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Coronavirus Disease-19 Outbreak: Barriers to Hand Hygiene Practices Among Healthcare Professionals in Sub-Saharan Africa

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ABSTRACT

BACKGROUND: Hand hygiene practice entails hand washing, which is simple, cost-effective, and one of the first lines of defense in ceasing the spread of the current pandemic. This narrative review of published studies is conducted to highlight factors impacting hand hygiene practice and identify evidence-based strategies for improvement in sub-Saharan Africa.

METHODS: The literature search strategy covered printed and online sources, including manual library search (PubMed), Embase, Medline, and Cochrane Library. For papers written in English and published in the last ten years. A systematic analysis of available data was subsequently performed based on the review questions.

RESULTS: An estimated 134 articles were found online, and thirty-two articles utilized in the final analysis. Overall, hand hygiene betides with low compliance rates in developing countries. The calculated compliance rate was 20.49%. The challenges identified were the poverty of awareness and scientific knowledge concerning hand hygiene, infrastructural deficit including lack of access to clean and potable water, soap, hand rub gel, misconceptions regarding hand hygiene practice, etc.

CONCLUSION: Healthcare-associated infections draw increasing attention from all and sundry due to the growing recognition that most of these are preventable. Free evidence-based practice suggests that strict adherence to hand hygiene reduces the risk of cross-transmission of infections and especially in the COVID-19 pandemic era. The challenges identified in this review are consistent with the findings of studies conducted elsewhere. With "Clean Care is Safer Care" as a prime list of the World Health Organization's global initiative on patient safety programs; therefore, it is high time for developing countries to formulate the much-needed policies for implementing basic infection prevention practices in our healthcare settings.

Keywords: COVID-19; Hand hygiene; Handwashing; Healthcare workers; Infection prevention; Sub-Saharan Africa

INTRODUCTION

Hygiene is a collective term for every practice aimed at minimizing contacts with pathogens, such as bacteria and viruses [1]. That includes hand hygiene (HH), bathing, and keeping the work-place, kitchen and toilet clean, etc. Clean hands are the primary preventive tool for spreading pathogens. Besides, it might yet be necessary to disinfect sometimes even after cleaning [1]. In this light, HH is one of the crucial measures paramount for preventing the transmissions of Severe Acute Respiratory Syndrome (SARS)-CoV-2 virus, which causes the Coronavirus disease (COVID-19) [2, 3]. HH practice entails hand washing, which is simple, cost-effective, and one of the first lines of defense in ceasing the spread of the current pandemic. It must be adequately done using soap and water for at least 20 seconds [2-5].

Moreover, a respiratory infection caused by viruses like COVID-19 spread when virus-containing droplets advance into the body through the eyes, nose, or throat. Most often, this happens through contact with contaminated hands. The risk of COVID-19 transmission is magnified when people contact an infected person, or when they abut surfaces that an infected person has contaminated [2, 5]. The lasting effects of coronavirus in the hands may be erased with handwashing using soap and water, especially when done correctly [2, 6]. Currently, there is a systematic review of handwashing and its risk for respiratory infection, and it implied that HH could reduce the risk of the disease by 16% [2, 7]. Compliance with the recommended hand hygiene practices has paramount importance in averting the spread of COVID-19. Subsequently, there are reports that, in several settings, HH customary procedure

remain an area that calls for improvement [2, 3, 8-11]. A recent study by Pogrebna *et al.* found that a country's HH culture is a very compelling predictor of the degree of COVID-19 spread [2, 11].

Furthermore, healthcare workers (HCWs) are regularly exposed to microorganisms. Many of which can cause severe or even lethal infections [12, 13]. "Healthcare-associated infections (HCAIs) encompass infections developed by HCWs as a result of healthcare administration, hospital infections manifesting during hospitalization or after patient discharge, nursing home-acquired, long term care-associated, outpatient-related (e.g., dialysis, chemotherapy) and also home care-associated infections" [12, 14-16]. Interestingly, the World Health Organization (WHO) has strongly recommended that all the state members proffer public HH stations in response to COVID-19, and ensuring obligatory usage of these when visitors or personnel enter and leave the facilities, such as hospitals and health centers, etc., [1, 3]. Besides, an institution-based assessment of students' handwashing behavior in Cameroon revealed that "the prevalence of handwashing with soap was estimated at 10.7%. Besides, the majority of the study participants (75.2%) had poor handwashing practices score" [17]. Yet, compliance of HCWs to HH guidelines is low, especially in the African settings [18]. Consequently, there are general concerns about the poor HH culture in sub-Saharan African (SSA). Their negative implications in the control of COVID-19 were the motivations behind the undertakings of this study.

PANDEMICS OF CORONAVIRUS DISEASE 2019

SARS-CoV-2 is remarked as a novel virus responsible for the severe acute respiratory syndrome pandemic, also known as Coronavirus Disease 2019 (COVID-19). First discovered in December 2019, SARS-CoV-2 has been the causative agent for a pneumonic illness initially detected in Wuhan City, Hubei province, China. Surprisingly, COVID-19 had spread throughout China and to 210 additional countries and territories as of April 13, 2020. Phylogenetic data implicate a zoonotic origin, and the rapid spread suggests ongoing person-to-person transmission. Several studies offer further insight into person-to-person transmission [19, 20-23]. However, there remain unknown details regarding the range of humans, including the level of exposure to a confirmed case at which transmission is more likely to occur. On March 15, 2020, Illinois, USA, reported the state's first laboratory-confirmed case (index case) of SARS-CoV-2 in a traveler who returned from Wuhan, China [19, 20, 24]. New guideline to help protect the citizen from the transmission of the SARS-CoV-2 virus has been issued by the International Federation of the Red Cross (IFRC), UNICEF, and the World Health Organization (WHO) published on March 26, 2020. The direction provides practical checklists to keep schools protected from the pandemic. It also advises the State and Federal governments on how to adapt and implement emergency plans for educational facilities [19, 20, 23]. The primary focus is Global public health security and efforts to preventing the spread of COVID-19 pandemic. The guideline equally focuses on serious attempts to detect, report, and support infection prevention and control measures in general. Global health governance assists clinicians with laboratory facilities, especially those with state-of-the-art tools and quick reporting, which are crucial components of this response [19, 20, 24]. The overall response permits rapid information outflow and collaboration, especially between laboratory scientists and clinicians on the frontline. Healthcare workers are most at risk from outbreaks due to reemerging and novel pathogens. This risk has been observed in the current COVID-19 outbreak in China, whereas estimated 1716 health workers were infected by the virus, with six deaths as on February 14, 2020 [19, 20, 25]. As it was observed in a single-center case series of SARS-CoV-2 from Wuhan published recently [19, 20, 25]. The WHO released data dated April 13, 2020, showed a total estimated figure of COVID-19 infections at 1,920,181 cases, with 119,410 deaths and 443,735 recovered instances [19, 26]. The preceding brings to the fore HCWs exposure to the SARS-CoV-2 virus that caused lethal HCAIs, which in this case, it is COVID-19 [12, 13], and the basis for this review could have been averted initially by proper HH practices.

OBJECTIVE

The study aimed to critically review existing literature to highlight factors impacting on hand hygiene practice and identify evidence-based strategies for improvement, available in the sub-Saharan African.

METHODS

Literature Search Strategy

We identified relevant articles to date using a manual library search (PubMed), Embase Medline, and Cochrane Library as well as ClinicalTrials.gov for current trials on hand hygiene practices amid COVID-19 pandemic in sub-Saharan Africa. The Google search was done covering the following periods between March 1 and June 30, 2020, for papers written in English and published in the last ten years. Interestingly, the search was conducted using different keywords, including names of countries within sub-Saharan African, which were combined during the literature search and where applicable. The final search terms include these categories: "hand hygiene in healthcare" or "potent hand hygiene techniques" or "barriers" or "strategies to improve practice." Others are "hand wash" or "hand hygiene" or "hand cleansing" or "hand decontamination" or "hand-rubs" "infection control" AND "substitutes to handwashing" AND "healthcare worker" or "health care worker" or "nurse" or "medical doctor" or "healthcare profession" AND "Africa" or "sub-Sahara" or "sub-Sahara" or "Africa south of Sahara" or "Gambia" or "Swaziland" or "Sao Tome and Principe" or "Central Africa" or "Mozambique" or "Cote d'ivoire" or "Comoros" or "Madagascar" or "Lesotho" or "Senegal" or "Seychelles" or "Togo" or "Somalia" or "Sudan" or "Guinea" or "Tanzania" or "Sierra Leone" or "Niger" or "Kenya" or "Botswana" or "Burundi" or "Benin" or "Angola" or "Cameroon" or "Congo" or "Mauritania" or "Liberia" or "Ghana" or "Uganda" or "Malawi" or "Burkina-Faso" or "Chad" or "Zimbabwe" or "Zambia" or "Namibia."

Moreover, there were attendant six million hits at the initial period, after that, the search was narrow to COVID-19 and hand hygiene research themes and relevant references were collected, analyzed, producing the subsequent 134 articles. Consequentially, the study team read through them, and a final selection of the most pertinent thirty-two research articles was then critically reviewed in the final analysis.

Data Analysis

The data were extracted according to the review questions, and a narrative synthesis was conducted to identify the factors impacting hand hygiene practice.

RESULTS AND DISCUSSION

HISTORICAL PERSPECTIVE

The concept of handwashing and its significance in inpatient care was initially expounded in the early 19th

century [27-30]. Labarraque [28] submitted the initial evidence that hand decontamination could markedly reduce the incidence of puerperal fever and maternal mortality. Semmelweis, the Hungarian obstetrician, observed in 1847 that puerperal illness was more common in a maternity ward, whereby physicians and medical students provided care to women in labor than it was in the department where midwives assisted in such deliveries. He concluded that physicians and medical students were contaminating their hands while performing autopsies and later attending the examination of women without handwashing [27, 29].

Consequently, he was the first to recognize the importance of handwashing in preventing transmission of infection [31, 33]. Florence Nightingale equally provided similar evidence during the Crimean war, when in Scutari in 1854; she called for essential public health in a military hospital. "Her interventions helped significantly to improve hygiene, cleanliness in the hospital environment, food, and therefore resulted in a reduction in mortality. Nightingale made history as one of the first who identified the relationship between nursing and infection control," [32-36].

