A REVIEW OF THE ROLE OF CLEANERS IN ESTABLISHING AND MAINTAINING ENVIRONMENTAL HEALTH CONDITIONS IN HEALTHCARE FACILITIES IN MALAWI

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ABSTRACT

Hayley E. Schram: A review of the role of cleaners in establishing and maintaining environmental health conditions in healthcare facilities in Malawi
(Under the direction of Dale Whittington)

Healthcare facility (HCF) cleaners, including ward attendants and grounds laborers, play an important role in preventing healthcare-acquired infections and promoting a safe healthcare environment. There is little evidence describing cleaner roles in HCFs in low- and middle-income countries and the factors that facilitate and constrain their roles and responsibilities. In response, we analyzed data from 57 interviews with cleaners in 45 rural HCFs in Malawi.

Cleaner constraints included: inadequate training on infection prevention and control and waste management; insufficient work-related resources; performing tasks unrelated to core responsibilities; risk of work-related injuries; and occasional disrespect from medical staff and patients. Job facilitators included: positive collaboration with medical staff and highly expressed job satisfaction.

Male ward attendants attained higher education than females and reported excess physical tasks, such as stocking supplies; females reported performing more administrative duties. Descriptions of cleaner roles did not differ by region, HCF type, cleaner type, or gender.

To my loving family…for all the support, encouragement, and most of all faith.

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LIST OF ABBREVIATIONS

ARI	Acute respiratory infection
CHAM	Christian Health Association of Malawi
CSDW	Children's Safe Drinking Water Program
DEHO	District environmental health officials
DHO	District health official
EH	Environmental health
EHO	Environmental health official
EHS	Environmental health services
ESCOM	Electricity Supply Corporation of Malawi Limited
HAIs	Healthcare acquired infections
HCFs	Healthcare facilities
HCW	Healthcare worker
HICs	High income countries
IPC	Infection prevention and control
IRB	Internal Review Board
JCE	Junior Certificate of Secondary Education
JMP	Joint Monitoring Program
LICs	Low income countries
LMICs	Low- and middle-income countries
LMRFT	Lilongwe/Medical Relief Fund Trust
MoH	Ministry of Health
MSCE	Malawi School Certification Exam
NGO	Non-government organization
OPD	Outpatient department

PPE	Personal protective equipment
PSLE	Primary School Leaving Certificate Examination
SDGs	Sustainable Development Goals
SEIPS	Systems Engineering Initiative for Patient Safety
SPA	Service Provision Assessment
STDs	Sexually transmitted diseases
TB	Tuberculosis
UNC	University of North Carolina
UNICEF	United Nations Children's Fund
USAID	United States Agency for International Development
WaSH	Water, sanitation, and hygiene
WHO	World Health Organization

CHAPTER ONE: INTRODUCTION AND BACKGROUND

1.1 – Introduction

A safe healthcare environment is necessary to protect patient, staff, and visitor health and prevent healthcare acquired infections (HAIs). Elements of a safe healthcare environment include access to safe and sufficient water, adequate and accessible toilets for both staff and patients, proper ventilation, appropriate hygiene practices, adequate management of healthcare waste, and clean laundry and surfaces (Adams, Bartram, & Chartier, 2008). Additionally, reliable energy services are important to safeguard the quality of healthcare services and ensure the regular functioning of adequate environmental health (EH) services (Adams et al., 2008; F Reuland et al., 2019).

In healthcare facilities (HCFs), adequate EH conditions are essential to achieve national and international policy goals and targets such as the Sustainable Development Goals (SDGs), where Goal 3 aims to achieve improvements in good health and well-being, and SDG 6 aims to achieve universal access to water, sanitation, and hygiene (WaSH) by 2030 (United Nations General Assembly, 2018). The Joint Monitoring Program for Water Supply, Sanitation, and Hygiene (JMP) of the World Health Organization (WHO) and the United Nations International Children's Emergency Fund (UNICEF), is responsible for monitoring the progress of SDG 6 and interprets universal access to WaSH to include HCFs; and defines indicators for water, sanitation, hygiene, medical waste management, and surface cleaning (WHO & UNICEF, 2018).

According to the 2018 JMP baseline assessment, 26% of HCFs are without access to basic water services, 22% lack basic sanitation, 16% lack handwashing facilities, 40% do not follow proper waste segregation procedures, and 60% lack reliable electricity (Cronk & Bartram, 2018; WHO & UNICEF, 2015). While global monitoring statistics describe many elements of safe healthcare environments,

including cleaning frequency, availability of cleaning supplies and disinfectant, little is reported about HCF cleanliness and cleaning procedures (WHO & UNICEF, 2015).

Inadequate environmental conditions and poor cleaning procedures can increase the risk of HAIs. In low- and middle-income countries (LMICs), HAIs are estimated to affect 15% of all hospitalized patients (Allegranzi et al., 2011; CDC, 2014). An estimated 60-80% of HAIs are caused by unsafe EH conditions and inadequate healthcare worker (HCW) hygiene (Weinstein, 1991). Poor EH conditions coupled with unhygienic cleaning practices contribute to inadequate infection prevention and control (IPC) in HCFs (Graham et al., 2016). Therefore, a safe working environment must be established by those responsible for maintaining HCF cleanliness. (Litwin, Avgar, & Becker, 2017).

There is little evidence describing the roles and responsibilities of cleaners in HCFs. Available evidence describes many types of cleaning staff, including orderlies, domestic assistants, clinical aides, janitors, housekeepers, hospital/ward attendants, grounds laborers, and cleaners (Litwin et al., 2017). Their roles and responsibilities vary but often include sweeping, dusting, mopping, disinfecting floors, surfaces, and doors, disposing of and treating infectious and non-infectious healthcare waste, and cleaning sanitation facilities (Cross et al., 2019; Messing, 1998). While cleaners are responsible for ensuring safe EH conditions for patients and employees, little reference is made to them in research studies or IPC guidelines. For example, cleaners were overlooked as a key stakeholder among healthcare professionals in the WHO Essential Environmental Health Standards in Health Care (WHO, 2008).

While literature describing the role of cleaners in establishing and maintaining EH conditions is limited in low income countries (LICs), several studies conducted in high income counties (HICs) document the positive impact of improved cleaning practices on HAIs. One study from Glasgow, Scotland found that introducing one additional cleaner to a hospital reduced the levels of microbial contamination at hand washing stations by 33% (Dancer, White, Lamb, Girvan, & Robertson, 2009).

Studies highlight that cleaners are responsible for the level of cleanliness and IPC in HCFs. At the same time, the studies indicate that the roles and responsibilities of cleaners are poorly defined, and cleaners as a whole are institutionally neglected (Cross et al., 2019; Marmot, Bosma, Hemingway,

Brunner, & Stansfeld, 2013). Evidence does not indicate whether cleaners' roles and responsibilities include the establishment of safe EH practices and does not enumerate the factors that facilitate or constrain the work of cleaners in HCFs. Therefore, understanding the role of cleaners in promoting clean HCFs must be established.

A qualitative inductive method, based on the perceptions of cleaners, was used to better understand the roles and responsibilities of cleaners. The Water Institute at UNC conducted a mixed methods study collecting data on WaSH and EH conditions from 57 cleaners in 45 government-run HCFs in Malawi. The qualitative dataset was used to answer the following research questions:

1. What roles and responsibilities are reported by cleaners (including ward attendants and grounds laborers) in different types of HCFs in Malawi? Do the roles and responsibilities of cleaners differ by sub-national region, HCF type, and gender?
2. Do cleaners report performing, establishing and maintaining safe IPC practices? And if so, what tasks do cleaners state are important in IPC?
3. According to the cleaners, what factors in their working environment facilitate or constrain safe EH practices and conditions?

The results describe HCF and cleaner characteristics, and EH conditions including outcomes related factors that facilitate and constrain the ability of cleaners to carry out their EH roles and responsibilities.

1.2 – Background

1.2.1 – Baseline Assessment of Water, Hygiene and Sanitation in HCFs in Malawi

In 2014, a Service Provision Assessment (SPA) was conducted in 977 HCFs in Malawi. The SPA, conducted by the United States Agency for International Development (USAID), gave an overview of the service delivery capacity in the country (USAID, 2019). The assessment reviewed conditions in hospitals, health centers, dispensaries, clinics, and health posts and found that 37% of facilities did not have toilets available for patients, that 40% lacked both soap and running water, and approximately 50% did not have hand-washing supplies (MoH & ICF International, 2014).

In 2017, the Water Institute at the University of North Carolina at Chapel Hill (UNC) in partnership with UNC Project Malawi[1] assessed EH conditions in 45 government-run HCFs in Malawi. This project aimed to address the integration of WaSH and EH conditions in HCFs by evaluating both the knowledge, attitudes, and practices of different actors concerning WaSH, EH, and IPC in delivering health services. The assessment was conducted in all three regions of Malawi. Qualitative and quantitative data were collected on access, ventilation, infection control, vector control, energy access, and solid waste management.

The objective of the HCF assessment conducted by UNC was to interview five different actors in HCFs including HCWs, administrators, patients, environmental health officials (EHOs), and cleaners – to gather data needed to answer the following question: *What are enablers and barriers to safe environmental health practices in healthcare facilities?* (The Water Institute at UNC & UNC Project Malawi, 2019).

[1] UNC Project Malawi is an institution in collaboration with the Malawian Ministry of Health (MoH) and the University of North Carolina at Chapel Hill. Largely, they aid in the development and design of programs to control the spread of HIV and sexually transmitted diseases (STDs) ("About Us UNC Project-Malawi," n.d.). UNC Project Malawi strives to help strengthen health systems in Malawi and continues to be instrumental in research pertaining to WaSH in HCFs.

1.2.2 – Healthcare facilities in Malawi

In 2017, there were 1,060 private and government-run HCFs in Malawi (MoH, 2017). The Malawian healthcare system is organized in three tiers: primary, secondary, and tertiary levels. These levels are linked together by a referral system.

At the primary level, health services are offered in health posts, dispensaries, maternity wards, clinics, health centers, and community hospitals. Health centers usually offer outpatient and maternity services and are responsible for serving roughly 10,000 people (MoH, 2011). These centers offer outpatient services including but not limited to HIV testing, immunizations, the management of acute respiratory infections (ARIs) and diarrhea in children under the age of five. Due to their rural location and small facility size, they usually experience large patient volumes and exhibit a high ratio of patients to medical staff. Community (or rural) hospitals offer free services and lack adequate medical supplies and personnel. Community hospitals are larger than health centers and offer outpatient and inpatient services and conduct minor surgical procedures. These hospitals usually have a bed capacity of 250.

The secondary level consists of district hospitals and hospitals owned and operated by the Christian Health Association of Malawi (CHAM). This major provider contributes approximately 29% of all health services in Malawi (MoH, 2017). These hospitals provide both outpatient and inpatient referral services and receive referrals from lower level health centers. There are 27 district hospitals located throughout the 28 districts of Malawi.

Central hospitals with a bed capacity ranging from 500 to 2,000 operate at the tertiary level and provide specialty services within a region. They manage cases referred by district hospitals within their region. There are only four central hospitals located in the urban areas of Malawi. **Table 1** shows the distribution of HCFs by type and ownership.

Table 1. *Public and private ownership of HCFs in Malawi by type (MoH & ICF International, 2014).*

	Hospital	Health Center	Dispensary	Clinic	Health Post	Total
n (%)	**119**	**489**	**55**	**369**	**28**	**1060**
Government	51 (42.9)	360 (73.6)	46 (83.6)	25 (6.8)	27 (96.4)	509 (48.0)
CHAM[2]	44 (37.0)	112 (22.9)	2 (3.6)	11 (3.0)	1 (3.6)	170 (16.0)
Private	22 (18.5)	5 (1.0)	2 (3.6)	223 (60.4)	0 (0.0)	252 (23.8)
NGO	2 (2.7)	5 (1.0)	0 (0.0)	52 (14.1)	0 (0.0)	59 (5.6)
Company[3]	0 (0.0)	7 (1.4)	5 (9.1)	58 (15.7)	0 (0.0)	70 (6.6)

1.2.3 – Cleaners in HCFs in Malawi

Cleaners in Malawi have the titles ward attendant and grounds laborer. Generally, a ward attendant works inside the HCF and cleans different wards while a grounds laborer works outside the HCF to ensure that the external environment is clean. Government documents found little evidence that lists and defines the roles and responsibilities of cleaners, their educational requirements, or their qualifications and experience to work in government-run HCFs. UNC Project Malawi provided a job description which stated the roles and responsibilities and educational requirements for both a ward attendant (listed as clinical aide) and a grounds laborer (listed as gardener) (UNC Project Malawi, 2018). The job description of a clinical aide can be found in Appendix A and the gardener job description can be found in Appendix B. A ward attendant should hold a Malawi secondary certification of education (MSCE) which certifies the completion of secondary education. A grounds laborer role requires the junior certificate of education (JCE) which certifies the completion of primary school. Both men and women can be either type of cleaner and conduct similar roles within the HCF.

The Malawian personnel system ranks staff from A to M. Each healthcare professional is assigned a grade according to his/her title. In 2017, the monthly salary allowance in Malawi operates as a graded pay system, ranging from the highest pay (Grade A) to the lowest (Grade M), where each

[2]CHAM is the largest non-government healthcare provider and trainer of healthcare practitioners in Malawi and is separate from the NGOs displayed in this table.
[3] This represents HCFs that are owned privately by foreign companies.

healthcare professional is assigned a grade according to their title. For example, physicians receive the highest pay in HCFs and receive an allowance anywhere from Grade A to Grade C (ranging from MKW 810,000 to 1,000,000 or USD 1,100 to 1,350 per month) depending on their specialty. Healthcare professionals including nurses and HCWs range from Grade G to Grade J; and salaries range from MKW 140,000 to 260,000 or USD 190 to 350 USD per month. Cleaners are categorized as Grade L, the second to last grade and earn a monthly salary of MKW 97,000 or USD 130. Unlike doctors, nurses, and other medical professionals, cleaners do not qualify for end of the year bonuses, as any pay grade lower than Grade K is not eligible.

1.2.4 – Malawi Education System

The education system in Malawi has an 8 – 4 – 4 structure, with eight years of primary education (Standard 1-8), four years of secondary education (Form 1-4), and four years of university-led education; only primary education is free (The World Bank, 2010). On completing Standard 8 students take the Primary School Leaving Certificate Examination (PSLE). Securing this certificate allows students to enter secondary school. At the end of the fourth year of secondary education, students take the Malawi School Certification Exam (MSCE). Passing this examination qualifies the certificate holder to enroll in technical and vocational institutions. A MSCE is required to attend a university but some university programs accept students with a Junior Certificate of Education (JCE) depending on the area of study.

CHAPTER TWO: RELEVANT PUBLICATIONS

Since 2017, the dataset which interviewed different actors in healthcare facilities has been used to identify EH conditions related to specific actors (e.g. HCF administrators) and WaSH components (e.g. IPC practices), EH policies and energy access in HCFs in Malawi. Most recently, EH conditions and IPC practices were assessed in the maternity wards of 31 HCFs. This assessment found a strong association between poor IPC practices and microbial contamination. Improving IPC practices could enhance EH conditions in the maternity wards (Oza et al., 2020).

Another study examined the successes and shortcomings of EH policies in Malawian HCFs. An EH policy was finalized in 2018 by the Malawian MoH which defined specific targets and programs for EH in healthcare settings. Using data from 53 respondents operating at different levels of government, the study showed that the success of the policy resided in the structure of the EH department and its ability to connect individual HCFs and EH actors directly to the policy-making level of government (McCord et al., 2019). The shortcomings included insufficient financial support, lack of human resources, incomplete reporting, poor stakeholder coordination, and insufficient training of EH actors. Recommendations include refresher trainings for all EH actors and strengthened coordination to advocate for the additional funding needed to develop programs to apply effective EH interventions.

In 2019, energy access in 44 HCFs was highlighted and related to potential consequences for health service delivery. This study recommended the consideration for facility-type specific measures to improve energy functionality in HCFs (Reuland et al., 2019).

CHAPTER THREE: METHODS

3.1 – Study setting

Malawi, located in Sub-Saharan Africa and landlocked by Zambia, Tanzania, and Mozambique, has a population of 17.5 million people (**Figure 1**). Malawi has three regions; an estimated 14 million people (80% of the population) live in the central and southern regions and the remaining three and a half million (20%) live in the northern region. The capital city of Lilongwe is in the central region, and the second largest city of Blantyre is in the southern region.

3.2 – Study sample

Qualitative and quantitative data were collected in 45 government-run HCFs in Malawi on five different actors including HCWs, administrators, patients, EHOs, and cleaners. This paper analyzes the qualitative and quantitative data collected on cleaners and, in some instances, on HCWs as their responses relate to cleaners. The information provided by administrators, patients, and EHOs were not analyzed in this study[4].

The HCFs were distributed by region as follows: 10 facilities in the northern region; 16 in the central; and 19 in the southern region. The different HCF types (excluding the CHAM and NGO HCFs) are shown by region of Malawi in **Figure 2**. The HCFs consisted of three central hospitals, 14 district hospitals, 15 health centers, and 13 health posts or dispensaries. **Table 2** shows the distribution of HCF types by sub-national region in Malawi. To ensure that the sample represented the entire geographic area of each sub-national region, a spatial clustering approach was used to select the districts and then the HCFs. Therefore, 14 of Malawi's 28 districts were selected to ensure that the number of districts in each

[4] The information provided by these actors remain to be analyzed.

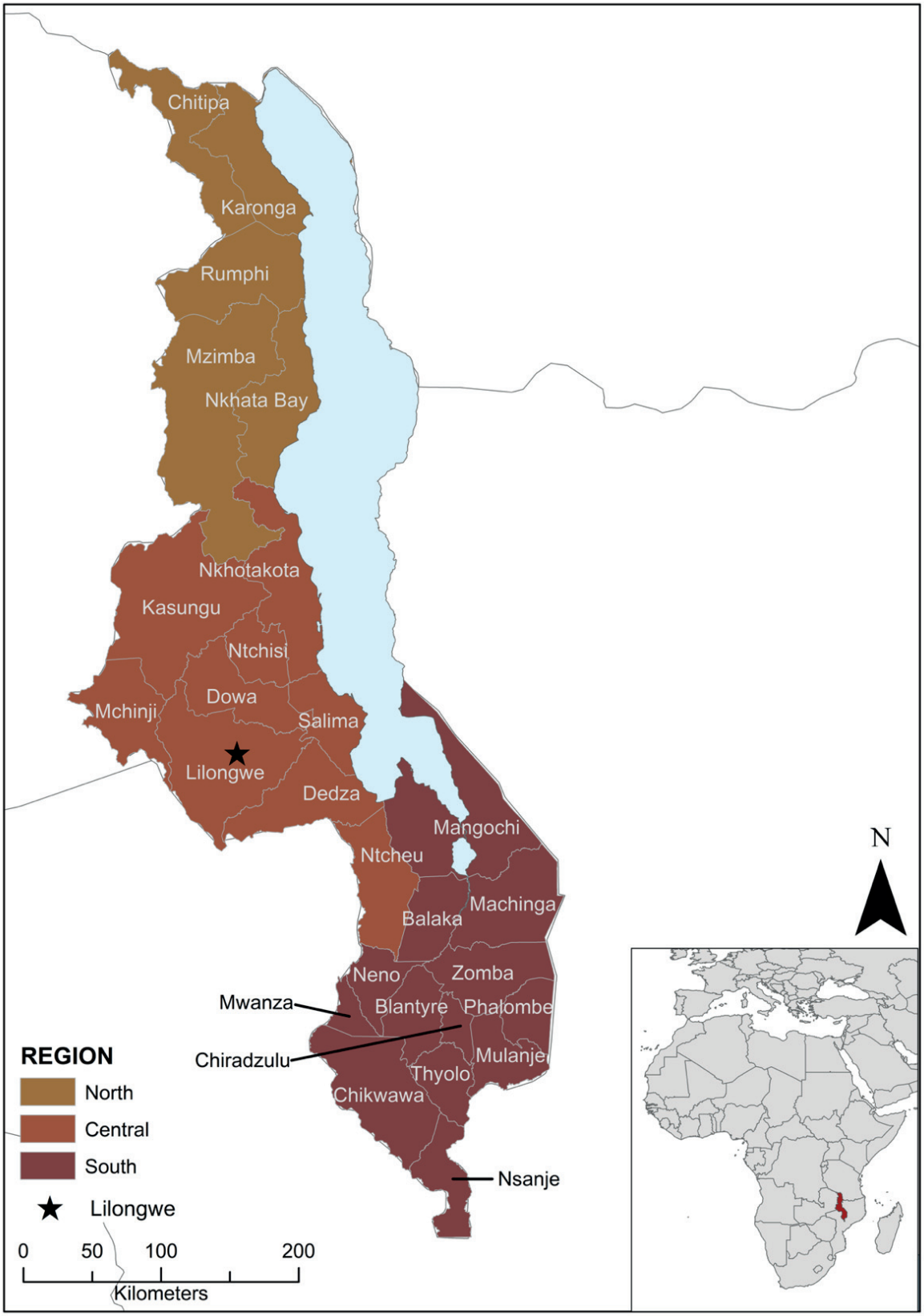

Figure 1. *Map of Malawi by sub-national region and district.*

of the three regions corresponded with the relative population. UNC Project Malawi staff, along with representatives from the Environmental Department of Malawi's MoH selected a health center and a health post or dispensary within each of the 14 district hospitals that could be reached by car in one day.

