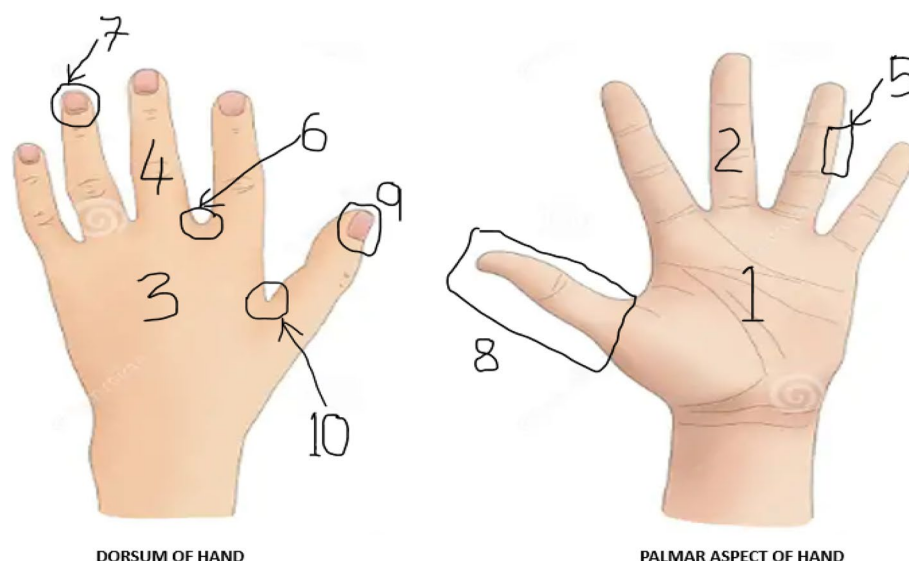


Fig. 1 Zones of the hands. 1-Palm, 2-Palmar aspect of finger, 3-Dorsum of hand, 4-Dorsum of fingers, 5-Side of fingers, 6-Web of fingers, 7-Finger nails and Perimeter of fingernails, 8-palmar aspect, dorsum and side of thumb, 9-thumb nail and perimeter of thumbnail, 10-web space between index finger and thumb

3. Rub hands palm to palm.
4. Rub right palm over left dorsum with interlaced fingers and vice versa
5. Rub palm to palm with fingers interlaced.
6. Rub back of right fingers to left palm with fingers interlocked and vice versa.
7. Do rotational rubbing of left thumb clasped in right palm and vice versa.
8. Do rotational rubbing, backwards and forwards with clasped fingers of right hand in left palm and vice versa.
9. Rinse hands with water.
10. Dry hands thoroughly with a single use towel.
11. Use the towel to turn off the tap.

One mark was awarded for each step correctly done and a total score of 11 was obtainable. Aside from step 1 and step 11 which represent mandatory first and last steps in the hand washing technique respectively, other steps might be performed in no particular order, and were scored if performed at all.

Duration of hand washing

The time taken to completely wash the hands which implies washing one's hands from steps 1 to 10 (excluding 11) was monitored with a stopwatch or timer. The duration taken to complete this task was then documented.

Use of glo germ gel and the ultraviolet light

A peanut drop of glo gel was applied to the palm of the participant by the researcher following which the participant was instructed to carefully rub this gel on every part of the hand (palm, back of hand fingers, and finger webs). The researcher observed that this had been properly done as instructed. To optimize the uniformity of spread of the glo germ on the hand between participants before actual handwashing, the UV light was shone over the hand to confirm acceptable spread, and more gel was applied if the spread was suboptimal. Glo germ gel processes the property of illumination when exposed to ultraviolet light (UV) light. Participants were then asked to wash their hands as they had been taught or learned in line with infection prevention and control (IPC) guideline of the hospital or according to the highest standard of hand washing technique they were aware of. After the last step of hand washing their hands were placed in a dark glo germ box or in the open away from light and then exposed to UV light from a 21 LED UV light touch. The inspection of the hand with the UV light was done sequentially starting with the palm, palmar aspect of the fingers and thumbs, back of the hands and fingers, the nails and perimeter of the nails (ie the nail folds and the area at the distal edge of the nail plate), the sides of

the fingers and thumb and the finger webs). Any area of the hand that glowed under the UV light was identified and documented in accordance with the zones listed and indicated in Fig. 1. Such zones are zones that retained the Glo germ gel even after hand washing and represent areas of the hand not adequately washed.

Effectiveness of hand washing

This was defined in terms of the number of zones retaining the glow germ after hand washing. Effective hand washing was defined as one in which no glo germ was detected by UV light in either the left or the right hand after hand washing. Ineffective hand-washing occurred if at least one zone was found to have retained glo germ by UV light in either hand after hand washing. Ineffective hand washing was graded based on the numbered zones where the glo germ was retained viz: zone1-3 as low retention, zone 4–6 as moderate retention and zone7-10 as high retention.