EPIDEMIOLOGY OF HEALTHCARE-ASSOCIATED INFECTIONS IN SSA

"Since December 2019, multiple cases occurring unexplainable pneumonia were successively reported in some hospitals in Wuhan city with a history of exposure to a sizeable Hua'nan seafood market in Wuhan city, Hubei province, China," [52-55]. "It has been confirmed to be an acute respiratory infection caused by a novel coronavirus; So far the numbers of cases have been increasing progressively," [52-55]. Besides, "clustered cases and confirmed cases without a history of travel to Wuhan emerged. Also, confirmed cases without precise exposure to the Wuhan seafood market had been found in many foreign countries or regions" [52-55].

Considering that HCWs are at the front-line of patient care, they are exposed to HCAIs. In China, as of March 2020, over 33,000 HCWs were diagnosed with COVID-19. The source of infection was proposed to be mainly through nosocomial transmission [56]. Interestingly, current evidence is in favor of a higher rate of HCAI in developing countries when compared to developed countries [57]. This evidence implies that HCAIs in developing countries can create spiral events of spreading of cases especially in the current pandemic. Surprisingly, there is a paucity of data on rate of HCAIs in sub-Saharan Africa during this COVID-19 pandemic. However, a review on the previous Ebola viral outbreak in Africa suggests that HCAI range from 5-18% of recorded infections in the year 2019 and 2020" [58].

Furthermore, "HCAIs are characterized by antimicrobial resistant pathogens. Another author submitted that secondary infections due to antimicrobial resistant pathogens contribute significantly to mortality rate of COVID-19 patients" [59]. Therefore, reduction of HCAIs in regions of high burden of antimicrobial resistance such SSA is important for addressing the effect of the pandemic [60, 61]. At 24:00 on July 2, 2020, an overall estimate of 10,533,779 total confirmed cases, 176,102 confirmed new situations, and 512,842 deaths have been reported by WHO globally; while the figures for Africa include, an overall estimate of 318,432 total confirmed cases, 11,638 confirmed new situations, and 6,340 deaths [52-56].

ROUTE OF TRANSMISSION

"The 2019 SARS-CoV-2 is a zoonotic communicable disease with possible source as a wild animal, most especially bats" [52- 55, 62-66]. "Up to the present, the primary infection source was the patients with pneumonia infected by the 2019-SARS-CoV-2. Respiratory air-droplet transmission is the main route of communication. Meanwhile, it can be transmitted through contact with infected persons and coming into contact with articles contaminated with virus droplets," [52- 55, 62-66]. "To date, many details, such as the source of the virus and its ability to spread between people remain unknown, increase numbers of cases reinforcing human-to-human transmission," [52- 55, 62-66]. Besides, a study showed that SARS-CoV-2 nucleic acid could be detected in the feces and urine of patients with COVID-19, suggesting that SARS-CoV-2 may be transmitted through the digestive tract through the fecal-oral route" [67-69]. "An author submitted that there is currently no credible evidence to support the claim that SARS-CoV-2 originated from a laboratory-engineered CoV. It is more likely that SARS-CoV-2 is a recombinant CoV generated in nature between a bat CoV and another coronavirus in an intermediate animal host. More studies are needed to explore this possibility and resolve the natural origin of SARS-CoV-2" [70]. "The main symptoms of COVID-19 caused by SARS-CoV-2 are fever, dry cough, and fatigue. A few patients may have a runny nose, sore throat, and diarrhea. Some patients may have dyspnea, and those who have a severe form of COVID-19 may rapidly progress to acute respiratory distress syndrome, coagulation dysfunction, and septic shock" [67-69]. "From the present treatment cases, mild patients only show low fever and slight fatigue but no pneumonia. Most patients have a good prognosis; a few patients may have a severe condition, and the elderly and those with basic chronic diseases have a poor prognosis" [67-69].

REGIONAL VARIATIONS IN THE INCIDENCE OF COVID-19

Almost every country reported some cases of COVID-19, but some areas have been hit much harder than others. Researchers are speculating why the new coronavirus has infected thousands in some countries but has left other countries relatively untouched? —The answer "could have profound implications for how countries respond to the virus, for determining who is at risk, and for knowing when it's safe" to ease specific mitigation measures, Beech and colleagues write [71].

1. Younger Populations: "Researchers have noted that a lot of the countries experiencing comparatively lower rates of COVID-19 cases also have relatively younger populations. Therefore, they have theorized that countries with younger residents on average are less likely to see widespread outbreaks of COVID-19" [71]. "This theory could explain why Africa, which has the most youthful population so far, has reported about 45,000 cases of COVID-19 among about 1.3 billion people. While Italy, which has a national median age of more than 45, is among the countries most affected by COVID-19, Beech, and colleagues report," [71]. According to Robert Bollinger, a professor of infectious diseases at the John Hopkins School of Medicine, "younger patients often are less likely to have underlying health conditions like diabetes and hypertension, which can cause potentially fatal complications in COVID-19 patients. Josip Car, a population and global health expert at Nanyang Technological University in Singapore, said younger patients usually have more robust immune systems than older patients, which can make them more likely to experience milder cases of COVID-19" [71].

2. Cultural Distance: "People in some countries tend to be more socially distant than others, which researchers theorize could help to prevent the new coronavirus from spreading, Beech and colleagues write. For instance, in India and Thailand, people typically greet each other from a distance by putting their palms together—a greeting that does not require people to

touch others. These countries have reported relatively low numbers of COVID-19 cases, Beech, and colleagues report," [71].

3. Environment: "Researchers have noted that the new coronavirus has appeared to spread faster in countries with temperate environments like the United States. It was noted that, when countries first started reporting. cases of COVID-19, countries with warmer climates were not reporting many cases," [71]. "The observations led researchers to question whether the new coronavirus struggled to survive in the heat. Further, Beech and colleagues note that a study by ecological modelers at the University of Connecticut has found that ultraviolet rays could inhibit the new virus, suggesting that surfaces in sunny places may be less likely to remain contaminated" [71].

4. Governments' Response: "Countries that enacted strict hygiene practices, social distancing, and stay-at-home policies early in their outbreaks mostly experienced milder outbreaks overall, Beech and colleagues write" [71]. They noted that countries in Africa that previously experienced outbreaks of HIV and Ebola 'reacted quickly' and were able to enact specific mitigation measures faster than other countries. For instance, employees at airports in Sierra Leone and Uganda were wearing masks and asking travelers for contact details long before some Western nations enacted similar precautions, Beech and colleagues write [71]. "Sierra Leone also repurposed disease-tracing protocols that officials had used during West Africa's Ebola outbreak in 2014. So far, the country has reported only 155 confirmed cases of COVID-19. Countries that initiated stay-at-home and social distancing policies early also have reported fewer instances of COVID-19" [71].

5. Delayed Wave Theory: "Researchers point to the 1918 Spanish outbreak as a basis for the theory, noting that the explosion didn't hit areas like Alaska and the South Pacific until its third wave occurred in 1919" [71]. "In terms of the new coronavirus pandemic, the world still is in the 'really early' stages, Ashish Jha, Director of the Harvard Global Health Research Institute, said. If this were a baseball game, it would be the second inning, and there's no reason to think that by the ninth inning the rest of the world that looks now like it hasn't been affected won't become like other places, Jha explained" [71].

BENEFITS OF HAND HYGIENE PRACTICES

Several Clinicians on the global front opined that HH is a critical factor in reducing hospital-acquired infection. The finding was further substantiated, especially during the initial development of healthcare systems [31, 72]. "Proper HH is suggested as the most crucial, simplest, and cheapest means of eradicating HCAIs and a means of reducing the spread of antimicrobial resistance [27, 35, 73-75]. Also, HH practice is equally found to be efficient in the COVID-19 pandemic era in reducing the spread of the disease" [27, 35, 73-75]. Several studies have demonstrated that hand washing virtually eradicates MRSA's carriage, which invariably occurs in HCWs working in ICUs [27, 76, 77]. An increase in handwashing compliance is accompanied by a fall in MRSA rates [27, 78]. "The HH liaison group identified nine controlled studies, all of which showed significant reductions in infection-related outcomes, even in settings with high infection rates in critically ill patients" [27, 79, 80]. Transmission of Health-care-associated *Klebsiella sp.* has also been documented to reduce with improvement in HH [27, 75]. "The evidence suggests that adherence to HH practices has significantly reduced the rates of acquisition of pathogens on hands and has ultimately reduced the prices of HCAIs in a hospital," [27, 75, 81-83].

INDICATIONS FOR HAND HYGIENE DURING PATIENT CARE

The World Health Organization (WHO) advocates 'Save Lives: Clean Your Hands' programs [27, 38, 84] that give credence to the "My Five Moments for Hand Hygiene" approach as critical to protecting the patients, HCWs, and the healthcare facility from the spread of pathogens and thus reduce HCAIs. Besides, the program – "My Five Moments for Hand Hygiene" teaches HCWs to clean their hands: before touching a patient, before clean/aseptic procedures, after body fluid exposure/risk, after touching a patient and after touching patient surroundings as documented in Figure 1 [27, 38].

Similarly, it is paramount to wash the hands often and correctly to stop the spread of COVID-19 [2-4, 85]. The accurate way of handwashing requires five key steps: (1) Wet both sides under clean running water; (2) Stow a liberal amount of soap to the front and back of the hands, as well as fingertips; (3) Rub in between and around the fingers; rub the back of each hand using the palm of the other hand; rub fingertips of each hand to the opposite palm of the other hand, and rub each thumb clasped to the opposite hand for at least 20 seconds; (4) Rinse thoroughly under running water, and dry hands with clean paper/towel; (5) Turn off the water using a paper towel as documented in Table 1 [2, 3, 86, 87]. "Besides, it motivates the HCWs to wash their hands with soap and water when (i) overly contaminated with proteinaceous material, blood, or other body fluids. Meanwhile, if exposure to *Bacillus anthracis* is suspected or proven, then washing and rinsing hands in such circumstances are recommended. Mainly because alcohols, chlorhexidine, iodophors, and other antiseptic agents have weak activity against spores; (ii) advocated also, after using a restroom, wash hands with a non-antimicrobial soap and water or with an antimicrobial soap and water; and (iii) before and after having food" [27, 73-75, 84, 88, 89].

Furthermore, in all other clinical situations described below, when hands are not overly dirty, it is mandatory to use an alcohol-based hand rub routinely for decontaminating hands. The clinical scenarios for routine use of an alcohol-based hand rub is as documented in Table 2 [27, 67-69, 84, 88, 89].

POTENT HAND HYGIENE TECHNIQUES

"Mani *et al.* in 2010 submitted that result-oriented HH practice involves the cleansing of visible contaminants and the reduction of microbial colonization of the skin. The hands of any Healthcare workers are commonly exposed to two types of pathogens. They include (a) Transient (contaminating) microbes, and (b) Resident (typical or colonizing) microorganisms," [90].