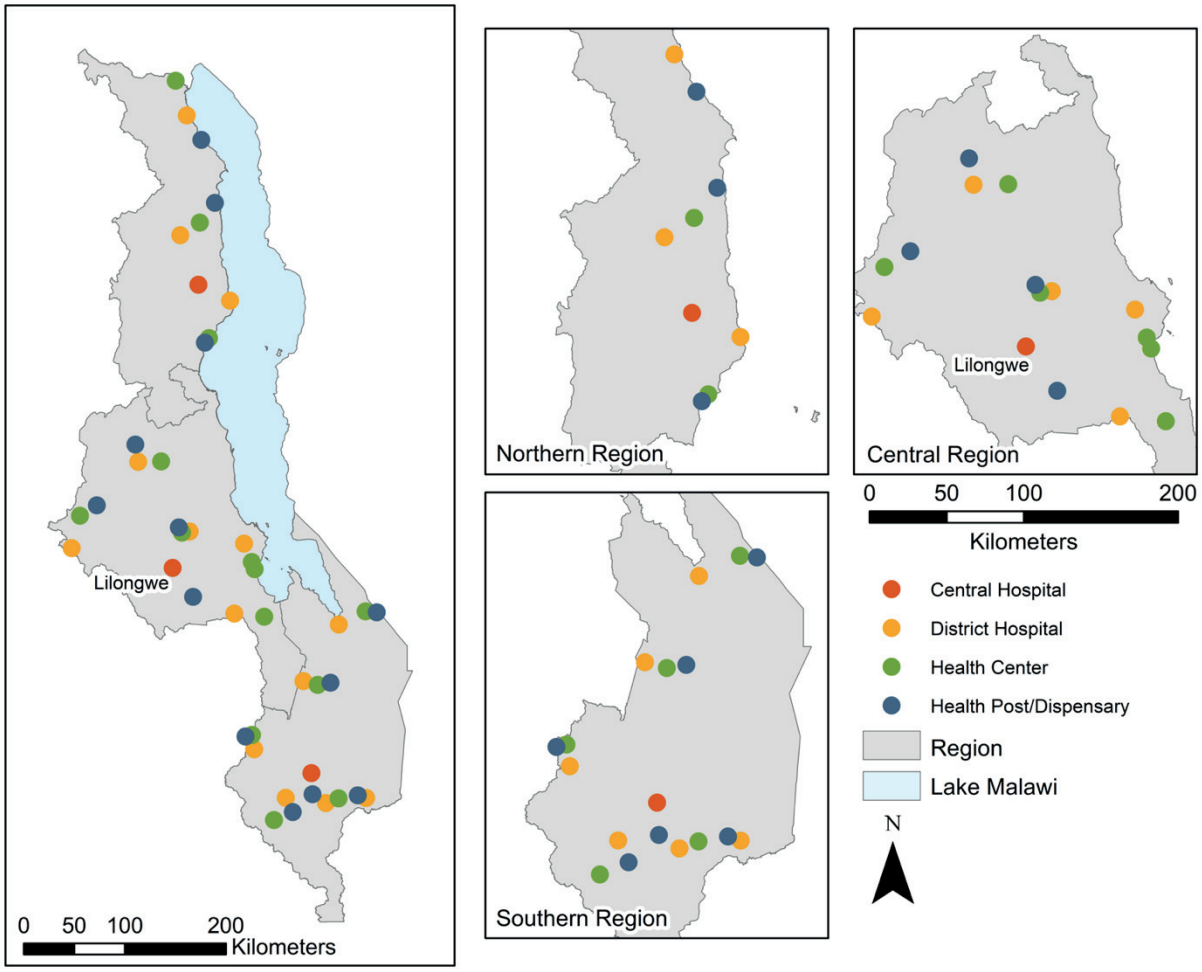

Figure 2. *Facilities assessed, by facility type, region, and district in Malawi.*

***Table 2**. Number of healthcare facilities surveyed, organized by facility type and sub-national region in Malawi.*

Sub-national Region	Central Hospital	District Hospital	Health Center	Health Post/Dispensary	Total
n (%)	**3**	**14**	**15**	**13**	**45**
North	1 (33.3)	3 (21.4)	3 (20.0)	3 (23.1)	10 (22.2)
Central	1 (33.3)	5 (35.7)	6 (40.0)	4 (30.8)	16 (35.6)
South	1 (33.3)	6 (42.9)	6 (40.0)	6 (46.2)	19 (42.2)

3.3 – Qualitative data overview and survey development

A qualitative interview guide was developed by the Water Institute at UNC, the Malawian MoH, and UNC Project Malawi. Data were collected using a structured approach that featured questions relating to personal experiences, perceptions, events, and knowledge of EH conditions (Guest, Namey, & Mitchell, 2017). Five questionnaires were developed for HCWs, administrators, patients, EHOs, and cleaners. The cleaner questionnaire can be found in Appendix C and the HCWs questionnaire can be found in Appendix D. The final cleaner surveys were translated by UNC Project Malawi staff, as most of the cleaner interviews were conducted in Chichewa (the local language in Malawi). Field researchers were trained in qualitative research methods prior to data collection. Throughout the interview process the research team periodically conducted internal quality checking of bias by sitting in on each other's interviews to ensure the highest quality of collected data.

Data were collected by field researchers in the dry season (June to August 2017). All cleaners provided verbal and written consent to be interviewed and interviews were recorded in either English or Chichewa. A copy of the English consent form can be found in Appendix E. Interviews were conducted with 57 cleaners (29 males, 28 females) in 45 HCFs and at least one cleaner interview was conducted in each facility. Each facility visit began with a meeting with the District Environmental Health Officer (DEHO), the HCF administrator, or another facility leader to explain the purpose of the research. Interviews and surveys were conducted with ward attendants and grounds laborers who had been working at the facility for at least one year to ensure that each had sufficient knowledge and familiarity with

facility conditions. Interviews with cleaners were conducted in Chichewa or a mix of Chichewa and English. UNC Project Malawi staff interviewed the participants and ensured that questions were asked appropriately and respectfully. Field researchers took field notes daily; these were compiled and used to identify research themes and to develop the codebook for qualitative data analysis.

An emergent data collection design was used to allow interviewers to make decisions in the field regarding the effectiveness of the questions being asked. The first few interviews were much longer than the rest as a result of redundant responses. In the course of the survey, changes were made to the questions to avoid confusion and to clarify the question of EH conditions in the HCFs. For example, early interviews revealed that many cleaners did not understand the concept of "EH conditions", and also indicated that the question needed further clarification. A description of the term was added to the interview questions to ensure the cleaners understood the term and the purpose of the interview.

3.4 – Quantitative data overview and survey development

Quantitative data were collected from all five actors working in HCFs in Malawi. The quantitative data on cleaners, HCF characteristics, and WaSH conditions in HCFs were the only datasets used in this paper.

A quantitative survey was developed by adapting the following tools: the WHO's Essential Environmental Health Standards in Health Care (EHS Health Care); the Soap Box Collaborative WASH and CLEAN Toolkit (WASH and CLEAN); WHO and UNICEF's Water and Sanitation for Health Facility Improvement Tool (WASH FIT); Clean and Safe Health Facilities (CASH) Audit Tool from the Medical Services Directory in Ethiopia, Service Delivery Indicator (SDI) Survey from Kenya, WHO's Service Availability and Readiness Assessment (SARA); and Malawi's Service Provision Assessment (SPA) (Adams et al., 2008; Ethiopia Ministry of Health, 2015; ICF International, 2013-14; The Soapbox Collaborative, 2014; World Bank Group, 2013; World Health Organization, 2017). Questions for the survey were taken from each document to make a comprehensive assessment of EH components

including water quality, water quantity, water access, sanitation, waste management and disposal, cleaning, building layout and design, IPC, and energy access.

A gap analysis was conducted to identify where the toolkits did not sufficiently address indicators proposed in environmental health services (EHS); these gaps were filled with information collected through a targeted literature review (Reuland, 2018). Indicator inclusion was also informed by reviewing the linkages available in the most recent literature between specific environmental health-related practices and health outcomes. One or more questions were selected to evaluate each indicator. Final question selections and alterations were validated using indicator selection criteria and panelist review (Schwemlein, Cronk, & Bartram, 2016). The questions were uploaded to the mWater mobile application (New York, NY, USA) in English. The surveys can be found in supplementary materials.

The facility-wide quantitative survey was administered to an HCF administrator at each facility, or to another actor knowledgeable about the facility's general EH conditions. At all health centers and health posts, the administrator doubled as the lead health care provider, referred to as the "in-charge". At 34 of 45 HCFs, the survey was administered to the administrator or the in-charge. In eight cases where the administrator was unavailable or the in-charge was attending patients, facility-level EHOs responded to the survey. **Table 3** lists the respondents to the facility-wide survey.

Table 3. *HCF actors who responded to the healthcare facility-wide survey.*

Respondent	Administrator/ Facility In-charge	Nurse/ Midwife	Medical Assistant / Clinician	Environmental Health Officer	Other	Total
Healthcare facility- wide survey	34 (75.6)	0 (0.0)	0 (0.0)	8 (17.8)	3 (6.7)	45 (100.0)

CHAPTER FOUR: ANALYTICAL STRATEGY

4.1 – Analytical strategy overview

The two datasets used in this thesis include qualitative data collected from cleaner interviews regarding the facilitators and constraints to EH conditions and quantitative data on WaSH and EH conditions in HCFs. The data were collected in 2017 by researchers from the Water Institute at UNC and UNC Project Malawi.

The qualitative data were coded using qualitative analysis software and analysis was done using code count, code co-occurrence and frequency counts. The first step of this analysis consisted of coding the transcripts in Dedoose, a qualitative data analysis software, to label and organize the qualitative data and to identify the relationships (Dedoose, Los Angeles, CA, USA). This allowed for categorization of cleaner responses based on the questions they were asked about EH conditions. The next step was to analyze the relationships between codes using analysis tools available in Dedoose, including code cloud, code application, code presence, code count, and code co-occurrence. Code count was used to show the highest occurring codes within each transcript, and code co-occurrence was used to determine the highest occurring relationships of codes. These relationships showed themes within the data which were used to categorize the results. For example, the theme of insufficient waste management training emerged from the code co-occurrence analysis allowing for the calculation of frequencies and percentages of cleaners that either experienced or lacked waste management training.

The quantitative data were collected and analyzed by researchers at the Water Institute at UNC and published in a final report submitted to project sponsors (The Water Institute at UNC & UNC Project Malawi, 2019). The following sections describe the qualitative and quantitative data analysis process in more detail.

4.2 – Qualitative analysis: coding

Audio recordings in English and Chichewa were translated and transcribed by transcribers at UNC Project Malawi who were fluent in both languages. The coding process consisted of reading through transcripts and applying codes deductively to cleaner responses in order to categorize the data into a suitable form for analysis. The team practiced simultaneous coding, i.e., applying two or more different codes to a single qualitative datum (Saldaña, 2013). Multiple codes could be assigned to each transcript excerpt to reflect multiple meanings.

The coding team consisted of seven members who met every week for one year to develop and define a codebook that fit the dataset. The codebook consisted of either parent, child, grandchild, and in some cases great-grandchild codes. The parent code was the root code while the secondary code (or child code) and tertiary code (or grandchild, and great-grandchild codes) were more in-depth categorizations. For example, if a transcript mentions cleaning supplies, the item would be placed in the root code of 'HCF characteristics', the child code of 'HCF supplies' and the grandchild code of 'cleaning supplies' (**Figure 3**). Because the codes were tiered, some codes were more specific than others. Using the same example, the code 'HCF characteristics' were used more broadly than the code 'cleaning supplies.' This code structure caused parent codes to occur more frequently in the dataset than child, grandchild, or great-grandchild codes.

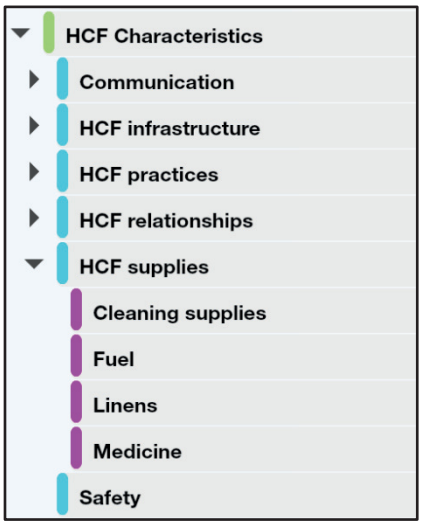

***Figure 3**. Example of a parent, child, and grandchild code in the final codebook.*

The team met weekly to code the transcripts and identify themes from the dataset and to determine how codes were to be applied in different contexts. Most codes were not given a definition as they were descriptive unambiguous codes. For example, codes such as 'hot water', 'personal protective equipment', and 'waste treatment' were easily and unanimously applied to responses that mentioned such topics. When problems arose with specific codes, a definition was established so that all coders had a

clear understanding of the meaning when it was applied in context. For example, definitions were needed for similar codes such as 'water system breakdown' and 'water system reliability.' 'Water system breakdown' was defined as a respondent's description of a specific example of their water system malfunction or breakdown, when the facility ran out of water, or when there were infrastructural issues. 'Water system reliability' referred to how often water was available from the source when accessed by users. Additional definitions of complex codes can be found in Appendix F.

To ensure that codes were applied appropriately and consistently, coding was conducted using a two-stage process. The first stage included the development of a preliminary codebook, where codes were deductively determined based on field notes taken by the data collectors. The first codes that were developed included EH conditions, such as water, sanitation, hygiene, waste management, and energy services. Transcripts were distributed among team members by sub-national region and the coding team met weekly to discuss, edit, approve, and refine new codes. Additional codes inductively emerged from cleaner responses during the first stage of coding. The final codebook consisted of a total of 255 deductive and inductive codes. The final codebook was then used for the second stage of coding, so that all transcripts were reviewed by two different researchers, all transcripts had been reviewed with the final codebook, and coding was conducted consistently and reliably among coders. The final codebook is in Appendix G.

4.3 – Qualitative thematic analysis: code count and code co-occurrence

Once the coding was completed, qualitative tools within Dedoose were used to identify emerging themes. Analysis consisted of assessing the code count, or number of codes within each of the 57 cleaner transcripts. This table was disaggregated by cleaner type (ward attendant and grounds laborer), HCF type, and gender. Extensive review determined that the code count table showed little thematic results. For example, one transcript showed that the code "training" was applied 12 times. Appendix H shows the partial code count table. While this allowed me to see the highest frequency of transcripts coded with "training", it was unable to distinguish the type of training, if training was available and sufficient, or

Codes	Actor	Central government	Cleaner	Grounds laborer	Ward attendant	Committee	District committee	Facility committee	IP committee	National	Village committee	Community	Community leader	DHO	District government	Environmental health	AEHO	Central level	District level	EHO	Facility level	HSA	SHSA
Actor		45	182	30	47	184	48	37	37	8	67	211	37	142	85	135	29	8	42	71		95	22
Central government	45		1			4	2			4		4	1	2	10	1			1	2		1	
Cleaner	182	1		29	46	5			5			3		5	1	8	2			4		6	2
Grounds laborer	30		29		5	1			1					1									
Ward attendant	47		46	5		3			2		1	1		2		2				1		2	1
Committee	184	4	5	1	3		50	39	37	8	68	38	24	14	11	14	2		4	12		16	6
District committee	48	2				50		6	3	3	3	4	7	5	7	8	1		3	5		4	
Facility committee	37					39	6		3		8	8	4	5	2	2			1			3	
IP committee	37		5	1	2	37	3	3				2	2	1		5	1		1	3		3	2

Figure 4. *Partial code co-occurrence matrix from Dedoose.*

which actors were involved in training. Therefore, to develop a better understanding of the relationship between codes, code co-occurrence analysis was conducted. Code co-occurrences provides information about how different codes were used across all project excerpts (Dedoose, n.d.). Examining the code co-occurrences revealed the relationships between codes and identified which codes occurred most frequently with "training" along with the other codes in the codebook. The most frequent code co-occurrences relating to EH conditions were identified as themes within the data.

The code co-occurrence matrix presents the frequencies for which all code pairings were applied to the same excerpt and overlapping excerpts (Dedoose, n.d.). This display exposes both expected (deductive) and unexpected (inductive) patterns in which codes were or were not used together. There were 255 codes in the codebook; therefore, this matrix shows 64,770 code co-occurrence options as codes that occur with itself are not counted (and are displayed as gray boxes in the matrix). **Figure 4** shows a small portion of the code co-occurrence matrix for this dataset. The code co-occurrence matrix was exported into Microsoft Excel, as data sorting and filtering were not available in Dedoose. Within Excel, codes were sorted from highest to lowest code co-occurrence frequency and then were organized based on

EH conditions. This allowed for differentiation between the different EH conditions (including water, sanitation, hygiene, waste management, and energy) and revealed the highest frequency of code co-occurrences.

Due to the nature of the surveys, certain codes were expected to have higher co-occurrence frequencies than others. For example, the code co-occurrences for the code 'training' were expected to have higher frequency than codes such as 'hygiene/infection prevention', 'hand hygiene', and 'personal protective equipment' because the qualitative survey specifically asked cleaners about training in relation to those topics. However, some codes showed unexpected co-occurrences. Using the same example, the code 'training' co-occurred frequently with codes such as 'absent', insufficient', 'roles and responsibilities', and 'cleaning practices.' None of these terms were specifically asked about in relation to training in the cleaner questionnaire. **Table 4** shows an example of the frequency of code co-occurrences from largest to smallest for the code 'training.' Inductive code co-occurrences from cleaner interview are highlighted in yellow.

