**THE IMPACT OF AN MHEALTH AND ENVIRONMENTAL CUES INTERVENTION** **ON HAND HYGIENE PRACTICE AMONG HEALTHCARE WORKERS IN THE GREATER KAMPALA METROPOLITAN AREA. A CLUSTER RANDOMISED TRIAL.**

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# **Acronyms**

HAI Healthcare Acquired Infections

HCF Healthcare Facility

HCW Healthcare workers

Mhealth Mobile Health

WASH Water, Sanitation and Hygiene

WHO World Health Organization

# **Operational definitions**

**Mhealth:** mHealth (mobile health) is a general term for the use of mobile phones and other wireless technology in medical care.

**Hand hygiene:** The act of cleaning hands for the purpose of removing soil, dirt, and microorganisms. Generally, it includes the appropriate use of handwashing, antiseptic handwashing, and antiseptic handrubbing.

# **Abstract**

**Introduction**

Hand hygiene (HH) is one of the critical standard precautions for infection control in healthcare facilities (HCFs). However, a lack of adequate water, sanitation, and hygiene (WASH) facilities and insufficient knowledge about HH among healthcare workers (HCWs) in low- and middle-income countries makes it difficult for them to adhere to HH during critical moments. Despite these challenges, there is little evidence on the effectiveness of mhealth and environmental cues to promote HH among HCWs.

**Objective of the study**

To determine the impact of mhealth WASH messages and environmental cues on HH practice among HCWs in the Greater Kampala Metropolitan Area.

**Methodology:** The study will be guided by the “Behaviour Centred Design” framework for behaviour change programming (Aunger and Curtis, 2016), which guides hygiene program design through the “ABCDE” steps. A formative study using qualitative approaches will identify facilitators and barriers to good HH practice, and findings will inform the create phase. The intervention will be delivered through a cluster randomized trial (CRT) comprising 30 clusters of HCFs (15 intervention and 15 control groups) with a sample of 450 HCWs. HCWs in the intervention arm will receive environmental cues and approx. 3 WASH text messages per week giving advice on HH best practices, critical times and benefits. Using a mobile app, data on knowledge, attitudes and practices (KAP) will be collected during the baseline, midterm and end line assessments. STATA version 14.0 will be used for analysis of HH events and hand contamination. The primary outcome, HH practice will be compared through a difference-in-difference analysis.

**Outcomes**: The primary outcome will be the proportion of used HH events. Secondary outcomes include *E. coli* levels in hand rinses from HCWs that indicate recent fecal contamination and HH failure.

# **CHAPTER ONE: INTRODUCTION AND BACKGROUND**

Water, sanitation and hygiene (WASH) in healthcare facilities (HCF) are critical in the provision of quality health care. It has been argued that good WASH infrastructure and practices in HCF should reduce health-care acquired infections (HAI), increase trust and uptake of healthcare services, increase efficiency and improve staff morale. It is for the same reason that all major initiatives to improve global health depend on basic WASH services in HCF. Unfortunately, many HCF in low- and middle-income countries lack basic WASH infrastructure. Survey data from 54 countries indicated that 38% of HCF do not have an improved water source, 19% do not have improved sanitation and 35% do not have water and soap for hand-washing (WHO and UNICEF, 2015). This lack of WASH infrastructure compromises the ability to provide safe and quality health care services and places both those providing and those seeking health care at considerable and preventable health risk.

Poor WASH in HCF can lead to HAI in more vulnerable hospitalized populations, especially the immune-compromised, elderly as well as those with underlying diseases (Ducel et al., 2002). It has also been observed that patients (especially mothers and children), staff, caretakers and the general community are also at risk (Moffa et al., 2017). In low-income countries, the prevalence of HAI is estimated to be 16% (Allegranzi et al., 2011). HAI contribute to morbidity and mortality, and increase financial burdens and length of stay for patients in low-, middle-, and high-income countries (Anaissie et al., 2002, WHO, 2002). Mothers who give birth in HCF are at risk of infection because of lack of WASH infrastructure coupled with unsafe hygiene practices, and this risk increases if a caesarean section is needed.

The World Health Organization (WHO) reports that every day approximately 8 women die from preventable diseases related to pregnancy and childbirth, with 99% of deaths occurring in low income countries. Preventable infections cause 36% of maternal mortality (WHO/UNICEF, 2015). Caesarean section is the biggest risk factor for postpartum puerperal sepsis infection (van Dillen et al., 2010). Besides, the WHO reports that new-borns are at higher risk of acquiring HAI infections in low income countries, with infection rates 3-20 times higher than in high-income countries (WHO, 2015). A study in Nigeria, reported 6.5 cases of neonatal sepsis per 1000 live births in a referral hospital (Airede, 1992), and 21 cases of neonatal sepsis per 1000 live births were reported from a referral hospital in Zimbabwe (Nathoo et al., 1990). Furthermore, HAI in neonates in low income countries are far more likely to be caused by anti-microbial resistant pathogens and are more challenging to treat (Zaidi et al., 2005). Therefore, it is critical to focus on infection prevention especially through improvements of environmental conditions including WASH in HCF. Many HAI have been attributed to three major factors including: poor hand-washing practices, poor environmental conditions and insufficient standard precaution items (Galadanci et al., 2011, Erasmus et al., 2010, Moffa et al., 2017, Anaissie et al., 2002).

Sustainable Development Goal 6 includes a target to achieve universal access to basic drinking water, sanitation and hygiene for households, schools and HCF, by 2030, but there is little evidence about the health impact of improved WASH infrastructure and practices in HCF. In Uganda, we have conducted several WASH status and environmental conditions assessments in HCF through our partnerships with the Ministry of Health, Ministry of Water and Environment as well as several Non-government organizations (NGOs). Findings from our recent WASH assessment in 63 HCF in Kampala metropolitan area (Kampala, Mukono and Wakiso) districts reveal that 62.7% (188/300) of the mothers visited HCF that had piped water while nearly a quarter (14.3%) (43/300) of mentioned that water at the HCF was unsafe. Regarding the sanitation status of the HCF, majority 46% (162/300) of the mothers felt the number of drop holes in the toilets were not enough. More than a quarter (15.3%) (46/300) of the mothers at HCF failed to wash hands due to inadequate water and soap at the toilet facilities. Adherence to hand-washing standards amongst healthcare providers was also reported to be low, and interventions to improve compliance with this critical practice in HCF have not been researched (WHO, 2013, Erasmus et al., 2010).

The gaps that our proposed study research will address include: 1) the lack of understanding as to why Healthcare workers (HCWs) don’t adhere to hand hygiene guidelines in Uganda and 2) the lack of research on simple, effective and inexpensive interventions to enhance hand-hygiene practices among health care workers (HCWs) in Uganda (Gould et al., 2017). The use of text messaging technology (mhealth) in promoting health and preventing diseases is a proven and growing intervention (Zurovac et al., 2011, Terry, 2008). There is evidence that mhealth is critical in improving patients’ adherence to treatment as well as adherence of HCWs to treatment guidelines. However, the use and effect of mhealth in enhancing WASH practices including hand hygiene has not been tested. There is also evidence that in schools, nudges (environmental cues) have the potential to improve handwashing with soap among school-aged children (Dreibelbis et al., 2016) but such evidence doesn’t exist for HCF. Complex interventions such as: use of HCF wide poster campaign, combined with performance feedback and alcohol-based hand rub placed at every bedside; introducing alcohol-based hand rub accompanied by education/training; applying social marketing strategies as well as using multiple strategies including involvement of staff in planning activities have been suggested as interventions for improving adherence to hand-hand-hygiene guidelines among HCWs (Gould et al., 2017). However, no information exists about the effect of simple inexpensive mhealth and nudges/environmental cues related interventions on compliance to hand hygiene among HCWs.

# **CHAPTER TWO: LITERATURE REVIEW**

## **2.1 Barriers and opportunities for enhancing healthcare workers’ hand hygiene practices in HCFs**

A study in larger New York City metropolitan area assessed healthcare workers knowledge, attitude and practices on infection prevention and control and hand hygiene practice in three paediatric long-term care facilities (pLTCFs). The hand hygiene products and knowledge, awareness perception and beliefs were some of the barriers to hand hygiene identified. There were varying perceptions and preferences of the hand hygiene products which included; undesired smell, side effects with prolonged use; lack of hand washing sinks or their location or other products leading to limited availability and access. The knowledge, awareness perception and beliefs barriers cited included; lack of core knowledge of infection prevention and control practices; recommended practices had varying opinions and applicability; and setting-specific differences for application of guidelines (Løyland et al., 2016).

In Queensland Australia, a qualitative study among nurses revealed that emergencies, irritation of hands, lack of sinks, ignorance, forgetfulness and distractions, high work load, inability to interrupt task and belief of sensor taps being wasteful were some of the control belief barriers to the 5 moments of hand hygiene (White et al., 2015).In Addis Ababa Ethiopia, a study which explored infection prevention and control in the national referral hospital found that TB infection control and knowledge among healthcare workers was above 90%. However, barriers to proper hand hygiene practice were no different from those found in pLTCFs in New York City which included a lack of hand hygiene products (77%), hand washing sinks (30%), proper training (50%) adverse reactions hand sanitizers (67%) which were prepared according to WHO standards (Tenna et al., 2013).

A study among physiotherapists in an Ebola endemic region of Enugu in Nigeria revealed lack of hand hygiene products and infrastructure and forgetfulness as some of the barriers to hand hygiene practice (Ibeneme et al., 2017).Despite the barriers to hand hygiene practice, healthcare workers have reported, availability of hand hygiene products and sinks, available treatment of skin irritations, health education, incidences of infectious disease outbreaks, the IPC unit audits, environmental ques as some of the facilitators to hand hygiene (White et al., 2015).

## **2.2 Impact of mobile phone WASH text messages and environmental cues on hand hygiene practice**

Usage of mobile phone messages is an emerging low-cost intervention approach that can result in improved health outcomes. Encouragement of healthy behaviours can be achieved through mHealth at both individual and population level (Dimitriou et al., 2017). A 16% increase knowledge and practice among healthcare workers to manage viral, upper respiratory and middle ear infections in rural China indicated the effectiveness of text messages as tools to increase knowledge and practice among healthcare workers. Physicians reported text messages as the only way they received new approved medical knowledge and less than 3 hours a week to study medical literature. They also appreciated text messages as an easy way to receive and retrieve information (Chen et al., 2014).

A study in Kenya observed that a one-way message remainder to healthcare workers about paediatric malaria management resulted in an immediate 21.4% improvement and a 23.7% improvement in artemether-lumefantrine management. The remainder messages were found to address forgetfulness and increased task priority among healthcare workers (Zurovac et al., 2011).

In Bangladesh, the Cholera-Hospital-Based-Intervention-for-7-Days (CHoBI7) mHealth through voice and text messages was found to be acceptable and feasible in facilitating WASH behaviour change of household members of cholera patients through handwashing with water and soap and improved drinking water quality (George et al., 2016).

An increase of 11% in knowledge levels of transmission, common symptoms and prevention of Ebola virus was reported after mHealth tutorials for knowledge and attitude change towards Ebola virus were delivered to healthcare workers in Nigeria. The intervention also increased willingness to practice infection prevention and control practices of frequent hand washing, disinfection of surfaces and use of PPE (Otu et al., 2016).

Psychological studies have shown that environmental cues like notes, lists and general environmental information boost performance through offsetting forgetfulness (Konkel et al., 2015). Environmental cues have also been found to lead to behaviour change through engaging unconscious decision-making process. A study in rural Bangladesh found that environmental cues led increase in hand washing with soap after the toilet from 4% at baseline to 74% after 6 weeks in two primary schools (Dreibelbis et al., 2016).

Significant increase in hand hygiene behaviour of healthcare workers, patients and visitors was observed in a hospital in Germany, after an electronic monitoring and feedback system with visual cues of injunctive emoticons feedback was installed inside the patient rooms on top of hand-rub dispensers (Gaube et al., 2018).

# **CHAPTER THREE: PROBLEM STATEMENT, JUSTIFICATION, CONCEPTUAL FRAMEWORK AND RESEARCH QUESTIONS**

## **3.1 Problem statement**

Access to water, sanitation and hygiene is critical for quality health care and is vital for infection prevention and control in healthcare settings. Nevertheless, healthcare facilities in Uganda still lack WASH infrastructure and adequate supplies for infection control. In addition, these facilities are characterised by inactive infection control committees (Wasswa et al., 2015), making it difficult to foster adherence to hand hygiene standards among healthcare providers. A recent study by Mulogo et al. (2018) that 76% of healthcare facilities in south western Uganda had hand washing stations within the healthcare facility, however, only 24% of these health care facilities had both water and soap at these points thus compromising effectiveness of hand hygiene. Only 38% of the healthcare facilities had hand washing stations at the toilets.

In our recent assessment in the Greater Kampala Metropolitan area, 48.1% of the health care facilities had a limited water service; 85.2% had a limited sanitation service; more than half (51.9%) had limited environmental cleanliness service; 57.4% had limited hand hygiene service, and 53.7% had a limited health care waste management service. These statistics are indicative of WASH infrastructural gaps and are likely to impede on adherence to hand hygiene. Besides infrastructural challenges, a lack of knowledge and behavioural dynamics hamper hand hygiene among healthcare personnel. Observations in these healthcare facilities indicate that healthcare providers rarely adhere to the critical moments of hand hygiene, yet it remains one of the mainstay interventions in preventing hospital acquired infections. Failure to adhere to the critical moments of hand hygiene poses health risks to not only the healthcare providers but also the caregivers and patients seeking healthcare. It is associated with the transmission of hospital acquired infections such as sepsis. Failure to adhere to the standards of hygiene is often attributed to a lack of knowledge, and effective evidence-based hand hygiene interventions targeting improvements in healthcare settings. To be particular, there is a dearth of knowledge on the impact of mhealth and environmental cues interventions on hand hygiene in healthcare settings. Therefore, this trial will assess the impact of an mhealth and environmental cues intervention on hand hygiene practice among healthcare workers in the greater Kampala Metropolitan area, Uganda.