Furthermore, "active HH, either by hand washing with antimicrobial soap or alcohol-based hand-rub, is one critical way to minimize the cross-infection risk. Therefore, potent hand washing is the application of a plain (non-antimicrobial) or antiseptic (antimicrobial) soap onto wet hands. After that, vigorous rubbing together of both sides to form a lather, subsequently ensuring that the hand-rubs cover the entire surface of the hands, the base of the fingers, between the fingers, back of the fingers, fingers tips, fingernails, thumb and wrists for one minute, etc.," [31, 91, 92]. "It is equally beneficial for the nails to be made low. It is remarked that artificial fingernails are potential traps for bacteria and must be avoided as much as possible. Some authors mentioned that new nail polish on natural nails does not aggravate microbial load; however, chipped nail polish can harbor bacteria" [91]. Wearing jewelry, such as rings or hand watches, could lead to bacterial colonization, especially for the underlying skin

Once soap and hand rub have been applied, then the hands need to be appropriately rinsed in other that the lather is completely removed [92-95].

"Hand drying is equally essential to prevent cross-infection because microorganisms tend to thrive in a damp environment. Moreover, proper hand drying is required before wearing gloves, as trapped moisture under gloves can cause skin irritation and increase the harboring of bacteria" [91, 94]. "Alcohol-based hand-rub is recommended for hand decontamination in all clinical settings apart from visibly soiled hands," [91].

Alcohol hand-rub uses alcohol instead of water. In contrast to the mechanical (friction) removal of flora in hand washing, alcohol works by killing the vegetation. Alcohol hand-rub differs from hand washing because it acts on the microorganisms by denaturing their proteins and thus can eradicate all transient flora and most resident flora," [92]. "It also takes lesser time than hand washing, between 15 to 30 seconds. The process of alcohol hand-rub starts by applying a sufficient amount of the alcohol-based hand-rub product (liquid, gel or foam) according to the manufacturer's recommendation (usually between 3 to 5 ml), and spreading it all over the hands, especially the areas between fingers, thumbs and fingernails. The effective concentration of alcohol should be 60% to 95%; levels of greater than 95% are not recommended because they have less water, which is essential for the protein denaturation of microorganisms, making them less potent" [91,93, 95].

HCWs should adopt either procedure for HH, either alcohol hand-rub or handwashing with antimicrobial or non-antimicrobial soap, but use the latter if hands are visibly soiled. Using both methods simultaneously is not recommended, as it doubles both cost and time. Trampuz & Widmer in 2004 argues that using alcohol hand-rub immediately before or after hand washing could cause dermatitis and further recommend wearing powder-less gloves to avoid possible alcohol reaction with a residual powder [92]. However, Kampf & Loffler in 2010 maintains that using alcohol hand rub after hand washing could reduce irritation caused by hand washing detergents since this method also removes soap from the skin [93].

BARRIERS TO HAND HYGIENE PRACTICES

Several factors are responsible for inadequate hand hygiene compliance among HCWs which are well discussed. In one exhaustive review by Ataiyero *et al.* "the various barriers identified are consistent with the findings of studies conducted elsewhere; however, it appears that heavy workload, infrastructural deficit, and poorly positioned facilities are more likely in developing countries" [96]. They are equally summarized in Table 3 [96-128].

A. Lack of Awareness and Scientific Knowledge: Some authors suggest that poverty of awareness and scientific knowledge concerning hand hygiene are established barriers to the practices [31, 90, 92]. Karabay *et al.* in 2005 emphasize that lack of adequate knowledge of proper infection control during training programs, especially by students, leads to lousy HH practice [96-128, 129-132]. According to Ott & French in 2009, who advocated that nursing students receive training on standard infection control precautions during their first seven weeks [72]. However, the training benefits decline from the beginning to the third year of study [72]. Therefore, it is essential to emphasize the teaching of infection control courses at every cadre of study. Nazarko in 2009 found that most graduating pre-registration nursing students do not receive a broad education program in infection control [133].

B. Limited Promotional Courses or Seminars:

Takahashi & Turale in 2010 [101] reported that educating the populace through short courses and seminars are fundamental in promoting HH and help staff to comply with the institutional protocols of infection control. Although 90% of the NHS trusts provide induction training in infection control for their team, but many individuals are of the opinion that NHS fails to provide annual updates for such infection control training [96-128, 133].

C. Misconceptions Regarding Hand Hygiene: Other authors suggest that misconceptions regarding HH are also believed to contribute to low compliance; for instance, when gloves are used as an alternative to HH, or the notion that skin irritation arises from frequent HH practice [90, 92, 96-128, 132].

D. Professional and Organizational Barriers:

Besides, increased workloads, under-staffing, limited time, lack of role models among colleagues or seniors, lack of organizational pledge to proper HH practice, disagreement with guidelines and protocols and lack of motivation have all contributed to poor compliance with HH and infection control measures [31, 90, 96-128, 129].

E. Lack of Hand Hygiene Infrastructure: Lack of HH infrastructure such as tap water, sinks, antiseptic or non-antiseptic soaps, and alcohol hand-rubs, etc., can also play a significant role in low-quality HH practice [31, 90, 93, 96-128, 134]. Such unavailability of infrastructure is further compounded in our developing countries. For instance, Ogunsola & Adesiji in 2008 reported that most wards in Nigerian hospitals lack support for proper HH. There are bucket and bowl methods as an alternative to tap water [135]. A similar report in India, by Devnani e*t al.* in 2011 suggest insufficient or inconveniently positioned sinks, inadequate access to soap and water, as obstacles to appropriate HH practice [136]. Lotfinejad *et al.* in a 2020 study on COVID-19 and hand hygiene, submitted that HH is an essential component of infection prevention and control (IPC), which is often neglected by HCWs both in developed and developing countries, with compliance rates sometimes dipping below 20% [48, 137, 138]. Besides, overcrowding of healthcare facilities, and the absence of distinct patient zones and lack of reliable and adequate alcohol-based hand rub (ABHR), are among the many challenges preventing effective HH procedure in resource-limited healthcare settings [48, 137, 138].

F. Limited access to Clean and Portable Water: "In some rural communities of SSA, there is a lack of soap and clean water to hand. An estimated 3 billion people worldwide have no access to the portable at home. In the era of the COVID-19 outbreak, the public health directive to "wash your hands" is a challenge for people with limited access to clean water. Everyone knows by now what we have to do to "flatten the curve" for COVID-19: we have to practice social distancing and wash our hands as if our lives depended on it" [48, 137-139].

Furthermore, "handwashing is arguably even more important when people live shoulder-to-shoulder, near trash heaps and open drains. Handwashing for the prevention of infectious diseases has been promoted for over a century; the current crisis even spawned a Google Doodle demonstrating proper handwashing in six distinct steps" [48, 137-139]. "But how do you adhere to these expectations if you have no access to piped water, or even if you are one of the lucky households with piped water, but from a communal tap that is only intermittently supplied? Consider families whose members have to fetch water from even a reasonably close-by source. In 2015, according to a report from UNICEF and WHO, 263 million people spent over 30 minutes per round trip to collect

water from an improved source, and 159 million people collected drinking water directly from surface water sources" [48, 137-139].

Interestingly, in rural India and Africa, for instance, due to the inadequate water supply, "feco-oral transmission" of microbes is a commonplace. Few families may have soap and a communal tap. But in the dry season, when the between-supply spells lasted for easily a week, definitely no more washing of hands with soap except after the toilet, because with used soap, even more water is needed to get the soap off [48, 137-139]. Community members have to make that water stretch. This situation is the reality of low-income households in low-income countries around the world. When there is no running water or no mechanism for delivering enough water, you cannot practice proper, handwashing.

Consequently, COVID-19 may not differentiate between prince and pauper, but running water does [48, 137-139].

STRATEGIES TO IMPROVE COMPLIANCE TO HAND HYGIENE PRACTICES

A. Healthcare Workers' Education: Some works of literature submitted to increase HCWs' compliance with HH, and it is essential to consider the enhancing factors. For example, staff education and proper follow-up training in HH practice are imperative [93-95].

B. Adequate Knowledge on Handwashing: "The governments and public health experts worldwide have been telling us to wash our hands with Soap and Water. Good hand hygiene could reduce cases of respiratory diseases by 20% and diarrhea by 30%. That means it has the potential to have a considerable impact on the spread of the coronavirus. The virus is made up of genetic material wrapped in a fatty coating. Soap molecules can disrupt this lipid membrane, causing it to fall apart," [85-87, 93-95]. "The virus's 'spike' proteins, which generally help it invade human cells, are lost into the surrounding environment, rendering the virus inactive. With the fragments of the virus enveloped by the soap molecules, they are washed away when you rinse your hands. The physical action of scrubbing hands can also help to dislodge viral particles, which is why there has been so much emphasis on how we wash our hands and for how long" [93-95].

C. Removal of Misconceptions: "Besides, equally important is to clarify HCWs' misconceptions in terms of glove usage and skin problems to achieve better adherence to HH practice. The ward manager responsible for HH products ensures they are always available and placed in accessible locations, most importantly inside and outside of patients' room, nursing stations, and offices, etc.," [93].

D. Use of Promotional Materials: Smith & Lokhorst in 2009 [95] suggest using promotional materials, such as posters, which can be sited in visible sites within the hospital. Doing so serves as a reminder to HCWs, patients, and visitors of the significance of HH practice. Additionally, video jingles can be placed on the wards to show patients the importance of hand hygiene in preventing cross-infection. Proper hand hygiene technique illustrations above sinks or near to alcohol hand-rub dispensers have been proven to be very relevant to improved compliance [95]. On the other hand, improving handwashing through knowledge alone is typically insufficient to change handwashing behaviors [140-143]. "In many cases, humans modify their behavior in a socially desirable way when being observed by others. Hence, applying this basic idea to public handwashing stations may help positively influence individuals" [140-143]

E. Raising the Sense of Accountability Among HCWs: Besides, Maxfield & Dull in 2011 [130] point out that every nurse should be held responsible for reminding co-workers to practice hand hygiene, thereby raising the sense of accountability among HCWs.

F. Granting Incentives (such as Recognition or Awards): "Moreover, staff with good hand hygiene should be granted incentives like recognition or awards, such as the announcement in the hospital newsletter, an accolade that may positively impact one other to perform likewise. Short messages about hand hygiene practice could also be set on computer screen savers to motivate computer users," [130].