These inductive code co-occurrences revealed themes in the data. For example, Table 4 identified the theme of insufficient training. To limit the number of themes, a cutoff point of 20 code co-occurrences was established, where all excerpts over this cutoff were reviewed. This was conducted to limit the number of infrequent associations (below 20 code co-occurrences) and to focus more efficiently on co-occurrences with the highest frequencies (above 100 code co-occurrences). Frequencies for all code co-occurrences were reviewed with qualitative experts at the Odum Institute at UNC who determined that any code frequency less than 20 had low association. However, in some cases excerpts of code co-occurrences below the cutoff point were reviewed.

All excerpts for each code co-occurrence were reviewed to ensure that transcripts were coded accurately and in accordance with the final codebook. Representative quotations from cleaners were taken from excerpts that fit into the Systems Engineering Initiative for Patient Safety (SEIPS) model which was used to organize the data. This model categorized elements of the working system which includes elements of person, organization, tools and technology, tasks, and environment. After all excerpts were

reviewed, a representative statement was selected to summarize a theme due to the large number quotations that arose from code co-occurrences.

Table 4. *Highest frequency of code co-occurrences relating to training. Yellow highlighted codes indicate co-occurrences with inductive codes related to 'training'.*

Code co-occurrences Total	**Training 2412**
Hygiene/Infection Prevention	261
Sufficiency	203
Staffing	122
Absent	116
Actor	93
Hand hygiene	91
Personal protective equipment	89
HCF Characteristics	85
Training level	81
Insufficient	63
Waste Management	62
HCF practices	57
Sufficient	55
Roles and responsibilities	45
Cleaning practices	44
Energy	44
Facility	40
Qualifications	37
Waste disposal	28
Policy	28
HCF conditions	26
EH responsibilities	26
Insufficient resources	24
Challenges	22
Recommendations	20

4.4 – Qualitative thematic analysis and organization: SEIPS model

To provide an organizational structure to the results, we applied the Systems Engineering Initiative for Patient Safety (SEIPS) model (Carayon et al., 2006; Holden et al., 2013). This model was first created to assess the structures, processes, and outcomes in healthcare and includes three sub-models: the work system, process, and outcomes. Instead of focusing on patients as this model suggests, we focused on cleaners.

The data were not coded to correspond with the SEIPS model. The model was used to highlight and organize the themes into the work system and process elements including person, organization, tools and technology, tasks, and environment. **Table 5** shows the elements that were included in each work system and process components discussed by cleaners. The SEIPS model organizational structure of the results is shown in **Figure 5**.

Table 5*. Components and elements of Work System and Process from the SEIPS model in relation to cleaners in HCFs.*

Models	Components	Element discussed by cleaners
Work System	Person	Education, training (initial and refresher)
	Organization	Staff communication, record keeping, social relationships, staff interaction and attitudes, and staff incentives
	Tools and Technology	Availability of supplies and resources (including PPE and cleaning materials)
	Tasks	Roles and responsibilities, excess tasks, work related stress and pressures
	Environment *Internal Environment* *External Environment*	Physical environment *Layout, lighting, hot water availability, work-related injuries* *Use and operation of HCF equipment*
Process	Process Improvement Quality Improvement	HCF accessibility WaSH reporting and response

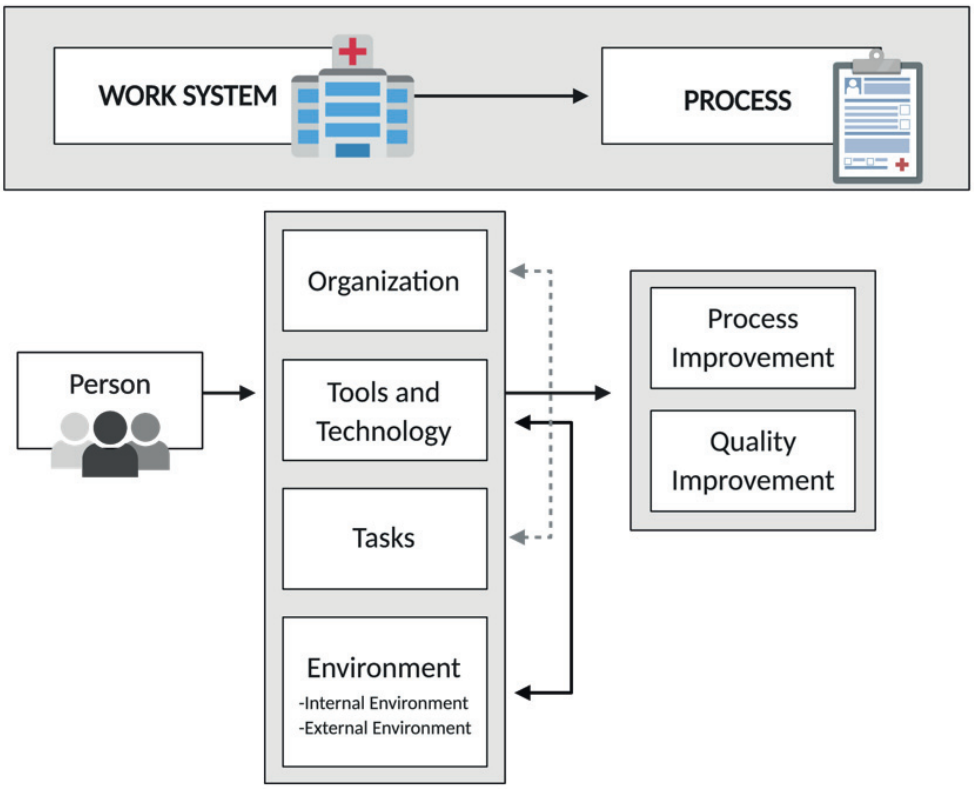

Figure 5. *The Systems Engineering Initiative for Patient Safety (SEIPS) model, adapted from Carayon et al., 2006 and Carayon et al., 2013. Components of the SEIPS work system can often influence and interact with each other and are represented by dashed lines.*

4.5 – Qualitative data quality assessment

To ensure data validity, an assessment was conducted to determine the trustworthiness of the qualitative findings by considering four criteria: credibility, dependability, transferability, and confirmability (Tolley, Ulin, Mack, Robinson, & Succop, 2016).

Credibility is defined as examining the data that the findings show a logical relationship with one another. Credible interpretations of qualitative data provide explanations which are consistent with the original data. No matter how divergent the findings are, credible interpretations can relate them to the context. Three techniques in which data are assessed for credibility include: looking for negative cases (or contradicting data to your research objectives); testing rival explanations; and seeking explanations for inconsistencies (Patton, 1999). Insufficiencies and negative responses regarding facilitators and constraints were expected and were expanded upon during analysis. Rival responses and inconsistencies

emerged in a small set of interviews. Responses that were inconsistent were expanded upon in the interview, where interviewers would ask follow-up questions with the interviewee and compare responses with other researchers to triangulate the findings.

Dependability is the extent to which the findings can be replicated. The study methodology ensured dependability through internal team quality checks to ensure that questions were asked appropriately and that questions were neither leading the witness nor biased. Each researcher also took turns observing and being observed while giving an interview and met regularly to discuss and ensure the highest quality data. These quality control methods ensured that the questions were clearly connected to the research question, and data collection protocols were comparable between researchers. The dependability of the data was also determined through an audit trail, or a record that enables the reader to track the process that led to conclusions, which includes the raw data, study protocols, instruments, data analysis procedures, and data reconstruction products (Maman, 2019).

For this study, the raw data are comprised of the uncoded cleaner transcripts, recorded cleaner interviews, and fieldnotes taken during field work. The study protocol includes the research objectives and overarching research questions that were established prior to data collection. The instruments include both the qualitative and quantitative surveys/questionnaires that were developed and approved by multiple organizations and institutions including the University of North Carolina at Chapel Hill, the UNC Institutional Review Board (IRB), the Malawi National IRB, the Water Institute at Chapel Hill, and the Malawian Ministry of Health.

Confirmability ensures that the ideas presented represent those of the participant and not the researcher (Tolley et al., 2016). There are two techniques which ensure data confirmability and they include utilizing multiple coders or analysts and making field notes of field related decisions and changes. Both techniques were used in this study. Coding was conducted in two phases, and multiple coders were used to ensure code consistency and reliability. Additionally, field notes were taken by each field researcher and recorded decisions or changes in the study as they occurred in real time.

Transferability/generalizability includes determining whether conclusions of this study are transferrable to other contexts. To do so, the description of the research context is needed including characteristics of the study population, nature of the interviewee's interaction with the researchers, and the physical environment (Maman, 2019). Within the context of Malawi, these data are transferrable as they do not focus on a single HCF type or sub-national region.

In summary, to assess the trustworthiness of the qualitative data collected on cleaners and their understanding of EH conditions in HCFs, the dataset was determined to be credible, dependable, confirmable, and transferable as supported by the literature and qualitative specialists at UNC (Tolley et al., 2016; Maman 2019).

4.6 – Quantitative analysis

The quantitative data were cleaned and analyzed using Microsoft Excel and Stata (V13, StataCorp, College Station, TX, USA). Summary statistics of EH conditions in Malawian HCFs were assessed in terms of water, sanitation, hygiene, waste management, energy services and environmental cleanliness.

4.7 – Ethics statement

Ethical approval and all relevant research permits were received from the University of North Carolina at Chapel Hill's Office of Human Research Ethics (approved non-biomedical research, project 16-1682), and the Malawi Health Sciences Research Committee (approval number UNCPM 21908).

CHAPTER FIVE: RESULTS

5.1 – Quantitative results

5.1.1 – HCF characteristics

Researchers from the Water Institute collected data from 45 government-run HCFs: three central hospitals; 14 district hospitals; 15 health centers; and 13 health post and dispensaries. The estimated population served at these facilities ranged from 1,000 to 6,000,000 people. Health posts and dispensaries served between 1,000 and 34,000 people, health centers between 3,000 and 60,000, district hospitals between 6,200 and 1,000,000, and central hospitals serving upwards of 6,000,000 people (MoH & ICF International, 2014). Larger HCFs including central and district hospitals offered inpatient pediatric services, along with outpatient, maternity and delivery services, and other specialty services. Smaller HCFs provided more limited services. All 15 of the health centers where interviews took place offered outpatient services, and 14 (93%) offered maternity and delivery services. All 13 health posts and dispensaries offered outpatient services but not inpatient and maternity and delivery services.

Central hospitals, district hospitals, and health centers were open seven days a week and 24 hours a day. Eight (61%) health posts and dispensaries operated seven days a week, one (8%) was open for six days, two (15%) for five days, and one (8%) for four days. Seven (54%) health posts and dispensaries were open 24 hours a day, while four (31%) were open for ten hours or less. The days and hours of operation did not differ by region. Population served and HCF hours of operation are presented in **Table 6**. All quantitative data were collected and compiled by researchers at the Water Institute at UNC as part of a broader project (The Water Institute at UNC & UNC Project Malawi, 2019).

***Table 6**. HCF services offered, population served, and HCF hours of operation by HCF type.*

	Central Hospital	District Hospital	Health Center	Health Post /Dispensary	Total
n	**3 (%)**	**14 (%)**	**15 (%)**	**13 (%)**	**45 (%)**
Estimated population size this facility serves	6,000,000	6,200 – 1,000,000	3,000 – 60,000	1,000 – 34,670	-
Types of services provided					
Inpatient pediatric	3 (100)	14 (100)	0 (0)	0 (0)	17 (38)
Outpatient	3 (100)	14 (100)	15 (100)	13 (100)	45 (100)
Maternity/Delivery	3 (100)	14 (100)	14 (93)	0 (0)	31 (69)
How many days in a week is this facility open?					
7 days	3 (100)	14 (100)	15 (100)	8 (61)	40 (89)
6 days	0 (0)	0 (0)	0 (0)	1 (9)	1 (2)
=<5 days or less	0 (0)	0 (0)	0 (0)	4 (30)	4 (9)
Is this facility open 24 hours?					
24 hours	3 (100)	14 (100)	15 (100)	7 (54)	39 (87)
<10 hours	0 (0)	0 (0)	0 (0)	4 (31)	4 (9)
Not specified	0 (0)	0 (0)	0 (0)	2 (15)	2 (4)

5.1.2 – Environmental health conditions

5.1.2.1 – Water

Twenty-two of 45 (48%) HCFs reported that water was piped into the facility from the municipal supply system. Smaller HCFs, including health centers and health posts and dispensaries, reported that water was either piped to a yard or plot of land (1, 2%), or accessed from a tube well or borehole (3, 6%). The reliability of the water system varied widely across HCFs. Central hospitals (n=3) reported that breakdowns occurred between three and ten times in the past six months. Four (28%) district hospitals reported no breakdowns, one (2%) reported having one to two breakdown occurrences, and the remaining nine reported ten or more breakdowns in the past six months. Health centers, health posts, and dispensaries had a range of breakdowns from none to more than ten in the past six months. HCFs reported that water was unavailable as a result of broken machinery, weather, or the inability of the facility to pay. Seventeen HCFs did not report any breakdowns. In those with breakdowns, the length of time between breakdown and report varied. All central hospitals (3, 100%) reported that it took half a day to a full day to repair broken down water systems. District hospitals reported a range from less than one day to greater

than one month to repair. Health centers, health posts and dispensaries reported that repairs took between one day and less than one week.

Seasonal water shortages were reported in 28 (62%) HCFs, with central hospitals (3, 10%) and district hospitals (10, 35%) making up approximately half of HCFs experiencing seasonal water issues. HCFs reported that water shortages occurred from September to December (hot and rainy season), where few water issues arose between March and August (dry season).

Few HCFs reported regularly testing and treating water. Central hospitals (3, 100%) reported that they did not treat or test the water quality. One (7%) district hospital reported treating water and four (28%) reported testing water quality. Six (40%) health centers both treated and tested their water regularly. Six (46%) health posts and dispensaries reported that they treated their water, but only two reported (15%) testing it. **Table 7** shows the water availability and reliability at the HCFs.

5.1.2.2 – Sanitation

Limited data were available on sanitation conditions. Eight (67%) health centers and health posts and dispensaries reported that all toilets were functional. Similarly, central and district hospitals that had maternity (n=32) and outpatient wards (n=31) also reported that toilets were functional. HCFs with outpatient wards (16, 50%), and maternity wards (22, 71%) reported that the toilets were often clean, but that cleanliness varied from day to day. Of all HCFs, only two (4%) had facilities for menstrual hygiene management. **Table 8** shows sanitation services by HCF type.

***Table** 7. Water source type, availability, and reliability by HCF type.*

	Central Hospital	District Hospitals	Health Center	Health Post/ Dispensary	Total
n	**3 (%)**	**14 (%)**	**15 (%)**	**13 (%)**	**45 (%)**
Source type					
Piped into facility from onsite source	0 (0)	0 (0)	7 (47)	3 (23)	10 (22)
Piped into facility from municipal supply	3 (100)	14 (100)	4 (27)	1 (8)	22 (49)
Piped to yard or plot	0 (0)	0 (0)	1 (7)	1 (8)	2 (4)
Tube well or borehole	0 (0)	0 (0)	2 (13)	5 (39)	7 (16)
Other	0 (0)	0 (0)	1 (7)	2 (15)	3 (7)
Source functional on day of survey	3 (100)	12 (86)	13 (87)	10 (77)	38 (84)
Number of breakdowns in past 6 months					
None	0 (0)	4 (29)	7 (47)	6 (46)	17 (38)
1-2	0 (0)	1 (7)	2 (13)	3 (69)	6 (13)
3-5	2 (67)	0 (0)	1 (7)	0 (0)	3 (7)
6-10	1 (33)	0 (0)	1 (7)	0 (0)	2 (4)
>10	0 (0)	9 (64)	4 (27)	2 (15)	15 (33)
Reason why water was unavailable					
Machinery broken	0 (0)	1 (10)	2 (25)	4 (31)	7 (16)
Lack of water due to weather	0 (0)	4 (40)	1 (13)	2 (15)	7 (16)
Inability of the facility to pay	0 (0)	0 (0)	1 (13)	0 (0)	1 (2)
Other	3 (100)	8 (80)	4 (50)	2 (15)	17 (38)
Time until service was restored					
No breakdowns reported in last 6 months	0 (0)	4 (29)	7 (47)	6 (46)	17 (38)
< 1 day	2 (67)	3 (21)	3 (20)	2 (15)	10 (22)
1 day	1 (33)	3 (21)	2 (13)	1 (8)	7 (16)
< 1 week	0 (0)	1 (7)	1 (7)	2 (15)	4 (9)
< 1 month	0 (0)	1 (7)	1 (7)	0 (0)	2 (4)
> 1 month	0 (0)	2 (14)	1 (7)	0 (0)	3 (7)
Water supply ever experiences seasonal shortages	3 (100)	10 (71)	9 (60)	6 (46)	28 (62)
Month(s) during which shortages are experienced	n=3	n=10	n=9	n=6	n=28
January	1 (33)	1 (10)	0 (0)	1 (17)	3 (11)
February	1 (33)	0 (0)	1 (11)	1 (17)	3 (11)
March	0 (0)	0 (0)	1 (11)	1 (17)	2 (7)
April	0 (0)	1 (10)	1 (11)	0 (0)	2 (7)
May	0 (0)	1 (10)	1 (11)	0 (0)	2 (7)
June	0 (0)	1 (10)	2 (22)	0 (0)	3 (11)
July	0 (0)	2 (20)	1 (11)	1 (17)	4 (14)
August	0 (0)	6 (60)	3 (33)	2 (33)	11 (39)
September	1 (33)	8 (80)	4 (44)	2 (33)	15 (54)
October	2 (67)	10 (100)	5 (56)	4 (67)	21 (75)
November	1 (33)	9 (90)	4 (44)	4 (67)	18 (64)
December	1 (33)	6 (60)	3 (33)	2 (33)	12 (43)
Facility reports treating water	0 (0)	1 (7)	6 (40)	6 (67)	13 (46)
Facility reports testing water	0 (0)	4 (31)	6 (43)	2 (33)	12 (43)
Facility water source is used by community members	2 (67)	7 (50)	10 (67)	7 (54)	26 (93)

Table 8. *Availability and accessibility of sanitation facilities in assess HCFs.*

	Central Hospital	District Hospitals	Health Center	Health Post/ Dispensary	Total
n	**3 (%)**	**14 (%)**	**15 (%)**	**13 (%)**	**45 (%)**
What proportion of toilets are functional in one-ward facilities?	n=0	n=0	n=1	n=11	n=12
None	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Some	0 (0)	0 (0)	1 (100)	3 (27)	4 (33)
All	0 (0)	0 (0)	0 (0)	8 (73)	8 (67)
What proportion of toilets are functional in maternity wards?	n=3	n=14	n=14	n=0	n=31
None	0 (0)	2 (14)	3 (21)	0 (0)	5 (16)
Some	0 (0)	2 (14)	6 (43)	0 (0)	8 (26)
All	3 (100)	10 (71)	5 (36)	0 (0)	18 (58)
What proportion of toilets are functional in outpatient wards?	n=3	n=12	n=15	n=2	n=32
None	0 (0)	1 (8)	0 (0)	0 (0)	1 (3)
Some	1 (33)	4 (33)	8 (53)	1 (50)	14 (44)
All	2 (67)	7 (58)	7 (47)	1 (50)	17 (53)
At least one functional toilet is present in all wards observed	3 (100)	9 (75)	12 (80)	13 (100)	37 (100)
One-ward facilities have at least one improved toilet	0 (0)	0 (0)	1 (100)	9 (75)	10 (100)
Outpatient ward has at least one improved toilet	3 (100)	12 (86)	15 (100)	2 (100)	32 (100)
Maternity ward has at least one improved toilet	3 (100)	14 (100)	13 (93)	0 (0)	30 (100)
All observed wards have at least one improved toilet	3 (100)	12 (86)	14 (93)	9 (75)	38 (100)
Toilets observed in one-ward facilities are clean	0 (0)	0 (0)	1 (100)	6 (55)	7 (100)
Toilets observed in maternity ward are clean	3 (100)	11 (79)	8 (57)	0 (0)	22 (100)
Toilets observed in outpatient ward are clean	2 (67)	6 (50)	8 (53)	0 (0)	16 (100)
Toilets in all observed wards are clean	2 (67)	5 (42)	7 (47)	6 (55)	20 (100)
One-ward facilities have a facility for menstrual hygiene management	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Maternity ward has a facility for menstrual hygiene management	0 (0)	1 (8)	0 (0)	0 (0)	1 (100)
Outpatient ward has a facility for menstrual hygiene management	0 (0)	0 (0)	1 (7)	0 (0)	1 (100)
All observed wards have a facility for menstrual hygiene management	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)

5.1.2.3 – Waste management and hygiene

All central hospitals (3, 100%) reported adequate sharps waste disposal and infectious waste disposal, but reported inadequate treatment for general non-infectious, non-sharps waste disposal. Twelve (86%) district hospitals reported adequate treatment of sharps waste disposal. Of the twelve, five (36%) reported adequate treatment of infectious waste disposal. Most health centers (13, 87%) reported adequate disposal of sharps waste (13, 87%), infectious waste (8, 53%), and general non-infectious waste (6, 40%). Many health posts and dispensaries reported some but inadequate disposal of sharps (8, 62%), infectious wastes (9, 69%), and general non-infectious wastes (10, 77%).