Statistical analysis

Data were collected via questionnaire and documentation of observations was scored with subsequent analysis done on SPSS version 24. Participants' characteristics such as age, cadre, duration of practice etc. were analysed as frequencies and percentages and presented in a table. Level of hand hygiene knowledge was presented as a pie chart. The zones indicating ineffective hand washing as well as the steps missed in hand washing was separately analyzed as percentages and presented as a histogram. Chi-square was used to compare the level of hand hygiene knowledge and effectiveness of hand washing among different cadre of nurses on the one hand and nurses across four major department of surgery, medicine, paediatrics and obstetrics and gynaecology on the other. Multiple logistic regression was employed to evaluate prediction of level of hand hygiene knowledge and effectiveness of hand washing by variables such as age, sex, duration of service, and previous hand hygiene training. A significant relationship was considered to exist if *p*-value was less than 0.05; otherwise, no significance.

Results

Socio-demographic data

A total of 395 nurses participated in the study (Table 1). They were mostly females (93.2%) and Christians (99.2%). Majority of them were married (80.8%) and had Bachelor's degree (62.8%). Most of the nurses have received formal training in hand hygiene (87.3%) mainly between 2016–2020 for their last training (49.3%) and mostly in UNTH (70.1%). Majority of the nurses routinely used alcohol-based hand rub for hand hygiene while almost all routinely washed their hands with soap (96.8%). Most

Table 1 Demographic characteristics of the nurses

Variables	Frequency (n = 395)	Percent
Age in years, mean 41.40 ± 8.82		
—≤ 30	38	9.6
—31–40	164	41.5
—41–50	118	29.9
—51 +	64	16.2
—No response	11	2.8
Sex		
—Male	21	5.3
—Female	368	93.2
—No response	6	1.5
Religion		
—Christian	392	99.2
—Non-Christian	1	0.3
—No response	2	0.5
Marital status		
—Single	65	16.5
—Married	319	80.8
—Separated	2	0.5
—Widowed	8	2.0
—Others	1	0.3
Highest educational qualification		
—RN	44	11.1
—Post basic Nursing	72	18.2
—Bachelor's degree	248	62.8
—Master's degree	25	6.3
—PhD	4	1.0
—No response	2	0.5
Designation/cadre		
—DDN	33	8.4
—ADN	35	8.9
—CNO	118	29.9
—ACNO	53	13.4
—SNO	17	4.3
—NOI	127	32.2
—NOII	11	2.8
—No response	1	0.3
Department		
—Medicine	69	17.5
—Obstetrics and gynaecology	45	11.4
—Surgery	152	38.5
—Paediatrics	67	17.0
—Others ^a	62	15.7
Ever received formal training in hand hygiene	345	87.3
Year in which hand hygiene training was received (n = 345)		
—≤ 2005	5	1.4
—2006–2010	10	2.9
—2011–2015	17	4.9
—2016–2020	170	49.3
—2021 +	130	37.7

Table 1 (continued)

Variables	Frequency (n = 395)	Percent
—No response	13	3.8
Location/modality of hand hygiene training (n = 345)		
—UNTH	242	70.1
—Another hospital	61	17.7
—Online/virtual training	49	14.2
—Non-hospital-based training	36	10.4
—School	11	3.2
—University	3	0.9
—Other	7	2.0
Routinely using an alcohol-based hand rub for hand hygiene	249	63.0
Routinely washing hands with soap for hand hygiene	384	96.8
Confidence to perform hand washing with soap according to Nigeria Centre for Disease Control (NCDC)'s recommendation	322	81.5

DDN Deputy Director of Nursing, AND Assistant Director of Nursing, CNO Chief Nursing Officer, ACNO Assistant Chief Nursing Officer, SNO Senior Nursing Officer, NOI Nursing Officer I, NOII Nursing Officer II

^a Others comprises family medicine, haematology unit and clinic, mental health clinic, psychiatric ward, and staff clinic

of the nurses believed they could correctly perform hand washing with soap according to the recommendation of Nigeria Centre for Disease Control (NCDC); 81.5% which is identical to the WHO recommendation.

Level of knowledge of hand hygiene among nurses

The level knowledge of hand hygiene was graded as good if a participant answered 75% of the questions correctly, moderately good for 50–74% and poor for correct answers of less than 50%. Only 0.5% had good knowledge. Altogether good and moderately good level of knowledge

were demonstrated by 58.7% of the participants. The distribution of level of knowledge is shown in Fig. 2.

Regarding the knowledge questions posed to the nurses (Table 2), the majority knew that hand hygiene actions that prevent transmission of germs to patients were actions done before touching a patient (92.9%) and immediately before a clean/aseptic procedure (85.1%) while actions that prevent transmission of germs to the health-worker were those done after touching a patient (93.2%), immediately after a risk of body fluid exposure (91.9%) and after exposure to the immediate