G. Evidence for Recommending Alcohol Hand-Rub: There is much evidence for recommending alcohol hand-rub because of its clinical benefits and cost-effectiveness. Canham, 2011 [91] finds that alcohol hand-rub contains various emollients which are better tolerated by HCWs than hand washing. According to Trampuz & Widmer, 2004, [92] factors such as color, odor, and consistency of alcohol hand-rub products could influence HCWs' acceptance of the product.

H. Positioned Alcohol Hand-Rub Dispensers: Additionally, alcohol hand-rub dispensers can be readily accessed at the patients' bedside, waiting areas inside and outside patients' rooms, the nursing stations, and next to computers [92, 131].

I. Cost Reduction Scheme: Mani *et al.* in 2010 [90] claim that alcohol hand-rub is suitable for use in countries where resources are limited. Also, alcohol hand-rub increases the potential of economic benefits by reducing annual costs, especially in countries where water has to be refined. There are also hidden costs: water decontamination, power for water heating, and water drainage [132].

J. Effective Use of Alcohol Hand-Rub: Effective use of alcohol hand-rub means that HCWs must strictly adhere to the manufacturers' instructions, especially in terms of the amount used and the time needed to evaporate completely from the hands. Alcohol impregnated wipes are not as effective as alcohol hand-rub and not recommended for routine hand hygiene [92, 133, 144].

K. Ensuring Safety of Alcohol Hand-Rub: Trampuz & Widmer, 2004, submitted that alcohol hand-rub products tend to ignite, depending on the type and concentration. However, fires associated with such products are sporadic. Nonetheless, alcohol hand-rub products should be stored away from high temperatures, and containers should be designed to minimize evaporation [92].

L. Sustainable Solution to Water Scarcity: "Integrated Water Resource Management (IWRM) is becoming recognized as the only sustainable solution to water scarcity; by ensuring the provision of clean and potable water. This holistic water resource approach referred to as the Dublin - Rio principle (UNCED Rio de Janeiro 1992), highlights that freshwater is finite, vulnerable, and essential to sustain life, economic development, and the environment. Water development and management should be based on a participatory approach, involving users, planners, and policymakers," [145].

Water production and consumption growth rates in many regions are unsustainable. IWRM promotes a holistic approach for the finite water resource that considers all users, planners, and policymakers. One practical benefit resulting from numerous high-level environmental conferences is an increase in communication and initiatives between municipalities, non-governmental organizations (NGOs), and private enterprises. The worldwide Business Partners for Development (BPD) program, established by the World Bank in 1998, includes this pilot project. Vivendi Water, with its project partners — Durban Metro, City of Pietermaritzburg, Umgeni Water, Mvula Trust (NGO), and Water Research Commission -

installed and operate a new water distribution network for the townships in Durban and Pietermaritzburg, etc., [145]. "The partnership also trains employees to work the system. These sustainable solutions in most African communities provide the following benefits: (i) Community partnership with affordable water supplies in poor informal settlements; (ii) Making available an additional eight percent of potable water for the community; (iii) Guaranteeing lower water costs to industry (25% than clean); and (iv) Reducing flow to an overloaded long sea outfall, thereby extending its life. Similar projects are ongoing in several rural communities worldwide," [145].

KEY PANEL MESSAGE

1. The impact of HCAI is pronounced in developing countries, and especially in Africa
2. From evidence-based practices, contaminated hands play a significant role in the spread of HCAI and especially COVID-19.
3. Hand hygiene is a highly beneficial approach to reducing healthcare-associated infections and the COVID-19 pandemic.
4. The hand hygiene compliance rate among SSA healthcare workers is generally low.
5. The 'My Five Moments for Hand Hygiene' defines when hand hygiene should occur.
6. Barriers to hand hygiene practice include lack of water and soap, overcrowding, lack of infrastructure, or inadequate funds for procurement of hand rubs or gel, etc., particularly in the SSA.
7. Many low-resource settings have successfully implemented hand hygiene programs; some emphasized alcohol hand-rub as cheaper than running tap-water.
8. The impact of the WHO, NGOs, and Global Health Governance in the support and regulation of essential components of infection prevention and control amid the COVID-19 pandemic cannot be overemphasized.
9. Integrated Water Resource Management (IWRM) is becoming recognized as the only sustainable solution to water scarcity; by ensuring the provision of clean and potable water, especially in rural African settings.
10. Hand washing is only feasible with clean running water, and sustainable solutions to water scarcity highlight that freshwater is finite, vulnerable, and essential to sustain life, economic development, and the environment.

CONCLUSION

Healthcare-associated infections are drawing increasing attention from all and sundry due to the growing recognition that most of these infections are preventable. Free evidence-based practice suggests that strict adherence to hand hygiene reduces the risk of cross-transmission of infections, especially in the COVID-19 pandemic era.

The challenges identified in this review are consistent with the findings of studies conducted elsewhere. With "Clean Care is Safer Care" as a prime list of the World Health Organization's global initiative on patient safety programs; therefore, it is high time for developing countries to formulate the much-needed policies for implementing basic infection prevention practices in our health care settings.

RECOMMENDATIONS

1. We are advocating for an updating of the knowledge and practice of HCWs through continuing in-service educational programs.
2. We emphasize the importance of following the latest evidence-based practices of infection control in continuing education/training programs.
3. Develop and maintain infection prevention and occupational health programs.
4. Assure availability of sufficient and appropriate supplies necessary for adherence to Standard Precautions (e.g., hand hygiene products, personal protective equipment, and injection equipment).
5. Assure at least one individual with training in infection prevention is employed by or regularly available (e.g., by contract) to manage the facility's infection prevention program.
6. Develop written infection prevention policies and procedures appropriate for the services provided by the facility and based upon evidence-based guidelines, regulations, or standards.
7. Provide job- or task-specific infection prevention education and training to all HCWs.
   This includes those employed by outside agencies and available by contract or on a volunteer basis to the facility.
8. Training should focus on principles of both HCWs safety and patient safety.
9. Training should be provided upon hire for newly employed HCWs about infection control and repeated annually and when policies or procedures are updated/revised.
10. We are also advocating training competencies should be documented following each training.
11. A regular periodic in-service observational check should be done to assess hand hygiene compliance and practice in our healthcare settings.
12. There is a need to adopt a sustainable solution to water scarcity as a lasting remedy to providing clean and potable water, especially in rural African settings.

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REFERENCES

[1] National Institute for Public Health and the Environment; Ministry of Health, Welfare and Sport Netherlands Gov. *Hygiene and COVID-19*. 2020. https://www.rivm.nl/en/novel-coronavirus-covid-19/hygiene-and-covid-19

[2] Sahiledengle B, Tekalegn Y, Takele A, Zenbaba D, Teferu Z, Tasew A *et al.* Hand Washing Compliance and COVID-19: A Non2 Participatory Observational Study among Hospital Visitors. medRxiv preprint June 2020. doi: https://doi.org/10.1101/2020.06.02.20120022.

[3] Centers for Disease Control and Prevention (CDC). Hand Hygiene in Healthcare Settings. 2019. Retrieved from https://www.cdc.gov/handhygiene/index.html (Accessed May 12, 2020).

[4] World Health Organization (WHO). WHO interim recommendation on hand obligatory hand hygiene against transmission of COVID-19. 2020. Retrieved

[5] from:https://www.who.int/docs/default-source/inaugural-who-partners-forum/who-interim-recommendation-on-obligatory-hand-hygiene-against-transmission-of-covid-19.pdf (Accessed May 12, 2020).
[6] UNICEF. Everything you need to know about washing your hands to protect against coronavirus (COVID-19)Retrieved from , https://www.unicef.org/coronavirus/everything-you-need-know-about-washing-your-hands-protect-against-coronavirus-covid-19 (Accessed May 12, 2020)
[6] COVID-19 and water, sanitation and hygiene message for policy makers. Retrieved from https://www.sanitationandwaterforall.org/sites/default/files/2020-04/SWA%20messages%20on%20COVID23819.pdf (Accessed May 12, 2020)
[7] Rabie T, Curtis V. Hand washing and risk of respiratory infections: a quantitative systematic review. Tropical medicine and international health 2006; 11(3):258-67.
[8] Alzyood M, Jackson D, Aveyard H, Brooke J. COVID19 reinforces the importance of handwashing. J Clin Nurs. 2020. https://doi.org/10.1111/jocn.15313
[9] Bezerra TB, Valim MD, Bortolini J, Ribeiro RP, Marcon SR, Moura MEB. Adherence to hand hygiene in critical sectors: Can we go on like this? Journal of Clinical Nursing 2020. Accepted Author Manuscript. https://doi.org/10.1111/jocn.15293228-241.
[10] Loftus MJ, Guitart C, Tartari E, Stewardson AJ, Amer F, Bellissimo-Rodrigues F *et al.* Hand hygiene in low254 and middle-income countries. Int J Infect Dis. 2019; 86:25-30.
[11] Pogrebna G, Kharlamov A. The Impact of Cross-Cultural Differences in Hand washing Patterns on the COVID-19 Outbreak Magnitude (preprint). March 2020. DOI: 10.13140/RG.2.2.23764.96649
[12] Fashafsheh I, Ayed A, Eqtait F, Harazneh L. Knowledge and Practice of Nursing Staff towards Infection Control Measures in the Palestinian Hospitals. Journal of Education and Practice 2015; 6(4): 79-90
[13] Twitchell KT. Bloodborne pathogens. What you need to know–Part II. AAOHN J, 2003; 51(2): 89-97.
[14] Sax H, Allegranzi B, Chraïti MN, Boyce J, Larson E, Pittet D. The World Health Organization hand hygiene observation method. American Journal of Infection Control 2009; 37: 827-834. https://doi.org/10.1016/j.ajic.2009.07.003
[15] Friedman, ND, Kaye KS, Stout JE, McGarry SA, Trivette SL, Briggs P, *et al.* Health care-associated bloodstream infections in adults: A reason to change the accepted definition of community-acquired infections. Ann Intern Med 2002; 137:791-7.
[16] Nejad SB, Allegranzi B, Syed SB, Ellis B, Pittet D. Health-care-associated infection in Africa: a systematic review. Bulletin of the World Health Organization 2011; 89:757-765
[17] Teumta GM, Niba LL, Ncheuveu NT, Ghumbemsitia MT, Itor POB, Chongwain P *et al.* An Institution-Based Assessment of Students' Hand Washing Behavior. Hindawi BioMed Research International Volume 2019, Article ID 7178645, 7 pages. https://doi.org/10.1155/2019/7178645
[18] Graf K, Chaberny IF, Vonberg R. Beliefs about hand hygiene: A survey in medical students in their first clinical year. American Journal of Infection Control. 2011; 39:885-888.
[19] Jantchou P, Alegbeleye BJ, Nguyen V. Physician Roles and Responsibilities in the Context of a Pandemic in Resource-Limited Areas: Impact of Social Media. Iberoamerican Journal of Medicine 00 (2020) XXX–XXX. (Ahead of Print). http://doi.org/10.5281/zenodo.3813830
[20] Patela KS, Rathic JC, Raghuvanshi K, Dhimana N. Coronavirus (SARSCoV-2): Preventions, keys to diagnosis and treatment of SARS-CoV-2. Iberoam J Med. 2020; 2(2):87-99. doi: http://doi.org/10.5281/zenodo.3715266.
[21] World Health Organization. Available from: https://www.who.int/emergencies/diseases/novel-coronavirus2019/technicalguidance/naming-the-coronavirus-disease-(covid-2019)-andthe-virus-thatcauses-it.
[22] Lee N, Hui D, Wu A, Chan P, Cameron P, Joynt GM *et al.* A major outbreak of severe acute respiratory syndrome in Hong Kong. N Engl J Med. 2003;348(20):1986-94. doi: 10.1056/NEJMoa030685.
[23] World Health Organization. Available from: https://www.who.int/emergencies/diseases/novel-coronavirus2019technicalguidance
[24] Kavanagh MM. Authoritarianism, outbreaks, and information politics. Lancet 2020;5(3):e135-e136. doi: 10.1016/S2468-2667(20)30030-X.
[25] WHO. WHO Director-General's remarks at the media briefing on COVID2019 outbreak on 14 February 2020. 2020. Available from: https://www.who.int/dg/speeches/detail/who-director-general-s-remarks-atthe-media-briefing-on-covid-2019-outbreak-on-14-february-2020 (accessed Feb 2020)
[26] WHO. WHO Director-General's remarks at the media briefing on COVID-2019 outbreak on 2 April 2020.Available from: https://www.who.int/dg/speeches/detail/who-director-general-s-remarks-atthe-media-briefing-on-covid-2019-outbreak-on-1-april-2020 (accessed April 2020)
[27] Mathur P. Hand hygiene: back to the basics of infection control. Indian J Med Res 2011; 134: 611-620.
[28] Labarraque AG. Instructions and observations regarding the use of the chlorides of soda and lime. In: Porter J, editor. New Haven, CT: Baldwin and Treadway; 1829.
[29] Semmelweis I. Etiology, concept, and prophylaxis of childbed fever. In: Carter KC, editor. 1st ed. Madison, WI: The University of Wisconsin Press; 1983.
[30] Rotter ML. 150 years of hand disinfection-Semmelweis' heritage. Hyg Med 1997; 22: 332-339
[31] Akyol AD. 'Hand hygiene among nurses in Turkey: opinions and practices', Journal of Clinical Nursing 2007; 16: 431-437
[32] Meers P, Jacobsen W, McPherson M. Hospital infection control for nurses. London: Chapman & Hall. 1992.
[33] Trampuz A, Widmer AF. 'Hand hygiene: a frequently missed lifesaving opportunity during patient care'. Mayo Clinic Proceedings 2004; 79 (1): 109-116.
[34] Minnaar A. Infection control made easy, a hospital guide for health professionals. Kenwyn SA: Juta. 2008.
[35] Seimetz E, Kumar S, Mosler H-J. Effects of an awareness raising campaign on intention and behavioural 280 determinants for hand washing. Health Educ Res. 2016; 31(2):109-120.