One hundred percent of central hospitals, district hospitals, health centers and health posts and dispensaries reported that hand soap or alcohol-based hand rub (ABHR) was available at the point of care of at least one location in the facility. **Table 9** shows services level HCF type.

***Table 9**. Waste management and hygiene services by HCF type.*

	Central Hospital	District Hospital	Health Center	Health Post/ Dispensary	Total
n	**3 (%)**	**14 (%)**	**15 (%)**	**13 (%)**	**45 (%)**
Sharps waste disposal					
No treatment	0 (0)	0 (0)	0 (0)	2 (15)	2 (4)
Some but inadequate treatment	0 (0)	2 (14)	2 (13)	8 (62)	12 (27)
Adequate treatment	3 (100)	12 (86)	13 (87)	2 (15)	30 (67)
Infectious waste disposal					
No treatment	0 (0)	0 (0)	1 (7)	0 (0)	1 (2)
Some treatment	0 (0)	8 (57)	6 (40)	9 (69)	18 (40)
Adequate treatment	3 (100)	5 (36)	8 (53)	3 (23)	24 (53)
General non-infectious, non-sharps waste disposal[†]					
No treatment	0 (0)	0 (0)	1 (7)	0 (0)	1 (2)
Some but inadequate treatment	1 (33)	7 (50)	8 (53)	10 (77)	26 (58)
Adequate treatment	1 (33)	7 (50)	6 (40)	2 (15)	16 (36)
Surface cleaning					
Facility has written cleaning procedures	3 (100)	14 (100)	15 (100)	12 (92)	44 (98)
Facility tracks stock of cleaning supplies	2 (67)	14 (100)	4 (27)	6 (46)	24 (53)
Facility has a cleaning schedule	3 (100)	12 (86)	14 (93)	10 (77)	39 87)
Vector control					
Facility takes any kind of action for vector control	3 (100)	12 (86)	11 (73)	5 (39)	31 (69)
Infection prevention and control					
Facility has written IPC guidelines	3 (100)	14 (100)	9 (60)	2 (15)	28 (62)
Facility has an environmental health budget	3 (100)	14 (100)	0 (0)	0 (0)	17 (38)
Staff receive IPC training	3 (100)	14 (100)	8 (53)	4 (31)	29 (64)
Handwashing at point of care					
Handwashing or alcohol-rub station is available at the point of care in at least one location in the facility	3 (100)	14 (100)	15 (100)	13 (100)	45 (100)

5.1.2.4 – Energy services

Thirty-seven of 45 (82%) HCF administrators responded to the survey regarding energy services. All central hospitals (3, 100%) and district hospitals (14, 100%) reported being connected to the grid and having a backup energy source. Fourteen (93%) health centers and six (46%) health post and dispensaries were connected to the grid, and five (33%) health centers and one (8%) health post had backup energy sources. The majority of the 37 HCFs (20, 54%) reported using a fuel-based generator, including central hospitals (3, 8%) and district hospitals (13, 35%). Two health centers (5%) and one (3%) health post

reported using solar photovoltaic systems with batteries as a backup energy source. Energy services are summarized in **Table 10**.

Table 10. *Energy services and backup energy sources by HCF type.*

	Central Hospital	District Hospitals	Health Center	Health Post/ Dispensary	Total
n	**3 (%)**	**14 (%)**	**15 (%)**	**13 (%)**	**45 (%)**
Facility is connected to the grid	3 (100)	14 (100)	14 (100)	6 (100)	37 (100)
Facility has a backup energy source	3 (100)	14 (100)	5 (36)	1 (33)	23 (100)
Type of backup energy source	n=3	n=14	n=5	n=1	23 (100)
Solar Photovoltaic system with batteries	0 (0)	1 (7)	2 (40)	0 (0)	3 (100)
Fuel-based generator	3 (100)	13 (93)	3 (60)	1 (100)	20 (100)
Solar Photovoltaic system with batteries is functional	0 (0)	1 (100)	0 (0.0)	0 (0)	1 (100)
Fuel-based backup generator is functional	3 (100)	10 (77)	0 (0)	0 (0)	13 (100)

5.1.2.5 – Environmental cleanliness

HCFs reported that either HCF cleaners or external cleaning professionals were responsible for cleaning the facility. All three (100%) central hospitals reported that external cleaning professionals (private sector companies) oversaw HCF cleanliness. All HCF administrators at district hospitals (14, 100%) and health centers (15, 100%) as well as 11 (85%) health posts reported that cleaners were responsible for conducting cleaning in the HCF. A mechanism to track the supply of cleaning materials varied across HCFs, with most central hospitals (2, 67%) and district hospitals (12, 86%) reporting that such mechanisms existed. Most health centers (11, 73%) and health posts and dispensaries (7, 54%) did not have a mechanism for tracking cleaning material inventory.

All central hospitals and district hospitals reported that they had written policies related to IPC, and that their staff were trained on IPC at the hospital by their environmental health officer (EHO). Some health centers reported that policies on IPC did exist (9, 60%), that staff were trained on IPC (8, 53%) in their facility (7, 46%), by their EHO (5, 33%). Seven (54%) health posts and dispensaries reported that they did not have a mechanism in place for identifying inventory, that they lack policies relating to IPC

(11, 85%) and are not trained on IPC (9, 70%). **Table 11** presents data on environmental cleanliness by HCF type.

5.2 – Qualitative results: disaggregated cleaner characteristics

Of the 57 recorded interviews with cleaners, the average duration of each was almost 39 minutes, with researchers collecting a total of nearly 38 hours of recorded material (2,258 minutes). This section disaggregates characteristics of cleaners by contract type, work experience, education, roles and responsibilities, excess tasks, and training. Cleaner education, reported excess tasks, and training were also disaggregated by HCF type. Factors that facilitate and constrain cleaners are organized using the SEIPS model.

5.2.1 – Contract type and work experience

Cleaners included in this study held the title of ward attendant (38, 67%) or grounds laborer (19, 33%), with an almost even ratio of male (29, 51%) to female (28, (49%) cleaners (**Table 12**). Within all HCF types, all ward attendants (38, 100%) worked on permanent contracts that ensured job security until retirement. Twelve (63%) grounds laborers worked on permanent contracts and seven (37%) were temporary contracted employees with contracts renewed every three months.

All ward attendants, both male (15, 39%) and female (23, 61%), were permanent contracted employees. Of the 19 grounds laborers, nine (47%) males and three (16%) females were permanent employees. On average, both ward attendants and grounds laborers worked at their respective HCF for seven years (range: 1 - 32 years); no cleaners with less than one year of experience were included in this study. Work experience was similar between male and female cleaners, although male grounds laborers on average had three years more experience than their female colleagues.

Table 11. *Availability of environmental cleanliness mechanism and availability of IPC training by HCF type.*

	Central Hospital	District Hospital	Health Center	Health Post /Dispensary	Total
n	**3 (%)**	**14 (%)**	**15 (%)**	**13 (%)**	**45 (%)**
Who is responsible for cleaning this facility?					
External Provider	3 (100)	1 (7)	0 (0)	0 (0)	4 (9)
Cleaner	1 (33)	14 (100)	15 (100)	11 (85)	41 (91)
Other	0 (0)	1 (7)	2 (13)	1 (8)	4 (9)
Does a mechanism exist to track the supply of cleaning materials and identify stock-outs?					
Yes	2 (67)	12 (86)	4 (27)	6 (46)	24 (53)
No	1 (33)	2 (14)	11 (73)	7 (54)	21 (47)
Does a mechanism exist to track the cleaning schedule?					
Yes	3 (100)	12 (86)	14 (93)	10 (77)	39 (87)
No	0 (0)	2 (14)	1 (7)	3 (23)	6 (13)
Is there a written policy, guidelines, or standards related to infection prevention for this facility?					
Yes	3 (100)	14 (100)	9 (60)	2 (15)	28 (62)
No	0 (0)	0 (0)	6 (40)	11 (85)	17 (38)
Are staff trained on infection prevention and control?					
Yes	3 (100)	14 (100)	8 (53)	4 (31)	29 (64)
No	0 (0)	0 (0)	7 (47)	9 (69)	16 (36)
Do staff receive the [IPC] training at this facility?					
Yes	3 (100)	14 (100)	7 (47)	3 (23)	27 (60)
No	0 (0)	0 (0)	1 (7)	1 (8)	2 (4)
Not specified	0 (0)	0 (0)	7 (47)	9 (69)	16 (36)
Who primarily conducts these [IPC] trainings?					
EHO	2 (67)	2 (14)	5 (33)	1 (8)	10 (22)
International NGO	0 (0)	3 (21)	4 (27)	0 (0)	7 (16)
Other (IP Coordinator, National trainers, MoH, District level staff)	2 (67)	12 (86)	5 (33)	2 (15)	21 (47)

***Table 12**. Gender of ward attendants and grounds laborer by HCF type.*

HCF Type	Ward attendant		Grounds laborer		Total	
Central Hospital	Male	1	Male	1	Male	2
	Female	4	Female	1	Female	5
District Hospital	Male	5	Male	12	Male	17
	Female	8	Female	1	Female	9
Health Center	Male	4	Male	1	Male	5
	Female	10	Female	2	Female	12
Health Post & Dispensary	Male	5	Male	0	Male	5
	Female	1	Female	1	Female	2
Total	**Male**	**15**	**Male**	**14**	**Male**	**29**
	Female	**23**	**Female**	**5**	**Female**	**28**

5.2.2 – Education

Education and training were disaggregated by HCF type, sub-national region, and gender. All but one cleaner (56, 98%) completed primary school (completing Standards 1-8). There was a range of educational certifications between ward attendants and grounds laborers. Both ward attendants and grounds laborers had a variety of educational accomplishments from completing Standard 8 to receiving their MSCE certification (secondary education). Some ward attendants (17, 45%) and grounds laborers (9, 47%) had either completed Form 4 or received their JCE certification (primary education). Five (13%) ward attendants and three (16%) grounds laborers received their MSCE. Education did not vary by HCF type or sub-national region but did by gender, where more male ward attendants and grounds laborers had received their MSCE, while most female cleaners had received their JCE.

5.2.3 – Roles and responsibilities

Reported roles and responsibilities were consistent by sub-national region and gender. Both ward attendants and grounds laborers reported similar tasks with the main difference being that ward attendants cleaned the interior of the HCF, and grounds laborers cleaned the exterior.

As their primary daily tasks, ward attendants reported mopping, sweeping, dusting, disinfecting floors, doors, and surfaces, disposing and treating of infectious and non-infectious waste, and cleaning sanitation facilities. Grounds laborers reported similar cleaning roles and responsibilities with the addition of mowing and tending to the lawn and landscape of the HCF. The roles and responsibilities listed above differed in HCF types only by specificity of reported tasks. It should be noted that ward attendants and grounds laborers in central and district hospitals reported roles that were more specific and more clearly defined when compared with cleaners at smaller HCFs who reported numerous roles and responsibilities, some of which fell outside of representative reported tasks (**Table 13)**.

Table 13*. Representative daily roles and responsibilities of ward attendants and grounds laborers summarized from cleaner transcripts.*

Cleaner type	Roles and responsibilities summarized from transcripts

Ward attendant	- Responsible for cleaning the interior of the HCF
	- Representative roles and responsibilities:
	  - Sweeping, mopping, and disinfecting the clinics, wards, operating rooms, and laboratory
	  - Cleaning surfaces, doors, walls, and sterilizing equipment
	  - Removing cobwebs/dusting every month
	  - Removal and treatment of HCF infectious and non-infectious waste
	  - Cleaning and maintenance of interior sanitation facilities

Grounds laborer	- Responsible for cleaning the exterior of the HCF
	- Representative roles and responsibilities:
	  - Sweeping, mopping, and disinfecting the exterior rooms and walkways
	  - Disposal of garbage/litter and outdoor waste
	  - Mowing/slashing the grass on a regular basis
	  - Cleaning and maintenance of exterior sanitation facilities
	  - Tends to the grass, flowers, and other landscape

5.2.4 – Reported excess tasks

Reported excess tasks, or tasks that took time away from cleaner's expected roles and responsibilities, varied by gender. Some female ward attendants (12, 52%) reported performing excess tasks of sterilizing medical equipment, working the outpatient department (OPD) register, testing patients for malaria, assisting with maternity services and delivery, dressing wounds, and packing medications. Thirteen (87%) male ward attendants reported performing excess tasks of operating machines, changing wound dressings on patients, testing patients for malaria, working the OPD register, running samples to the lab, and fetching water.

Four (80%) female grounds laborers reported that they conducted excess tasks that included helping at the OPD register, testing patients for malaria, distributing medicine, weighing babies and changing wound dressings on patients. When compared to female grounds laborers, 5 (36%) male grounds laborers reported performing excess tasks including testing patients for malaria but also more physical activities such as loading and unloading supplies and packing medication. Excess tasks were compared by HCF type and minimal variation was found. **Table 14** shows cleaner characteristics by cleaner type, sub-national region, HCF type, education, and experience.

Table 14. *Cleaner characteristics by cleaner type, region of Malawi, HCF type, gender, average working experience and highest level of education obtained.*

Cleaners by region	Central Hospital	District Hospital	Health Center	Health Post/ Dispensary	Total	Average working experience by gender (years)		Highest level of education obtained by gender	
n (%)	**7**	**26**	**17**	**7**	**57**				
North						**Male**	**Female**	**Male**	**Female**
Ward attendants	1 (14)	3 (12)	2 (12)	2 (29)	**8 (14)**	3	6	MSCE	Form 4
Grounds Laborers	1 (14)	3 (12)	0 (0)	1 (14)	**5 (9)**	9	7	JCE	Form 4
Central									
Ward attendants	3 (43)	4 (15)	7 (41)	2 (29)	**16 (28)**	11	10	MSCE	Form 4
Grounds Laborers	0 (0)	5 (19)	0 (0)	0 (0)	**5 (9)**	9	0	MSCE	0
South									
Ward attendants	1 (14)	6 (23)	5 (29)	2 (29)	**14 (25)**	4	6	MSCE	MSCE
Grounds Laborers	1 (14)	5 (19)	3 (18)	0 (0)	**9 (16)**	7	2	MSCE	JCE

5.2.5 – Training

IPC, HCF equipment, and waste management training differed slightly between ward attendants and grounds laborers. Most ward attendants (29, 76%) and grounds laborers (10, 53%) received a one-day IPC training during orientation. Training regarding PPE differed slightly as more ward attendants (31, 82%) received training compared to grounds laborers (16, 84%). As a result, more grounds laborers (10, 53%) were given supplies and told what to do rather than receiving training.

Training in relation to the use and operation of HCF equipment, such as incinerators and autoclaves, was minimal; few ward attendants (2, 5%) and grounds laborers (3, 16%) received such training. Waste management training was offered to more ward attendants (22, 58%) compared to grounds laborers (8, 42%). Refresher trainings regarding IPC were only offered to one ward attendant.

IPC, HCF equipment, and waste management training did not differ by HCF type, sub-national region or gender.

5.2.6 – Roles and responsibilities, education, excess tasks, and training by HCF type

Further disaggregation of roles and responsibilities, education, reported excess tasks and training were conducted to determine the differences between cleaner and HCF type. In all HCF types, reported roles and responsibilities did not differ and the representative tasks reported are presented in Table 13. Education differed minimally, where cleaners with the highest obtained education (MSCE) were in health centers. Reported excess tasks occurred most frequently at health centers and health posts and dispensaries, as those facilities most often had fewer members of cleaning staff.

5.2.6.1 – Education

Education level was examined by cleaner type across the different HCFs. The variation in education differed minimally with the highest percentages of cleaners with an MSCE occurring in health centers.

Of the seven cleaners working at central hospitals, two (100%) grounds laborers and three (60%) ward attendants achieved their JCE, where only two (40%) ward attendants achieved their MSCE. Cleaners at district hospitals represent almost half of the sample size with 26 cleaners, where 10 (77%) ward attendants achieved their JCE and three (23%) achieved their MSCE. Nine (69%) grounds laborers achieved their JCE and four (31%) had their MSCE. In health centers, eight (57%) of ward attendants achieved their JCE and six (43%) had their MSCE. At health posts and dispensaries showed that five (83%) ward attendants had achieved their JCE and one (17%) had an MSCE. One (17%) grounds laborer working at a health post showed that she had not achieved either a JCE or MSCE certification.

5.2.6.2 – Excess tasks

Reported excess tasks, or tasks which fall outside daily roles and responsibilities, varied by HCF type with the most tasks reported by ward attendants and grounds laborers in health centers and health posts and dispensaries.

In central hospitals, four (80%) ward attendants reported delivering samples to the lab, testing patients for TB and malaria, and assisting in patient wound dressing. In district hospitals, six (46%) ward attendants and five (38%) grounds laborers reporting packing medication, loading and unloading inventory, and delivering samples to the lab. In health centers, 12 (86%) ward attendants reported testing patients for TB and malaria, packing medications, and assisting in patient wound dressing. In health posts and dispensaries four (67%) ward attendants reported working the OPD register, testing patients for TB and malaria, and fetching water for the HCF.

5.2.6.3 – Training

IPC, PPE, and hand hygiene training differed by cleaner type and HCF type, where central hospitals had the highest occurrence of training among ward attendants and grounds laborers.

In central hospitals, all five (100%) ward attendants had IPC, PPE and hand hygiene training. Of the two grounds laborers, both received IPC training and one received PPE and hand hygiene training. In

district hospitals ward attendants received IPC training (11, 85%), PPE training (10, 77%) and HH training (5, 38%). Over 50% of grounds laborers received all three trainings, where seven (54%) had IPC training, ten (77%) had PPE training, and five (38%) had hand hygiene training. In district hospitals 11 (79%) ward attendants had IPC training, PPE training (13, 93%) and hand hygiene training (6, 43%). Ward attendants in health posts and dispensaries had the fewest trainings where two (33%) received IPC training, three (50%) received PPE training, and no ward attendants received hand hygiene training. Grounds laborers reported the absence of IPC, PPE, and hand hygiene training.