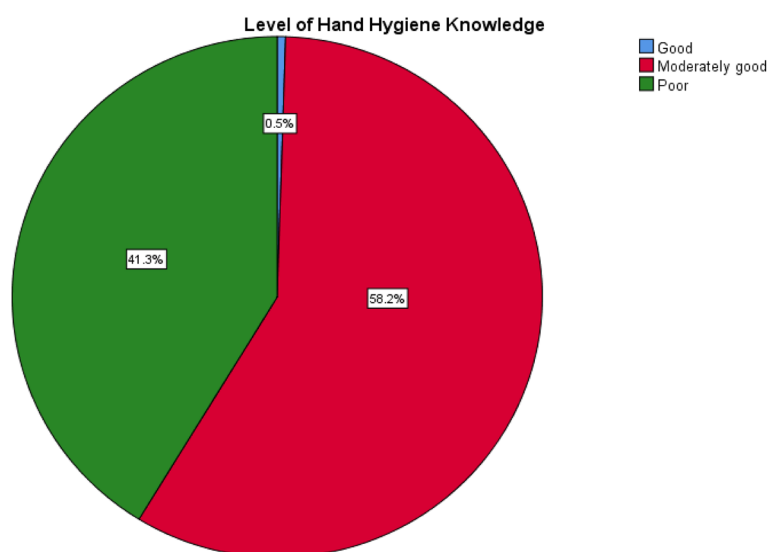
**Fig. 2** Distribution of level of hand hygiene knowledge among nurses

Table 2 Distribution of knowledge questions, and answers chosen by nurses

Knowledge question# (n = 395)	Yes n (%)	No n (%)	Don't know n (%)
Hand hygiene actions that prevent transmission of germs to the patient			
—Before touching a patient	367(92.9)*	25(6.3)	3(0.8)
—Immediately after a risk of body fluid exposure	344(87.1)	37(9.4)*	14(3.5)
—After exposure to the immediate surroundings of a patient	303(76.7)	75(19.0)*	17(4.3)
—Immediately before a clean/aseptic procedure	336(85.1)*	42(10.6)	17(4.3)
Hand hygiene actions that prevent transmission of germs to the health-care worker			
—After touching a patient	368(93.2)*	23(5.8)	4(1.0)
—Immediately after a risk of body fluid exposure	363(91.9)*	19(4.8)	13(3.3)
—Immediately before a clean/aseptic procedure	275(69.6)	105(26.6)*	15(3.8)
—After exposure to the immediate surroundings of a patient	358(90.6)*	24(6.1)	13(3.3)
Statements on alcohol-based hand rub and hand washing with soap and water that are true			
	True n (%)	False n (%)	Don't know n (%)
—Hand rubbing is more rapid for hand cleansing than hand washing	236(59.7)*	147(37.2)	12(3.0)
—Hand rubbing causes skin dryness more than hand washing	255(64.6)	125(31.6)*	15(3.8)
—Hand rubbing is more effective against germs than hand washing	104(26.3)*	274(69.4)	17(4.3)
—Hand washing and hand rubbing are recommended to be performed in sequence	320(81.0)	71(18.0)*	4(1.0)
Type of hand hygiene method required in the following situations			
	Rubbing n (%)	Washing n (%)	Don't know n (%)
—Before palpation of the abdomen	227(57.5)*	154(39.0)	14(3.5)
—Before giving an injection	87(22.0)*	293(74.2)	15(3.8)
—After emptying a bedpan	19(4.8)*	365(92.4)	11(1.8)
—After removing a patient's bed	40(10.1)	350(88.6)*	5(1.3)
—After making a patient's bed	36(9.1)*	352(89.1)	7(1.8)
—After visible exposure to blood	21(5.3)	363(91.9)*	11(2.8)
—After checking vital signs	111(28.1)*	279(70.6)	5(1.3)
Which should be avoided as associated with increased likelihood of colonization of hands with harmful germs			
	Yes n (%)	No n (%)	Don't know n (%)
—Wearing jewellery	302(76.5)*	89(22.5)	4(1.0)
—Damaged skin	351(88.9)*	42(10.6)	2(0.5)
—Artificial fingernails	381(96.5)*	13(3.3)	1(0.3)
—Regular use of a hand cream	116(29.4)	274(69.4)*	5(1.3)
Knowledge question#			
	Frequency	Percent	
Minimal time needed for alcohol-based hand rub to kill most germs			
—20 s*	156	39.5	
—3 s	59	14.9	
—1 min	72	18.2	
—10 s	106	26.8	
—Don't know	2	0.5	
Minimal time recommended for washing dirty hands with soap			
—20 s	141	35.7	
—30 s	102	25.8	
—1 min	137	34.7	
—40 s*	12	3.0	
—Don't know	3	0.8	
Main route of cross-transmission of potentially harmful germs between patient in health-care facility			
—Health-care workers' hands when not clean*	240	60.8	
—Air circulating in the hospital	8	2.0	
—Patients' exposure to colonised surfaces	94	23.8	
—Sharing non-invasive objects	44	11.1	

Table 2 (continued)

Knowledge question# (n = 395)	Yes n (%)	No n (%)	Don't know n (%)
—Don't know	9	2.3	
Most frequent source of germs responsible for health care-associated infections			
—The hospital's water system	12	3.0	
—The hospital air	3	0.8	
—Germs already present on or within the patient*	85	21.5	
—The hospital environment (surfaces)	289	73.2	
—Don't know	6	1.6	
Overall knowledge level			
—Good (knowledge score > 75%)	2	0.5	
—Moderately good (knowledge score 50–74%)	230	58.2	
—Poor (knowledge score < 50%)	163	41.3	

Asterisk(*) indicates the correct answer to each question; #questions appear as statements here but in the form of question in the study questionnaire

surroundings of a patient (90.6%). However, only 21.5% knew that germs already present on or within the patient were the most frequent source of germs responsible for HCAI.