[36] Smith SM. 'A review of hand-washing techniques in primary care and community setting.' Journal of Clinical Nursing 2009; 18(6): 786-790
[37] Goma NS, Bandana T. Knowledge and Practice on Infection Prevention among Nurses of Bir Hospital, Kathmandu. J Nepal Health Res Council 2018 Jul-Sep;16(40): 330-335
[38] Vaz K, McGrowder D, Lindo RA, Gordon L, Brown P, Irving R. Knowledge, Awareness and Compliance with Universal Precautions among Health Care Workers at the University Hospital of the West Indies, Jamaica 2010; 1(4): 171-181.
[39] World Health Organization [WHO]. The first Global Patient safety challenge: "Clean care is safer care". Geneva: WHO. 2008. Retrieved December 12, 2019, from.http://www.who.int/gpsc/background/en/index.html.
[40] World Health Organization. Report on the Burden of Endemic Health Care-Associated Infection Worldwide: A systematic review of the literature. 2011; ISBN 978 92 4 150150 7.
[41] Doronina O, Jones D, Martello M, Biron A, Lavoie-Tremblay M. A Systematic Review on the Effectiveness of Interventions to Improve Hand Hygiene Compliance of Nurses in the Hospital Setting. Journal of Nursing Scholarship 2017; 49: 143. https://doi.org/10.1111/jnu.12274. North American Edition: 228-241.
[42] World Health Organization. Infection prevention and control in health care: time for collaborative action. 2010; Available at: http://apps.who.int/iris/bitstream/10665/80135/1/9789241501507_eng.pdf?ua=1. Accessed 1/14, 2020.
[43] Raka L, Mulliqi-Osmani G. Infection Control in Developing World. In: Sudhakar C, editor. Infection Control - UpdatesCroatia: InTech; 2012, p. 65.
[44] Vindigni SM, Riley PL, Jhung M. Systematic review: hand washing behavior in low- to middle-income countries: outcome measures and behaviour maintenance. Trop Med Int Health 2011; 16:466-477.
[45] World Health Organization. WHO guidelines on hand hygiene in health care: First global patient safety challenge clean care is safer care. 2009.
[46] Weston D, Weston D. Fundamentals of infection prevention and control: theory and practice. Chichester, West Sussex: John Wiley & Sons; 2014.
[47] Erasmus V, Daha TJ, Brug H, Richardus JH, Behrendt MD, Vos MC et al. Systematic review of studies on compliance with hand hygiene guidelines in hospital care. Infect Control Hosp Epidemiol 2010;31:283-294
[48] Loftus MJ, Guitart C, Tartari E, Stewardson AJ, Amer F, Bellissimo-Rodrigues F *et al*. Hand hygiene in low- and middle-income countries. Int J Infect Dis. 2019 Sep; 86:25-30. doi: 10.1016/j.ijid.2019.06.002. Epub 2019 Jun 9.
[49] Damani N, Mehtar S, and Allegranzi B. Hand hygiene in resource-poor settings. in: D. Pittet, J. Boyce, B. Allegranzi (Eds.) Hand hygiene: a handbook for medical professionals. John Wiley & Sons, Chichester, West Sussex; 2017: 357–366
[50] Bagheri Nejad S, Allegranzi B, Syed SB, Ellis B, Pittet D. Health-care-associated infection in Africa: a systematic review. Bull World Health Organ. 2011; 89: 757–765
[51] Zaidi AK, Huskins WC, Thaver D, Bhutta ZA, Abbas Z, Goldmann DA. Hospital-acquired neonatal infections in developing countries. Lancet. 2005; 365: 1175–1188
[52] Alegbeleye BJ, Coker AO, Ohene JE, Oke OO, Jantchou P, Mohammed RK. The Global Impact of Covid-19 Pandemic on General Surgical Services. International Journal of Healthcare Sciences ISSN 2348-5728 (Online) Month: April 2020 - September 2020; Vol. 8, Issue 1, pp: (104-119), Available at: www.researchpublish.com Page | 104 Research Publish Journals
[53] Correia MITD, Ramos RF, Von Bahten LC. The surgeons and the COVID-19 pandemic. Rev Col Bras Cir 47:e20202536. DOI: 10.1590/0100-6991e-20202536
[54] Chen N, Zhou M, Dong X, Qu J, Gong F, Han Y et al. Epidemiological and clinical characteristics of 99 cases of 2019 novel coronavirus pneumonia in Wuhan, China: a descriptive study. Lancet. 2020 Feb 15; 395(10223):507- 513. doi: 10.1016/S0140-6736(20)30211-7. Epub 2020 Jan 30.
[55] Chang D, Lin M, Wei L, Xie L, Zhu G, Cruz CD *et al.* Epidemiologic and clinical characteristics of novel coronavirus infections involving 13 patients outside Wuhan, China. JAMA https://doi.org/10.1001/jama.2020.1623 (2020).
[56] Wang X, Zhou Q, He Y, Liu L, Ma X, Wei X et al. Nosocomial outbreak of COVID-19 pneumonia in Wuhan, China. European Respiratory Journal, 2020; 55(6):2000544 [https://doi.org/10.1183/13993003.00544-2020].
[57] Wang X. Meta-analysis and systematic review on edipemiology of healthcare, associated infection in developing countries: a case study in a chinese hospital. 2015.
[58] Wilkason C, Lee C, Sauer LM, Nuzzo J, McClelland A. Assessing and Reducing Risk to Healthcare Workers in Outbreaks. Health security, 2020; 18(3): 205-211.
[59] Zhou F, Yu T, Du R, Fan G, Liu Y, Liu Z *et al.* Clinical course and risk factors for mortality of adult inpatients with COVID-19 in Wuhan, China: a retrospective cohort study. The lancet, 2020.
[60] Okeke IN, Klugman KP, Bhutta ZA, Duse AG, Jenkins P, O'Brien TF *et al.* Antimicrobial resistance in developing countries. Part I: recent trends and current status. The Lancet infectious diseases, 2005; 5(8): 481-493.
[61] Rothe C, Schlaich C, Thompson S. Healthcare-associated infections in sub-Saharan Africa. Journal of Hospital Infection, 2013; 85(4): 257-267.
[62] Stone SP, Fuller C, Savage J, Cookson B, Hayward A, Cooper B. Evaluation of the national Cleanyourhands campaign to reduce Staphylococcus aureus bacteraemia and Clostridium difficile infection in hospitals in England and Wales by improved hand hygiene: four year, prospective, ecological, interrupted time series study. BMJ 2012; 344: e3005. https://doi.org/10.1136/bmj.e3005.
[63] Rodriguez-Morales AJ, Cardona-Sospina JA, Gutiérrez-Ocampo E, Villamizar-Peña R, Holguin-Rivera Y, EscaleraAntezana JP *et al.* Clinical, laboratory and imaging features of COVID-19: A systematic review and metaanalysis. Travel Med Infect Dis. 2020; 101623. doi: 10.1016/j.tmaid.2020.101623.
[64] World Health Organization. Available from: https://www.who.int/emergencies/diseases/novelcoronavirus2019/globalresearch-on-novel-coronavirus-2019-ncov
[65] European Centre for Disease Prevention and Control: COVID-19 situation update worldwide- European Centre for Disease Prevention and Control-An agency of the European Union. https://www.ecdc.europa.eu/en/geographicaldistribution-2019-ncov-cases- (Accessed on May 11, 2020).
[66] Favre G, Pomar L, Qi X, Nielsen-Saines K, Musso D, Baud D. Guidelines for pregnant women with