5.3 – Qualitative thematic results: SEIPS model

Using supportive representative excerpts from qualitative interviews with cleaners, themes within each SEIPS work system component (including person, organization, tools and technology, tasks, and environment), along with the factors that facilitate and constrain safe EH standards in HCFs, are summarized below. The themes emerged from the code co-occurrence analysis which focused on EH conditions. All representative quotations can be seen in **Table 15**. Certain themes relate to either ward attendants (n=38) or grounds laborers (n=19). Those that do will be referred to individually as such.

5.3.1 – Person

The themes affecting ward attendants and grounds laborers in the person component include insufficient training on IPC, hand hygiene, personal protective equipment (PPE), and the use and operation of HCF equipment, including the use and operation of incinerators, autoclaves, and waste pits.

5.3.1.1 – Insufficient IPC and hand hygiene training

Most ward attendants (29, 76%) and grounds laborers (10, 53%) received a one-day IPC training that included proper use of PPE. Training on IPC took place during the initial orientation and was provided by current cleaning staff members or nurses to ward attendants (12, 32%) and grounds laborers (5, 58%). Training was also provided as an activity of on-the-job training to ward attendants (9, 24%) and

grounds laborers (5, 58%), or, in a few cases, ward attendants (3, 8%) and grounds laborers (2, 11%) taught themselves. In some cases, PPE training was absent as ward attendants (7, 18%) and grounds laborers (10, 53%) were hired and given PPE without receiving training or instruction of any kind (Table 15, quotation 1).

Refresher trainings, meant to reacquaint and improve cleaner's skills and knowledge, were lacking, as only one ward attendant (1, 2%) received a refresher training in the months following orientation. In one case, it had been years since either IPC or PPE refresher trainings were available (Table 15, quotation 2). Initial and refresher training regarding hand hygiene practices were also inadequate. Only some ward attendants (15, 39%) and grounds laborers (7, 37%) received hand hygiene training during orientation, and three (5%) received refresher training over the course of their working history. If trainings did occur, it was unlikely that the entire cleaning staff could participate. For example, "*what happens here is that when [trainings] happen, they just pick a few people to participate"* – central hospital, grounds laborer. Many ward attendants (29, 76%) and grounds laborers (13, 68%) reported that medical staff, including doctors and nurses, did not check to ensure that cleaners complied with effective hand hygiene practices.

5.3.1.2 – Insufficient PPE training

Most ward attendants (29, 76%) and grounds laborers (16, 84%) reported that insufficient financial resources prevented routine provision of PPE and PPE training. Similarly, a few ward attendants (5, 13%) reported that a lack of funds greatly reduced the number of refresher trainings offered. Due to the lack of training, supervisors would provide PPE to cleaners with no prior knowledge of PPE or cleaning procedures (Table 15, quotation 3). In one case, a health center ward attendant expressed concern about personal safety, stating *"…it is very important for us to know these things [protective precautions] because being in a hospital there are lots of patients with different kinds of disease and if care is not taken it is easy for us to risk our lives."*

5.3.1.3 – Insufficient HCF equipment training

Almost all ward attendants (36, 95%) and grounds laborers (16, 84%) reported that training on the use and operation of equipment needed to ensure effective EH standards had not been provided. Due to the lack of training, most ward attendants (25, 66%) and grounds laborers (12, 63%) expressed concerns about carrying out their roles and responsibilities with respect to energy use and the operation of equipment such as incinerators, autoclaves, and waste pits (Table 15, quotation 4). One ward attendant at a district hospital stated, *"…we don't know the importance or the hazard the electricity can cause, at times you find that you are working with your hands wet and the oxygen machine goes off and they tell you to hold the socket this could put my life at risk because you don't know what the electricity can do, so I think it can be dangerous because I have never been trained.*"

Concerns for personal safety were expressed. One ward attendant at a health center reported the lack of compensation after an incinerator-related injury stating, *"…they say even if you are to get injured there would be no compensation, so that is scary, one time when I was going to burn waste a bottle burst and hit my hand, it was swelling and because they say no compensation…we just work accepting any thing that can happen*." In addition to the concerns over possible risks and injuries, a few ward attendants (7, 18%) suggested that energy training would create a safer working environment and increase productivity (Table 15, quotation 5).

Training on waste management was reported to be brief and inconsistent (Table 15, quotation 6). While some ward attendants (22, 58%) and grounds laborers (8, 42%) reported receiving initial waste management training at orientation, only one received additional refresher training. Because of this limited training, most ward attendants (28, 74%) and grounds laborers (12, 63%) were concerned about risks of injury and illness associated with poor waste segregation. For example, a ward attendant at a health post reported: "*the concern is there because if you mishandle the wastes you may be pricked by the syringes, which is a risky thing to happen*."

Despite the lack of training provided to ward attendants and grounds laborers, all cleaners (57, 100%) reported enjoying their work and being happy with their job and employment status. For example, when asked if he/she was happy working at this facility one ward attendant at a health center replied, *"yes, I am happy, there are other people who wish they could work here and [I] am happy [I] was employed."*

5.3.2 – Organization

The themes affecting the organization of the working environment include the lack of consistent cleaning practices, schedules, and records, insufficient staff interaction and communication, the lack of rewards and incentives provided to cleaners, and the disrespect of cleaners by medical staff.

5.3.2.1 – Insufficient cleaning record keeping

All cleaners (57, 100%) reported inconsistent record keeping of cleaning procedures and practices. At one HCF, regular reports on cleaning practices existed at one point in time but went missing shortly thereafter. Without adequate record keeping, some cleaners (16, 28%) irregular cleaned the HCF (Table 15, quotation 7). In a few cases (11, 19%), these irregularities were caused by miscommunications. Despite these irregularities, most cleaners (30, 53%) stated that cleaning occurred twice daily, during their shift.

Most cleaners (33, 58%) followed IPC procedures correctly to prevent the transmission of disease (Table 15, quotation 8). While IPC procedures were followed when mopping, other cleaning procedures, such as disinfecting sanitation facilities, often did not take place due to insufficient resources, such as chlorine. One ward attendant at a health center stated, "*there is no major [IPC] procedure due to lack of resources which are supposed to be used when cleaning*."

5.3.2.2 – Staff communication

Communication between medical, non-medical, and cleaning staff took place in all HCFs, although some types of communication were reported to be more effective than others. Communication consisted of face-to-face interaction, meetings/appointments, and using mobile phones, switchboards, and posted memos. Most cleaners (43, 75%) reported that face-to-face communication took place when discussing non-urgent matters, such as scheduling, and that this communication met their needs. However, some cleaners (12, 21%) reported that miscommunications took place when they had questions regarding their roles and responsibilities, lacked cleaning materials, wanted to report low inventories, or needed to connect with a nurse or supervisor.

Challenges were reported regarding mobile phone communication. Most cleaners (27, 47%) reported that mobile phones were the primary means of communicating with the medical staff. However, some cleaners (26, 46%) reported challenges regarding a lack of airtime (prepaid phone minutes). A few cleaners (5, 9%) personally paid for their phone but often lacked the funds required to ensure enough airtime to meet the communication demands of their job (Table 15, quotation 9). Some cleaners (11, 19%) reported electricity cuts and frequent blackouts due to the poor services of the Electricity Supply Corporation of Malawi Limited (ESCOM) or inadequate solar technology. Extended periods of darkness prevented switchboards and mobile phones from functioning properly, leading to reduced communication throughout the day and especially at night (Table 15, quotation 10). A few cleaners (5, 9%) relied on the energy supply of the HCF to charge their phone prior to starting their shift. In one case, the combination of unreliable energy supply, high frequency of blackouts, lack of airtime, and poorly functioning cellular network was reported to have made communication almost impossible.

5.3.2.3 – Lack of incentives

Many cleaners indicated that incentives or rewards for conducting their work would be gratefully received as almost all (53, 93%) cleaners lacked current incentives or rewards of any kind. While most

cleaners (25, 44%) agreed that staff motivation could be improved if salaries were increased or an incentive was introduced, a few (7, 12%) stated that they were content without incentives. Cleaners believed that they would be able to earn a better livelihood, have pride in their work, and achieve improved environmental conditions if they had incentives (Table 15, quotation 11).

A few cleaners (3, 5%) recalled instances when past incentives had improved the working environment. One ward attendant at a health post reported, "*we received prizes three times there for being the cleanest health facility. And I was the one who was receiving those prizes."*

5.3.2.4 – Incentive recommendations

When asked about incentives, most cleaners (29, 51%) proposed financial incentives such as increased salaries or bonuses (Table 15, quotation 12). In one case, a grounds laborer at a district hospital proposed providing financial compensation for work-related injuries. This cleaner suffered an injury to his eyes when operating the incinerator. He said, *"I developed this problem because of work but there is nothing that was done. So, this is demoralizing. As a result, we [cleaners] work in fear thinking that should anything happen, there is nothing that I will benefit…there should be a compensation when staff are injured at work.*"

A few cleaners (4, 7%) noted that nurses were given bonuses and additional pay for doing work similar to the work of the cleaners. For example, a ward attendant at a health center noted: "…*us attendants work in the labor ward even at night but there is nothing that they give us…our friends that [are] nurses receive money for working at night, we don't get anything."*

While many cleaners suggested that increased salaries and cash rewards would be effective incentives, a few (9, 16%) indicated that additional materials such as gumboots, brooms, or mops would improve environmental conditions (Table 15, quotation 13). In a few cases (4, 7%), cleaners purchased and provided their own cleaning materials. For example, a grounds laborer at a health center stated that providing a broom would eliminate the necessity of her buying it: "...*ever since I came here the*

government has never bought a broom, I buy them myself which is not appropriate because the rules say the brooms have to be delivered here or we should be given money and buy them."

Some cleaners (11, 19%) suggested providing IPC, PPE, hand hygiene, waste management or energy training to improve EH conditions. By providing effective and comprehensive initial and refresher trainings, cleaners reported that they would feel more effective in carrying out their roles and responsibilities (Table 15, quotation 14). In one case, a ward attendant at a district hospital argued that his in-charge supervisor was biased and would only allow senior cleaning staff to attend the limited trainings that were provided: *"...sometimes our bosses are biased; they just take the same people to go for trainings, but they sideline us juniors*." Another stated that training incentives would only be beneficial if nurses or doctors conducted periodic compliance checks or verified that cleaners were following the proper procedure in relation to IPC and hand hygiene. If this practice was adopted, supervisors would directly observe the conditions in the HCF with respect to heightened staff motivation and increased environmental cleanliness.

5.3.2.5 – HCF patient, staff, and cleaner interaction

Most cleaners (39, 68%) considered their interactions with medical staff, including doctors and nurses, to be positive and supportive; one ward attendant at a dispensary stated, "*we have such a good relationship. Such that when we have problems, we do not worry, we help each other*." However, due to the stigmas associated with cleaning, some medical personnel, patients, and guardians voiced negative opinions towards cleaners; this affected the quality of their work. In 11 cases (19%) medical staff were discourteous or rude to cleaners (Table 15, quotation 15). In one case, medical staff suspected the cleaning staff of stealing PPE items from their offices or supply rooms. For example, a ward attendant at a dispensary reported, "*...there is one room when I want something from there, they suspect that I can steal from their office. Yet I have worked for 32 years*."

Most cleaners had pleasant and courteous interactions with patients and guardians, however a few cleaners (4, 7%) reported that poor patient interactions occurred as a result of the patient's poor health. In those cases, instead of confronting the patient, cleaners reported carrying on with their duties (Table 15, quotation 16). On the other hand, some patients were reported to have disregarded the work cleaners perform by deliberately making messes and being discourteous while cleaning was taking place. For example, a ward attendant at a health center reported, "…*people step when I am cleaning…they do it deliberately just to see how I will respond to them which is not good at all*." It was reported that guardians, or patient caretakers, sometimes did not respect the cleaners. One cleaner reported that guardians ignored the importance of cleaning practices because they were unaware of the waste management and cleaning procedures.

5.3.3 – Tools and Technology

The themes of tools and technology affecting cleaners include insufficient PPE, cleaning materials, and hand hygiene resources.

5.3.3.1 – Lack of PPE resources

Most cleaners (51, 89%) reported that the lack of PPE resources including gloves, aprons, goggles, and gumboots were the primary constraints to achieving HCF cleanliness. However, when asked what PPE was available, 50 (88%) of cleaners reported that examination gloves and aprons were always available. Most cleaners (42, 75%) were concerned with the poor condition of their gumboots (Table 15, quotation 17). In one case, cleaners were instructed to purchase their own gumboots, with a grounds laborer at a district hospital reporting, "*We also can't find gumboots and we are told that everyone should buy their own protective shoes because the government does not have money to buy these things*." When asked why PPE was unavailable, some cleaners (21, 37%) reported that funds were insufficient to replenish the items in a timely manner. (Table 15, quotation 18). Materials were frequently unavailable in the quantities required to maintain HCF cleanliness.

5.3.3.2 – Risks and injuries related to lack of PPE

Because of insufficient supply of PPE, most cleaners (40, 70%) reported experiencing work-related injuries, largely from sharp sticks as a result of absent waste bin liners and inadequate waste segregation. Most cleaners (42, 75%) were concerned with the risk of disease transmission as their gumboots were in poor shape. One ward attendant at a health center stated, "…*it's because we need to protect our feet for example if during delivery blood spills on the floor*." Where gumboots were not available, a few cleaners (5, 9%) either bought or provided their own shoes to clean facilities and to dispose of medical waste. In one case, the lack of protective shoe covers created the risk of disease transmission into the home. For example, one health center ward attendant noted, *"... we just use our own shoes that we have brought from home, that is not right because we can transfer infections to our homes because we go into the toilets with these shoes and we go home and step on the mats we sleep on so I just feel we just transfer infections, and I feel we might have already contracted [disease]*."

5.3.3.3 – Availability of cleaning materials

Missing cleaning materials, such as soap and chlorine, affect the overall cleanliness of the HCF. Some cleaners reported that chlorine (22, 39%) was unavailable and that hygienic conditions within HCFs were substandard (Table 15, quotation 19). In one case, a grounds laborer at a district hospital suggested that staff should take better care of the cleaning materials available, as this could encourage staff to think about the long-term care and maintenance of these items: *"I think sometimes we don't take care of the materials when they are available, and we only get to use them for a short while without thinking about the next time the things will be available again. So, we have to take care of the tools so that they can be used for a long time. That can help us use the materials for a long time."*

5.3.3.4 – Borrowing of materials

In situations where soap and chlorine were unavailable, a few cleaners (3, 5%) borrowed materials from other wards (Table 15, quotation 20). Cleaners frequently asked nurses and in-charge supervisors to provide additional chlorine when needed. Both nurses and in-charge supervisors shared the resources with cleaners when these items were available, however, materials such as examination and heavy-duty gloves were not always supplied.

5.3.3.5 – Lack of sterilization and waste transportation materials

Wheelbarrows and sterilization equipment were lacking in a few HCFs (9, 16%). Cleaners used wheelbarrows to transport both infectious and non-infectious waste to either waste pits or an incinerator. A few cleaners (3, 5%) lacked wheelbarrows and instead had to use buckets, bins, or their hands to dispose of waste (Table 15, quotation 21). Some equipment such as sterilizers and autoclaves were not operational in a few HCFs (6, 11%) because fuel and electricity were unavailable. One dispensary ward attendant reported that, *"we don't sterilize the equipment because they stopped sending us gas which is used to sterilize the equipment*."

5.3.3.6 – Improvising cleaning materials

A few cleaners (5, 9%) improvised cleaning materials (either buckets or mops) with available but substandard materials. For example, one cleaner made a mop using an old blanket (Table 15, quotation 22). Materials for practicing safe waste segregation and disposal were scarce; this prompted a few cleaners (2, 4%) to use leftover paper as bin liners. In addition, one cleaner collected empty prescription bottles, sold them in the market and used the money to buy mops (Table 15, quotation 23).

5.3.3.7 – Insufficient hand hygiene resources

Most cleaners reported that resources necessary to practice hand hygiene were inadequate. Some cleaners were without hand soap (24, 42%) and most did not have access to hand drying materials (37, 65%) such as a handkerchief or towel (Table 15, quotation 24). In these situations, the cleaners either air dried their hands or wiped them on their clothes. For example, a ward attendant at a district hospital reported, "*...if one brought their own [towel] then after washing hands, they drain them by shaking, let them stand in the sun a little then dry with the handkerchief."* In one case, the limited availability of water, hand soap, and drying materials made it impossible to practice effective hand hygiene (Table 15, quotation 25).

5.3.4 – Tasks

Ward attendants and grounds laborers were often asked to perform additional tasks not included in their job description, which sometimes caused work-related stress.

5.3.4.1 – Excess tasks

Most ward attendants (26, 68%) and grounds laborers (9, 47%) were required to perform tasks that were outside of their job description. The most frequent tasks reported by ward attendants included conducting tuberculosis (TB) and malaria tests (13, 34%), delivering samples to the laboratory (10, 26%), packing and unpacking supplies (3, 8%), assisting with wound care (3, 8%), distributing prescription medication (3, 8%), and working the register in the outpatient department (OPD) (2, 5%). Grounds laborers reported packing and unpacking supplies (6, 32%) and delivering samples to the laboratory (5, 26%).

When asked if additional training was needed to perform these excess tasks, one ward attendant reported that additional training was not provided, but they were still expected to conduct these tasks (Table 15, quotation 26). Due to staff shortages at smaller HCFs (including health centers and

dispensaries), a few ward attendants (13, 34%) and grounds laborers (5, 26%) reported that their current roles and responsibilities felt burdensome as a result of being overworked.

5.3.4.2 – Work-related stress

Most ward attendants (32, 84%) and grounds laborers (16, 84%) reported that they worked hard and conducted their tasks smoothly and without excess stress. However, a few ward attendants (9, 24%) reported that, as a result of becoming frustrated with long patient wait times, patients and guardians caused cleaners to experience stress. The limited availability of nurses and doctors and high patient volumes caused ward attendants to feel unsure how to handle situations when patients and guardians complained. For example, one ward attendant at a health center reported, *"... sometimes when a patient comes, they may not find a doctor. So, problems arise that the doctor is out of [the] office so they start complaining that the doctor will not attend to them. But the doctor may be busy. We are not doctors so we cannot attend to them and it leaves us stranded on what to do."*

5.3.5 – Environment

The constraints within the internal environment experienced by both ward attendants and grounds laborers include the absence of hot water, poor facility workspace design, and a lack of sufficient lighting. The barriers in the external environment include the insufficient and unsafe use and operation of equipment necessary to ensure effective EH standards.

5.3.5.1 – Internal Environment

5.3.5.1.1 – Lack of hot water and water sharing

Almost all cleaners (51, 89%) had experienced a situation where hot water was not available in the HCF or in specific wards. To provide hot water, a few ward attendants (3, 8%) were responsible for heating water in pots (Table 15, quotation 27). Hot water was unavailable in the majority of HCFs (51, 89%) because most depended on the unreliable municipal water supply, boreholes, solar powered water

systems, or piped and non-piped networks and lacked reliable energy to provide hot water. In some cases (20, 35%), HCFs relied upon boreholes that were shared with the surrounding community as their primary water source (Table 15, quotation 28). The distance to the borehole from the HCF ranged from a few hundred meters to two kilometers, and a few ward attendants (2, 5%) and grounds laborers (1, 5%) were sometimes responsible for fetching and supplying water to the HCF.