## **3.2 Justification of the study**

Hand hygiene remains a critical component in infection prevention and control in healthcare settings. However, the prevalence of adherence to hand hygiene especially during the critical moments remains low in low and middle income countries. This low prevalence could be as a result of a low level of knowledge and negative attitude towards hand hygiene, and a lack of supplies, supportive environment and effective strategies for influencing behavioural change. The purpose of this trial therefore, is to determine the impact of using mobile phone text messages and environmental cues on hand hygiene among healthcare providers in the Greater Kampala metropolitan area. Findings from this study will be used to inform the promotion and scaleup of environmental cues and mhealth interventions among healthcare providers. The findings of this study could be used to inform policy and programming.

The proposed research implementation activities fall under multiple Development Objectives and Intermediate Results (IR) of the USAID Uganda Country Development Cooperation Strategy. In particular, IRs 1.1 (Key drivers of vulnerability addressed defined by beneficiaries), 2.1 (Adoption of reproductive health behaviours increased), 2.1 (Child wellbeing improved), 3.2 (Citizens actively participate in development), 3.3 Key elements of systems strengthened, and 3.4 (Improved enabling environment).

It has been argued that improved access to WASH services in healthcare settings may encourage women to give birth in HCF and reduce delays in seeking care (Velleman et al., 2014). Research has indicated that improving WASH in HCF can help to establish trust in health services and encourage mothers to seek prenatal care and deliver in HCF rather than at home (Russo et al., 2012). Improved WASH in HCF has been documented as critical in preventing nosocomial pathogens (Rutala & Weber, 1997; Geldreich 1996; WHO 2015).

According to the World Health Organization (WHO), the provision of WASH in HCF serves to prevent infections and spread of disease, protect staff and patients, as well as uphold the dignity of vulnerable groups of people such as pregnant women and the disabled (WHO and UNICEF, 2015). The proposed research activities are a response to the critical WASH gaps in Uganda and will support efforts towards achieving Sustainable Development Goal (SDG) 6. This research specifically contributes towards achieving, target 6.1 which seeks to achieve universal and equitable access to safe and affordable drinking water for all by 2030, as well as target 6.2 which seeks to ensure access to adequate and equitable sanitation and hygiene for all and ending open defecation by the year 2030 (WHO/UNICEF, 2017; UN, 2015). The proposed research also fits into the USAID Water and Development Country Plan for Uganda. The plan indicates that USAID/ Uganda will: drive a systematic and evidence-based social and behaviour change program in households and in institutions (including schools and HCF); support HCF hygiene audits and action planning in each of the supported districts; support the establishment and strengthening community/local, district and regional institutions to develop the necessary capabilities to enable sustainable WASH outcomes in home, school, and HCF settings as well as to build upon existing health information monitoring systems.

## **3.3 Significance of the study**

The knowledge from the proposed research will be critical in achieving policy and programmatic impacts based on the already existing developments and needs in the sector including:

1. The development of hand hygiene indicators for HCF and a framework for promoting and scaling up hand hygiene interventions.
2. Development of local policies for improving adherence to hand hygiene guidelines among healthcare workers and stipulating realistic, simple and scalable interventions of enhancing hand hygiene.

MaKSPH is internationally recognized for its research and training programs in public health. Currently, it houses four departments, including: Department of Disease Control and Environmental Health; Department of Community Health; Department of Health Policy Planning and Management, and Department of Epidemiology and Biostatistics. MaKSPH has several research centers and projects/programs such as: the Centers for Disease Control and Prevention (CDC) program for “Supporting Policy Engagement for Evidence based Decisions” (SPEED); the Centre of Excellence for Maternal and Newborn Health Research; monitoring and evaluation technical support; the public health fellowship program, among many others. The collaborations between MaKSPH with the Ministry of Health (MOH), Ministry of Water and Environment (MWE), Ministry of Gender, Labour and Social Development (MGLSD), NGOs such as WaterAid Uganda, Oxfam Uganda and AMREF Uganda will be critical in helping research findings to influence policy.

The project’s policy objective is to use research findings to influence local policies and interventions that will enhance hand hygiene in HCF. The main policy audiences of this research are MOH and MWE which have the mandate of promote WASH and provide water for hand hygiene in HCF respectively. The major program audience is WaterAid Uganda, an influential Non-government organization (NGO) and one of the leading NGOs working on WASH in HCF. The other stakeholder to be involved is AMREF Uganda, especially because of their interest in providing WASH infrastructure in HCF in Uganda. The private sector especially telecommunication companies as well companies that manufacture soap and alcohol hand rubs will be involved for purposes of creating opportunities for public-private partnerships which are critical in scaling up and sustaining intentions. The local authorities in Kampala, Mukono and Wakiso districts will be involved as well. MakSPH has a memorandum of understanding (MOU) with WaterAid Uganda, MOH, KCCA and AMREF Uganda, and we have on-going research projects and a platform for sharing research findings and joint response. Through the already existing MOUs and work platforms, we shall have an opportunity to engage the stakeholders.

## **3.4 Theoretical framework**

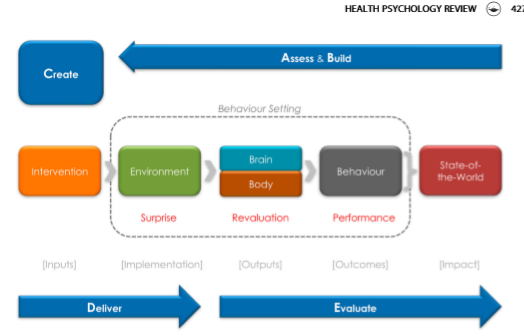


Figure 1 : Based on a behaviour Centred Design(Brackett, 2016)

## **3.41 Narrative**

This study is based on the Behaviour Centred Design (BCD) framework. This framework encompasses a theory of change, a suite of behavioural determinants and a programme design process (Aunger and Curtis, 2016). This study is based on the assumption that putting in place appropriate environmental cues and channelling out hand hygiene related text messages will create a cascade of effects via the environments, through brains, to behaviours and hence to the desired impact such as improved hand hygiene behaviour among healthcare workers.

## **3.5 Research questions**

**Specific objectives**

1. What are the barriers and opportunities for enhancing healthcare workers’ hand hygiene practices in HCFs in the GKMA?
2. What is the impact of mobile phone WASH text messages and environmental cues on hand hygiene practice among health workers in HCFs in the GKMA?

# **CHAPTER FOUR: STUDY OBJECTIVES**

## **4.1 Main objective**

To determine the impact of mobile phone WASH text messages and environmental clues on hand hygiene practice among healthcare workers in the GKMA.

## **4.2 Specific objectives**

1. To understand the barriers and opportunities for enhancing healthcare workers’ hand hygiene practices in HCFs in the GKMA.
2. To determine the impact of mobile phone WASH text messages and environmental cues on hand hygiene practice among health workers in HCFs in the GKMA.

# **5.0** [**CHAPTER FIVE: METHODOLOGY**](#_Toc21638059)

## **5.1 Description of study area**

The study will be conducted in the Greater Kampala Metropolitan Area (GKMA) which includes Kampala, Wakiso and Mukono districts. The three districts of the GKMA are associated with increasing population as well as economic development (KCCA, 2005). In partnership with the MOH, MWE, WaterAid Uganda and KCCA, we recently conducted a WASH assessment in 63 HCFs in the GKMA, and this proposed study will be building upon the evidence from that assessment, as well as priorities and needs that have been identified by stakeholders. According to the Uganda National Information Technology Agency (NITA), 70.9% of adult Ugandans own a mobile phone, and ownership is even higher in professional groups of people including HCWs (NITA, 2018).

## **5.2 Trial design and study population**

The study will use a cluster randomized trial (CRT) design. The study will be carried out in both private and public health centres of level III and IV in Wakiso and Mukono districts. HC IVs have a target population of 100,000, and are responsible for preventive, outpatient health services, maternity, inpatient health services, emergency surgery and blood transfusion and laboratory services. HC IIIs provide all the services of HC IIIs with the exception of emergency surgery. These health centres serve the health needs of the majority of the Ugandan population, however there is no data on hand hygiene status in these HCFs. The study will be guided by the “Behaviour Centred Design” framework for behaviour change programming (Aunger and Curtis, 2016), which guides hygiene program design through the “ABCDE” (Assess, Build, Create, Deliver and Evaluate) steps.

Prior to the implementation of the trial, the investigators will obtain a list of healthcare facilities and healthcare providers from the respective district health offices. This list will be used to randomly assign the clusters (healthcare facilities) to the intervention and control groups. Healthcare facilities will be purposively selected based on whether these provide delivery services or not. Once the clusters have been assigned, the study participants in the maternity and children’s wards within the selected healthcare facilities will be informed about the purpose of the study and recruited in the study after the consenting process. See Annex 1 for the Consent form.

## **5.3 Trial procedure/s**

This trial will be implemented following these stages;

**5.3.1 Assess - document existing hand hygiene behaviour**

In determining the barriers and opportunities for enhancing HCWs’ hand hygiene practices, the first component will involve collating available information on hand hygiene provisions and behaviour among HCWs in HCFs in Uganda. This will involve reviewing available literature (published and grey literature, including any publicly available data sets) and consulting with local experts and stakeholders. Literature on the drivers of HH among HCWs identified in previous studies and program evaluations will be reviewed. With the help of a literature review guide (Annex 2), national and local literature on hand hygiene interventions and practices will be reviewed. The findings from the literature review will be presented to stakeholders in a one-day work framing workshop to review the findings and establish the completeness of the information. The findings from the literature review will guide the build (formative) research phase.

**5.3.2 Build - Formative phase (objective 1):**

The formative research phase will address Objective 1 of the study, and the findings will inform the design and implementation of the intervention (mhealth and environmental cues on hand hygiene). The purpose of the build/formative phase is to understand the drivers of hand hygiene among HCWs. During the formative phase of the study, we shall conduct key informants’ interviews and in-depth interviews using a key informants’ interview guide and an in-depth interview guide respectively (See annex 3 and 4 for the key informants’ interview guide and in-depth interview guide respectively). Observations in 100 HCFs to establish the status of infrastructure and behaviour settings will be done using a structured observation checklist provided in annex 5. Details on the recruitment criteria for the key informants and in-depth interviewees are provided in section 5.7.

**5.3.3 Create - Stakeholders’ workshops to develop and refine the intervention**

A stakeholders’ workshop shall be conducted to share findings with the stakeholders on the barriers and facilitators of hand hygiene, and discuss contextual mechanisms of designing and implementing the intervention (mhealth and environmental cues). Stakeholders will give their ideas on how best the mhealth intervention should be designed and used to disseminate messages to HCWs. The choice of the environmental cues (colours or pictures to paint around hand hygiene stations, branding of mirrors etc) and the mhealth (mobile texting approach or use of social media like Facebook or whatsapp etc) for communicating behavioural change messages will depend on the guidance of the stakeholders. The stakeholders will include MWE, MOH, NGOs, representatives from local authorities, District and HCFs IPC committees, WASH consultants as well as HCWs from HC IIIs and IVs in the GKMA.

In each of the workshops, the World Café approach (Fouché & Light, 2011; Broom et. al. 2013) will be used, and 7-8 participants will sit around tables to internalize the findings from the formative research. Within the different groups, participants will use findings from the formative research to develop themes which will be used to develop insights, appealing stories that link the theme to the behaviour (hand hygiene among HCWs). The insights will be formulated to include: the behaviour to change; the character to influence; the motives to encourage behaviour of that character as well as the direct or indirect reinforcement of social norms to encourage behaviour change. The insights form the different groups will be presented, and participants will choose the best 4-5 insights based on: richness (how many of the formative research findings are captured by the insight), power (how strong is the logic that links the insight to the target behaviour), plasticity (how likely is that the idea on which she insight is based could be changed by the intervention), novelty (is it surprising) and acceptability (is it likely to be acceptable to the target population). Using “how might we questions”, participants will identify the campaign activities, tools and touch points that will enable HCWs to practice hand hygiene, change the settings, and create social norms.

The workshops will be used to develop and refine the intervention for implementation in the HCFs, using the workshop guide/creative brief attached in Annex 6.

**5.3.4 Delivery**

The study will be implemented though a cluster randomised trial targeting HCWs working in maternity and children’s wards. The messages and tools to be used will be pretested before implementing the intervention. Prior to implementing the intervention, a quantitative baseline study will be conducted for 1 month using a sample of 450 HCWs (225 in the intervention and 225 in the control arm). The baseline survey will use a direct hand hygiene observation tool (Annex 7) coupled with a structured questionnaire (Annex 8). The observation checklist will be based on the WHO’s 5 moments for Hand Hygiene (WHO, 2009). As part of the baseline survey, hand rinses for HCWs will be collected and analysed for *E. coli*, using the membrane filtration method, to establish levels of faecal contamination on their hands before the intervention.

The intervention will be implemented over a period of 4 months. The intervention will be implemented in partnership with WaterAid, MOH, KCCA, MWE as well as the selected HCFs.

**5.3.5 Evaluation**

Two types of evaluations (process and outcome) will be conducted. The process evaluation will be conducted at midline to understand how the intervention has been implemented. The process evaluation will seek to establish: whether the intervention is being implemented according to plan; whether the intervention is working or not; how many HCWs will be getting exposed to the touch points; how many HCWs will be responding to the mhealth intervention as well as the aspects of the intervention that participants will have liked. The end-line/outcome evaluation will be conducted at the end of the intervention for one month to assess if the intervention worked. The evaluation of the impact of the intervention will be based on the theory of change.