[67] suspected SARS-CoV-2 infection. Lancet Infect Dis. 2020. doi: 10.1016/S1473-3099(20)30157-2.
[68] Lu R, Zhao X, Li J, Niu P, Yang B, Wu H *et al.* Genomic characterization and epidemiology of 2019 novel coronavirus: implications for virus origins and receptor binding. Lancet. 2020; 395(10224):565-74. doi: 10.1016/S01406736(20)30251-8.
[69] Xu Z, Shi L, Wang Y, Zhang J, Huang L, Zhang C *et al.* Pathological findings of COVID-19 associated with acute respiratory distress syndrome. Lancet Respir Med. 2020; 8(4):420-422. doi: 10.1016/S2213-2600(20)30076-X. Epub 2020 Feb 18.
[70] Scientific American. Available from: https://www.scientificamerican.com/article/how-chinas-batwomanhunteddown-viruses-from-sars-to-the-new-coronavirus1/
[71] Wu F, Zhao S, Yu B, Chen YM, Wang W, Song ZG *et al.* A new coronavirus associated with human respiratory disease in China. Nature. 2020; 579(7798):265-269. doi: 10.1038/s41586-020-2008-3.
[72] Beech H, Rubin AJ, Kurmanaev A, Maclean R. As COVID-19 deaths pile up across globe, scientists ponder why the virus wallops some places and spares others. The New York Times May 04, 2020 14:32:56 IST. The New York Times Company-2020. firstpost.com/world/as-covid-19-deaths-pile-up-across-globe-scientists-ponder-why-the-virus-wallops-some-places-and-spares-others-8329321.html
[73] Ott M. French R. 'Hand hygiene compliance among healthcare staff and student nurses in a mental health setting.' Mental Health Nursing 2009; 30: 702-704.
[74] Infection control guidelines. Communicable disease report. Canada: Laboratory Centre for Disease Control, Bureau of Infectious Diseases; 1998.
[75] Larson E. Skin hygiene and infection prevention: more of the same or different approaches? Clin Infect Dis 1999; 29: 1287-1294.
[76] Larson E. A causal link between handwashing and risk of infection? Examination of the evidence. Infect Control Hosp Epidemiol 1988; 9: 28-36.
[77] Peacock JE, Marsick FJ, Wenzel RP. Methicillin resistant Staphylococcus aureus; introduction and spread within a hospital. Ann Intern Med 1980; 93: 526-532.
[78] Thompson RL, Cabezudo I, Wenzel RP. Epidemiology of nosocomial infection caused by methicillin resistant Staphylococcus aureus. Ann intern Med 1982; 1987: 309-317.
[79] Pitet D. Effectiveness of a hospital-wide program to improve compliance with hand hygiene. Lancet 2000; 356: 1307-1312.
[80] Conley JM, Hills S, Ross J, Lertzman J. Hand washing practices in an intensive care unit: the effects of an educational program and its relationship to infection rates. Am J Infect Control 1989; 17: 330-339.
[81] Khan MU. Interruption of Shigellosis by hand washing. Trans R Soc Med Hyg 1982; 76: 164-168.
[82] Larson EL, Early E, Cloonan P, Sugrue S, Parides M. An organizational climate intervention associated with increased hand washing and decreased nosocomial infections. Behav Med 2000; 26: 14-22.
[83] Mortimer EA Jr, Lipsitz PJ, Wolinsky E, Gonzaga AJ, Rammelkamp CH Jr. Transmission of staphylococci between newborns. Am J Dis Child 1962; 104: 289-295.
[84] Maki DG. The use of antiseptics for handwashing by medical personnel. J Chemother 1989; 1 (Suppl 1): 3-11.
[85] Guide to implementation of the WHO multimodal hand hygiene improvement strategy. Available from: http://www. who.int/patientsafety/en/, accessed on December 24, 2019.
[86] WHO. Coronavirus disease (COVID-19) advice for the public. Retrieved from https://www.who.int/emergencies/diseases/novel-coronavirus-2019/advice-for-public (Accessed May 12, 2020).
[87] WHO. How to hand wash poster. 2019. Retrieved fromhttps://www.who.int/gpsc/5may/How_To_HandWash_Poster.pdf?ua=1 (Accessed May 12, 2020).
[88] Centers for Disease Control and Prevention (CDC). Hand washing: Clean Hands Save Lives. Retrieved from https://www.cdc.gov/hand washing/when-how-hand washing.html (Accessed May 12, 2020).
[89] Boyce JM, Pittet D. Guideline for Hand Hygiene in HealthCare Settings. Recommendations of the Healthcare Infection Control Practices Advisory Committee and the HICPAC/ SHEA/APIC/IDSA Hand Hygiene Task Force. Morb Mortal Wkly Rep 2002; 51: 1-44.
[90] Infection control guidelines for the prevention of transmission of infectious diseases in the health care setting. Govt. of Australia: Communicable Diseases Network Australia, the National Public Health Partnership and the Australian Health, Ministers' Advisory Council; January 2004
[91] Mani A, Shubangi AM, Saini R. 'Hand hygiene among healthcare workers.' Indian Journal of Dental Research 2010; 21(1): 115-118.
[92] Canham L. 2011. 'The first step in infection control is hand hygiene.' The Dental Assistant, 42-46.
[93] Vaidotas M, Yokota PK, Marra AR, Camargo TZ, da Silva Victor E, Gysi DM *et al.* Measuring hand hygiene compliance rates at hospital entrances. American journal of infection control. 2015; 43(7):694-696.
[94] Kampf G, Loffler H. 'Hand disinfection in hospitals-benefits and risks.' Journal of the German Society of Dermatology 2010; 8 (12): 978-983.
[95] Collins F, Hampton S. 'Hand-washing and methicillin-resistant staphylococcus aureus.' British Journal of Nursing 2005; 14(13): 703-707.
[96] Smith JM, Lokhorst DB. 'Infection control: can nurses improve hand hygiene practice?' Journal of Undergraduate Nursing Scholarship 2009; 11(1): 1-6.
[97] Ataiyero Y, Dyson J, Graham M. Barriers to hand hygiene practices among health care workers in sub-Saharan African countries: A narrative review. Am J Infect Control. 2019 May; 47(5):565–573. doi: 10.1016/j.ajic.2018.09.014.
[98] Abdella NM, Tefera MA, Eredie AE, Landers TF, Malefia YD, Alene KA. Hand hygiene compliance and associated factors among health care providers in Gondar University Hospital, Gondar, North West Ethiopia. BMC Public Health 2014; 14:96.
[99] Adegboye MB, Zakari S, Ahmed BA, Olufemi GH. Knowledge, awareness and practice of infection control by health care workers in the intensive care units of a tertiary hospital in Nigeria. Afri Health Sci 2018; 18(1): 72-78. https://dx.doi.org/10.4314/ahs.v18i1.11
[100] Alex-Hart B, Opara PI. Handwashing practices amongst health workers in a teaching hospital. American Journal of Infectious Diseases 2011; 7:8-15.
[101] Alex-Hart B, Opara PI. Observed Hand Washing Practices among Health Workers in Two Critical Pediatrics Wards of a Specialist Hospital. American Journal of Infectious Diseases 2014; 10:95-99.
[102] Allegranzi B, Nejad SB, Combescure C, Graafmans W, Attar H, Donaldson L et al. Burden of endemic