On the other hand, very few knew that alcohol hand rub is required before giving an injection (22.0%), after emptying a bedpan (4.8%), after making a patient's bed (9.1%) and after checking vital signs (28.1%). Only 39.5% of the nurses knew that the minimal time needed for alcohol-based hand rub to kill most germs on hands was 20 s and even fewer (3.0%) knew that the minimal time recommended for washing dirty hands with soap was 40 s.

Effectiveness of hand washing technique among nurses

Only 29.2% of the nurses demonstrated effective hand washing technique. Many of them still retained the glo germ stain after hand washing as shown in Fig. 3 comparing the proportion of nurses that demonstrated effective hand washing compared to those that did not.

Steps of hand-washing technique missed during hand-washing

Steps mostly missed during hand washing were the use of towel to turn off faucet (94.3%), followed by washing backs of fingers with opposing palms with fingers interlocked (89.8%) and wetting hands with water before applying soap (55.9%). Fig. 4 shows the frequencies of

Effectiveness of hand washing technique

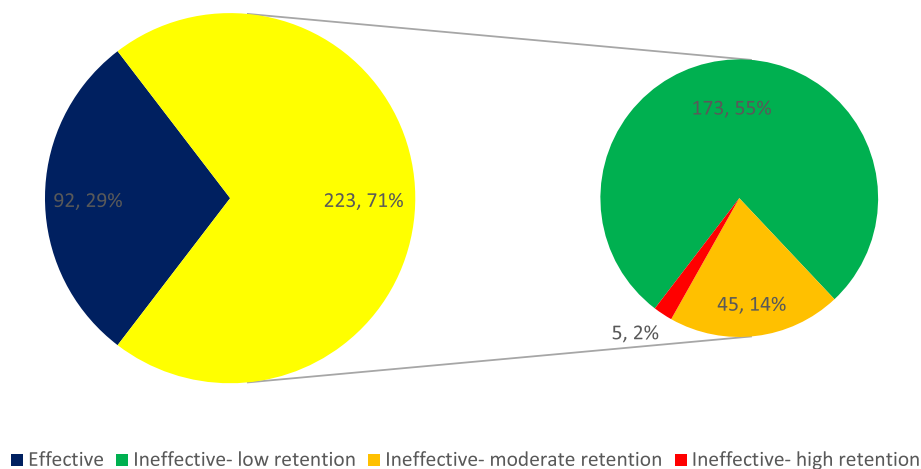


Fig. 3 Distribution of effective vs ineffective hand washing

missed steps compared to applied steps during hand washing.

Zones of hands not adequately washed after hand-washing

The zone of hands not adequately washed after washing were mainly the finger nails and perimeter of finger nails (38.4%), followed by the palm (28.6%), the dorsum of hand (22.9%) and the dorsum of fingers (21.9%). Fig. 5 represents the complete zones of the hand and to what extent each zone is inadequately washed relative to the other zones.

Comparing the level of hand hygiene knowledge of hand-washing among nurses

There was no significant difference in hand hygiene knowledge across the different age groups ($p=0.823$), sex groups ($p=0.734$), marital status ($p=0.285$), cadres ($p=0.754$), educational qualifications ($p=0.203$), departments ($p=0.098$), clinic or ward ($p=0.589$) and whether formally trained in hand hygiene or not ($p=0.674$). Details of the comparison is shown in Table 3.

Comparing the effectiveness of hand washing among nurses

There was no significant difference in effectiveness of hand washing across the different age groups ($p=0.416$), sex groups ($p=0.585$), marital status ($p=0.156$), cadres ($p=0.728$), educational qualifications ($p=0.832$),

departments ($p=0.909$), clinic or ward ($p=0.757$) and whether formally trained in hand hygiene or not ($p=0.923$). Details of the comparison are shown in Table 4.

Discussion

The hands of the healthcare worker are the main route of cross-transmission of potentially harmful germs between patients in a healthcare facility. Here, we accessed the knowledge of hand hygiene and compliance with the recommended steps of hand washing, and found that only a slight majority of the nurses had moderately good knowledge of hand hygiene.