This research did not assess or cross examine cleaners from the perspective of the three other actors (administrators, patients, and EHOs), because the qualitative data for those actors have yet to be analyzed. However, the HCWs dataset found some overlap which mentioned cleaners when discussing satisfaction with HCF cleanliness. Some HCWs (21 of 48, 44%) stated that they were satisfied with the cleanliness of their HCF, however some noted that there was some level of absenteeism of cleaners. A few (5, 10%) mentioned that cleaning staff do not work on the weekends, for example, one HCW at a central hospital reported: *"Ward attendant does not come during the weekend, so during the weekend the cleanliness is sort of compromised."* In one case, a HCW at a health center stated, *"Attendants complain because they don't have part time allowances, so they say it's not possible for them to clean after every delivery. They get tired, so they just clean in the morning and then they go."* Due to this absence, some HCWs mentioned that nurses and other medical staff contribute to the cleaning process; one HCW at a health center said, *"sometimes it happens that somebody is sick or off duty, so the nurses will do the cleaning."*

5.3.5.1.2 – HCF design and layout

Most ward attendants (36, 95%) had no difficulty accessing materials and the necessary wards and offices within the HCF. However, a few ward attendants (2, 5%) were unable to perform their duties because many of the in-charge supervisors locked the doors to the supply cabinets, offices, and entire wards (Table 15, quotation 29) and did not provide them with keys. Consequently, ward attendants had to rely on medical assistants or other medical staff to secure access. Ward attendants reported that they were

told that keys could not be provided simply because there was not a sufficient quantity. One dispensary ward attendant suggested a solution, stating, *"it will take the effort of both me and the in charge. I told him to give me the keys so that I can be thoroughly cleaning the rooms, but he just says keys are a problem."*

5.3.5.1.3 – Cleanliness of the sanitation facilities

Without adequate PPE and cleaning materials, most ward attendants (20, 53%) and grounds laborers (13, 68%) found it difficult to establish and maintain clean toilets and pit latrines. A few ward attendants (5, 13%) and grounds laborers (2, 11%) had insufficient sanitation access to clean the facilities because their HCF had few toilets and bathrooms available due to unhygienic conditions; in these cases, facilities were reported to be dirty, blocked, or broken. Some ward attendants (14, 47%) and grounds laborers (11, 58%) commented that the toilets did not preserve their dignity because the condition of the toilet was poor and did not provide privacy. For example, a district hospital grounds laborer states, "*...when you are in the toilet someone can see you from outside because there are no doors."* In addition, some ward attendants (16, 42%) and grounds laborers (10, 53%) felt that there were risks of infections from the sanitation facilities and did not feel comfortable using them (Table 15, quotation 30).

5.3.5.1.4 – Risks and safety concerns relating to the lack of lighting

Most ward attendants (17, 45%) and grounds laborers (5, 26%) had sufficient indoor and outdoor lighting. However, some ward attendants (11, 29%) and grounds laborers (9, 47%) reported that they were unable to perform their roles and responsibilities because the HCF was dark (Table 15, quotation 31). Some ward attendants (20, 53%) and grounds laborers (4, 21%) reported feeling afraid during the night. One dispensary ward attendant stated, "*it is scary outside when there is no electricity because it is dark. A place is not good without electricity."* Tasks such as the sterilization of medical equipment, were often neglected when electricity was unavailable. One ward attendant reported that the lack of lighting

caused the entire HCF to fall short of achieving EH standards (Table 15, quotation 32). In a few cases (10, 26%), ward attendants waited until daylight to perform their tasks.

5.3.5.2 – External Environment

5.3.5.2.1 – Insufficient HCF infrastructure

Ward attendants and grounds laborers operated incinerators, dispose of sharps boxes, maintain autoclaves, and clean sanitation facilities as a part of their daily roles and responsibilities. Almost all cleaners (55, 96%) reported that the incinerator had not been replaced or serviced since it was installed. Some ward attendants (17, 45%) and grounds laborers (7, 37%) expressed concerns about the condition of the incinerator (Table 15, quotation 33). Over time some cleaners reported that incinerators cracked or began to crumble, leaving cleaners susceptible to injury. A grounds laborer at a district hospital reported, "*...at the incinerator we use paraffin. We sprinkle paraffin and light it up. The problem is that our incinerator cracked and so it is not really safe."* Some incinerators were also missing parts such as doors and covers, contributing to unsafe operation of waste disposal.

Other concerns included dangerous methods of waste disposal, including the use and operation of waste pits and placenta pits (a waste pit that allows pathological waste to degrade naturally). Some grounds laborers (9, 47%) stated that the main concern associated with poor waste disposal practices was the absence or breakdown of waste pits (Table 15, quotation 34). The utilization and operation of placenta pits also posed safety concerns for cleaners as a few ward attendants (5, 13%) reported slipping and falling hazards. For example, a ward attendant at a health center said *"...it is a big pit and the top part was made in such a way that it is slippery so once we throw anything they go where no one can access them."* Eight ward attendants (21%) expressed concerns over improper waste removal and incineration. The remnants of partially incinerated waste create hazards as children (and in some cases dogs) can find and transport items back to their homes. For example, a health center ward attendant noted, *"... there are a couple of us that just throw [waste] any how because they do not care, and as a result, if you were to go*

around, you will find that there is waste from the bin because children surrounding this health facility pick items from the bins and take them to their homes."

5.3.6 – Process Improvement

5.3.6.1 – Insufficient access to rooms and wards

To achieve the highest level of cleanliness in the HCF, cleaners need to be able to clean rooms and surfaces. Almost all cleaners (55, 96%) had no problems with access to wards and rooms that needed cleaning, however, a few ward attendants (2, 5%) were unable to clean their assigned wards and offices because they could not access the rooms. It was reported that since some medical staff distrust the employees and patients, they lock their office and ward doors. As one health post ward attendant reported, this action prevents cleaners from doing their jobs effectively: *"we are not able to meet the standards because I don't clean other rooms like the doctor's office. When he is not around, he locks the door all the time. So, I don't clean the office daily until he comes back from where he went."*

5.3.7 – Quality Improvement

5.3.7.1 – Environmental health reporting and response

When materials or equipment were lacking, cleaners reported that they asked the in-charge supervisor or district health official (DHO) to replenish resources. Most cleaners (33, 58%) reported that the in-charge supervisor responded slowly or delayed remedying the situation. It was reported that a few supervisors (10, 18%) did not relay cleaners' concerns because of limited district funding and the assumption that resources and materials would not be made available (Table 15, quotation 35). One dispensary ward attendant explained that he reported a lack of supplies to a non-government organization (NGO) instead of the DHO because the response is quicker and shows results, *"…it depends on who we report the challenge to at the time, like I said at the beginning. If we take the issue to [NGO] it doesn't take much time but if we take it to district it takes long."* Some cleaners (22, 39%) found that district officials responded more rapidly when water services were unavailable than they did to other issues, as

the perceived urgency and demand for water within the HCF warranted quick action by the maintenance teams that could fix the issue in one to two days (Table 15, quotation 3).

Table 15. *Representative quotations addressing themes organized using the SEIPS framework.*

Person	Insufficient IPC and hand hygiene training	1. *"We were just told, not like a formal training where everybody was told, "you are now employed go to such and such". This is where our colleagues told us, "we put on gloves, here is the apron, this is a mask and this is the way we put it on"* – health center, ward attendant 2. *"We [cleaners] have been taught about infection prevention but it's a while back, a lot of years have gone by."* – health center, ward attendant
	Insufficient PPE training	3. *"They just told us we would need aprons, gloves, heavy [duty materials] …they just said, here are the things you need to use, but not how to use them."* -dispensary, ward attendant
	Insufficient HCF infrastructure training	4. *"Maybe we should be cautious of electric appliances when there is a blackout. Because we don't know how dangerous electricity is and even the voltage itself."* – district hospital, ward attendant 5. *"If I learn how to use electricity, it can be very helpful… There is nothing that we can do if we are working in the darkness; you cannot see what you are doing."*- district hospital, ward attendant 6. "*Yes, we were trained, although the training is not consistent, they still trained us. They taught us that we are supposed to be careful with the waste because some of it is sharp and some is not, so they are supposed to be put in bins"* – district hospital, ward attendant
Organization	Lack of cleaning records	7. "*…we cannot say how many times we clean a day."* – district hospital, ward attendant 8. *"…there is no place where there are no infections, but we start [mopping] from places with fewer infections"* – central hospital, ward attendant
	Insufficient staff communication	9. "*…the challenge is airtime and if there is no airtime you cannot communicate so you just go where your colleague is and call her/him"* – health post, ward attendant 10. *"Maybe it can be the blackouts when you need to charge your phone especially when you have one phone and you have an urgent issue to communicate"* – health center, ward attendant
	Lack of incentives	11. "*There is need for an incentive if this facility and other facilities are to be clean. We need to be motivated…especially those that are practicing environmental health"* – health center, ward attendant 12. *"I wish they could give me a salary increment and also upgrading my profession because as of now I would have been Grade 1 [promoted]"* -dispensary, ward attendant

	Resources as an incentive	13. *"If we can have the resources, environmental health conditions can be improved but if we have no resources, there cannot be an improvement in environmental health"* – district hospital, ward attendant
	Training as incentives	14. "…*the incentive that we can get to improve environmental health conditions at this facility is; first of all, continuous trainings so that we don't forget how we are supposed to do our work"* – district hospital, ward attendant
	Disrespect of cleaners	15. "…*some HSAs [health surveillance assistants] speak rudely to me"* – dispensary, ward attendant 16. *"You know sometimes patients can insult you, but in such times, we know that we don't have to continue arguing with them to avoid making mistakes on our job. So, we keep away from such things because if you speak you will just be wrong"* – district hospital, ward attendant
Tools and technology	Lack of PPE	17. *"As of now the gumboots on our part, some of them are completely torn. But because we do not have new ones then we still wear them which put our lives in danger because their bodies are exposed to harmful things"* – district hospital, grounds laborer 18. "…*currently [PPE] is quite hard, when we ask the supervisors, they tell us that it's because of financial problems. Previously however, they were readily available"* – district hospital, grounds laborer
	Insufficient cleaning supplies	19. "…*sometimes we may lack resources we need such as soap for washing hands or scrubbing walls stained with blood. So those things make us insufficient"* – health center, ward attendant
	Borrowing materials	20. *"...because they are not there, we ask for the ordinary gloves from our friend's ward so that we should protect ourselves even a little, using the soft gloves"* – district hospital, ward attendant
	Lack of wheelbarrows	21. *"...we do not have resources like wheelbarrows. So that makes our job difficult because we have to carry the waste in buckets and dispose it in the bins, so it is hard"* – district hospital, grounds laborer
	Improvising cleaning materials	22. *"...there was a time we were out of mops for almost 3 months and because we are not allowed to sweep, we took an old blanket that we had stopped using and turned it into a mop"* – health center, ward attendant 23. "…*we find other means; maybe we go and sell the empty bottles of those bottles that are for diluting drugs. The money we make we buy mops in the market"* – district hospital, grounds laborer
	Insufficient hand hygiene resources	24. "W*hen we say we are washing hands, currently we do not have soap. This means that we just wash hands without anything else just like we usually do"* – dispensary, ward attendant

		25. "*It is hard if there are no materials to use for washing hands. If soap for instance is not available, it is hard for you to wash hands the right way. Or if water is not available, there are also problems for you to wash hands the right way"* – district hospital, ward attendant
Tasks	Excess tasks	26. *"I am supposed to do what I have been asked and after that I am supposed to tell them [the supervisor] that I have finished. If the doctor says 'go to the lab and collect blood' I am supposed to rush to [the] lab and collect blood. If there is no blood, I am supposed to report that 'they say there is no blood we should wait"* – central hospital, ward attendant
Internal Environment	Lack of hot water	27. *"No, there is no hot water. It is heated on pots"* – district hospital, ward attendant 28. "*…at the borehole it is difficult because it is used by many people, so it is difficult, water needs to be near where we work, but because the water source is far, and we carry by hand so it is difficult"* – dispensary, ward attendant
	Poor design of workspace	29. *"It's hard for me to work because they haven't really told me to be free to clean the rooms because they lock the doors. So, it's hard for me to clean them because whenever I want to clean the rooms, they lock the doors"* – dispensary, ward attendant 30. *"…as staff we don't feel safe and it is not respectful because it happens that you want to use the sanitation facility and when you go there you find there is a patient. And sometimes, patients have different infections and it happens that you get an infection that you could prevent just because you have shared a sanitation facility with a patient. So, it puts us at a risk, and we don't feel good…there is no privacy"* – health center, ward attendant
	Risk and safety concerns due to lack of lighting	31. "*…you cannot work in the dark. You can step on an infectious waste and you can be infected"* – central hospital, ward attendant 32. "*There could be a big risk because if there is no electricity, the whole hospital would suffer. Patients would also suffer. If we don't have lights, most things would not work. As I have said, the metals have to be sterilized before they are used and that requires electricity. Meaning that if there are no lights, our metals would be unsterilized, and the clothes wouldn't be washed. So, it is risky, and the patients are sometimes referred to Lilongwe because there are no lights here"* – district hospital, ward attendant
External Environment	Insufficient HCF infrastructure	33. *"…right now we have one problem on the part of the incinerator. This is where we throw the syringes or sharps. The incinerator is not ok, it is not functioning properly..."* – health center, ward attendant 34. *"For [there] to be good hygiene they need to fix the pits in good time so that it does not lead to us disposing just anywhere"* – health center, ward attendant

Process	Quality improvement	35. *"Why do you think it takes so long for the toilets to be fixed? R: They just say they are waiting for funding"* – health post, ward attendant 36. *"It doesn't take long [for water to be available] you know water is life, if it were to take too long things would not work well"* – health center, ward attendant

CHAPTER SIX: LIMITATIONS

6.1 – Limitations

All data included in this study was collected from HCFs within Malawi, and the results therefore may not be generalizable to other contexts. To assess the 45 HCFs, two days at each central and one day at each district hospital were granted to conduct surveys. In each district, the health center and health post/dispensary were surveyed in the same day as they were located within proximity to each other. Because of this sampling approach, HCFs located in remote rural areas were likely to have been under-sampled. Therefore, the study sample may not be representative of all HCFs in Malawi. This sampling and data collection method also limited the amount of time spent at each HCF. Although the research team successfully carried out the qualitative and quantitative tools at each HCF, researchers may have been able to probe more deeply if more time had been available during interviews.

As in most qualitative research, recall bias on behalf of the respondent may affect reliability of the data collected. Data quality was likely affected by both the memory of the participants and their familiarity with water, sanitation, waste management, and energy systems within the facility. Response bias may have led some cleaners of HCWs to under-report deficiencies in their own practices or capabilities. Due to the structured nature of the interview tool, it is also possible that interviewer bias influenced some responses.

The structured interview guide and the practice of conducting the interviews had some deficiencies which could have affected the results and discussion. After meeting with multiple qualitative experts in the Gillings School of Global Public Health and the Odum Institute at UNC, the interview guide was determined to lack probing questions, which usually ask for more detail on a particular issue.

In addition, some cases exhibited leading questions, which can prompt the respondent to answer in a certain way. Therefore, it is possible that interviewer bias influenced some responses. The survey was developed prior to my inheritance of the dataset, but I would have taken different measures to ensure the quality of the interview guide prior to data collection. Some of these steps were taken, just not to a high degree. First, I would have met with qualitative experts to create an interview guide containing research questions that ensured that each question was asked appropriately. In doing so, I would have gone through each individual question to ensure that they were written in a neutral, non-leading manner. Next I would have ensured that all interviewers: were trained in conducting qualitative interviews; understood types of qualitative bias and; understood how to probe to obtain more complete information from the respondent.

Due to limited human resources in the field, some transcripts were translated and transcribed by the same researchers who conducted the interview. Ideally, these processes would have been carried out by independent research teams in order to ensure objective translation and transcription of the interview. Human error within the coding process is a possibility. Weekly coding meetings were held to standardize the coding process and a two-stage coding process was used to improve code reliability, but it is possible inter-enumerator disagreement affected results and conclusions.

All data were collected during the dry season, so seasonal variation in the EH conditions, cleaner responsibilities and satisfaction were likely not detected.

Despite the limitations listed in this chapter, I am confident that the data and information collected are valid because they represent the views of the cleaners. While there were questions that arose surrounding the methods of data collection and analysis, the data are representative from a large sample size of 57 cleaners and give confidence to the results. Additionally, this study is one of the largest that I have found throughout the literature, where similar studies have advised and recommended actions on less data.

CHAPTER SEVEN: DISCUSSION AND CONCLUSIONS

7.1 – Discussion

We used qualitative data from 57 cleaner interviews and quantitative data from 45 administrative actors in 45 government-run HCFs in rural Malawi to understand cleaner's roles and responsibilities, determine current EH conditions, and identify the factors that facilitate or constrain their tasks in relation to EH conditions.

The first research question was: *What roles and responsibilities are reported by cleaners (including ward attendants and grounds laborers) in different types of HCFs in Malawi? Do the roles and responsibilities of cleaners differ by sub-national region, HCF type, and gender?* Roles and responsibilities differed minimally by cleaner type and did not differ by HCF type, sub-national region, or gender. Both cleaner types reported similar roles of sweeping, mopping, disinfecting, disposing of HCF waste (including general, infectious and non-infectious wastes), and cleaning and maintaining the sanitation facilities. When disaggregated by gender, we found that male ward attendants had attained higher education levels than females and reported performing more physically demanding excess tasks such as stocking supplies, compared to females who reported performing more administrative duties.

The second research question was: *Do cleaners report performing safe IPC practices? And if so, what tasks do cleaners state are important in IPC?* Cleaners mentioned performing many tasks regarding IPC, and reported that practicing hand hygiene, the appropriate use of PPE, the safe management of healthcare waste, and overall environmental cleanliness were important in IPC practices. There were three more characteristics that the WHO includes in "safe IPC practices" which include equipment sterilization, safe handling of linen, and the prevention of sharps injuries (WHO, 2016). While cleaners discussed these characteristics in the interviews, they did refer to them as important for IPC

Table 16. *Reported roles and responsibilities by cleaner type. Similarities between cleaner types are bolded.*

Cleaner Type	Roles and responsibilities summarized from transcripts
Ward attendant	- **Sweeping, mopping, and disinfecting the clinics, wards, operating rooms** - Cleaning surfaces, doors, walls, and sterilizing equipment - Removing cobwebs/dusting every month - **Removal and treatment of HCF infectious and non-infectious waste** - **Cleaning and maintenance of interior sanitation facilities**
Grounds laborer	- **Sweeping, mopping, and disinfecting the exterior rooms and walkways** - **Disposal of garbage/litter and outdoor waste** - Mowing/slashing the grass on a regular basis - **Cleaning and maintenance of exterior sanitation facilities** - Tends to the grass, flowers, and other landscape

Lastly, the third research question was: *According to cleaners, what factors in their working environment facilitate or constrain safe EH practices and conditions?* We found that cleaner constraints included inadequate training on IPC and waste management; insufficient PPE and hand hygiene resources; performing tasks unrelated to their core responsibilities; risk of work-related injuries; the occasional disrespect from medical staff and patients; and lack of work incentives. The main facilitators reported included positive collaboration with medical staff, high job satisfaction, and a hard-working attitude.