To assess the outcome of the intervention, a structured questionnaire will be administered at baseline, midline and end-line. In addition, observations of hand hygiene practice among the HCWs will be done at baseline, midline and end-line using an observation tool. Hand rinses will be collected and analysed, and the results will be entered in a hand rinses form. All the data collection tools to be employed (attached in the annexes) are guided by the WHO’s 5 moments for Hand Hygiene (WHO, 2009).

The theory of change is based on the stages in behaviour change (WHO, 2018). Developing and implementing a behaviour change intervention is a multi-stage process that is guided by different stakeholders. The stages (activities) will include: documentation of existing behaviour through literature review, key informants’ interviews and engagement with stakeholders; understanding behavioural drivers; developing the intervention and testing intervention effects and impact. The outcomes of the activities will be increased adherence to hand hygiene guidelines as well as Increased knowledge on hand hygiene benefits and procedure.

## **5.4 Trial interventions**

Findings from the formative phase will be used to inform the intervention phase. The study will be implemented through a CRT. In both the intervention and control HCFs, simple hand washing facilities (HWF) (tapped plastic jerricans with a stand and basin) will be provided (where needed) in delivery rooms, post-natal wards, and children’s ward. Soap for hand washing as well as alcohol hand rub will be provided at the hand hygiene stations. Hand hygiene demonstrations using the “glo germ” gel will be done in both study arms at the beginning of the study. The choice of the departments/ward for the interventions is based on the understanding that mothers and neonates are at greatest risk of infection because of lack of WASH infrastructure coupled with unsafe hygiene practices in HCFs (Cross et al., 2016).

In the intervention HCFs, besides the provisions in the control group, two interventions, mhealth and environmental cues (nudges) that have been successful in enhancing adherence to treatment guidelines (Zurovac et al., 2011) and enhancing hand-hygiene in school going children (Dreibelbis et al., 2016) respectively will be used. The choice of the specific mhealth intervention will be determined in the insight workshops, and participants will be exposed to messages three times a week for a period of 4 months. The mhealth intervention messages will be designed with a focus on: information on the benefits of hand hygiene; when to do hand hygiene; how to do hand hygiene and how to protect others. However, the messages will also have educational jokes and response prompts where HCWs with the highest number of responses will win hand hygiene supplies. The educational messages and jokes in the mhealth intervention will be guided by the results from the formative study. The SMS messages will be sent using Rapid SMS which is a complete SSaaS-based free and open source bulk SMS software. The software has the capacity to track message history and delivery, and this will be critical in understanding the proportion of HCWs receiving messages on a daily basis. Additionally, environmental cues (wall paintings, eyes on walls, words such as “I practice hand hygiene” on clinical coats or “talking mirrors” of sizes, shapes, colours and wordings) will to be determined during the formative research.

## **5.5 Randomization and Trial arms**

Selected healthcare facilities will randomly be assigned to the intervention and control arms. Randomization will be stratified at level III and IV HCF. All HCWs from the same HCF will be allocated to the same group as the randomized HCF in which they are working. HCWs will be masked of the intervention they are receiving.

## **5.6 Masking/ blinding**

The data analysts and the data collectors will be blinded to the group assignment. Both the intervention support team and the data collection team will be blinded from the intervention.

## **5.7 Data collection methods**

1. **Key informants’ interviews**

A total of 20 KIs selected based on their knowledge, position and experience on WASH aspects in HCF will be conducted. KIs will include in-charges of HC IIIs and IVs, nurses, administrators, Environmental Health Officers as well as officials from the MOH and district Public health team. More KIs may be recruited through snowball sampling until saturation of information is achieved. KIs interviews will be conducted in English using a KIs interview guide (Annex 3) with questions on the barriers and facilitators of hand hygiene in HCF.

1. **In-depth interviews**

A total of 10 in-depth interviews with HCWs will be conducted using an in-depth interview guide (Annex 4), to assess barriers to hand hygiene, motives of hand hygiene, social norms related to hand hygiene, behavioural settings and touch points, and data will be analysed using thematic analysis (Braun & Clarke, 2006).

1. **Observations in HCFs**

As part of the formative study, structured observations will be conducted in 100 HCFs to assess the hand hygiene infrastructure, roles, presence of hand hygiene supplies, functionality of facilitates, and norms. This will be done using an observation checklist (Annex 5).

## **5.8 Outcome measurement**

The primary outcome will be the proportion of used HH events/opportunities (number of times HH is observed to be done at critical times out of the total number of observed HH events/opportunities. Secondary outcomes include *E. coli* levels in hand rinses from HCWs that indicate recent fecal contamination and HH failure.

*Hand hygiene practice will be assessed through two approaches.*

Firstly, observations based on the WHO’s 5 moments for Hand Hygiene (WHO, 2009). The participants will be observed by a trained HCW from a different HCF and the hand hygiene moments to be observed include cleaning hands: before touching a patient; immediately before performing an aseptic procedure; immediately after an exposure risk to body fluids (and after glove removal); after touching a patient and his or her immediate surroundings when leaving as well as after touching any object or furniture in the patient’s immediate surroundings, when leaving - even without touching the patient. The observers’ training will aim to minimize potential observer bias and to ensure participant blinding. In each of the HCF, during the baseline, midline and end-line, each of the study participants will be observed for at least two hours in the morning (9am – 12pm), afternoon (2pm – 5pm) and evening (6pm – 8pm). Within the targeted time, 15 hand hygiene opportunities will be observed for each of the HCWs, and the used and missed opportunities will be recorded.

Data for the primary outcome will be collected during the evaluation surveys including: baseline, mid-line (2 months into the intervention), end line (after the 4 month of intervention) and impact 3 months after the intervention. During surveys, social demographic, knowledge and attitudes questions will be collected from all participating HCWs through a verbally administered questionnaire. The questionnaires will be administered to the HCWs before the observations. In order to maintain systematic consistency for measurement indicators, the same research tools used at baseline will be used for mid-term, end-line and impact evaluation.

Secondly, hand rinses for HCWs will be analysed for E. coli using the membrane filtration method, to establish if there are differences between levels of contamination on the hands of the HCWs before the intervention and after the intervention. Results from the microbial analysis of hand rinses will be recorded in the hand rinse laboratory form as provided in Annex 9.

## **5.9 Sample size**

A sample size of 30 clusters / HC IIIs and IVs (15 HCF under the intervention and 15 HCF under the control arm) with 15 HCWs per HCF will allow us to detect a 20% increase in the proportion of HCWs that practice hand hygiene (hand washing/hand rub) at the 5 critical moments at 4 months between the control and the intervention groups. Considering the following assumptions in calculating the sample size: a 25% and 5% increase in hand hygiene in intervention and control group respectively, a standard normal deviate of at 95% confidence level (1.96), a standard normal deviate at 80% power level (0.84), proportion of HCWs practicing hand hygiene in the control group (0.747) from an infection control study in HCF in Arua district, Northern Uganda (Waiswa et al 2015) and a design effect of 2. A sample size of 426 HCWs (doctors, clinical officers, nurses, midwives, laboratory technicians and nursing assistants) will be obtained. However, in order to achieve a consistent cluster size, the sample size will be round off to 450 participants, with 225 in each of the arms.

## **5.10 Eligibility**

The study will enroll healthcare providers working in the maternal and children’s wards of selected healthcare facilities. In order to be eligible to participate in the study, the inclusion criteria will include

* Being a full-time staff in the selected healthcare facility. This will be based on appointment letters wherever possible.
* Having worked in the selected healthcare facility for at least 6 months prior to the study.

## **5.11 Exclusion criteria**

The exclusion criteria will include:

* All healthcare workers in maternal and children’s wards of selected healthcare, who will be on leave at the time of the baseline
* All healthcare workers in maternal and children’s wards of selected healthcare, who will be so sick at the time of the baseline

## **5.12 Data management and analysis plan**

### 5.12.1 Data management

Data will be collected electronically on tablets/phones using Open Data Kit software. Data capture forms with in-built restrictions plus logical checks to minimize errors and missing data at collection will be designed by the study data management team. The data collected from the field will be submitted to the cloud on a daily basis and only accessible by the data management team for data security purposes. The data will be converted to comma-separated value (csv) format, exported to STATA version 14 after which consistency checks programs will be run daily and error reports produced. The generated errors will be sent back to the field team for clarification and cleaning. The data manager will be responsible for the security of the data and will back it up on the cloud server on a daily basis to avoid its loss.

Study progress will be monitored by comparing numbers accrued against those expected. Numbers accrued will further be verified against the physical counts form the field team. Progress reports will be provided to the study team on a daily basis for purposes of monitoring the progress. There will be a data quality team which will monitor the data collection activity and carry out re-interviews on a randomly selected percentage of the records to further ensure quality data is collected.

The cleaned data will be saved in csv format which can easily be imported into other software for analysis. The csv formats containing no participant personal identifiers but with unique IDs for each record will be uploaded onto a repository. In the event that amendments are made to the data collection forms following commencement of the study, data sets will first be saved by version and subsequently merged in order to produce one study data set with corresponding documentation.

Data will be pass-word protected when being transferred from the data management team to the data analyst. Information about the database or data sets will stored along with the data sets themselves. These meta data, that is, data set names and a description of what they contain, the codebooks with variable definitions, data cleaning files will be stored and provided a long with the data set for public consumption. Data will be availed to the public when the study is completed. For purposes of protecting respondents, de-identified data will be made publicly available.

### 5.12.2 Data analysis strategy

**Qualitative (formative stage):**

The KIIs will be transcribed verbatim without losing meaning. The typed transcripts will then read several times by all members of the study team and developed codes and code book definitions developed based on the objectives of the study while integrating in emerging themes from the data. The code book will be discussed and agreed by the study team. Then two experience research assistants will code the articles using ALTAS-ti software to ease further analysis. The code reports will then be read and discussed by all the investigators who agreed on both codes and categories. Then codes were grouped into categories and then themes.

**Quantitative (effect of intervention)**

The effect of the intervention will be evaluated at three time-points: midway the intervention (2 month), immediately after the completion of the intervention period to assess the short-term effects on hand-hygiene, and 3 months after the completion of the intervention to ascertain whether there was any lasting improvements in hand-hygiene among the HCWs. Data from all surveys will be double entered into REDcap and statistical analysis will be carried out using Stata version 15. The primary outcome, HH practice will be compared through a difference-in-difference analysis. We will calculate the prevalence of cluster level hand hygiene at baseline and follow-up for each HCF. Mixed sub-group analysis will be stratified by sex, cadre, experience, and level of training.

## **5.13 Quality Assurance/ Quality Control of Data and Collection**

* Experienced research assistants (RAs) will be recruited from a well-established network of RAs that have participated in successful research projects.
* All RAs will be trained about the research protoccol and ethical issues surrounding the study to ensure quality data collection.
* Prior to data collection, the study investigators together with the research assistants will conduct a pretest of the data collection tools. This will help the research assistants to familiarise with the data collection tools and also correct any errors if discovered. The pretest activity will be conducted in Nyimbwa health centre IV, Luweero district. Nyimbwa health-centre IV, Luweero district will purposively be selected as a pretest site because it shares similar characteristics with some of the HCFs in the GKMA.
* The study investigators will institute a quality control team. The QC team will include field supervisors whose role will be to ensure that research assistants adhere to the approved study protocol. To ensure quality quantitative data entry, the data entry screen will be designed with skips and restrictions to ensure quality data entry.
* In case of samples for hand rinses, a duplicate sample of the hand rinses will be obtained for validation of results.

## **5.13.1 Ethical considerations**

Ethical approval will be obtained from Makerere University School of Public Health Higher Degrees and Research Ethics Committee (MakSPH HDREC) and the Uganda National Council for Science and Technology (UNCST). Administrative clearance to conduct the study within healthcare facilities will be obtained from the respective district local governments and in charges of the selected healthcare facilities. Informed written consent will also be obtained from the individual respondents.

### 5.13.2 Informed consent process

* Informed written consent will be obtained in an appropriate language using consent forms. Information sheets describing the objectives the study, procedures to be followed; risks and benefits will be provided to the prospective study participants.
* During the consent discussions, each section of the consent form will be read exactly as it is written either by the research assistants, and further explained to the participant if necessary. All participants will be informed that participation in the study is completely voluntary and that they can withdraw from the study at any time they wish without reprimand.
* Informed written consent will be documented using consent forms. All consenting participants will be requested to sign a consent form in the presence of a witness.
* **Information on risks:** Although this study poses minimal risks, participants will be requested to point out any risks as they participate in the study.

**Confidentiality:** Data collection tools will be designed to ensure utmost confidentiality. In this case, data collection instruments will have unique codes (identification numbers) in order to conceal the identity of the study participants. Interviews will also be conducted in a private place in order to foster confidentiality. Data will be treated as confidential by the study personnel and all records will be kept secure in locked filling cabinets and offices.

## **5.14 Dissemination plan**

* We plan to hold a dissemination workshop where all key stakeholders in health services will be invited. These stakeholders will include ministry of health officials, district health team members and implementing partners in the health sector
* The findings of our study will also be presented during international workshops and conferences
* Peer reviewed manuscript will be submitted to an open access journal to increase the sharing of knowledge.