A recent study in a tertiary health facility in Nigeria [24] which used a similar knowledge questionnaire and grading system also demonstrated 39.7% had fair knowledge. A greater percentage of their participants (36.1%) however had good knowledge compared to this study (0.5%). Their study population however, included other health workers such as doctors and laboratory scientists. In contrast a higher number of health care workers had good knowledge level in previous studies by Ndu et al. (80.3%), Ekwere et al. (83%) and Garba (72.4%) conducted at tertiary health facilities in Nigeria, at Enugu, Lagos and Kaduna states respectively. The discrepancy may be a reflection of differences in the number and quality of knowledge questions used in the questionnaires and the number of nurses sampled. This present study administered 27 knowledge questions while the previous studies used 6, 5 and 30 knowledge questions and smaller

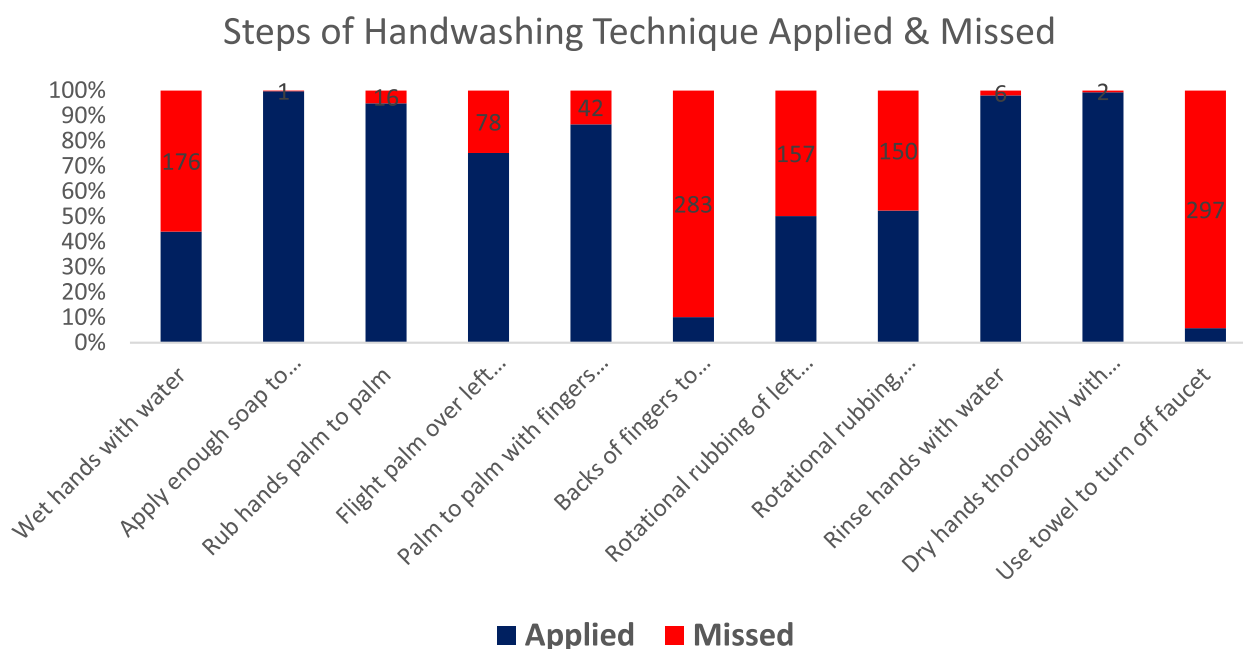


Fig. 4 Distribution of steps of hand washing missed vs applied steps. $n=315$; figures within the bar charts denote number of participants