[103] health-care-associated infection in developing countries: systematic review and metaanalysis. Lancet 2011; 377 North American Edition: 228-241.
[104] Amissah I, Salia S, Craymah JP. A Study to Assess Hand Hygiene Knowledge and Practices among Health Care Workers in a Teaching Hospital in Ghana. International Journal of Science and Research 2016; 5:301-307.
[105] Ango UM, Awosan KJ, Adamu H, Salawu S, Sani MM, Ibrahim AH. Knowledge, Attitude and Practice of Hand Hygiene among Healthcare Providers in
[106] Semi-urban Communities of Sokoto State, Nigeria. International Journal of Tropical Disease & Health 2017; 26:1-9.
[107] Asare A, Enweronu-Laryea C, Newman MJ. Hand hygiene practices in a neonatal intensive care unit in Ghana. J Infect Dev Countries 2009; 3:352-356.
[108] Bello S, Effa EE, Okonkon EE, Oduwole OA. Handwashing practice among healthcare providers in a tertiary hospital in southern Nigeria. International Journal of Infection Control. 2013; 9.
[109] Desta M, Ayenew T, Sitotaw N, Tegegne N, Dires M, Getie M. Knowledge, practice and associated factors of infection prevention among healthcare workers in Debre Markos referral hospital, Northwest Ethiopia. BMC Health Services Research 2018; 18:465. https://doi.org/10.1186/s12913-018-3277-5
[110] Ekwere TA, Okafor IP. Hand hygiene knowledge and practices among healthcare providers in a tertiary hospital, South West Nigeria. International Journal of Infection Control. 2013; 9.
[111] Geberemariyam BS, Donka GM, Wordofa B. Assessment of knowledge and practices of healthcare workers towards infection prevention and associated factors in healthcare facilities of West Arsi District, Southeast Ethiopia: a facility-based cross-sectional study.
Archives of Public Health 2018; 76:69.
https://doi.org/10.1186/s13690-018-0314-0
[112] Holmen IC, Seneza C, Nyiranzayisaba B, Nyiringabo V, Bienfait M, Safdar N. Improving Hand Hygiene Practices in a Rural Hospital in Sub-Saharan Africa. Infect Control Hosp Epidemiol 2016; 37:834-839.
[113] Holmen IC, Niyokwizerwa D, Nyiranzayisaba B, Singer T, Safdar N. Challenges to sustainability of hand hygiene at a rural hospital in Rwanda. Am J Infect Control 2017; 45:855-859.
[114] Ibeneme S, Maduako V, Ibeneme GC, Ezuma A, Ettu TU, Onyemelukwe NF *et al.* Hand Hygiene Practices and Microbial Investigation of Hand Contact Swab among Physiotherapists in an Ebola Endemic Region: Implications for Public Health. Hindawi-BioMed Research International Volume 2017, Article ID 5841805, 13 pages.
https://doi.org/10.1155/2017/5841805
[115] Iliyasu G, Dayyab FM, Habib ZG, Tiamiyu AB, Abubakar S, Mijinyawa MS *et al.* Knowledge and practices of infection control among healthcare workers in a Tertiary Referral Center in North-Western Nigeria. Ann Afr Med. August 2015; 0:0. DOI: 10.4103/1596-3519.16172
[116] Kalata NL, Kamange L, Muula AS. Adherence to hand hygiene protocol by clinicians and medical students at Queen Elizabeth Central Hospital, Blantyre-Malawi. Malawi Med J 2013; 25:50-52.
[117] Kesah NF, Vincent KP, Chrysanthus N. Healthcare-associated infections in three hospitals in Dschang, West Region, Cameroon. Ann Trop Med Public Health 2013; 6:23-29. Available from: http://www.atmph.org/text.asp?2013/6/1/23/115174
[118] Mearkle R, Houghton R, Bwonya D, Lindfield R. Barriers to hand hygiene in ophthalmic outpatients in Uganda: a mixed methods approach. Journal of Ophthalmic Inflammation and Infection 2016; 6:11. DOI 10.1186/s12348-016-0077-0
[119] Muhumuza C, Gomersall JS, Fredrick ME, Atuyambe L, Okiira C, Mukose A *et al.* Health care worker hand hygiene in the pediatric special care unit at Mulago National Referral Hospital in Uganda: a best practice implementation project. Int J Evid Based Healthc 2015; 13:19-27.
[120] Ojong IN, Etim MI, Nlumanze FF, Akpan MI. The practice of hand washing for the prevention of nosocomial infections among nurses in general hospital Ikot Ekpene, Akwa Ibom State, Nigeria. Archives of Applied Science Research 2014; 6:97-101.
[121] Omogbai JJ, Azodo CC, Ehizele AO, Umoh A. Hand hygiene amongst dental professionals in a tertiary dental clinic. African journal of clinical and experimental microbiology. 2011; 12:9-14.
[122] Omuemu VO, Ogboghodo EO, Opene RA, Oriarewo P, Onibere O. Hand hygiene practices among doctors in a tertiary health facility in southern Nigeria. Journal of Medicine in the Tropics.2013; 15:96-101.
[123] Opara PI, Alex-Hart BA. Handwashing practices among medical students in Port Harcourt, Nigeria. The Nigerian health journal. 2009; 9:16-20.
[124] Owusu-Ofori A, Jennings R, Burgess J, Prasad PA, Acheampong F, Coffin SE. Assessing Hand Hygiene Resources and Practices at a Large African Teaching Hospital. Infect Control Hosp Epidemiol 2010; 31(8):802-808. doi: 10.1086/654005.
[125] Patel B, Engelbrecht H, McDonald H, Morris V, Sythme W. A multifaceted hospital-wide intervention increases hand hygiene compliance. South African Medical Journal 2016; 106(4):335-341.
[126] Samuel AM, Hagos G, Albin S, Mutungi A. Promotion of handwashing as a measure of quality of care and prevention of hospital-acquired infections in Eritrea: the Keren study. Afr Health Sci 2005; 5:4-13.
[127] Schmitz K, Kempker RR, Tenna A, Stenehjem E, Abebe E, Tadesse L *et al.* Effectiveness of amultimodal hand hygiene campaign and obstacles to success in Addis Ababa, Ethiopia. Antimicrob Resist Infect Control 2014;3:8
[128] Shobowale EO, Adegunle B, Onyedibe K. An assessment of hand hygiene practices of healthcareworkers of a semi-urban teaching hospital using the five moments of hand hygiene. Niger Med J 2016; 57:150-154.
[129] Tobi K, Enyi-Nwafor K. Hand washing practices and compliance among health care workers in the intensive care unit of a teaching hospital in Nigeria. .Nigerian Medical Practitioner 2013; 63(4): 82-89.
[130] Uneke CJ, Ndukwe CD, Oyibo PG, Nwakpu KO, Nnabu RC, Prasopa-Plaizier N. Promotion of hand hygiene strengthening initiative in a Nigerian teaching hospital: implication for improved patient safety in low-income health facilities.. The Brazilian journal of infectious diseases 2014; 18(1): 21-27.
[131] Yawson AE, Hesse AAJ. Hand hygiene practices and resources in a teaching hospital in Ghana. J Infect Dev Ctries 2013; 7:338-347.
[132] Karabay O, Sencan I, Sahin I, Alpteker H, Ozcan A, Oksuz S. 'Compliance and efficacy of hand-rubbing during in-hospital practice. Medical Principles and Practice.' International Journal of the Kuwait University 2005; 14(5): 313-317.
[133] Maxfield D, Dull D. 'Influencing hand hygiene at spectrum health.' Physician Executive Journal 2011; 37(3): 30-34

[134] Penzias A. 'Don't get complacent with hand hygiene.' ED Nursing 2010; 13 (5):54-55.
[135] Al-naami MY, Anjum MN, Afzal MF, Al-yami MS, Al-qahtani SM, Al-dohavan AD *et al.* 'Alcohol based hand-rub versus traditional surgical scrub and the risk of surgical site infection: a randomized
[136] controlled equivalent trial.' EWMA Journal 2009; 9(3): 5-10.
[137] Nazarko L. 'Potential pitfalls in adherence to hand washing in the community.' British Journal of Community Nursing 2009; 14(2): 64-68.
[138] Takahashi I, Turale S. 'Evaluation of individual and facility factors that promote hand washing in aged-care facilities in Japan', Nursing and Health Sciences 2010; 12(1): 127-134.
[139] Ogunsola FT, Adesiji YO. 'Comparison of four methods of hand washing in situations of inadequate water supply'. West African Journal of Medicine 2008; 27 (1): 24-28.
[140] Devnani M, Kumar R, Sharma RK, Gupta AK. 'A survey of hand-washing facilities in the outpatient department of a tertiary care teaching hospital in India.' Journal of Infection in Developing Countries 2011; 5(2): 114-118
[141] Lotfinejad N, Peters A, Pittet D, Hand hygiene and the novel coronavirus pandemic: The role of healthcare workers, Journal of Hospital Infection, https://doi.org/10.1016/ j.jhin.2020.03.017.
[142] Allegranzi B, Bagheri Nejad S, Combescure C, Graafmans W, Attar H, Donaldson L *et al.* Burden of endemic health-care-associated infection in developing countries: systematic review and metaanalysis. Lancet 2011; 377(9761):228-241.
[144] Ray Isha. Hand-washing in the Time of COVID-19. In partnership with the Office of the Dean of the Division of Social Sciences, Social Science Matrix has created a portal to aggregate insights about the coronavirus pandemic from across the UC Berkeley social science community. April 13, 2020. https://matrix.berkeley.edu/research/hand-washing-time-covid-19
[143] Pfattheicher S, Strauch C, Diefenbacher S, Schnuerch R. A field study on watching eyes and hand hygiene compliance in a public restroom. Journal of Applied Social Psychology. 2018; 48(4):188-194.
[144] Willison-Parry T, Haidar E, Martini L, Coates A. Hand washing adherence by visitors is poor: Is there a simple solution? American Journal of Infection Control. 2013; 41:928-929.
[145] Seimetz E, Kumar S, Mosler HJ. Effects of an awareness raising campaign on intention and behavioural determinants for hand washing. Health Educ Res. 2016; 31(2):109-120.
[146] Global Hand washing Partnership. Retrieved from https://globalhand washing.org/about-hand washing/faqs/ (Accessed May 12, 2020).
[147] Werner R. 'Hand washing and what happens if you don't.' Massage and Bodywork 2007; 22(2): 114-118
[148] The water world: Integrated Water Resource Management (IWRM): Sustainable Solution to Water Scarcity.2020.https://www.waterworld.com/technologies/filtration/article/14172753/solarpowered-desalination-system-provides-waterkiosk-in-africa-with-clean-water**TABLE 1:** THE WHO APPROVED MY FIVE MOMENTS FOR HAND HYGIENE [2, 3, 86, 87]

TABLE 1: THE CLINICAL SCENARIOS FOR ALCOHOL-BASED HAND RUB[27, 73-75, 84, 88, 89]

NO	THE FIVE KEY STEPS OF HANDWASHING
1	Wet both sides under clean running water
2	Stow a liberal amount of soap to the front and back of the hands, as well as fingertips
3	Rub in between and around the fingers; rub the back of each hand using the palm of the other hand; rub fingertips of each hand to the opposite palm of the other hand, and rub each thumb clasped to the opposite hand for at least 20 seconds
4	Rinse thoroughly under running water, and dry hands with clean paper/towel
5	Turn off the water using a paper towel

TABLE 2: THE CLINICAL SCENARIOS FOR ALCOHOL-BASED HAND RUB [27, 73-75, 84, 88, 89]

NO	THE VARIOUS MOMENTS
1	Before having direct contact with patients
2	Before wearing sterile gloves, especially when inserting a central intravascular catheter
3	Before inserting indwelling urinary catheters, peripheral vascular catheters, or other invasive devices that do not require a surgical procedure
4	After contact with a patient's intact skin (e.g., when taking a pulse or blood pressure or lifting a patient)
5	Also, after contact with body fluids or excretions, mucous membranes, non-intact skin, and wound dressings if hands are not visibly soiled
6	After contact with inanimate objects (including medical equipment) near the patient
7	After removing gloves
8	When the HCW is moving from a contaminated body site to a clean body site during patient care

TABLE 3: SUMMARY OF INCLUDED STUDIES [96-128]