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# Detailed workplan

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **S. N** | **Activity** | **Months** | | | | | | | | | | | |
| **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** |
| **1.0** | **Preparations** |  |  |  |  |  |  |  |  |  |  |  |  |
| **1.1** | Development of data collection protocol |  |  |  |  |  |  |  |  |  |  |  |  |
| **1.2** | Obtain ethical approval MakSPH HDREC |  |  |  |  |  |  |  |  |  |  |  |  |
| **1.3** | Ethical approval from UNCST obtained |  |  |  |  |  |  |  |  |  |  |  |  |
| **1.4** | Site visit to study area |  |  |  |  |  |  |  |  |  |  |  |  |
| **1.5** | Document review |  |  |  |  |  |  |  |  |  |  |  |  |
| **1.6** | Stakeholder consultative workshop |  |  |  |  |  |  |  |  |  |  |  |  |
| **2.0 Baseline activities** | |  | | | | | | | | | | | |
| **2.1** | Interview and recruitment of research assistants (RAs) |  |  |  |  |  |  |  |  |  |  |  |  |
| **2.2** | Training of RAs |  |  |  |  |  |  |  |  |  |  |  |  |
| **2.3** | Pre-test of data collection tools |  |  |  |  |  |  |  |  |  |  |  |  |
| **2.4** | Finalize the data collection tool based on feedback from the field testing |  |  |  |  |  |  |  |  |  |  |  |  |
| **2.5** | Printing of tools and logistics management |  |  |  |  |  |  |  |  |  |  |  |  |
| **2.6** | Planning meeting prior to data collection |  |  |  |  |  |  |  |  |  |  |  |  |
| **2.7** | Baseline data collection |  |  |  |  |  |  |  |  |  |  |  |  |
| **2.8** | Data cleaning |  |  |  |  |  |  |  |  |  |  |  |  |
| **2.9** | Planning meeting |  |  |  |  |  |  |  |  |  |  |  |  |
| **2.10** | Data analysis |  |  |  |  |  |  |  |  |  |  |  |  |
| **2.11** | Development of a qualitative code book and qualitative analysis |  |  |  |  |  |  |  |  |  |  |  |  |
| **2.12** | Meeting to harmonize data analysis |  |  |  |  |  |  |  |  |  |  |  |  |
| **2.13** | Meeting to discuss finding and harmonise study report |  |  |  |  |  |  |  |  |  |  |  |  |
| **2.14** | Writing draft report |  |  |  |  |  |  |  |  |  |  |  |  |
| **2.15** | Baseline report finalized |  |  |  |  |  |  |  |  |  |  |  |  |
| **3.0 Implementation of interventions** | | | | | | | | | | | | | |
| **3.1** | Selection of Healthcare facilities |  |  |  |  |  |  |  |  |  |  |  |  |
| **3.2** | Installation of environmental cues |  |  |  |  |  |  |  |  |  |  |  |  |
| **3.3** | Sending of mhealth messages |  |  |  |  |  |  |  |  |  |  |  |  |
| **4.0 Midterm review** | | | | | | | | | | | | | |
| **4.1** | Midterm data collection |  |  |  |  |  |  |  |  |  |  |  |  |
| **4.2** | Data cleaning and analysis |  |  |  |  |  |  |  |  |  |  |  |  |
| **5.0 Endline assessments** | | | | | | | | | | | | | |
| **5.1** | Refresher training of RAs |  |  |  |  |  |  |  |  |  |  |  |  |
| **5.2** | Pre-test of data collection tools |  |  |  |  |  |  |  |  |  |  |  |  |
| **5.3** | Review of Endline data collection tools |  |  |  |  |  |  |  |  |  |  |  |  |
| **5.4** | Printing of tools and logistics management |  |  |  |  |  |  |  |  |  |  |  |  |
| **5.5** | Planning meeting prior to data collection |  |  |  |  |  |  |  |  |  |  |  |  |
| **5.6** | Endline data collection |  |  |  |  |  |  |  |  |  |  |  |  |
| **5.7** | Data cleaning |  |  |  |  |  |  |  |  |  |  |  |  |
| **5.8** | Planning meeting |  |  |  |  |  |  |  |  |  |  |  |  |
| **5.9** | Data analysis |  |  |  |  |  |  |  |  |  |  |  |  |
| **5.10** | Development of a qualitative code book and qualitative analysis |  |  |  |  |  |  |  |  |  |  |  |  |
| **5.11** | Meeting to harmonize data analysis |  |  |  |  |  |  |  |  |  |  |  |  |
| **5.12** | Meeting to discuss finding and harmonise study report |  |  |  |  |  |  |  |  |  |  |  |  |
| **5.13** | Report writing |  |  |  |  |  |  |  |  |  |  |  |  |

# Annexes

## Annex 1: Consent forms

### 1.1 Consent form for healthcare providers

**Improving hand hygiene practice among healthcare workers through mhealth and environmental cues in Kampala Metropolitan Area.**

**Study Purpose:** My name is [*insert name*]. I am working with Makerere University School of Public Health and Emory University. We are conducting a study to learn about strategies of Improving hand hygiene practice among healthcare workers through mhealth and environmental cues in Kampala Metropolitan Area. We would like to talk about your expert perspectives regarding hand hygiene in healthcare facilities.

**Participation in study**: You have been selected to participate in this study since you are involved in the delivery of healthcare services. I will ask you some questions about the hand hygiene. In this study hand hygiene refers to hand washing with soap or the use of alcohol-based hand rub.

This interview will take approximately 45 minutes. Your participation in this study is strictly voluntary and you do not have to participate if you do not want to or to answer every question if you don’t feel comfortable. Your responses will be entered into a mobile phone application and later uploaded to a password protected online platform. You may request that the interview be paused at any time. You can also withdraw from this study at any time without any reprisal.

**Confidentiality:** The information that you provide is strictly confidential. This means that your information will be kept private and will not be shared with anyone else who is not part of the investigating team in this study. The information you share with us will be used for research purposes only and your name will not be used in the report.

**Study benefits and risks:** There is no direct benefit to participation in this study; however, the answers you provide may help to improve hand hygiene services in healthcare facilities. Also, we cannot directly answer any questions or concerns you have about the health system in your district. The risks of participating in this study are minimal. As we mentioned, you can refuse to answer any question or withdraw from the study at any time without incurring any penalties. You may ask the interviewer any questions before, during and after the interview.

**Rights:** If you have any further questions about this study or about your rights as a study participant, you can contact the Principal Investigator; Dr. Richard Mugambe, Makerere University School of Public Health P. O. Box 7072, Kampala, (+256 789 477 677) or by email on, [rmugambe@musph.ac.ug](mailto:rmugambe@musph.ac.ug). Should you have questions about your rights as a study participant, please contact Dr. Suzanne Kiwanuka, Chairperson of Makerere University School of Public Health, Higher Degrees Research and Ethics Committee. Tel: +256 414 532 207 or +256 414 543 872

If you agree to participate in this study, please sign below to indicate that you have understood what the study is about and what your role is. You will be given a copy of the signed consent form.

**Consent sheet**

I have been informed of the study purpose and of my rights as a study participant. The investigator has offered to answer my questions concerning this study. I hereby consent to participate in the study.

Study Participant PRINTED NAME\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Study Participant SIGNATURE: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Interviewer SIGNATURE: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

### 1.2 Consent form for Key informants

**Improving hand hygiene practice among healthcare workers through mhealth and environmental cues in Kampala Metropolitan Area.**

**Study Purpose:** My name is [*insert name*]. I am working with Makerere University School of Public Health and Emory University. We are conducting a study to learn about strategies of Improving hand hygiene practice among healthcare workers through mhealth and environmental cues in Kampala Metropolitan Area. We would like to talk about your expert perspectives regarding hand hygiene in healthcare facilities.

**Participation in study**: You have been selected to participate in this study since you are involved in the delivery of and management of health service delivery in this district. I will ask you some questions about the hand hygiene. In this study hand hygiene refers to hand washing with soap or the use of alcohol-based hand rub.

This interview will take approximately 45 minutes. Your participation in this study is strictly voluntary and you do not have to participate if you do not want to or to answer every question if you don’t feel comfortable. Your responses will be entered into a mobile phone application and later uploaded to a password protected online platform. You may request that the interview be paused at any time. You can also withdraw from this study at any time without any reprisal.

**Confidentiality:** The information that you provide is strictly confidential. This means that your information will be kept private and will not be shared with anyone else who is not part of the investigating team in this study. The information you share with us will be used for research purposes only and your name will not be used in the report.

**Study benefits and risks:** There is no direct benefit to participation in this study; however, the answers you provide may help to improve hand hygiene services in healthcare facilities. Also, we cannot directly answer any questions or concerns you have about the health system in your district. The risks of participating in this study are minimal. As we mentioned, you can refuse to answer any question or withdraw from the study at any time without incurring any penalties. You may ask the interviewer any questions before, during and after the interview.

**Rights:** If you have any further questions about this study or about your rights as a study participant, you can contact the Principal Investigator; Dr. Richard Mugambe, Makerere University School of Public Health P. O. Box 7072, Kampala, (+256 789 477 677) or by email on, [rmugambe@musph.ac.ug](mailto:rmugambe@musph.ac.ug). Should you have questions about your rights as a study participant, please contact Dr. Suzanne Kiwanuka, Chairperson of Makerere University School of Public Health, Higher Degrees Research and Ethics Committee. Tel: +256 414 532 207 or +256 414 543 872

If you agree to participate in this study, please sign below to indicate that you have understood what the study is about and what your role is. You will be given a copy of the signed consent form.

**Consent sheet**

I have been informed of the study purpose and of my rights as a study participant. The investigator has offered to answer my questions concerning this study. I hereby consent to participate in the study.

Study Participant PRINTED NAME\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Study Participant SIGNATURE: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Interviewer SIGNATURE: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

## **Annex 2: Literature review guide for hand hygiene interventions, barriers and facilitators among Healthcare workers (HCWs)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | | **Questions to consider** | **What is known about hand hygiene among HCWs** | **More to be known (Yes or No)** |
|  | Target behaviour | Define hand hygiene (what specific action, who will do it, where will they do it and when will they do it). |  |  |
| Environment | Physical | What is the physical setting like? What things in the physical environment enable or prevent hand hygiene among HCWs? |  |  |
| Biological | What risk is there from pathogens/faeces? What diseases do HCWs and other stakeholders know or worry about? |  |  |
| Social | How does the social environment (relationships, networks and organisations) affect hand hygiene among HCWs? |  |  |
| Brains | Executive | Do healthcare workers understand the need for hand hygiene during the 5 critical moments, and when and how it should be done? Do they make plans related to the hand hygiene? |  |  |
| Motivated | Is hand hygiene among HCWs rewarding? What emotional drivers of behaviour are there? |  |  |
| Reactive | What cues hand hygiene? When is it most commonly done currently and what triggers this? Is the hand hygiene habitual? Do HCWs know how to do hygiene using the hand hygiene technique? |  |  |
| Body | Traits, physiology and senses | How do different HCWs (nurses, doctors, laboratory staff) practice hand hygiene? Do they have different needs? |  |  |
| Behaviour settings | Stage | Where does hand hygiene among HCWs take place? |  |  |
| Roles | What is the role played by the HCWs and how does it relate to roles played by other staff (non-medical) in the health facility setting? |  |  |
| Routine and script | How does the daily routine of activities undertaken by HCWs influence hand hygiene? |  |  |
| Norm | What hand hygiene behaviour are the HCWs expected to have? What behaviour would be approved of? |  |  |
| Objects and infrastructure | What objects are needed for HCWs to do hand hygiene? What infrastructure need to be in place to perform hand hygiene? |  |  |
| Touch points | What are the ways in which a program can contact or communicate to the HWCs? |  |  |
| Context | Programmatic, political, economic, social | What hand hygiene programs are active in the region? What political or historical events need to be considered when delivering hand hygiene programs in this area? |  |  |

## **Annex 3: Key informant interview guide for health facility in charges and district officials**

Date of interview: \_\_\_\_\_\_/ \_\_\_\_\_\_\_/ \_\_\_\_\_\_\_\_\_\_\_\_

Name of health facility: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Venue: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Language of interview: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Time interview started: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Time interview ended: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Key informant interview identifier: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Note: The Key informant** **participant’s identifier** should be created as follows: Type the initials - “KII” – followed by the name of the health facility where the interview has taken place (first 3 digits), followed by the date of interview in the format ***yy/mm/dd*** and the participant’s number (3 digits) assigned cumulatively. The participant’s identifier should end with a code showing the cadre of the provider as explained below. For example, if the first respondent is interviewed on December 20th, 2015 at ABC health facility; this participant’s identifier should be in the form: **KII/ABC/15/12/20/001/MD, where MD= Medical Doctor. Please use: NO = Nursing officer and enrolled nurses; MW = Midwife or MD = Medical doctor; LAB=Laboratory staff; CO=Clinical officer at the end of each participant’s number to designate the type of participant interviewed.**

***Interviewer:* Please obtain any additional details about the participant, e.g. his/her name and telephone contacts should be kept separately for any follow-up interviews that may be deemed necessary after the initial contact.**

|  |
| --- |
| **Guiding questions** |

**SECTION A: General questions**

1. What services are offered by this healthcare facility/ healthcare facilities in this district?

How do you ensure that quality healthcare services are provided in this facility?

* Probe for: safety of both the providers and clients, patient and provider satisfaction with available services and environmental hygiene

1. Is infection prevention and control a priority in this healthcare facility? How is it a priority? If not a priority, why not?

* What infection and prevention control precautions are prioritised in this healthcare facility? In this district? How are these prioritised? Probe for: availability of IPC supplies such as hand washing facilities, budget for IPC interventions, trainings, policies and guidelines
* Are WASH services part of quality of care for you? Are you satisfied with those services?

**SECTION B: Compliance to hand hygiene in the healthcare facility**

1. How important do you think is hand hygiene in a healthcare setting? Why/why not?

* What is usual practice of hand hygiene among healthcare workers in this health care facility?
* Are you concerned about spread of infections in healthcare facilities? Why? Which infections?

1. How important do you think is hand hygiene is for patients? Why/why not? Do you think healthcare providers in this healthcare facility prioritise hand hygiene?
2. How do you ensure compliance to hand hygiene among healthcare providers in this healthcare facility/ district?
3. There are healthcare facilities where providers comply with hand hygiene during all the critical moments while there are those where compliance to hand hygiene is poor.