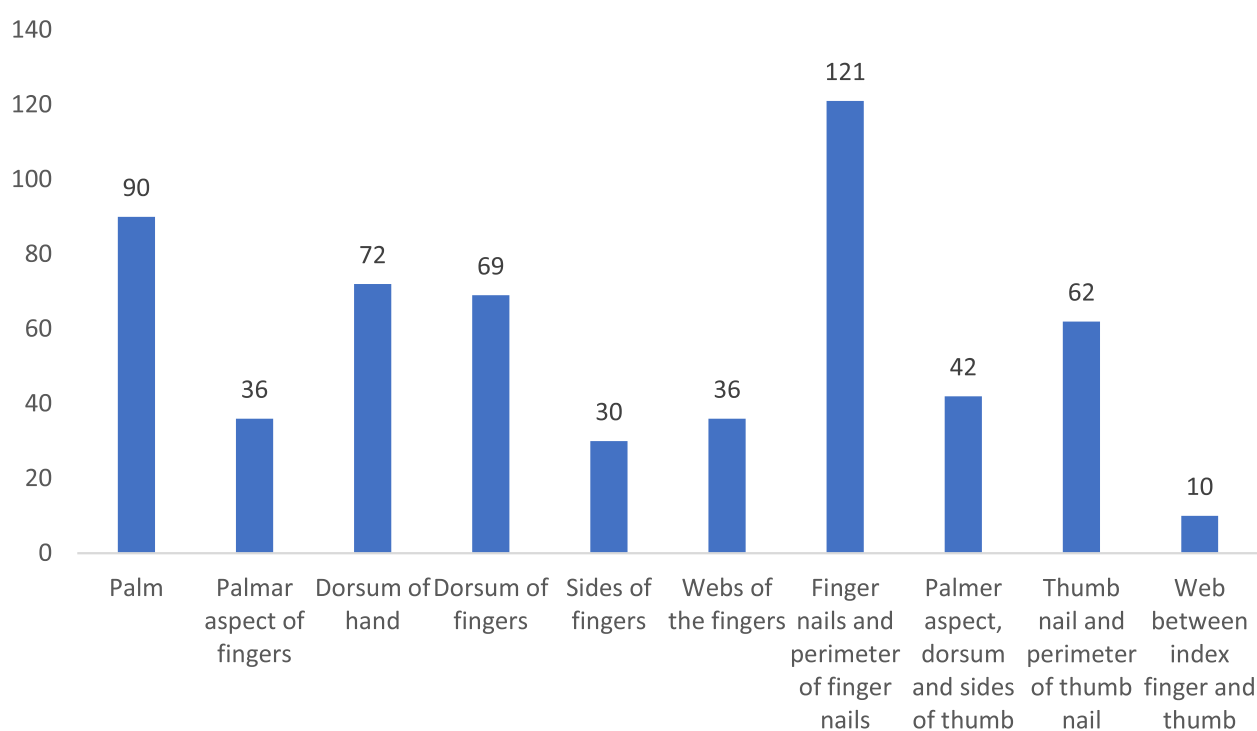


Fig. 5 Relative frequencies of zones of hands not adequately washed. $n = 315$; figure over the bar chart denotes number of participants

sample of nurses, 290, 250 and 44 respectively. Moreover, while the population in this study was homogenous as only nurses were studied, Ndu et al. and Garba studied doctors, nurses, laboratory scientists and hospital attendants/orderlies while Ekwere et al. studied doctors and nurses and the knowledge level documented was for their mixed population. Goodarzi et al. [25] found that 56.6% and 42.1% of nurses working in intensive care units of a tertiary hospital in Iran had good and fair level of knowledge of hand hygiene respectively. Similar to previous studies [24, 26, 27] most nurses in this study knew that hand hygiene actions that prevent transmission of germs to patients were actions done before touching a patient and immediately before a clean/aseptic procedure while actions that prevent transmission of germs to the health-worker were those done after touching a patient, immediately after a risk of body fluid exposure and after exposure to the immediate surroundings of a patient. Of concern however is the fact that only a few knew that alcohol hand rubbing is required before giving an injection, after emptying a bedpan, after making a patient's bed, and after checking vital signs. The poor level of knowledge demonstrated by 41.3% of the nurses in this present study indicates that more didactic training needs to be conducted to improve their knowledge base regarding hand hygiene and infective mechanisms.

Effective hand washing was poorly demonstrated in this study as just over a quarter of the nurses that participated in the actual hand washing had clean hands after hand washing. This is concerning as hospital acquired infections are known to be mainly transmitted through unclean [10, 28]. Inability to cover every part of the hands during hand hygiene procedures has been reported in previous studies. In a large scale hand hygiene study in a tertiary hospital in Singapore, in which 5,200 clinical staff received training on how to use hand rub solution, only 67% of them had satisfactory U-V light assessed hand-rub coverage, even when the assessment was done immediately after the training [29]. A Spanish study [30] on effectiveness of hand hygiene using a fluorescent marked hydroalcoholic solution which was conducted on medical and nursing students demonstrated effective hand hygiene (graded as "very good") only in 24.7% of participants, comparable to this present study. In that study, ineffective hand hygiene was graded as good, fair and poor and was associated with 29.8%, 25.1% and 20.3% of the participants respectively. Another study conducted among undergraduate nurses in Poland reported even a lower effective hand hygiene of 13% [31]. The low frequency of effective hand hygiene demonstrated in this present and previous studies emphasizes the care and presence

Table 3 Comparing the level of hand hygiene knowledge across nurses' characteristics

	Knowledge Level		Total	Chi-Square	p-value
	Good	Poor			
Age in years				.910	0.823
—≤ 30	20(52.6)	18(47.4)	38		
—31–40	98(59.8)	66(40.2)	164		
—41–50	72(61.0)	46(39.0)	118		
—51 +	37(57.8)	27(42.2)	64		
Sex				.115	0.734
—Male	13(61.9)	8(38.1)	21		
—Female	214(58.2)	154(41.8)	368		
Marital status				2.508	0.285
—Single	35(53.8)	30(46.2)	65		
—Married	188(58.9)	131(41.1)	319		
—*Widowed & separated	8(80.0)	2(20.0)	10		
—DDN	19(57.6)	14(42.4)	33		
—AND	23(65.7)	12(34.3)	35		
—CNO	72(61.0)	46(39.0)	118		
—ACNO	30(56.6)	23(43.4)	53		
—SNO	7(41.2)	10(58.8)	17		
—NOI	73(57.5)	54(42.5)	127		
—NOII	7(63.6)	4(36.4)	11		
Educational qualification				4.604	0.203
—RN	23(52.3)	21(47.7)	44		
—Post basic Nursing	36(50.0)	36(50.0)	72		
—Bachelor's degree	155(62.5)	93(37.5)	248		
—*Masters & PhD	18(62.1)	11(37.9)	29		
Department				7.829	0.098
—Medicine	38(55.1)	31(44.9)	69		
—Obstetrics and gynaecology	34(75.6)	11(24.4)	45		
—Surgery	81(53.3)	71(46.7)	152		
—Paediatrics	41(61.2)	26(38.8)	67		
—Others	38(61.3)	24(38.7)	62		
Clinic/ward				1.058	0.589
—Clinics	43(53.8)	37(46.3)	80		
—Wards	175(60.1)	116(39.9)	291		
—Others#	14(58.3)	10(41.7)	24		
Formal training in hand hygiene				.177	0.674
—Yes	204(59.1)	141(40.9)	345		
—No	28(56.0)	22(44.0)	50		

DDN Deputy Director Nursing, AND Assistant Director Nursing, CNO Chief Nursing Officer, ACNO Assistant Chief Nursing Officer, SNO Senior Nursing Officer, NOI Nursing Officer I, NOII Nursing Officer II

* Master's degree and PhD was merged; widowed and separated were merged because small frequencies

Others comprises family medicine, haematology unit and clinic, mental health clinic, psychiatric ward, and staff clinic

of mind that needs to be applied during hand rubbing or washing in order to ensure that every part of the hands is adequately rubbed or washed.