NO	AUTHOR (YEAR)	POPULATION AND SAMPLE SIZE	RESEARCH AIM AND METHODS	SUMMARY OF RESEARCH FINDINGS	REF.
1	Abdella *et al.* (2014)	Healthcare workers at a University Hospital in Ethiopia (n=405)	To assess HH compliance and determinants in a cross-sectional study involving through observations of HH and a questionnaire	Compliance was 16.5% Determinants were training, provision and locations of facilities, time, skin irritation, glove use, IPC committee and provision of individual towel/tissue paper	97
2	Adegboye *et al.* (2018)	Healthcare workers in a teaching hospital in Nigeria observations (n= 80)	To evaluate the HH practice among HCWs in the ICU through observational study	Overall compliance rate not reported. Factors influencing HH practices: contact type, glove use, training	98
3	Alex-Hart and Opara (2011)	Healthcare workers at a University teaching hospital in Nigeria (n=258)	To explore perceptions, attitudes and handwashing practices through a cross-sectional study involving questionnaires	Rate of handwashing of the healthcare workers in this hospital reported to be low; figure not given. Factors influencing HH practices: fear of contracting disease, handwashing facilities and training/education	99
4	Alex-Hart and Opara (2014)	Healthcare workers at a University teaching hospital in Nigeria (n=150)	To assess the handwashing practices through observational study	Overall compliance not reported. Factors influencing HH practices: glove use, patient contact type, need for personal protection and time of the day.	100
5	Allegranzi *et al.* (2010)	Healthcare workers at a University teaching hospital in Mali (n=224)	To evaluate the feasibility and effectiveness of the HH implementation strategy through a before and after study involving questionnaires, observations and an inventory of resources in each of 24 clinical wards	Factors influencing HH practices: professional category, HH indication, presence of hand sanitizer, facilities	101
6	Amissah *et al.* (2016)	Healthcare workers at a teaching hospital in Ghana (n=130)	To assess HH knowledge and practices through a cross-sectional, descriptive study (questionnaire)	Factors influencing HH practices: heavy workload, forgetfulness, lack of water, lack of cleaning towels, lack of hand dryer, lack of detergent, lack of time, HH training	102
7	Ango *et al.* (2017)	Healthcare workers in government-owned facilities in a local government area in Nigeria (n=144)	To assess knowledge, attitude and practice of HH through cross-sectional study involving questionnaire	Factors influencing HH practices: irregular water supply, inconveniently located sink, lack of hand sanitizer, lack of soap, knowledge/training, patient contact type	103
8	Asare *et al.* (2009)	Healthcare workers in a teaching hospital in Ghana (n=38)	To evaluate the nature and frequency of patient contacts and healthcare workers' compliance to HH guidelines through observation	Overall compliance not reported. Factors influencing HH practices: contact type, glove use, occupational category and training/education	104
9	Bello *et al.* (2013)	Healthcare workers in a teaching hospital in Nigeria (n=356)	To assess practice, knowledge, beliefs/attitudes and determinants of handwashing practices through cross-sectional study involving questionnaire	Factors influencing HH practices: lack of facilities/poor quality, lack of time, heavy workload and forgetfulness	105
10	Desta *et al.* (2018)	Healthcare workers in a referral hospital in Ethiopia observations (n= 150)	To assess the compliance level with respect to appropriate HH practices through observational study	Overall compliance rate not reported. Factors influencing HH practices: professional group, lengthy work experience and higher educational status, contact type, glove use, training	106

NO	AUTHOR (YEAR)	POPULATION AND SAMPLE SIZE	RESEARCH AIM AND METHODS	SUMMARY OF RESEARCH FINDINGS	REF.
11	Ekwere and Okafor (2013)	Healthcare workers in a teaching hospital in Nigeria (n=430)	To evaluate knowledge, attitude and HH practices and to identify both the barriers and motivators of handwashing practices through cross-sectional study involving questionnaire	Factors influencing HH practices: fear of contracting disease, heavy workload, facilities, patient contact type, training/knowledge and occupational category.	107
12	Geberemariyam *et al.* (2018)	Healthcare workers in Hospital settings in Ethiopia observations (n= 648)	To assess the compliance level with respect to appropriate HH practices through observational study	Compliance rate was 53.7% with only 25% of all HH being effective. Factors influencing HH practices: lack of resources, heavy workload, forgetfulness, negligence, location of facilities, professional category and perceived risk of infection	108
13	Holmen *et al.* (2016)	Healthcare workers in a hospital in Rwanda (n=66)	To explore HH compliance improvement following implementation of WHO tool kit through a quasi-experimental study. Observations and surveys conducted at baseline and 3 weeks post implementation	Factors influencing HH practices: occupational category, knowledge, contact type, lack of resources	109
14	Holmen *et al.* (2017)	Healthcare workers in a hospital in Rwanda (interviews n=17)	To assess HH compliance through observations at a rural hospital in Rwanda after HH improvement initiatives interviews.	Study is a continuation of previous study – see above (Holmen et al., 2016) Overall compliance fell from 68.9% to 36.8% within a year. Factors influencing HH practices: professional group, role model attitude, HH more for personal protection	110
15	Ibeneme *et al.* (2017)	Physiotherapists in 3 tertiary hospitals in Nigeria (FGD n=15; questionnaire n = 44)	To investigate compliance through cross-sectional study involving questionnaire, FGDs and inventory of resources	Factors influencing HH practices: inadequate infrastructure and materials, HH protocol, forgetfulness, distant location of HH facilities	111
16	Iliyasu et *al.* (2015)	Healthcare workers in a teaching hospital in Nigeria observations n= 200	To assess the compliance level with respect to appropriate HH practices through observational study	Overall compliance rate not reported. Factors influencing HH practices: lack of resources, excess workload and time constraint	112
17	Kalata *et al.* (2013)	Doctors and medical students in a hospital in Malawi (Observations n=58; questionnaires n=116)	To investigate HH compliance through observations and questionnaire	Compliance rate was 23.5% with only 30% of all HH being effective. Factors influencing HH practices: lack of resources, heavy workload, forgetfulness, negligence, location of facilities, professional category and perceived risk of infection	113
18	Kesah *et al.* (2013)	Healthcare workers at three Hospitals in Cameroon-retrospective study (n=12917)	To evaluate the handwashing knowledge, practices and compliance through questionnaire	Overall compliance rate not reported. Factors influencing HH practices: Scrupulous hand hygiene and lack of resources, excess workload, staff education and HAI surveillance were paramount.	114
19	Mearkle *et al.* (2016)	Healthcare workers in two hospitals in Uganda (Observations n=37; interviews n=9)	To explore current HH practice through observation and identify any barriers through inventory and interviews.	Factors influencing HH practices: contact type, HH training/knowledge, means of self-protection, busy workload, forgetfulness (carelessness), location of facilities	115

NO	AUTHOR (YEAR)	POPULATION AND SAMPLE SIZE	RESEARCH AIM AND METHODS	SUMMARY OF RESEARCH FINDINGS	REF.
20	Muhumuza *et al.* (2015)	Healthcare workers in a national hospital in Uganda (baseline n=18; follow up n=20)	To improve HH practice through an interventional study involving baseline (2 weeks) and follow up (2 weeks) observations and questionnaires. Implementation involved training, display of posters, feedback on baseline audit, provision of resources	Factors influencing HH practices: workload and overcrowding, staff attitude and lack of knowledge, limited resources	116
21	Ojong *et al.* (2014)	Nurses in a general hospital in Nigeria (n=102)	To assess the practice of handwashing through cross-sectional survey	Factors influencing HH practices: knowledge, IPC unit/guideline and facilities	117
22	Omogbai *et al.* (2011)	Dentists and dental students in a teaching hospital in Nigeria (n=105)	To assess handwashing attitudes and practices through cross-sectional survey	Factors influencing HH practices: glove use, time, facilities, forgetfulness, skin irritation, contact type	118
23	Omuemu et al. (2013)	Doctors in a teaching hospital in Nigeria (questionnaire n=326; observations n=108)	To ascertain the knowledge and practice of HH among medical doctors through cross-sectional survey and observations	Overall compliance is 16.7%. Factors influencing HH practices: lack of facilities, forgetfulness, lack of time, glove use, skin irritation, professional category, time of the day, contact type	119
24	Opara and Alex-Hart (2009)	Medical students in a teaching hospital in Nigeria (n=261)	To assess the perceptions, attitudes and handwashing practices through a cross-sectional survey	Factors influencing HH practices: lack of facilities, lack of motivation, lack of time, procedure type, time of the day	120
25	Owusu-Ofori *et al.* (2010)	Healthcare workers in a teaching hospital in Ghana (interviews n=27; observations (HH opportunities n=1226)	To establish baseline HH practices and resources through observations, interviews and inventory of HH resource	Overall compliance was 12%. Factors influencing HH practices: contact type, professional group, limited resources, lack of knowledge	121
26	Patel *et al.* (2016)	Healthcare workers in a hospital in South Africa (trained n=557; observed n=497; intervention group n=146)	To establish an improvement in HH compliance using a multifaceted pre-post intervention study involving pre-study needs assessment questionnaire, training and display of posters. Post-intervention evaluation involved observations and monthly feedback	Factors influencing HH practices: ward type, professional category, lack of motivation, time constraints, staff rotations and turnover of doctors and nurses.	122
27	Samuel *et al.* (2005)	Healthcare workers in a hospital in Eritrea (observations n=30; FGD n=34 HCWs, 30 patients)	To assess quality of HH care through FGDs, observations and inventory of resources in medical, surgical and obstetric units)	Overall compliance rate not reported. Factors influencing HH practices: contact type, glove use, training	123
28	Schmitz *et al.* (2014)	Healthcare workers in a university teaching hospital in Ethiopia (observations n = not reported; post-intervention survey n=161)	To define baseline HH compliance and assess the impact of implementing the WHO multimodal HH strategy through a before and after study. Intervention: distribution of hand sanitizers and implementation of the WHO multimodal HH strategy Pre and post-intervention : HH observations and post intervention questionnaires.	Factors influencing HH practices facilities, knowledge, professional group, time of the day, ward type (better in ER than surgical wards), type of patient care, hand sanitizer type (HCWs preferred commercially prepared to hospital prepared sanitizers)	124

NO	AUTHOR (YEAR)	POPULATION AND SAMPLE SIZE	RESEARCH AIM AND METHODS	SUMMARY OF RESEARCH FINDINGS	REF.
29	Shobowale *et al.* (2016)	Healthcare workers in a teaching hospital in Nigeria (n=148	To assess the compliance level with respect to appropriate HH practices through observational Study	Compliance before and after patient contact was 5.7% and 27% respectively. Factors influencing HH practices: assumption of HH as a means of personal protection, contact type, glove use	125
30	Tobi and Enyi-Nwafor (2013)	Healthcare workers in a teaching hospital in Nigeria (n=100)	To evaluate the handwashing knowledge, practices and compliance through questionnaire	Factors influencing HH practices: lack of time, skin irritation, lack of and inconveniently placed facilities, handwashing thought as not necessary, poor knowledge of policies	126
31	Uneke *et al.* (2014)	Healthcare workers in a teaching hospital in Nigeria (intervention phase n=202; evaluation phase n=209)	To identify factors associated with HH non-compliance through a cross-sectional, interventional study. Intervention phase: training, reminders at workplace etc. Evaluation phase: observations	Factors HH influencing practices: facilities, forgetfulness, occupational category, contact type, skin irritation, lack of awareness, absence of guidelines	127
32	Yawson and Hesse (2013)	Healthcare workers in a teaching hospital in Ghana (observations n= not reported)	To provide baseline survey data on HH practices and determine resources available in all the major clinical service provision centers through an observational study	Overall compliance rate not reported. Factors influencing HH practices: professional group, patient contact (exposure) type, facilities, perceived risk of infection	128

FIGURE 1: THE WHO APPROVED MY FIVE MOMENTS FOR HAND HYGIENE [27, 38]