* How would you rate this healthcare facility in terms of compliance with hand hygiene? **Probe:** Do you think hand hygiene in this healthcare facility/ healthcare facilities in this district is sufficient? If yes, why and if NO, why not? If not, what do you think most needs to be improved?
* Do you think all healthcare providers wash their hands during all the critical moments? If yes, what motivates them? If No, what challenges hinder them from practicing hand hygiene during all the critical moments?

**Expectations on Hand hygiene in healthcare facilities**

1. Do you have expectations about hand hygiene in this healthcare facility/ies? If so, what are they?

* Probes: Do you think that your expectations are similar to those of the healthcare facility staff?

1. Do you feel supported by healthcare staff for getting access to those services?

* Are the WASH services similarly accessible to anyone in the facility?
* Do you think that healthcare staff and patients should have similar goals for the provision of WASH services? Is it the case?
* Do you think that healthcare workers follow the rules in place relative to hygiene standards? If yes, why and if No, why not?

1. How is the culture of hand washing in this healthcare facility? How do healthcare providers in this healthcare facility perceive hand washing?

**Policy guidelines and standards relating to IPC**

1. What are national policies, guidelines, and/or regulations surrounding healthcare facility infection control and hand hygiene? Are there specific guidelines hand hygiene?

* What are the regional/local guidelines for healthcare facility infection control and hand hygiene?

1. Does this healthcare facility have specific guidelines on hand hygiene? What do the guidelines stipulate? Are those policies/ guidelines enforced? If yes, how and what are the repercussions for not complying with the guidelines?

**Supply chain of IPC materials**

1. What is your healthcare facility’s source of IPC materials? Who maintains the supply?
2. Who is in charge of buying hand hygiene supplies?
3. What hand hygiene supplies are used currently in the healthcare facility? Availability? For health workers? For patients and caregivers?
4. Do you have a sufficient budget to get a continuous supply of hand hygiene supplies?

Are your suppliers reliable?

**Capacity building (hygiene education, workers training, leadership building)**

1. Do staff receive any training or education about hand hygiene? How often? Who is the trainer? What is the information source?
2. Do staff ever receive training in management, supervision, or budgeting?
3. Do patients and caretakers receive any training or education about hand hygiene?
4. Did you see any change in IPC services after those trainings? What changes?
5. Do you feel confident in your capacities to maintain adherence to hand hygiene in this health care facility? What makes you confident/unconfident?
6. What is your experience training or arranging training for others? What is your own experience receiving training related to WASH services or management?

**Recommendations**

1. What are your suggestions for improving hand hygiene in this healthcare facility? What interventions do you think would be best suited for this healthcare facility?

## **Annex 4: In-depth Interview guide for the formative study**

Date of interview: \_\_\_\_\_\_/ \_\_\_\_\_\_\_/ \_\_\_\_\_\_\_\_\_\_\_\_

Name of health facility: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Venue: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Language of interview: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Time interview started: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Time interview ended: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Key informant interview identifier: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. What is hand hygiene? Have often do you see other HCWs in this facility doing hand hygiene?
2. What motivates HCWs to practice hand hygiene?
3. Does the leadership of this HCF promote hand hygiene? If yes, how do they promote hand hygiene?
4. Are the hand hygiene infrastructure in the HCF sufficient and functional? What factors affect the reliability and functionality of hand hygiene infrastructure?
5. What are the barriers to hand hygiene in this HCF? What do you think is the major barrier?
6. How can hand hygiene be promoted? Probe for suggestions on what can be done to motivate HCWs, change behavioural settings, create social norms? Probe for names and positions of people who can be used as Trusted voices to promote hand hygiene.
7. Do you have an infection prevention and control committee in place? Probe for the roles and activities of the IPC committee? Probe for frequency of the IPC activities and commitment of HCWs to the activities.
8. Do you have partners working with this HCF to improve WASH and IPC? Probe for the names of the partners and their roles?

**SECTION B: Compliance to hand hygiene in the healthcare facility**

1. How important do you think is hand hygiene in a healthcare setting? Why/why not?

* What is usual practice of hand hygiene among healthcare workers in this health care facility?
* Are you concerned about spread of infections in healthcare facilities? Why? Which infections?

1. How important do you think is hand hygiene is for patients? Why/why not? Do you think healthcare providers in this healthcare facility prioritise hand hygiene?
2. How do you ensure compliance to hand hygiene among healthcare providers in this healthcare facility/ district?
3. There are healthcare facilities where providers comply with hand hygiene during all the critical moments while there are those where compliance to hand hygiene is poor.

* How would you rate this healthcare facility in terms of compliance with hand hygiene? **Probe:** Do you think hand hygiene in this healthcare facility/ healthcare facilities in this district is sufficient? If yes, why and if NO, why not? If not, what do you think most needs to be improved?
* Do you think all healthcare providers wash their hands during all the critical moments? If yes, what motivates them? If No, what challenges hinder them from practicing hand hygiene during all the critical moments?

**Expectations on Hand hygiene in healthcare facilities**

1. Do you have expectations about hand hygiene in this healthcare facility/ies? If so, what are they?

* Probes: Do you think that your expectations are similar to those of the healthcare facility staff?

1. Do you feel supported by healthcare staff for getting access to those services?

* Are the WASH services similarly accessible to anyone in the facility?
* Do you think that healthcare staff and patients should have similar goals for the provision of WASH services? Is it the case?
* Do you think that healthcare workers follow the rules in place relative to hygiene standards? If yes, why and if No, why not?

1. How is the culture of hand washing in this healthcare facility? How do healthcare providers in this healthcare facility perceive hand washing?

**Policy guidelines and standards relating to IPC**

1. What are national policies, guidelines, and/or regulations surrounding healthcare facility infection control and hand hygiene? Are there specific guidelines hand hygiene?

* What are the regional/local guidelines for healthcare facility infection control and hand hygiene?

1. Does this healthcare facility have specific guidelines on hand hygiene? What do the guidelines stipulate? Are those policies/ guidelines enforced? If yes, how and what are the repercussions for not complying with the guidelines?

**Supply chain of IPC materials**

1. What is your healthcare facility’s source of IPC materials? Who maintains the supply?
2. Who is in charge of buying hand hygiene supplies?
3. What hand hygiene supplies are used currently in the healthcare facility? Availability? For health workers? For patients and caregivers?
4. Do you have a sufficient budget to get a continuous supply of hand hygiene supplies?

Are your suppliers reliable?

**Capacity building (hygiene education, workers training, leadership building)**

1. Do staff receive any training or education about hand hygiene? How often? Who is the trainer? What is the information source?
2. Do staff ever receive training in management, supervision, or budgeting?
3. Do patients and caretakers receive any training or education about hand hygiene?
4. Did you see any change in IPC services after those trainings? What changes?
5. Do you feel confident in your capacities to maintain adherence to hand hygiene in this health care facility? What makes you confident/unconfident?
6. What is your experience training or arranging training for others? What is your own experience receiving training related to WASH services or management?

**Recommendations**

1. What are your suggestions for improving hand hygiene in this healthcare facility? What interventions do you think would be best suited for this healthcare facility?

## **Annex 5: Structured observations guide for healthcare facilities**

Structured observations should be completed based on what is seen at the healthcare facility.

|  |  |  |
| --- | --- | --- |
| **S. N** | **IDENTIFICATION INFORMATION** | |
| **Date of observation** |  |
| **Unique ID** |  |
|  | **Initials of interviewer** |  |
|  | Name of the district | 1. Kampala 2. Mukono 3. Wakiso |
|  | Name of healthcare facility |  |
|  | Level of Health Facility | 1. Hospital 2. Health Centre IV 3. Health Centre III |
|  | Ownership of Health Facility | 1. Public 2. Private 3. PNFP |
|  | Location of Health facility | 1. Urban 2. Rural |

**Assessment of Sinks**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **Departments** | **Functionality of sinks** | **Presence of hand hygiene supplies** | | | |
| **Water only** | **Water with soap only** | **Alcohol hand rub only** | **WS and ABHR** |
|  | Number of sinks in Patient care areas across the entire HCF | Functional =  Non-functional =  Total = |  |  |  |  |
|  | Number of sinks in Food preparation areas | Functional =  Non-functional =  Total = |  |  |  |  |
|  | Number of sinks around Toilets | Functional =  Non-functional =  Total = |  |  |  |  |
|  | Number of sinks in patient consultation rooms | Functional =  Non-functional =  Total = |  |  |  |  |
|  | Number of sinks in the maternity ward | Functional =  Non-functional =  Total = |  |  |  |  |
|  | Number of sinks in the children’s ward | Functional =  Non-functional =  Total = |  |  |  |  |

|  |  |  |
| --- | --- | --- |
|  | Number of sinks in Patient care areas across the entire HCF | Functional =  Non-functional =  Total = |
|  | Number of sinks in Food preparation areas | Functional =  Non-functional =  Total = |
|  | Number of sinks around Toilets | Functional =  Non-functional =  Total = |
|  | Number of sinks in patient consultation rooms | Functional =  Non-functional =  Total = |
|  | Number of sinks in the maternity ward | Functional =  Non-functional =  Total = |
|  | Number of sinks in the children’s ward | Functional =  Non-functional =  Total = |

**SECTION II: This section requires that you move around the entire facility.**

|  |  |  |
| --- | --- | --- |
| S/n | **FACILITY OBSERVATION ITEMS** | **Response** |
|  | **Main water source** | 1. Protected water source onsite 2. Protected water source offsite 3. Unprotected water source onsite 4. Unprotected water source offsite 5. No water source |
|  | Does the healthcare facility have hand washing containers in all clinical areas? | 1. Yes 2. No 3. Not applicable (No clinical work in progress) |
|  | Is there running water and soap for washing hands in all clinical areas in the healthcare facility? | 1. Yes 2. No |
|  | Is there alcohol-based hand rub for cleansing hands in all clinical areas in the healthcare facility? | 1. Yes 2. No |
|  | Are there reminders and/or job aids posted that promote hand hygiene at this facility? | 1. Yes 2. No If No, go to 205 |
|  | If yes, describe what you saw |  |
|  | Do all healthcare providers wash their hands before examining patients? | 1. Yes 2. No 3. Not applicable (No clinical work in progress) |
|  | Do all healthcare providers wash their hands after examining patients? | 1. Yes 2. No 3. Not applicable (No clinical work in progress) |
|  | Do all healthcare providers wash their hands after touching the patient surroundings? | 1. Yes 2. No 3. Not applicable (No clinical work in progress) |
|  | Have any hand rinses stayed overnight in the HWF container overnight? | 1. Yes 2. No 3. Not applicable |
|  | Do all hand washing facilities have good drainage? | 1. Yes 2. No 3. Not applicable |
|  | Are there any splashes of waste water from hand hygiene facilities in the healthcare facility? | 1. Yes 2. No 3. Not applicable |
|  | Are handwashing facilities at the healthcare facility clean? | 1. Yes 2. No 3. Not applicable |
|  | **Hand hygiene supplies at the healthcare facility** | |
|  | Does the healthcare facility have any alcohol based handrub in stock at the time of observation? (Ask to check the store) | 1. Yes 2. No 3. Not applicable |
|  | Does the healthcare facility have any soap in stock at the time of observation? (Ask to check the store) | 1. Yes 2. No 3. Not applicable |
|  | Is there evidence of stocktaking for hand hygiene facilities at the healthcare facility? | 1. Yes 2. No 3. Not applicable |
|  | **Comments:** *Enter anything you are concerned about that is not captured by*  *the questionnaire:* |  |

## **Annex 6: Creative Brief for the Intervention design workshop**

|  |
| --- |
| **Stakeholders**   * Makerere University School of Public Health * Emory University Center for Global WASH * WaterAid Uganda * Ministry of Health * Ministry of Water and Environment * KCCA * Selected health facilities |
| **Back ground information**  What evidence is there that changes hand hygiene among HCWs, and results into positive public health outcomes. This will be got from the Assess step. |
| **What do you know about the hand hygiene among HCWs in the target setting?**  What are the common practices in relation to hand hygiene among HCWs in the target settings? What are some of the barriers and enabling factors related to hand hygiene among HCWs? This will be gathered from the information gathered from the Assess and build stages. |
| **Behaviour change task**  Increase hand hygiene (hand washing/hand rub) at the 5 critical moments among HCWs in selected HCFs in the Greater Kampala Metropolitan area. |
| **Desired Outcome**   * Hand hygiene (hand washing/hand rub) at the 5 critical moments among HCWs increases. * Faecal contamination in the hand rinses of HCWs from selected health facilities reduces. |
| **Insight**  State the insight identified in the creative workshop. |
| **Key aspects of change**  **Brain/Body**  Will the intervention need to change anything in the brain? e.g norms, roles, habits, routines, executive decision making, priorities etc.  **Behaviour**  How will the intervention enable performance?  **Environment**  Will the intervention need to change anything in the environment? e.g objects, infrastructure, settings, social networks |
| **Intervention design principles**  List the factors which may constrain the design process or things that are necessary to have in place. |
| **Creative team deliverables**  Explanation of the type of things you expect the creative team to deliver, and this will be based on intervention design principles. |

## **Annex 7: Hand hygiene Observation form**

draft

|  |  |  |
| --- | --- | --- |
| **S. N** | **IDENTIFICATION INFORMATION** | |
| **Date of observation** |  |
| **Unique ID** |  |
|  | **Initials of interviewer** |  |
|  | Name of the district | 1. Kampala 2. Mukono 3. Wakiso |
|  | Name of healthcare facility |  |
|  | Level of Health Facility | 1. Hospital 2. Health Centre IV 3. Health Centre III |
|  | Ownership of Health Facility | 1. Public 2. Private 3. PNFP |
|  | Location of Health facility | 1. Urban 2. Rural |
|  | Department where Hand hygiene behavior observation | 1. Maternity ward 2. Children’s ward |