Of the eleven steps of hand washing recommended by WHO the five most missed steps in this study include the

use of towel to turn off the tap after hand washing; rubbing back of right fingers to left palm with fingers interlocked and vice versa; wetting hands with water before applying liquid soap to the palms; rotational rubbing of left thumb clasped in right palm and vice versa; and

Table 4 Comparing effectiveness of hand washing across nurses' characteristics

	Effectiveness		Total	Chi-Square	p-value
	Effective	Ineffective			
Age in years				2.848	0.416
—≤ 30	11(34.4)	21(65.6)	32		
—31–40	40(29.4)	96(70.6)	136		
—41–50	22(23.4)	72(76.6)	94		
—51 +	17(35.4)	31(64.6)	48		
Sex				.298	0.585
—Male	5(23.8)	16(76.2)	21		
—Female	85(29.4)	204(70.6)	289		
Marital status				3.711	0.156
—Single	18(36.0)	32(64.0)	50		
—Married	69(27.2)	185(72.8)	254		
—*Widowed & separated	5(50.0)	5(50.0)	10		
Designation/cadre				3.617	0.728
—DDN	5(27.8)	13(72.2)	18		
—AND	9(33.3)	18(66.7)	27		
—CNO	24(24.5)	74(75.5)	98		
—ACNO	10(23.8)	32(76.2)	42		
—SNO	4(30.8)	9(69.2)	13		
—NOI	36(34.0)	70(66.0)	106		
—NOII	4(40.0)	6(60.0)	10		
Educational qualification				.873	0.832
—RN	12(34.3)	23(65.7)	35		
—Post basic Nursing	16(27.1)	43(72.9)	59		
—Bachelor's degree	59(29.6)	140(70.4)	199		
—*Masters & PhD	5(23.8)	16(76.2)	21		
Department				1.005	0.909
—Medicine	20(31.7)	43(68.3)	63		
—Obstetrics and gynaecology	13(32.5)	27(67.5)	40		
—Surgery	34(28.1)	87(71.9)	121		
—Paediatrics	14(30.4)	32(69.6)	46		
—Others	11(24.4)	34(75.6)	45		
Clinic-ward				.558	0.757
—Clinics	14(25.5)	41(74.5)	55		
—Wards	72(29.8)	170(70.2)	242		
—Others	6(33.3)	12(66.7)	18		
Formal training in hand hygiene				.009	0.923
—Yes	80(29.3)	193(70.7)	273		
—No	12(28.6)	30(71.4)	42		

DDN Deputy Director Nursing, AND Assistant Director Nursing, CNO Chief Nursing Officer, ACNO Assistant Chief Nursing Officer, SNO Senior Nursing Officer, NOI Nursing Officer I, NOII Nursing Officer II

* Master's degree and PhD was merged; widowed and separated were merged because small frequencies

rotational rubbing, backwards and forwards with clasped fingers of right hand in left palm and vice versa. This pattern of missed steps with the exception of wetting hands before applying soap was reported among student nurses in a teaching hospital in Sao Paulo Brazil [32]. Failure to use the paper tissue provided to the nurses at the time

of hand washing, to turn off the tap may be explained by the fact that they are not used to the practice. Paper tissues or towels are not provided at the hand wash stations at the institution of this study and this probably meant a missed opportunity for nurses to imbibe the practice of turning off the tap with the towel. Another factor is the

absence of tap or running water at some hand wash stations, where a cup is used instead to scoop water from a bucket of water and poured onto the hands. The non-provision of regular or periodic hand hygiene education and training for health care workers at the hospital might have contributed to the suboptimal level of adherence to the recommended steps of hand rubbing or washing. These limitations are challenges that many low-income countries still grapple with, keeping them at merely or below the basic level of hand hygiene implementation [3].

The zones of the hands that were more frequently not adequately washed after hand washing in this study include the fingernails and perimeter area of the nails, the palm and the dorsum of the hand, excluding the fingers. However, when the palmar and dorsal aspects of the fingers are taken as part and parcel of the palm and dorsum respectively, the most frequently inadequately washed part of the hand was the dorsum followed by the palm before the finger nails and their perimeter skin. This finding is similar to the Singapore study [29] where parts of the dorsum, parts of the palm and parts of the fingertips were missed in 24%, 18% and 3.5% of the participants respectively after using hand rub solution. Gniadek A et al. [31] in their assessment of inadequately covered parts of the hand during hand hygiene among undergraduate nursing students identified the whole thumb, finger tip of the little finger and the mid palm as the most commonly missed surface of the palm; the finger tips and the whole thumb constituted the most commonly missed surface of the dorsum of the hand.