Regarding training, many cleaners reported receiving a one-day IPC training which covered basic information on hand hygiene and PPE practices. Refresher trainings, which usually occur in the months following orientation, were also reported to insufficient and infrequent. Most cleaners reported that examination gloves were always available in their respective HCF. However, they also stated that resources such as gumboots, mops, and sometimes chlorine and hand hygiene supplies made their daily roles and responsibilities difficult as they would either have to improvise materials or work without the necessary resources to do their job effectively. Cleaners' reports of insufficient training and limited availability of PPE and cleaning resources are consistent with similar studies from other LMICs (Cross et al., 2019; Hopman et al., 2016). Our work also showed that cleaners experienced fear of work-related

health risks and injuries as the training and protective materials required to protect them were often unavailable.

An unexpected finding was the similarities of cleaner roles and responsibilities by gender. However, the reported excess tasks unrelated to cleaner responsibilities varied, where male cleaners reported conducting more physical tasks such as stocking storerooms and packing supplies, and female cleaners reported working in the OPD or testing patients for malaria. An additional gender disparity was found in relation to education level, as more male cleaners had received their MSCE (secondary education certificate) compared to females who received their JCE (primary school education) or partially completed their MSCE. Other findings from this research such as cleaner contract type, work experience, training received, and tasks performed were disaggregated by gender and were found to have no significant difference. No other studies that describe the differences in cleaner roles with respect to gender were found.

Our findings show that cleaners in government-run HCFs lacked official job descriptions and guidelines. There are few documents that describe and list cleaner's roles and responsibilities. The two that were used in this study did not indicate that cleaners would qualify for incentives or bonuses for their work. However, when asked about recommendations for incentives, most cleaners suggested increased pay or the introduction of bonuses, increased supply of PPE resources and cleaning supplies, and more frequent trainings. The introduction of the suggested incentives could increase staff motivation and productivity and would allow cleaners to earn a better livelihood, have pride in their work, and achieve improved EH conditions.

When comparing our findings to Cross et al., (2019), we found additional cleaner constraints including the fear of work-related injuries and often disrespect from medical staff, patients, and guardians. We also listed facilitating factors that included the availability of chlorine, disinfectant and gloves, positive staff interaction and communication, high job satisfaction, and a hard-working attitude.

7.2 – Recommendations

Training is the foundation of widespread systemic change which is needed to ensure EH improvement and the reduction of HAIs in HCFs (O'Connor, 2009). Short-term progressive improvement requires the provision of basic training on IPC, PPE, hand hygiene, waste management, and energy services in order to progress and improve EH conditions. This study identified gaps in initial orientation and refresher trainings, finding that most cleaners reported only receiving a one-day orientation on IPC procedures. To advance the effectiveness of trainings, the involvement of key stakeholders, such as managers, district health officials (DHOs), IPC committees, and other HCF staff, are needed to ensure more robust monitoring, surveillance, and compliance among cleaners. In addition to the involvement of other stakeholders, cleaners must unite and take it upon themselves to push their employers to put corrective measures in place.

A long-term recommendation for progressive improvement is the introduction of a multimodal training strategy, which includes elements of system change, education, monitoring of infrastructures, communication within the workplace, and cultural changes (WHO, 2016). In adopting this strategy, cleaners could become a more valued member of the HCF workforce and be critical actors in reducing HAIs.

Increasing access to PPE would be an important step in protecting cleaners and improving both moral and performance. Items such as PPE, gumboots, mops, and chlorine are essential in performing IPC procedures and ensuring a safe and clean healthcare setting. To improve the procurement of supplies, models for better service delivery and accountability must be tested and evaluated. These models must focus on the operation and logistics of the HCF, the involvement of government officials, and supply chain logistics. Additional mechanisms for tracking the lifecycle of inventory use must be put in place to achieve consistent, readily available supplies for cleaners.

Institutional support is the biggest hurdle limiting progressive improvement. The institutional neglect of cleaners and environmental hygiene only recently surfaced as a result of the 2015 WHO/UNICEF call to action in IPC (WHO & UNICEF, 2015). We recommend that HCF administrators

develop and provide job descriptions for cleaners that clearly define their roles and responsibilities, educational requirements, required work experience and compensation/benefits. In doing so, cleaners, administrators, and HCWs can better understand cleaners' role in the HCF and the tasks fall outside the boundaries of their work. Additionally, HCFs should develop environmental cleaning policies that list and describe the required frequency and type of cleaning for different purposes, how cleaning should be performed and recorded, and who is responsible for doing the cleaning (WHO, 2016). This action requires the collaboration of professionals at all HCF levels to develop standard operating procedures (SOPs) at the national, district, and local level to specify the tools and materials that would be used in the process. The result would immediately allow cleaning staff to work within their known boundaries, limiting excess tasks or stressors. In the medium-term, the increase of cleaner salaries or the incentivization of their work in conjunction with improved monitoring of IPC practices could lead to higher motivation and performance. Incentives could also be provided through the provision of more training, making fuel and gas available from the DHO or MoH for the sterilization of medical equipment, and the provision of cleaning supplies and PPE. The long-term recommendation is to link the multimodal strategy to national quality aims and initiatives surrounding the role of cleaners and IPC procedures (**Figure 6**). If the MoH were to establish a limited budget, we recommend starting with smaller HCFs before moving to district and central hospitals, as smaller HCFs including health centers and health posts and dispensaries would offer an opportunity to to implement and test in rapid fashion how best to provide and monitor the provision of supplies, training, and institutional support.

In order to estimate the cost of implementing these recommendations and enhancing EH conditions and services within HCFs, introducing a model for costing and planning should be considered. In 2020, a ten-step model was proposed to guide budgeting for EH services in HCFs (Anderson et al., 2020). The next step of this research would involve using the model to estimate a budget associated with EH services at different HCF types, starting at smaller HCFs and moving up to district and central hospitals. Using this model, which comprises ten steps in three phases: planning, data collection, and synthesis, stakeholders would be able to identify data gaps and chose an approach that best fit their needs.

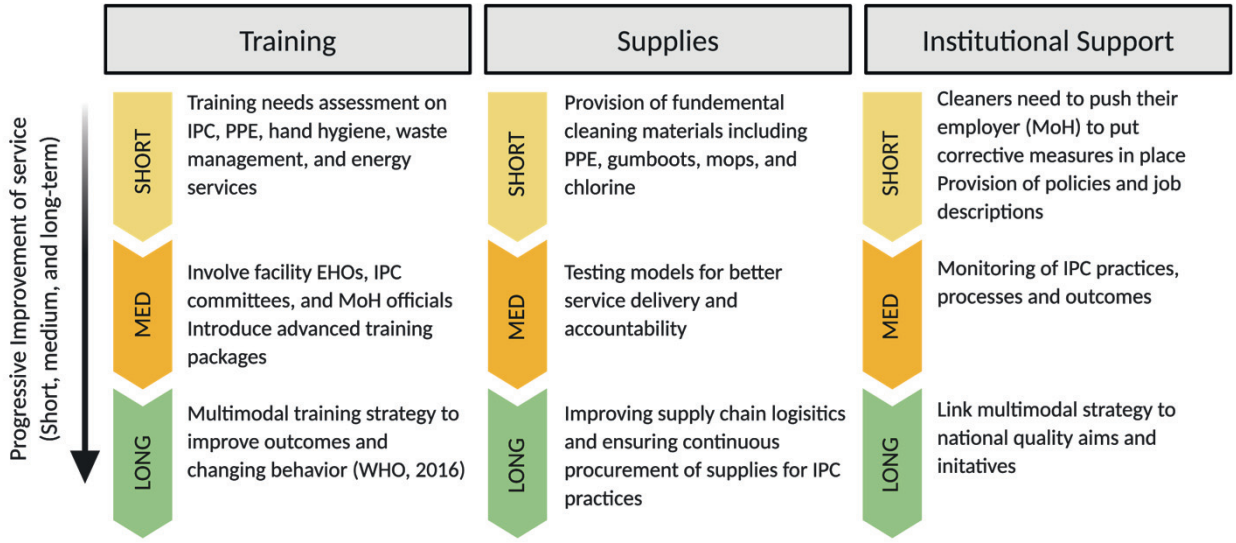

Figure 6. *Recommendations for progressive improvement for cleaners in HCFs. Short-term ranges from 0-1 year, medium-range from 1-5 years, and long-term from 5-10 years.*

7.3 – Conclusions

Data from 57 cleaner interviews in 45 HCFs in Malawi were analyzed. Across the HCFs cleaners generally are content with their employment status, are hardworking, and work with the materials available to maintain safe and clean EH conditions. And yet there are significant factors that prevent/constrain the establishment and maintenance of safe EH conditions, including inadequate IPC, PPE, HH, HCF equipment and waste management training, insufficient PPE and cleaning resources, and the performance of tasks unrelated to cleaners' job description. To improve and maintain EH conditions, more robust IPC, PPE, waste management, and energy trainings must be introduced as well as refresher trainings in the months following orientation. Resources such as PPE, gumboots, and chlorine are necessary to ensure HCF cleanliness and to keep cleaners safe. The provision of these materials, along with the introduction of mechanisms to record and monitor inventory supplies, will lay the groundwork for the improvement of EH conditions.

Finally, (the MoH or Malawi's Civil Service Commission) should define job descriptions for cleaners that will enable them and their colleagues to know the bounds of their roles and responsibilities.

The development of more structured job descriptions will allow cleaners to be viewed as important HCF staff members and stakeholders. Low cost, high impact interventions such as the provision of cleaning materials and the introduction of trainings for cleaners should improve EH conditions in HCFs in Malawi. Enhancing environmental cleanliness will provide confidence to cleaners, assuring that they are valued, important and vital to limit HAIs.

APPENDIX A: CLINICAL AIDE/WARD ATTENDANT JOB DESCRIPTION AS REPORTED BY UNC PROJECT MALAWI

2. **NURSING DEPARTMENT**

2.1. **CLINIC SUPPORT STAFF**

2.1.1 **Clinic Aide**

Job Title : Clinic Aide
Reports to : Chief Nursing Officer/ Team Leader
Level/Grade : Job Summary

A Clinic Aide in UNC Project is responsible mainly for maintaining cleanliness in the research clinic and laboratories and for transporting specimen from the clinic to the laboratory.
Main Duties/Responsibilities

Operational Issues

- Sweep and mops the clinic and laboratory floors daily
- Remove cobwebs from clinic and laboratory every month
- Scrub the walls of clinic and laboratory every four months
- Change bed linen daily
- Dust clinic and laboratory furniture daily
- Take precautionary measures in transporting specimen to avoid contamination
- Education and Personal Growth
- Take own responsibility in personal growth by asking questions and reading literature available in the clinic
- Develop personal interest in rotating between the clinic and laboratory
- Audit and Quality Control
- Ensure that specimens are labeled eligibly.
- Enter all information on the transfer log sheet in the laboratory and signs them.
- Alert research nurse and laboratory technician about unlabeled specimens.

Management

- Ensure effective and efficient channels of communication.
- Ensure economic use of clinic resources.
- Ensure safe custody of clinic resources.
- Take self-responsibility in becoming a member of a cohesive research team.

- Assist in other assigned duties.

A. Generalized Work Activities

- Handle and move Objects using arms and hands by installing, positioning, and moving materials, and manipulating things
- Monitor and control resources by issuing and storing clinic supplies
- Document/record information by entering, recording, storing, or maintaining information in written or electronic form
- Identify objects actions, and events by identifying by categorizing, estimating, recognizing differences or similarities, and detecting changes in circumstances or events
- Perform general physical activities by performing physical activities that require considerable use of arms and legs and moving of whole body, such as climbing, lifting, balancing, walking, stooping, and handling of materials.
- Assist and care for others by providing personal assistance, medical attention, emotional support, or other personal care to co-workers and clients
- Establish and maintain interpersonal relationships by developing constructive and cooperative working relationships with others and maintaining them over time,
- Keep personal safety and safety of other at the workplace,
- Perform any other duties assigned.

B. Qualification and Experience

- Malawi Schools Certificate of Education
- Good at English Speaking and writing
- From None to 2 years' experience

APPENDIX B: GARDENER/GROUNDS LABORER JOB DESCRIPTION AS REPORTED BY UNC PROJECT MALAWI

8.0 HUMAN RESOURCES MANAGEMENT AND ADMINISTRATION

8.1.1 Gardener

Job Title : Gardener
Reports to : Administrative Officer
Grade/Level :

Job Summary
The Gardener in the UNC Project is responsible for maintaining the grounds of designated places remarkably well. He ensures that all the surroundings are attended to and properly cared for including grass, flowers, hedges and shrubs. He also takes good care of the outside toilets in the designated places.

Specific Duties and Responsibilities
The specific duties shall include the following;

1. Mows/slashes grass to acceptable level
2. Waters grass and flowers so that they do not wither or die
3. Prepares flower beds
4. Sows and transplants flowers and grass
5. Cleans external toilets of the designated buildings
6. Ensures that the grounds in the designated places are clean including car parks and grooves
7. Performs any other duties assigned

Qualification and Experience

- Junior Certificate of Education or
- Malawi Certificate of Education Plus
- Certificate in landscaping
- From none to two years' experience

Education and Personal Growth

- Take own responsibility in personal growth by asking questions and reading literature available at the project,
- Enroll with schools and colleges to advance personal career.

Management

- Ensure effective and efficient channels of communication,
- Ensure economic use of project resources,
- Ensure safe custody of working tools,

- Take self-responsibility in becoming a member of a cohesive research team.
- Perform any other duties assigned.

Generalized Work Activities

- Handle and move Objects using arms and hands by installing, positioning, and moving materials, and manipulating things
- Monitor and control resources by issuing and storing working tools
- Document/record information by entering, recording, storing, or maintaining information in written or electronic form
- Identify objects actions, and events by identifying by categorizing, estimating, recognizing differences or similarities, and detecting changes in circumstances or events
- Perform general physical activities by performing physical activities that require considerable use of arms and legs and moving of whole body, such as climbing, lifting, balancing, walking, stooping, and handling of materials.
- Assist and care for others by providing personal assistance, medical attention, emotional support, or other personal care to co-workers and clients
- Establish and maintain interpersonal relationships by developing constructive and cooperative working relationships with others and maintaining them over time,
- Keep personal safety and safety of other at the workplace,
- Perform any other duties assigned.

APPENDIX C: INTERVIEW GUIDE FOR CLEANERS

Overarching Research Question: What are enablers and barriers to safe environmental health practices in health care facilities?

1) Can you tell me a little about yourself?
   a) Prompt: Ask about their educational background
   b) Prompt: Ask about their occupational training
   c) Prompt: Ask about post-school training, such as refresher trainings, in-service trainings, etc.
2) How long have you worked here?
   a) Is your contract renewable? Or, do you have a permanent position? (i.e. understanding incentives for engaging in improving environmental health)
3) Can you tell me about your roles and responsibilities here?
   a) Prompt: Ask them to talk about their job description. Is environmental health included?
   b) How do you define environmental health in health care delivery?
   c) We define environmental health as environmental components that impact the safety and the quality of health care which include water, sanitation, hygiene, waste, and energy. Are these considerations included in your roles and responsibilities?
4) I will now ask you a few questions about this facility.
   a) Cleanliness
      (1) Is the facility: always clean, sometimes clean, etc.?
      (2) Prompt: [If not always clean] you might ask about the barriers to cleanliness
      (3) Are you trained on cleaning procedures?
         (a) Prompt: What was the topic of this training?
         (b) Prompt: Who conducted the training?
         (c) Prompt: What do you recall from the training?
         (d) Prompt: Did you learn about infection transmission in health care? If yes, what did you learn? Can you give some examples of how this relates to your work?
   b) Atmosphere
      i) Could you describe how people interact? Is the interaction positive or negative (i.e. verbal, physical)?
         (1) Patients and non-medical staff?
         (2) Non-medical staff and doctors/nurses?
      ii) What is the method of communication used when you need to speak with another staff member?
         (1) What are the challenges associated with this method of communication?
      iii) Do you like working here? Why or why not?

I am interested in the environmental health conditions in your HCF. I will ask you a few questions about water, sanitation, hygiene, waste, and energy. Please feel free to share any particular experiences or stories on any of these topics and it is okay if you do not know the answers to some of my questions.

5) The following questions will relate to water at this facility.
   a) Where does water used for cleaning come from?
   b) How easy or difficult is it to get access to clean water at the HCF?
      i) Prompt: Is it shared with a nearby community? Do lots of people use it? Is it always available? Etc.

ii) Prompt: Do you have access to hot water?

c) Can you recall a time when you did not have access to water? How did you cope?
   i) Prompt: [If water was not available] Ask why.
   ii) Prompt: Ask about daily/weekly/monthly availability (and if they can actually remember). Is it erratically available or predictably available? How many hours per day is It available? Ask if availability is seasonal. (This is really important to help us design future quantitative questions)

d) Who do you report to if you detect a problem with the water system?
   i) What is the procedure for notifying the relevant party that the water system is broken?
      (1) How long does it usually take for the system to be fixed?

6) The following questions will relate to hygiene at this facility.
   a) Can you tell me the appropriate steps of hand washing?
   b) Did you undergo training for hand hygiene promotion?
      i) Who conducts this training and how often?
      ii) Are there compliance checks? If so, how often do they occur?
   c) Are you trained to use personal protective equipment while carrying out your duties?
      i) Prompt: Gloves, eye protection, face masks, etc.
   d) How easy or difficult is it to access personal protective equipment?
      i) Prompt: Gloves, eye protection, face masks, etc.
      ii) Are they always/sometimes/never available to you in the amounts you need them?
   e) How easy or difficult is it to practice hand washing in waste handling or cleaning?
   f) What do you use to dry your hands after washing? How do you cope if you don't have materials to dry?
   g) Please briefly describe key moments where you should wash your hands.

7) The following questions will relate to sanitation facilities and waste management at this facility.
   a) Who has access to sanitation facilities?
      i) Prompt: Patients, cleaning staff, nurses, doctors, admin, etc.
      ii) Prompt: Are these facilities separate or combined for staff and patients?
   b) How easy or difficult is it to maintain a level of cleanliness of sanitation facilities?
      i) What are the challenges to cleanliness?
      ii) What do you think could be done to overcome these challenges?
   c) Do you use the sanitation facility?
      i) Prompt: Do you feel safe using it? Do you think it's private?
      ii) Prompt: If you do not use it, why not?
   d) Who do you report to if there is a problem with the sanitation facilities?
      i) Prompt: How long does it usually take for this problem to be fixed?
      ii) Prompt: If it takes a long time, why do you think it takes so long? What prevents repairs from occurring quickly?
   e) Have you been trained on proper waste management?
      i) Prompt: Are you responsible for collecting waste from points of care?
      ii) [If yes] Prompt: How frequently do you collect waste from points of care?
   f) Are you satisfied with the method used to dispose of waste in this facility?
      i) [If equipment] Prompt: Does it always work?
         (1) [If it does not always work] Why does it usually stop working?
         (2) Prompt: Does it have a consistent power supply?
      ii) [If open pit or other] Prompt: Do you have concerns about the risk involved with this waste disposal method? Can you give me some examples?

(1) If you have concerns, why or why not?