**(Indication-related compliance with hand hygiene)**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Facility:** | | |  | | | **Period:** | | | **Setting:** | | |  | | |
|  | **Before touching a patient** | | | **Before clean/ aseptic procedure** | | | **After body fluid exposure risk** | | | **After touching a patient** | | | **After touching patient surroundings** | | |
| **Session N°** | **Indic (n)** | **HW (n)** | **HR**  **(n)** | **Indic (n)** | **HW (n)** | **HR**  **(n)** | **Indic (n)** | **HW (n)** | **HR**  **(n)** | **Indic (n)** | **HW (n)** | **HR**  **(n)** | **Indic (n)** | **HW (n)** | **HR**  **(n)** |
| **1** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **2** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **3** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **4** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **5** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **6** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **7** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **8** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **9** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **10** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **11** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **12** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **13** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **14** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **15** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **16** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **17** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **18** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **19** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **20** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Total** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Calculation** | **Act (n) =**  **Indic1 (n) =** | | | **Act (n) =**  **Indic2 (n) =** | | | **Act (n) =**  **Indic3 (n) =** | | | **Act (n) =**  **Indic4 (n) =** | | | **Act (n) =**  **Indic5 (n) =** | | |
| **Ratio**  **act / indic🞱** |  | | |  | | |  | | |  | | |  | | |

**Instructions for use**

1. Define the setting outlining the scope for analysis and report related data according to the chosen setting.
2. Check data in the observation form. Hand hygiene actions not related to an indication should not be taken into account and vice versa.
3. If several indications occur within the same opportunity, each one should be considered separately as well as the related action.
4. Report the session number and the related observation data in the same line. This attribution of session number validates the fact that data has been taken into count for compliance calculation.
5. Results per indication (indic) and per session (vertical):

4.1 Sum up indications per indication in the observation form: report the sum in the corresponding cell in the calculation form.

4.2 Sum up positive hand hygiene actions related to the total of indications above, making the difference between handwash (HW) and handrub (HR): report the sum in the corresponding cell in the calculation form.

4.3 Proceed in the same way for each session (observation form).

4.4 Add up all sums per each indication and put the calculation to calculate the ratio (given in percent)

## **Annex 8: Baseline, midline and end-line structured questionnaire for the HCWs**

|  |  |  |  |
| --- | --- | --- | --- |
| **Study Tittle:** Improving hand hygiene practice among healthcare workers through mhealth and environmental cues in Kampala Metropolitan Area.  **Preamble**  The interview with a healthcare provider should be conducted in as private a setting as you can find, and must be done individually. Data collectors should introduce themselves and explain the purpose of the survey saying that we are trying to find ways that our project can support the health services to improve hand hygiene in the healthcare facilities. You should inform the person that the interview will take about 15 minutes, and that the data you collect are confidential and that he/she will not be identified by name. Then request permission to conduct the interview.  Do not ask or write down the name of the person you are interviewing. If the person refuses to participate, accept the refusal and request to interview a different healthcare provider. If no one else is available or willing, report to your supervisor that the interview could not be completed at that facility. | | | |
| **IDENTIFICATION INFORMATION** | | | |
| **Date of interview** | |  | |
| **Unique ID** | |  | |
| **Initials of interviewer** | |  | |
| Name of the district | | 1. Kampala 2. Mukono | |
| Name of healthcare facility | |  | |
| Level of Health Facility | | 1. Hospital 2. Health Centre IV 3. Health Centre III | |
| Ownership of Health Facility | | 1. Public 2. Private 3. PNFP | |
| Number of beds | |  | |
| Number of outpatients | |  | |
| Number of inpatients | |  | |
| Number of delivers per day | |  | |
| Number of healthcare workers | |  | |
| Location of Health facility | | 1. Urban 2. Rural | |
| **SECTION 1: Socio demographic characteristics** | | | |
| **No.** | **Question** | **Response** | **Comment** |
|  | Sex | 1. Male 2. Female |  |
|  | Age (complete years) |  |  |
|  | Marital status | 1. Single (never married) 2. Married/cohabiting 3. Separated/divorced 4. Widowed |  |
|  | Profession | 1. Medical doctor 2. Clinical officer 3. Laboratory technician/ technologist 4. Laboratory assistant 5. Registered nurse 6. Enrolled nurse 7. Registered midwife 8. Enrolled midwife 9. Nursing assistant 10. Other (please specify) |  |
|  | Main department of work | 1. OPD 2. IPD 3. Maternity 4. Theatre 5. Laboratory 6. Others (specify) |  |
|  | For how long have you been practicing? (Duration in complete years) |  |  |
| **SECTION II** | | | |
| **Knowledge on hand washing (Adapted from the WHO standardized questionnaire on hand hygiene)** | | | |
|  | Did you receive any formal training in hand hygiene in the last three years? | 1. Yes 2. No |  |
|  | Do you routinely use an alcohol-based hand rub for hand hygiene? | 1. Yes 2. No |  |
|  | Which of the following is the main route of cross-transmission of potentially harmful germs between patients in a health-care facility? (tick one answer only) | 1. Health-care workers’ hands when not clean 2. Air circulating in the hospital 3. Patients’ exposure to colonised surfaces (i.e., beds, chairs, tables, floors) 4. Sharing non-invasive objects (i.e., stethoscopes, pressure cuffs, etc.) between patients |  |
|  | What is the most frequent source of germs responsible for health care-associated infections?  (tick one answer only) | The hospital’s water system  The hospital air  Germs already present on or within the patient  The hospital environment (surfaces) |  |
|  | Which of the following hand hygiene actions prevents transmission of germs to the patient? ***(tick all that apply)*** | |  |  |  | | --- | --- | --- | | **Actions** | **Yes** | **No** | | HW before touching a patient |  |  | | HW immediately after a risk of body fluid exposure |  |  | | HW after exposure to the immediate surroundings of a patient |  |  | | HW immediately before a clean/aseptic procedure |  |  | |  |
|  | Which of the following hand hygiene actions prevents transmission of germs to the health-care worker? ***(tick all that apply)*** | |  |  |  | | --- | --- | --- | | **Actions** | **Yes** | **No** | | HW after touching a patient |  |  | | HW immediately after a risk of body fluid exposure |  |  | | HW after exposure to the immediate surroundings of a patient |  |  | | HW immediately before a clean/aseptic procedure |  |  | | HW after touching patient surroundings |  |  | |  |
|  | Which of the following statements on alcohol-based hand rub and handwashing with soap and  water is true? | |  |  |  | | --- | --- | --- | | **Statement** | **T** | **F** | | Handrubbing is more rapid for hand cleansing than handwashing |  |  | | Handrubbing causes skin dryness more than handwashing |  |  | | Handrubbing is more effective against germs than handwashing |  |  | | Handwashing and handrubbing are recommended to be performed in sequence |  |  | |  |
|  | What is the minimal time needed for alcohol-based handrub to kill most germs on your hands?  ***(tick one answer only)*** | 1. 20 seconds 2. 3 seconds 3. 1 minute 4. 10 seconds |  |
|  | Which type of hand hygiene method is required in the following situations?  **R=Rubbing, W=Washing, N=None** | |  |  |  |  | | --- | --- | --- | --- | | **Situation** | **R** | **W** | **N** | | Before palpation of the abdomen |  |  |  | | Before giving an injection |  |  |  | | After emptying a bedpan |  |  |  | | After removing examination gloves |  |  |  | | After making a patient's bed |  |  |  | | After visible exposure to blood |  |  |  | | |
|  | Which of the following should be avoided, as associated with increased likelihood of colonisation of hands with harmful germs? **Y= Yes, N=No** | |  |  |  | | --- | --- | --- | | **Action to be avoided** | **Y** | **N** | | Wearing jewellery |  |  | | Damaged skin |  |  | | Artificial fingernails |  |  | | Regular use of a hand cream |  |  | | |
| **SECTION III: Perception Survey for Health-Care Workers** | | | |
| **You are in direct contact with patients on a daily basis and this is why we are interested in your opinion on health care-associated infections and hand hygiene.** | | | |
|  | In your opinion, what is the average percentage of hospitalized patients who will develop a health care-associated infection (between 0 and 100%)? |  |  |
|  | In general, what is the impact of a health care-associated infection on a patient's clinical outcome? | 1. Very low 2. Low 3. High 4. Very high |  |
|  | What is the effectiveness of hand hygiene in preventing health care-associated infection? | 1. Very low 2. Low 3. High 4. Very high |  |
|  | Among all patient safety issues, how important is hand hygiene at your institution? | 1. Low priority 2. Moderate priority 3. High priority 4. Very high priority |  |
|  | On average, in what percentage of situations requiring hand hygiene do health-care workers in your hospital actually perform hand hygiene, either by hand-rubbing or handwashing (between 0 and 100%)? |  |  |
|  | **Opinions on the effectiveness of handwashing actions in a healthcare facility**  **In your opinion, how effective would the following actions be to improve hand hygiene permanently in your institution?** | | |
|  | Leaders and senior managers at your institution support and openly promote hand hygiene. | 1. Very effective 2. Slightly effective 3. Effective 4. Neutral 5. Slightly effective 6. Not effective |  |
|  | The health-care facility makes alcohol-based handrub always available at each point of care. | 1. Very effective 2. Slightly effective 3. Effective 4. Neutral 5. Slightly effective 6. Not effective |  |
|  | Hand hygiene posters are displayed at point of care as reminders. | 1. Very effective 2. Slightly effective 3. Effective 4. Neutral 5. Slightly effective 6. Not effective |  |
|  | Each health-care worker receives education on hand hygiene | 1. Very effective 2. Slightly effective 3. Effective 4. Neutral 5. Slightly effective 6. Not effective |  |
|  | Each health-care worker receives text messages on hand hygiene | 1. Very effective 2. Slightly effective 3. Effective 4. Neutral 5. Slightly effective 6. Not effective |  |
|  | Clear and simple instructions for hand hygiene are made visible for every health-care worker | 1. Very effective 2. Slightly effective 3. Effective 4. Neutral 5. Slightly effective 6. Not effective |  |
|  | You always perform hand hygiene as recommended (being a good example for your colleagues). | 1. Very effective 2. Slightly effective 3. Effective 4. Neutral 5. Slightly effective 6. Not effective |  |
|  | Patients are invited to remind health-care workers to perform hand hygiene. | 1. Very effective 2. Slightly effective 3. Effective 4. Neutral 5. Slightly effective 6. Not effective |  |
|  | **SECTION IV: ATTITUDE TOWARDS HAND HYGIENE** | |  |
|  | Hand hygiene can be protective to HCWs | 1. Strongly agree 2. Agree 3. Indifferent 4. Disagree 5. Strongly disagree |  |
|  | Hand hygiene should be done when in contact with all patients and patient’s deformities | 1. Strongly agree 2. Agree 3. Indifferent 4. Disagree 5. Strongly disagree |  |
|  | I do not always adhere to hand hygiene because of a busy work schedule in between patients | 1. Strongly agree 2. Agree 3. Indifferent 4. Disagree 5. Strongly disagree |  |
|  | HCWs are motivated to do hand hygiene because of fear of contracting disease | 1. Strongly agree 2. Agree 3. Indifferent 4. Disagree 5. Strongly disagree |  |
|  | Hand hygiene can be improved by administrative order and continuous health education | 1. Strongly agree 2. Agree 3. Indifferent 4. Disagree 5. Strongly disagree |  |
|  | Hand hygiene in a healthcare setting is a waste of time | 1. Strongly agree 2. Agree 3. Indifferent 4. Disagree 5. Strongly disagree |  |
|  | Healthcare providers need reminders so as to practice hand hygiene | 1. Strongly agree 2. Agree 3. Indifferent 4. Disagree 5. Strongly disagree |  |
|  | Buying hand hygiene facilities in a healthcare facility is a waste of financial resources | 1. Strongly agree 2. Agree 3. Indifferent 4. Disagree 5. Strongly disagree |  |
|  | Hand hygiene should be a priority in all healthcare settings | 1. Strongly agree 2. Agree 3. Indifferent 4. Disagree 5. Strongly disagree |  |
|  | Hand hygiene should be compulsory in a healthcare setting | 1. Strongly agree 2. Agree 3. Indifferent 4. Disagree 5. Strongly disagree |  |
|  | Hand hygiene protects both the providers and patients from hospital acquired infections | 1. Strongly agree 2. Agree 3. Indifferent 4. Disagree 5. Strongly disagree |  |

**Thank you for your time**

## **Annex 9: Hand Rinse - Lab Processing Form**

**Hand Hygiene study**

**Sample ID Sample Processing Date Sample Processing Time**

\_\_ \_\_ : \_\_ \_\_ \_\_\_

Hour Minute AM/PM

Day Month Year

\_\_ \_\_ / \_\_ \_\_ / \_\_ \_\_ \_ \_

**Sample Site**

**Date and Time Placed in Incubator Date and Time Removed from Incubator**

\_\_ \_\_ : \_\_ \_\_ \_\_\_

Hour Minute AM/PM

Day Month Year

\_\_ \_\_ / \_\_ \_\_ / \_\_ \_\_ \_ \_

Day Month Year

\_\_ \_\_ / \_\_ \_\_ / \_\_ \_\_ \_ \_

\_\_ \_\_ : \_\_ \_\_ \_\_\_

Hour Minute AM/PM

*Fill in the following information in order of decreasing concentration. If you can record the E. coli count, indicate that the reading status is* ***Valid****. If you cannot record the E.coli count, indicate whether the E. coli is too numerous to count (****TNTC\*; > 200 for membrane filtration (MF), >100 for compact dry plates (CDP)****) or the tray is too dirty to count (****TDTC\*\*****).*