One would have hypothesized that the level of knowledge of hand hygiene will vary significantly across the different cadre of nurses with the more senior and supposedly more experienced nurses expected to have higher level of knowledge. However, this study did not demonstrate any such difference. There was also no significant difference in the level of knowledge of hand hygiene across the four departments of medicine, surgery, paediatrics and obstetrics and gynaecology(O&G) and “other” representing sub-departments and smaller clinical units that do not fall under the four major clinical departments. This is probably because unexpectedly the level of hand hygiene knowledge in general was not influenced by formal training possibly due to other “informal” observational or social learning that may have occurred over time between trained and untrained nurses. This does not however undermine hospital wide IPC training had been offered to all health care workers at the UNTH during and in the period after COVID-19 pandemic. The IPC training was organized by the Infectious disease unit and IPC committee of the hospital with the approval of hospital management. It consisted of didactic teaching and hand hygiene practical sessions among others and

was delivered in a similar manner to all sections of the hospital within few weeks. The study by Carla C Paz [32] among three different year levels of undergraduate nurses (2nd, 3rd and 4th year) in an institution in Brazil demonstrated that the 4th year students who received hand hygiene training few years before the 2nd and 3rd year students performed worse than the latter when they were all examined for compliance with correct steps of hand washing. So, the timing of training appears to have more impact on knowledge level and on correct performance of a technique than mere seniority by year of training.

This present study also showed there was no significant difference in effectiveness of hand washing across the nursing cadre and the departments. The same reasons attributed to no significant difference in knowledge level among the different groups are probably responsible for no significant difference in effectiveness of handwashing among the different groups. Also, neither the level of knowledge of hand hygiene nor the effectiveness of hand washing showed an association with the participant characteristics. Importantly, virtually all the nurses received their training on hand hygiene from the same resource persons and about the same period. About 70% of the nurses had received their hand hygiene training at the UNTH and not fewer than 87% received this training around the COVID-19 pandemic time.

Limitations

While training was conducted to ensure standardization with respect to the physical observation of the handwashing steps and application of glo gel, this may not have been fully achieved. Physical observation of the steps of handwashing and scoring each step based on the observation might not have been completely devoid of error such as missed observation of a step or steps due to observer's distraction or wrong scoring due to oversight but this observer bias was minimized by training the study team. Also, for persons in whom both questionnaire completion and observation of hand washing technique did not occur on the same day, there may have been an introduction of bias as these participants may have self-rehearsed the handwashing act before their set appointment with the study observer hence falsely improving the sensitivity but this occurred in a negligible few. Finally, being a single-centre study, the external validation and generalizability of the findings of this study are limited.

Conclusion

This study found that hand hygiene knowledge among a slight majority of nurses in a Nigerian tertiary hospital was moderately good although most nurses frequently missed some hand hygiene performance steps and only about a quarter of them demonstrated effective hand

washing. This was despite over 80% of them confirming they had received formal training in hand hygiene and affirmed that they were confident they could correctly perform hand washing with soap according to the NCDC recommendations. These gaps in hand hygiene knowledge and practice are a cause for concern as they reveal inadequacies in IPC which heightens the risk of patients acquiring HCAI. Therefore, we recommend that subsequent IPC training in the hospital should adopt a more practical approach and emphasize aspects of hand hygiene that tend to be easily forgotten while the hospital management on their part makes provision for single-use paper towels. Also, as standard practice, the picture of steps of hand washing with soap should be placed visibly at hand washing stations to be a constant reminder of the correct manner (the how) one's hand should be washed.

Abbreviations

COVID-19	Corona virus 19
HCAI	Healthcare-associated infections
IPC	Infection prevention and control
NCDC	Nigeria Centre for Disease Control
UNTH	University of Nigeria Teaching Hospital
UV	Ultraviolet light
WHO	World Health Organization

Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1186/s12912-024-02519-2>.

Additional file 1. Knowledge of Hand Hygiene and Evaluation of Hand Washing Technique among Nurses at the University of Nigeria Teaching Hospital, Ituku/Ozalla.

Additional file 2. WHO Hand Hygiene Knowledge Questionnaire for Health-Care Workers.

Additional file 3. Hand hygiene evaluation form /Checklist of Handwashing.

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Authors' contributions

NIN, JIM, EON, and ACN conceived and designed the study, OMU contributed to study design, NIN, JIM, JJO, PIN, NCU and OMU collected data, NIN, JIM, and ACN analysed and interpreted the result. All authors reviewed the manuscript.

Authors' information

Nnamdi Ikechukwu Nwosu is a medical doctor and physician with flare for public health research.

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Data availability

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

Declarations

Ethics approval and consent to participate

The participation of the nurses in this study was entirely voluntary. The consent of the all the participants used in the study was sought and obtained. Ethical approval for the study was obtained from the ethics committee on the UNTH under reference number UNTH/HREC/2023/06/531.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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