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Dilution (mL)** | **Volume**  **Tested (mL)** | ***E. coli* Count-CDP**  **(Blue colonies)** | | ***Klebsiella*Count-CDP**  **(Pink-Purple colonies)** | | ***Staphylococcus Aureus* Count-CDP**  **(Light Blue to Blue colonies)** | | ***E.coli* Count using Membrane Filtration (Blue colonies)** | |
| **Read Status** | **Count** | **Read Status** | **Count** | **Read Status** | **Count** | **Read Status** | **Count** |
| 🞎Undiluted  🞎 1 : 10  🞎 1 : 102 | 🞎 1(CDP)  🞎100 (MF) | Valid  🞎  TNTC\*  🞎  TDTC\*\*  🞎 |  | Valid  🞎  TNTC\*  🞎  TDTC\*\*  🞎 |  | Valid  🞎  TNTC\*  🞎  TDTC\*\*  🞎 |  | Valid  🞎  TNTC\*  🞎  TDTC\*\*  🞎 |  |
| 🞎Undiluted  🞎 1 : 10  🞎 1 : 102 | 🞎 1  (CDP)  🞎100  (MF) | Valid  🞎  TNTC\*  🞎  TDTC\*\*  🞎 |  | Valid  🞎  TNTC\*  🞎  TDTC\*\*  🞎 |  | Valid  🞎  TNTC\*  🞎  TDTC\*\*  🞎 |  | Valid  🞎  TNTC\*  🞎  TDTC\*\*  🞎 |  |
| 🞎Undiluted  🞎 1 : 10  🞎 1 : 102 | 🞎 1  (CDP)  🞎100  (MF) | Valid  🞎  TNTC\*  🞎  TDTC\*\*  🞎 |  | Valid  🞎  TNTC\*  🞎  TDTC\*\*  🞎 |  | Valid  🞎  TNTC\*  🞎  TDTC\*\*  🞎 |  | Valid  🞎  TNTC\*  🞎  TDTC\*\*  🞎 |  |

**Lab Operator Name**

**Notes**

# **CVs of investigators**

**Abbreviated CV: Dr. R K Mugambe (PI)**

**Lecturer, Dept of Disease Control and Environmental Health, School of Public Health, College of Health Sciences, Makerere University,**

**Old Mulago Hill Road, P.O Box 7072, Kampala, Uganda.**

**Ph: +256 774419596 (mobile); email:** [**rmugambe@musph.ac.ug**](mailto:rmugambe@musph.ac.ug)

**a. Professional Preparation**

|  |  |  |
| --- | --- | --- |
| Makerere University, Uganda | BSc. Environmental Health Sciences | 2003 |
| Wageningen University, The Netherlands | MSc. Environmental Sciences | 2007 |
| University of Ireland, Trinity College Dublin. | PhD in Global Health | 2014 |

**b. Appointments**

|  |  |
| --- | --- |
| 2015 - | Lecturer |
| 2007 - 2015 | Assistant Lecturer |
| 2003 - 2007 | Teaching Assistant |

**c. Publications**

(i) *Up to five publications most closely related to proposal project*

1. [Abdullah Ali Halage](http://www.hindawi.com/69470903/), [Charles Ssemugabo](http://www.hindawi.com/56706819/), [David K. Ssemwanga](http://www.hindawi.com/50940821/), [David Musoke](http://www.hindawi.com/74283853/), [**Richard K. Mugambe**](http://www.hindawi.com/40262741/)**,** [David Guwatudde](http://www.hindawi.com/25756742/), and [John C. Ssempebwa](http://www.hindawi.com/23960357/) (2015). Bacteriological and Physical Quality of Locally Packaged Drinking Water in Kampala, Uganda. Journal of Environmental and Public Health, Volume 2015, Article ID 942928, 6 pages.
2. **Richard K. Mugambe,** John Ssempebwa, Nazarius Mbona, Fiona Larkan. Access to and perceptions towards water, sanitation and hygiene: a case of HIV/AIDS affected and non-affected households in rural Uganda (2014). J Public Health, 22 (2014): 287 – 296.
3. **Richard K. Mugambe,** Nazarius Mbona Tumwesigye, Fiona Larkan (2013). Barriers to accessing water, sanitation and hygiene among people living with HIV/AIDS in Gomba and Mpigi districts in Uganda: a qualitative study. J Public Health, 21 (2013): 29 – 37.
4. **Richard K. Mugambe,** John Ssempebwa, Nazarius Mbona, Bas van Vliet and Adebola Adedimeji (2012). Healthcare wastes management in Uganda: management and generation rates in Public and Private Hospitals in Kampala. J Public Health, 20 (2012): 245 – 251
5. Yakubu H,  Robb K, Bwire C, **Mugambe R,** Michiel J, Mcgriff J, Moe C. Assessment of water, sanitation and hygiene (WASH) and infection, prevention and control conditions in six healthcare facilities in Western Uganda. Antimicrobial Resistance and Infection Control 2016, 6(Suppl 1):A22 DOI 10.1186/s13756-016-0153-0

(ii) *Up to five other significant publications*

1. Silvestro Ojja , Stevens Kisaka, Michael Ediau, Doreen Tuhebwe, Angela N. Kisakye, Abdullah A. Halage, **Richard K. Mugambe** and Joan N. Mutyoba (2018). Prevalence, intensity and factors associated with soil transmitted helminths infections among preschool-age children in Hoima district, rural western Uganda. BMC Infectious Diseases. <https://doi.org/10.1186/s12879-018-3289-0>
2. Edwinah Atusingwize, Geofrey Musinguzi, Rawlance Ndejjo, Esther Buregyeya, Barbara Kayongo, Ruth Mubeezi, **Richard K. Mugambe**, Abdullah Ali Halage, Deogratious K. Sekimpi, William Bazeyo, Jia-Sheng Wang & John. C. Ssempebwa (2018) Occupational safety and health regulations and implementation challenges in Uganda, Archives of Environmental & Occupational Health, DOI: [10.1080/19338244.2018.1492895](https://www.google.com/url?q=https%3A%2F%2Fdoi.org%2F10.1080%2F19338244.2018.1492895&sa=D&sntz=1&usg=AFQjCNEzGNGyXme7GDlInyeKl85CizZN_g)
3. Tonny Ssekamatte, John Bosco Isunju, Bonny Enock Balugaba, Doreen Nakirya, Jimmy Osuret, Patience Mguni, **Richard K. Mugambe** & Bas van Vliet (2018) Opportunities and barriers to effective operation and maintenance of public toilets in informal settlements: perspectives from toilet operators in Kampala, International Journal of Environmental Health Research, DOI: [10.1080/09603123.2018.1544610](https://www.google.com/url?q=https%3A%2F%2Fdoi.org%2F10.1080%2F09603123.2018.1544610&sa=D&sntz=1&usg=AFQjCNHuMyrEW-ga_vunin8wGOV52_U3vQ)
4. Rawlance Ndejjo, Edwinah Atusingwize, Frederick Oporia, Charles Ssemugabo, David Musoke, David K. Ssemwanga, Abdullah Ali Halage, John Bosco Isunju, Winnifred Kansiimea, Ruth Mubeezi, **Richard Kibirango Mugambe**, Emery Patrice Mbaha, Paul Luyima & John. C. Ssempebwa (2018): History, evolution and future of environmental health in Uganda, Archives of Environmental & Occupational Health, DOI: 10.1080/19338244.2018.1541858

**d. Synergistic Activities**

* Environmental Impact Assessor – Certified by the Uganda National Environmental Management Authority (NEMA) as a Private Practitioner to carry out Environmental Impact assessments in the fields of Water and Waste water management, Solid waste management, Renewable energy technologies besides Cost benefit analysis and Environmental Valuation.
* Team Leader, Masters of Environmental Health Sciences curriculum development team at Makerere University School of Public Health.
* Reviewer Journal of Alcohol addiction and Use
* Member of National Codex committee under the Uganda National bureau of standards
* External examiner, Busitema University, Uganda.
* Project leader on several Environmental assessment projects in the country including: water and sanitation projects, mini-hydro power projects, afforestation projects, solid waste management projects, health care facilities projects, telecommunication projects etc.
* Member of the Uganda Environmental Health Workers’ Association.

**e. Collaborators & Other Affiliations**

**(i)Collaborators** (partial list)

1. Prof. Bas van Vliet. Department of Social Sciences, Environmental Policy Division, Wageningen University.
2. Prof. Christine Moe, Center for Global Safe Water, Rollins School of Public Health, Emory University.
3. Dr. Lisa Lenker, Community for Global Health Equity, Buffallo University.

**Referees**

1. Dr. John C. Ssempebwa, Department of Biostatistics and Epidemiology, Makerere University School of Public Health.
2. Prof. Christine Moe. Emory University Center for global WASH.

**Abbreviated CV: Dr. Kyebambe Moses Ntanda (ICT Specialist).**

**Lecturer, Dept of Networks, School of Computing and Information Sciences, College of Computing and Information Sciences, Makerere University,**

**P.O Box 7072, Kampala, Uganda.**

**Ph: +256 752533355 (mobile); email:** [**mntanda@cis.mak.ac.ug**](mailto:mntanda@cis.mak.ac.ug)

**a. Professional Preparation**

|  |  |  |
| --- | --- | --- |
| Makerere University, Uganda | Bachelor of Science | 2002 |
| Makerere University, Uganda | MSc. Computer Science | 2009 |
| Xiangtan Univeristy, China | PhD in Computing and Information Sciences | 2014 |

**b. Appointments**

|  |  |
| --- | --- |
| 2019 - To date | Lecturer |
| 2010 - 2018 | Assistant Lecturer |

**c. Publications**

(i) *Up to five publications most closely related to proposal project*

1. **[Moses Ntanda Kyebambe](https://www.sciencedirect.com/science/article/pii/S0040162516307065" \l "!)**, [Ge Cheng](https://www.sciencedirect.com/science/article/pii/S0040162516307065#!), [Yunqing Huang](https://www.sciencedirect.com/science/article/pii/S0040162516307065#!), [Chun hui He](https://www.sciencedirect.com/science/article/pii/S0040162516307065#!), [Zhenyu Zhang](https://www.sciencedirect.com/science/article/pii/S0040162516307065#!). Forecasting emerging technologies: A supervised learning approach through patent analysis (2017). [Technological Forecasting and Social Change](https://www.sciencedirect.com/science/journal/00401625). [Volume 125](https://www.sciencedirect.com/science/journal/00401625/125/supp/C), December 2017, Pages 236-244
2. [Ge Cheng](https://www.mdpi.com/search?authors=Ge%20Cheng&orcid=), [Zhenyu Zhang](https://www.mdpi.com/search?authors=Zhenyu%20Zhang&orcid=0000-0002-9902-6870), [**Moses Ntanda Kyebambe**](https://www.mdpi.com/search?authors=Moses%20Ntanda%20Kyebambe&orcid=0000-0001-7671-1982), [Nasser Kimbugwe](https://www.mdpi.com/search?authors=Nasser%20Kimbugwe&orcid=). Predicting the Outcome of NBA Playoffs Based on the Maximum Entropy Principle. *Entropy* 2016, *18*(12), 450.

**d. Synergistic Activities**

* Field Attachment Coordinator, School of Computing and Information Sciences, Makerere University.
* Academic Staff representative to college administrative board

**e. Collaborators & Other Affiliations**

**(ii) Graduate and Postdoctoral Advisors** *(List your own graduate advisor(s), principal postdoctoral sponsor(s),and their current organizational affiliations.)*

**Doctoral degree advisor (s):**

1. Prof. Yunqing Huang, President Xiangtan University, China
2. Prof. Cheng Ge, Xiangtan University, School of Information Engineering.

**Abbreviated CV: Mr. D Ssemwanga (WASH Specialist).**

**Technical Assistant Uganda Sanitation Fund, Environmental Health Division, Ministry of Health.**

**Plot 6 Lourdel Road, P.O Box 7272, Kampala, Uganda.**

**Ph: +256 772507113 (mobile); email:** [**dssemwanga@yahoo.com or dssemwanga@gmail.com**](mailto:dssemwanga@yahoo.com%20or%20dssemwanga@gmail.com%20)

**a. Professional Preparation**

|  |  |  |
| --- | --- | --- |
| Makerere University, Uganda | Diploma Environmental Health Science | 2000 |
| Makerere University, Uganda | BSc. Environmental Health Sciences | 2005 |
| University of Ireland, Trinity College Dublin. | Master of Public Health | 2013 |

**b. Appointments**

|  |  |
| --- | --- |
| 2017 – | Technical Assistant Uganda Sanitation Fund, Environmental Health Division, Ministry of Health. |
| 2013 – 2017 | Public Health Specialist (Ministry of Water and Environment). |
| 2006 - 2013 | Environmental Health Officer (Division Health Inspector) Lubaga Division, Kampala Capital City Authority |
| 2001 - 2005 | Health Inspector, Kampala City Council, Kawempe Division. |

**c. Publications**

(i) *Up to five publications most closely related to proposal project*

1. [Abdullah Ali Halage](http://www.hindawi.com/69470903/), [Charles Ssemugabo](http://www.hindawi.com/56706819/), [**David K. Ssemwanga**](http://www.hindawi.com/50940821/)**,** [David Musoke](http://www.hindawi.com/74283853/), [Richard K. Mugambe](http://www.hindawi.com/40262741/)**,** [David Guwatudde](http://www.hindawi.com/25756742/), and [John C. Ssempebwa](http://www.hindawi.com/23960357/) (2015). Bacteriological and Physical Quality of Locally Packaged Drinking Water in Kampala, Uganda. Journal of Environmental and Public Health, Volume 2015, Article ID 942928, 6 pages.
2. Rawlance Ndejjo, Edwinah Atusingwize, Frederick Oporia, Charles Ssemugabo, David Musoke, **David K. Ssemwanga**, Abdullah Ali Halage, John Bosco Isunju, Winnifred Kansiimea, Ruth Mubeezi, Richard Kibirango Mugambe, Emery Patrice Mbaha, Paul Luyima & John. C. Ssempebwa (2018): History, evolution and future of environmental health in Uganda, Archives of Environmental & Occupational Health, DOI: 10.1080/19338244.2018.1541858

**d. Synergistic Activities**

* Environmental Impact Assessor, Certified by the Uganda National Environmental Management Authority (NEMA)
* Team Member, Masters of Environmental Health Sciences curriculum development team at
* Member of National Codex committee under the Uganda National bureau of standards
* Consulting Partner, Environpower (U) Ltd
* Project leader on several projects in the country for different government departments, NGOs and private entities.
* Member of the Uganda Environmental Health Workers’ Association.
* Member Uganda Red Cross Society

**e. Collaborators & Other Affiliations**

**(i)Collaborators** (partial list)

1. Prof. Bas van Vliet. Department of Social Sciences, Environmental Policy Division, Wageningen University.

**Referees**

1. Dr. John C. Ssempebwa, Department of Biostatistics and Epidemiology, Makerere University School of Public Health.
2. Prof. Christine Moe. Emory University Center for global WASH.

|  |  |  |  |
| --- | --- | --- | --- |
| BIOGRAPHICAL SKETCH Provide the following information for the Senior/key personnel and other significant contributors. Follow this format for each person. **DO NOT EXCEED FIVE PAGES.** | | | |
| NAME: Christine L. Moe | | | |
| eRA COMMONS USER NAME (credential, e.g., agency login) clmoe2010 | | | |
| Position Title: Eugene J. Gangarosa Professor of Safe Water and Sanitation, Director, Center for Global Safe Water, Sanitation and Hygiene at Emory University | | | |
| EDUCATION/TRAINING (Begin with baccalaureate or other initial professional education, such as nursing, include postdoctoral training and residency training if applicable. Add/delete rows as necessary.) | | | |
| INSTITUTION AND LOCATION | DEGREE  *(if applicable)* | YEAR(s) | FIELD OF STUDY |
| Swarthmore College, Swarthmore, PA | BA | 1979 | Biology |
| University of North Carolina, Chapel Hill, NC | MS | 1984 | Environmental Science |
| University of North Carolina, Chapel Hill, NC | PhD | 1989 | Environmental Science |
| Centers for Disease Control, Atlanta, GA | Post doc | 6/89-2/93 | Clinical Virology and Epidemiology |

**A. Personal Statement**

My research program focuses on environmental transmission of infectious agents. I have been actively engaged in water, sanitation and diarrheal diseases research since 1984 and norovirus research since 1990. My norovirus research is multi-faceted and includes: 1) human challenge studies to examine norovirus infectivity, determinants of host susceptibility and resistance, host immune response and the development of new norovirus inocula and vaccines; 2) development of improved diagnostics and salivary antibody assays for norovirus; 3) studies of the epidemiology of norovirus outbreaks and endemic infections in children in the US, Brazil, China and Peru, and in international travellers; 4) studies of environmental persistence of norovirus in water, surfaces, and hands; 5) studies of norovirus reduction by water and wastewater treatment processes, by high hydrostatic pressure treatment of oysters, and by hand sanitizers on finger pads; 6) studies of noroviruses as indicators of human fecal contamination in slum environments in developing countries. From 2011-2018, I was a co-investigator in the NoroCORE research collaborative funded by USDA to advance norovirus research related to food safety, and I co-lead the Epidemiology and Risk Assessment Core. My field research in Bangladesh, Bolivia, Cambodia, China, El Salvador, Ethiopia, Ghana, Honduras, India, Kenya, the Philippines, Rwanda, Uganda and the United States focuses on water, sanitation and hygiene and includes studies of diarrheal diseases; fecal contamination in low-income urban environments; water quality in drinking water distribution systems; water, sanitation and hygiene in healthcare facilities in low-resource settings; and environmental contamination of vegetable crops. I have mentored 4 post-doctoral fellows, 2 paediatric infectious disease fellows, 4 PhD students and served on the committees of 2 other PhD students. I have been the thesis advisor for >60 MPH students and served on the committee for 6 additional MPH students.

**B. Positions and Honors**

**Positions and Employment**

1991-2000 Adjunct Assistant Professor, Department of Environmental and Occupational Health, Rollins School of Public Health, Emory University, Atlanta, GA

1993-2000 Assistant Professor, Department of Epidemiology, School of Public Health, University of North Carolina at Chapel Hill, Chapel Hill, NC

1998-2009 Environmental Epidemiologist, National Center for Environmental Health, Centers for Disease Control and Prevention, Atlanta, GA. (IPA)

2000-2007 Associate Professor, Hubert Department of Global Health, Department of Epidemiology and Department of Environmental and Occupational Health, Rollins School of Public Health, Emory University, Atlanta, GA

2007-present Eugene J. Gangarosa Professor of Safe Water and Sanitation and Director of the Center for Global Safe Water, Sanitation and Hygiene at Emory University. Primary appointment in the Hubert Department of Global Health. Joint appointments in the departments of Epidemiology and Environmental Health in the Rollins School of Public Health, Emory University, Atlanta, GA

**C. Contributions to Science and Selected Publications**

**(From >150 articles, books, and book chapters. h-index=46; i10-index=92)**

**Contribution 1: Norovirus epidemiology in pediatric populations –** For many years, noroviruses were only recognized as the etiologic agent of outbreaks of acute gastroenteritis. Our work was one of the first to demonstrate that these are important pediatric pathogens in the US and other countries.

**1.** Parks, C, **CL Moe**, D Rhodes, A Lima, L Barrett, F Tseng, R Baric, A Talal and RL Guerrant. (1999) Genetic Diversity of “Norwalk-like Viruses” (NLVs): Pediatric Infections in a Brazilian Shantytown. *J Med Virol* 58:426-434. PMID: 10421412

**2.** Munir, N, P Liu, P Gastañaduy, J Montes, A Shane and **C Moe** (2014) Norovirus infection in immunocompromised and children with hospital-acquired acute gastroenteritis. *J Med Virol* 2014 Jul;86(7):1203-9. doi: 10.1002/jmv.23774. Epub 2013 Sep 30. PMID: 24115902

**3.** Liu P, X Wang, JC Lee, P Teunis, S Hu, HT Paradise and **C** **Moe**. (2014) [Genetic Susceptibility to Norovirus GII.3 and GII.4 Infections in Chinese Pediatric Diarrheal Disease.](http://www.ncbi.nlm.nih.gov/pubmed/25037042) *Pediatr Infect Dis J.* 2014 Nov;33(11):e305-9. doi: 10.1097/INF.0000000000000443 PMID: 25037402

**4**. Yi, J., K Wahl, BK Sederdahl, RR Jerris, CS Kraft, C McCracken, S Gillespie, EJ Anderson, AE Kirby, AL Shane, **CL Moe.**  (2016) Molecular epidemiology of norovirus in children and the elderly in Atlanta, Georgia, United States. *J Med Virol.* Jun;88(6):961-70. doi: 10.1002/jmv.24436. Epub 2015 Dec 14. PMID: 2660094

**Contribution 2: Norovirus inactivation and persistence on hands and in the environment –** Using our human challenge model, we were the first to describe the long persistence of norovirus infectivity in water and oysters, and their resistance to inactivation by high hydrostatic pressure in oysters and by alcohol-based hand sanitizers.

**5.** Liu, P., Y Yuen, H-M Hsiao, L-A Jaykus, **C Moe**. (2010) Effectiveness of Liquid Soap and Hand Sanitizer against Norwalk Virus on Contaminated Hands. *Appl Env Microbiol* 76:394-9 PMID: 1933337

**6.** Leon, JS, DH Kingsley, JS Montes, GP Richards, GM Lyon,GM Abdulhafid, SR Seitz, ML Fernandez, PF Teunis, GJ Flick, **CL Moe**. (2011) Human norovirus inactivation in oysters by high hydrostatic pressure processing: A randomized, double-blinded clinical trial*. Appl Environ Microbiol*. 2011 Aug;77(15):5476-82. PMID: 21705552

**7.** Seitz SR, JS Leon, KJ Schwab, GM Lyon, M Dowd, M McDaniels, G Abdulhafid, ML Fernandez, LC Lindesmith, R Baric,**CL Moe** (2011) Norovirus human infectivity and persistence in water. *Appl Environ Microbiol.* 2011 Oct;77(19):6884-8. Epub 2011 Aug 19. PMID: 21856841

**8**. Liu, P, B Escudero, LA Jaykus, J Montes, RM Goulter, M Lichtenstein, M Fernandez, JC Lee, E DeNardo, A Kirby, JW Arbogast, and **CL Moe** (2013) Laboratory evidence of Norwalk virus contamination on the hands of infected individuals. *Appl Environ Microbiol.* 2013 Dec;79(24):7875-81. doi: 10.1128/AEM.02576-13. PMID: 24123733

**Contribution 3: Characterizing exposure to fecal contamination in low-income settings –** We have used our strong environmental microbiology and risk assessment modeling skills to examine how children in slums are exposed to fecal contamination in their environment. Our findings indicate that poor sanitation in cities in developing countries leads to widespread fecal contamination of the environment and food and water supplies. Our quantitative risk assessment can provide guidance in where to target investments to reduce exposure.

**9.** Gretsch, SR, JA Ampofo, K Baker, J Clennon, CA Null, D Peprah, H Reese, K Robb, P Teunis, N Wellington, H Yakubu, **CL Moe**. (2016) Quantification of Exposure to Fecal Contamination in Open Drains in Four Neighborhoods in Accra, Ghana. *J Water and Health*. 14.2:255-266 doi**:10.2166/wh.2015.138 PMID: 27105441**

**10.** Teunis, PFM, HE Reese, C Null, H Yakubu, **CL Moe**. (2016). Quantifying contact with the environment: Behaviors of young children in Accra, Ghana. *Am J Trop Med Hyg* 94(4):920-931. PMID: 26880773

11. Berendes D, A Kirby, JA Clennon, S Raj, H Yakubu, J Leon, K Robb, A Kartikeyan, P Hemavathy, A Gunasekaran, B Ghale, JS Kumar, VR Mohan, G Kang, C Moe. (2017) The Influence of Household- and Community-Level Sanitation and Fecal Sludge Management on Urban Fecal Contamination in Households and Drains and Enteric Infection in Children. *Am J Trop Med Hyg.* 2017 Jun;96(6):1404-1414. doi: 10.4269/ajtmh.16-0170. PMID: 28719269

12. Berendes D, J Leon, A Kirby, J Clennon, S Raj, H Yakubu, K Robb, A Kartikeyan, P Hemavathy, A Gunasekaran, S Roy, BC Ghale, JS Kumar, VR Mohan, G Kang, C Moe. (2017) Household sanitation is associated with lower risk of bacterial and protozoal enteric infections, but not viral infections and diarrhoea, in a cohort study in a low-income urban neighbourhood in Vellore, India. *Trop Med Int Health*. 2017 Jun 27. doi: 10.1111/tmi.12915. [Epub ahead of print] PMID: 28653489

13. Robb, K, C Null, P Teunis, H Yakubu, G Armah, CL Moe. (2017) Assessment of fecal exposure pathways in low-income urban neighborhoods: Rationale, design, methods and key findings of the SaniPath Study.  *Am J Trop Med Hyg*. 2017 97: 1022–1034. PMID: 28722599

**14.** Wang, Y, **C Moe**, C Null, S Raj, K Baker, K Robb, H Yakubu, J Ampofo, N Wellington, M Freeman, Matthew, G Armah, H Reese, D Peprah, P Teunis, Multi-pathway quantitative assessment of exposure to fecal contamination for young children in low-income urban environments in Accra, Ghana: The SaniPath analytical approach . *Am J Trop Med Hyg*. 2017 97(4):1009–1019 PMID: 29031283

**Contribution 4: Assessing water, sanitation, and hygiene infrastructure and practices in healthcare facilities in low-income countries** and examining feasibility, performance, and sustainability of water treatment interventions in these settings

**15**. Huttinger, A, R Dreibelbis, K Roha, F Ngabo, F Kayigamba, L Mfura, **C Moe**. (2015) Evaluation of Membrane Ultrafiltration and Residual Chlorination as a Decentralized Water Treatment Strategy for Ten Rural Healthcare Facilities in Rwanda. *Int. J. Environ. Res. Public Health* 2015, 12, 13602-13623; doi:10.3390/ijerph121013602

16. Huttinger, A, R Dreibelbis, F Kayigamba, F Ngabo, L Mfura, B Merryweather, A Cardon, CL Moe. (2017) Water, Sanitation and Hygiene Infrastructure and Quality in Rural Healthcare Facilities in Rwanda. *BMC Health Services Research* 17(1):517

**17**. Huttinger, A, L Brunson, **CL Moe**, K Roha, P Ngirimpuhwe, L Mfura, F Kayigamba, P Ciza and R Dreibelbis. (2017) [Small Water Enterprise in Rural Rwanda: Business Development and Year-One Performance Evaluation of Nine Water Kiosks at Health Care Facilities](javascript:void(0)). *Int J Environ Res Public Health* 14 (12), 1584

**18.** Robb, KA, L Denny, S Lie-Tjauw, M Gallegos, J Michiel, **C Moe**. (2019) A Systematic Tool to Assess Sustainability of Safe Water Provision in Healthcare Facilities in Low-Resource Settings. *Waterlines* (Accepted)

# **Ethics certificate for the principal investigator**