8) The following questions will relate to cleaning at this facility.
   a) Are cleaning materials always/sometimes/never present?
   b) [If at least sometimes present], what types of cleaning materials are present?
      i) Are cleaning materials quickly replenished when stock is depleted?
      ii) Probe: Could you talk a bit about who is responsible for replenishing the stock and how this occurs?
   c) What happens if there are no cleaning materials present when you need to carry out a cleaning procedure?
   d) How frequently does cleaning occur?
      i) Is there a record of when the toilets and facility were last cleaned?
   e) How many cleaners are working at a given time?
   f) Are there any cleaning procedures specifically related to infection prevention that you follow?
      i) Probe: Can you describe the process of your procedure for cleaning and disinfecting the room?
      ii) Probe: Is there an order that you follow to clean and disinfect different areas of the facility? If yes, what order do and why?
9) The following questions will relate to energy at this facility.
   a) Do you ever work when it is dark out?
      i) [If yes] Are you satisfied with the lighting at night in this facility? Why or why not?
         (1) Prompt: Indoor lighting? Outdoor lighting?
         (2) Prompt: Do you feel safe working at night?
         (3) Prompt: Can you describe a time that lack of lighting has interfered with your ability to carry out your duties?
         (4) Prompt: Would improving lighting allow you to better carry out your duties? How so?
   b) Do you feel knowledgeable about the energy supply infrastructure in your healthcare facility?
      i) Prompt: Have you ever had any training/education related to the energy supply?
      ii) Prompt: Do you feel like this would be useful? In what ways?
   c) What types of services do you provide that require energy supply?
      i) Prompt: do you feel able to perform your duties well?
   d) Do you feel as though the power supply at your healthcare facility impacts the how well you are able to carry out your duties?
      i) Prompt: In what ways?
   e) Do you perceive any risks to yourself or other workers due to inadequate power supply?
      i) Prompt: Do you perceive any environmental risks outside of or within the facility? Can you describe these risks?
      ii) Prompt: Do you do anything to reduce the risk to yourself or other workers? Can you describe your behaviors?
   f) What do you think is necessary in terms of energy supply to reduce the risks to yourself or other healthcare workers?

APPENDIX D: INTERVIEW GUIDE FOR HEALTHCARE WORKERS

Overarching Research Question: What are enablers and barriers to safe environmental health practices in health care facilities?

10) Can you tell me a little about yourself?
    a) Prompt: Ask about their educational background
    b) Prompt: Ask about their occupational training
    c) Prompt: Ask about post-school training, such as refresher trainings, in-service trainings, etc.

11) How long have you worked here?
    a) Is your contract renewable? Or, do you have a permanent position? (i.e. understanding incentives for engaging in improving environmental health)

12) Can you tell me about your roles and responsibilities here?
    a) Prompt: Ask them to talk about their job description. Is environmental health included?
    b) How do you define environmental health in health care delivery?
    c) We define environmental health as environmental components that impact the safety and the quality of health care which include water, sanitation, hygiene, waste, and energy. Are these considerations included in your roles and responsibilities?

13) Could you please describe how the following people interact? Is the interaction positive or negative (i.e. verbal, physical)?
    a) Patients and health care providers?
    b) Non-medical staff and health care providers?

14) What is the method of communication used when you need to speak with another staff member?
    a) What are the challenges associated with this method of communication?

15) Now I will ask you some questions about this facility.
    a) Is demand for service is low/med/high? Is there overcrowding?
    b) Prompt: You might ask about which times of the day are the busiest; which times of year; etc. This gives us a picture of daily/weekly/annual variation. Ask for specific numbers.
    c) Are you satisfied with the cleanliness in this facility? Why, why not?
        i) Prompt: Are you able to appropriately sterilize medical equipment before use?
            (1) Prompt: [If yes] How? [If no] Why not?
        ii) Prompt: How is your healthcare waste managed?
        iii) Prompt: Do you feel protected from infectious or hazardous materials in this facility? Are patients? Why or why not?
    d) Prompt: Would improving cleanliness allow you to better care for patients? How so?

I am interested in the environmental health conditions in your HCF. I will ask you a few questions about water, sanitation, hygiene, waste, and energy. Please feel free to share any particular experiences or stories on any of these topics and it is okay if you do not know the answers to some of my questions.

16) The following questions will relate to water at this facility.
    a) Who has access to the water?

i) Prompt: Patients, cleaning staff, nurses, doctors, admin, etc.? Do these people access separate water sources?

b) How easy or difficult is it to get access to clean drinking water at the HCF?
   i) Prompt: Is it shared with a nearby community? Do lots of people use it? Is it always available? Etc.
c) Can you recall a time when you did not have access to water? How did you cope?
   i) Prompt: [If water was not available] Ask why.
      (1) [If water access is energy related] Is the water ever unavailable due to energy reasons?
   ii) Prompt: Ask about daily/weekly/monthly availability (and if they can actually remember). Is it erratically available or predictably available? How many hours per day is It available? Ask if availability is seasonal.
d) [If water access is energy related and a non-energy reason was given for lack of water availability] Prompt: Is the water ever unavailable due to energy reasons?
e) Prompt: Do you have hot water for personal or patient hygiene, or other purposes?
f) Are you satisfied with the provision of drinking water in this facility? Why, why not?
   i) Prompt: Would improving the availability of safe food and water allow you to better care for patients? How so?

17) The following questions will relate to hygiene and infection prevention at this facility.
   a) Can you tell me the appropriate steps of hand washing?
   b) Who has access to hand washing stations?
      i) Prompt: patients, cleaning staff, nurses, doctors, admin, etc.?
   c) Do you receive any training on infection prevention at this HCF?
      i) [If yes] How often?
      ii) What is included in this training?
         (1) Prompt: Is hand hygiene a component of this training?
   d) Do you know of any specific policies related to infection prevention?
      i) [If yes] Are they available for us to look at a copy after this interview?
   e) Do you talk to your patients about infection prevention practices?
   f) How easy or difficult is it to access personal protective equipment?
      i) Prompt: Gloves, eye protection, face masks, etc.
   g) How easy or difficult is it to practice hand washing at points of care?
   h) Can you recall a time when you were providing medical services and did not have access to hand washing station with soap? How did you cope?
   i) What do you use to dry your hands after washing? How do you cope if you don't have materials to dry?
   j) Please briefly describe up to five key moments where you should wash your hands.
   k) As a health care provider, what main challenges do you face in your work in terms of hygiene and safety?

18) The following questions will relate to sanitation at this facility.
   a) How easy or difficult is to access sanitation facilities? When you do not have access, how do you cope?
   b) Who has access to sanitation facilities?
      i) Prompt: Patients, cleaning staff, nurses, doctors, admin, etc.
      ii) Prompt: Are these facilities separate or combined for staff and patients?
   c) Can you describe the sanitation facilities?

i) Prompt: Are they clean? Ask about the number relative to population of HCF.

d) Where do people go to the bathroom if they don't use the sanitation facility provided (or if there is no sanitation facility available)?
e) How easy or difficult is to wash hands after using sanitation facilities?
f) How easy or difficult is it for women to have a private and safe space to take care of menstrual hygiene?
   i) Are water and/or sanitary pads provided?
g) Do people feel safe using the facilities? Do they afford privacy?
   i) Prompt: Is there adequate lighting? Do the doors lock? Ask about safety issues. Can they use it privately? Does it smell? Are there anal cleansing materials provided?
h) Do you use the sanitation facility?
   i) Prompt: Do you feel safe using it? Do you think it's private?
   ii) Prompt: If you don't use it, why not.
i) In the past year, has there been any flooding on the grounds?
   i) Probe: If so were the sanitation facilities impacted?

19) The following questions will relate to energy at this facility.
   a) Are you satisfied with the lighting at night in this facility? Why, why not?
      i) Prompt: Indoor lighting? Outdoor lighting?
      ii) Prompt: Is the facility open at night? Do you feel safe working at night?
      iii) Prompt: Can you describe a time that lighting has interfered with your ability to serve a patient?
      iv) Prompt: Would improving lighting allow you to better care for patients? How so?
   b) Are there services you cannot provide when energy is not available?
      i) [If yes] Prompt: How do you cope?
   c) Are you always satisfied with the temperature in this facility? Why, why not?
      i) Prompt: Is there ventilation or air conditioning?
      ii) Prompt: Do you ever feel too hot or too cold? Do patients?
      iii) Prompt: Would improving temperature control allow you to better care for patients? How so?

Summing it up:

20) Given our conversation today about environmental health conditions in this facility, what would you say is the most positive aspect of environmental health in this facility?

21) On the other hand, what would you say is the biggest challenge to maintaining hygiene and environmental health in this facility?

22) What incentives are needed for staff to improve environmental conditions?
   a) Prompt: Higher pay? Better incorporated into job description? Better training?

23) Have you ever worked at a different public HCF before? What was that like? How does it compare to this one?

24) Is there anything else you would like to share with me today?

APPENDIX E: CLEANER CONSENT FORM

University of North Carolina at Chapel Hill
Consent to Participate in a Research Study
Adult Participants

Consent Form Version Date: 1.0 dated January 30, 2017
UNC IRB Study # 16-1682

Title of Study: UNCPM 21604 - Baseline Assessment of Water, Sanitation, and Hygiene (WASH) in Health Care Facilities in Malawi

Protocol Version 1.0January 30, 2017

Malawi Principal Investigator: Innocent Mofolo
Malawi Phone number: 0888-202-152
Co-Investigators: Lydia Abebe
Holystone Maumsamatha Kafanikhale
UNC Principal Investigator: Irving Hoffman
UNC-Chapel Hill Department: Medicine

Funding Source and/or Sponsor: Funding source: Proctor and Gamble; University of North Carolina at Chapel Hill

Study Contact telephone number: 0888-202-152

What are some general things you should know about research studies?
You are being asked to take part in a research study. To join the study is voluntary.
You may refuse to join, or you may withdraw your consent to be in the study, for any reason, without penalty.

Research studies are designed to obtain new knowledge. This new information may help people in the future. You may not receive any direct benefit from being in the research study. There also may be risks to being in research studies. Deciding not to be in the study or leaving the study before it is done will not affect your relationship with the researcher, your health care provider, or the UNC Project-Malawi. If you are a patient with an illness, you do not have to be in the research study in order to receive health care.

Details about this study are discussed below. It is important that you understand this information so that you can make an informed choice about being in this research study.

You will be given a copy of this consent form. You should ask the researchers named above, or staff members who may assist them, any questions you have about this study at any time.

What is the purpose of this study?
The purpose of this research study is to conduct a countrywide assessment of environmental

conditions in health care facilities (HCF) in the northern, central, and southern regions of Malawi. The assessment will consist of data collection on environmental health conditions in tertiary / central hospitals, district hospitals, health centers, and health posts. Information will be collected on water, hygiene, sanitation, ventilation, infection control, vector control, energy access, and solid waste management to establish baseline values of the current status of facilities and serve as a basis for comparison for monitoring purposes and impact assessments.

You are being asked to be in the study because we are evaluating this health care facility. We are hoping to learn about the facility and your experiences as a government official, a staff member or a patient. If you are a government official or a staff member, you must have worked here for at least 1 year. If you are a patient, this cannot be your first visit to this health care facility.

Are there any reasons you should not be in this study?
You should not be in this study if this is your first visit to this health care facility.

How many people will take part in this study?
There will be approximately 45 facilities in this research study, and 5 to 10 participants at each facility. Total number of participants who will enroll in this study is 475.

How long will your part in this study last?
The research will take place over 6-months, with field research taking place over a period of a month or two. You will only be asked to participate in one interview, which will be audio-recorded with your permission.

What will happen if you take part in the study?
All activities will be arranged at a time and place that is convenient for you. The interview will be audio recorded with your permission. An interviewer will lead the conversation with questions regarding the environmental conditions in the health care facility.
The interview will consist of talking to you about the environmental conditions, your interactions with the infrastructure, and services provided at this health care facility. The interview may take 1 ½ hours if you agree to have it audio recorded. If you do not agree to audio recording the interview may take up to 2 ½ hours for note taking purposes.

What are the possible benefits from being in this study?
Research is designed to benefit society by gaining new knowledge. Your participation and this overall activity may eventually lead to improved environmental conditions at this facility. But you may also have no direct benefit from this research.

What are the possible risks or discomforts involved from being in this study?

You may feel uncomfortable to answer questions. You can refuse to answer any questions asked of you at any time.
Answers from the interview will not be shared outside of the team working on this study. We will not ask or record your name or other information about your identity, so your responses will remain anonymous.

If you choose not to be in the study, what other treatment options do you have?
Taking part in this research study is voluntary and you do not have to agree to participate. This means that you can leave at any stage, and do not have to participate in any activities or answer any questions if you do not want to. Please note that by finishing any of the activities, you are allowing the researchers to use any information you provided. Most of what you will share with the researchers will relate to your experiences in the health care facility. Please remember that you do not have to share any information that makes you feel uncomfortable or embarrassed.

What if we learn about new findings or information during the study?
You will be given any new information gained during the course of the study that might affect your willingness to continue your participation.

How will information about you be protected?
Your privacy and confidentially is important to the researchers, and we will put in place a number of steps to make sure that your rights are protected and your access to care is not affected if you are a patient or your work status is not affected if you are a government official or staff member. We do this by using codes to identify you instead of your names and personal contact details. Audio recordings will be de-identified, transcribed and translated into English.

Check the line that best matches your choice:

_____ OK to record me during the study

_____ Not OK to record me during the study

What if you want to stop before your part in the study is complete?
You can withdraw from this study at any time, without penalty. The investigators also have the right to stop your participation at any time. This could be because you have had an unexpected reaction, or have failed to follow instructions, or because the entire study has been stopped.

Will you receive anything for being in this study?
There is no compensation for participating in this study.

Will it cost you anything to be in this study?
It will not cost you anything to be in this study.

Who is sponsoring this study?
The company Proctor & Gamble is sponsoring this study along with the University of North Carolina, USA. This means that the research team is being paid by the sponsor for doing the study. The researchers do not, however, have a direct financial interest with the sponsor or in the final results of the study.

What if you have questions about this study?
You have the right to ask, and have answered, any questions you may have about this research. If you have questions about the study (including payments), complaints, concerns, or if a research-

related injury occurs, you should contact the researchers listed on the first page of this form.

What if you have questions about your rights as a research participant?

All research on human volunteers is reviewed by a committee that works to protect your rights and welfare. If you have questions about your rights as a research participant, or problems or concerns about how you are being treated in this study, contact, anonymously if you wish, the head of secretariat, Dr. Damson Kathyola at 0888-344-443.

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Title of Study: UNCPM 21604 - Baseline Assessment of Water, Sanitation, and Hygiene (WASH) in Health Care Facilities in Malawi

Malawi Principal Investigator: Innocent Mofolo
US Principal Investigator: Irving Hoffman

Participant's Agreement:

If you have read this informed consent, or have had it read and explained to you, and understand the information, and you voluntarily agree to participate in this research study, please sign your name or make your mark in the signature area at the bottom of this page**.**

PART A: LITERATE PARTICIPANT

Participant is literate: ☐

_____ _____ _____ _____

Participant Name (print) Participant Signature Date Time

_____ _____ _____ _____

Study Staff Conducting Consent Discussion (print) Study Staff Signature Date Time

PART B : ILLITERATE PARTICIPANT

Participant is illiterate: ☐

The study staff must complete this section, ONLY if an impartial witness is available.
The **study staff must write participant name and date of consent** on the **SHADED AREA.**

_____ _____ _____ _____

Participant Name (print) Participant Thumbprint Date Time

Participant Name and Date Written By…….on…...……

_____ _____ _____ _____

Study Staff Conducting Consent Discussion (print) Study Staff Signature Date Time

_____ _____ _____ _____

Impartial Witness Name Impartial Witness Signature Date Time

APPENDIX F: DEFINITIONS OF COMPLEX CODES

Coordination
Applied when the respondent is discussing working relationships with other departments, ministries, etc. Also coded when respondent mentions coordination struggles.

Decentralization
Applied anytime respondents are talking about chain of command, having to get in touch with a superior, or duties related to supervision/management. The decentralization in Malawi goes all the way down to the smallest facility level.

Energy access
Code used liberally. Applied when respondents are talking about whether a hospital/maternity ward has electricity, lighting, or anything related to the access of energy/electricity.

Energy breakdown
Applied when the respondent talks about a specific example of blackout or other breakdowns.

Energy reliability
When the respondent discusses the frequency and length of energy blackouts, the response should be coded using energy reliability.

Energy prioritization
The word "priority" is not often found. This code was applied when respondents discussed how the generator was used, specifically when they mention how the generator is hooked up to the HCF.

Human Rights
Often this is explicitly mentioned and obvious. However, this code can be applied when the respondent mentions equity, dignity, and patient rights or words that are similar in meaning.

Preventive health
Applied when someone talks specifically about preventive health/the preventive health, or when it is implied (this implies that the curative is focused on instead of preventive, even though it is not explicitly stated).

Specific Policy—Draft Environmental Health Policy
There are 5 components of the EH policy. This code is applied when respondents bring up EH and only talk about WaSH and perhaps climate change.

Water Access
Applied with respondent addresses how/where the facility gets its water, and less about how often it is available or working. Includes responses to the following questions: can they access it at the facility? Or do they get water from a borehole in the community?

Water system breakdown
This code is applied when the respondent mentions the breakdown of a specific water breakdown or discusses what happens when the facility runs out of water or there are infrastructural issues.

Water system reliability
Reliability has to do with how often water is available from the source when users go to draw water from it.

APPENDIX G: DEDOOSE FINAL CODEBOOK

Parent code	Description	Children codes	Grandchildren codes	Children/grandchildren code comments
Actor		HCF Administrator; Cleaner; Community; Community leader; DHO; District government; Environmental Health Official*; Central government; HCF*; HCW; HSA; Maintenance team; NGO/external support actor; Patient; SHSA; Ward in-charge; Utility; Committee*; Guardian; Other ministry*; Other actor	Committee: National committee; district committee; facility committee; village committee; IP committee / Environmental health official: EHO, AEHO, HSA, SHSA, Central level official, district level official, facility level official / HCF: Central HCF, District HCF, Health center, Health post/dispensary / Other Ministry: Ministry of Water and Irrigation	Note: "District hospital" ("DHO") is different from "District government" (District commissioner)
Budget		National budget; District budget; Facility budget; EH budget; specific allocation		
Challenges				
EH definition	For "what does EH mean to you?"--co-code with topics mentioned			
Energy	Energy supply	Energy supply characteristics*; energy maintenance; energy breakdown; energy payment; energy access; energy prioritization; Energy use*	Energy supply characteristics: Primary source; backup source; energy reliability; energy supply quality; Energy Use: sterilization, lighting, water pump, refrigeration, critical equipment, energy at night; temperature control	

HCF characteristics	Descriptions of HCF conditions	HCF practices*; HCF conditions*; HCF infrastructure*; HCF relationships*; HCF supplies*; Communication*	HCF practices: cleaning practices / HCF infrastructure: building; Incinerator; Isolation room; Guardian shelter; Pit with fence; Pit without fence / HCF relationships: HCW-HCW, HCW-patient; HCW-other staff; Other staff-other staff; Other staff-patients; Communication: posters; Outreach*; HCF supplies: Cleaning supplies; Fuel; Linens; Medicine	Outreach: Health talks
HCF conditions		Nosocomial infections; HCF cleanliness; Demand for service; Quality of care		
Human rights		Dignity; Equity; Patient rights; Human right to EH*	Human right to EH: affirmative; negative	
Hygiene/Infection prevention	In context of preventing nosocomial infections	Hand hygiene*; Sterilization/disinfection; Personal protective equipment; Laundry; Ventilation; Vector control; Food safety; Vaccines; Menstrual hygiene	Hand hygiene: access to stations; Access to soap; Access to drying materials	
Inspection				
Maternity	Specific maternity terms	Safety; Maternity conditions*; Maternity infrastructure*; Maternity practices	Maternity conditions: neonatal mortality; Maternal mortality / Maternity infrastructure: mattresses; Showers; nursery/incubation; Lighting; Post-natal; Ante-natal	Maternity practices: when the use of infrastructure or the implementation of policy deviates from its intended use/practice

Methods		Great quote; contradiction/lie; Unclear - follow up; New code needed; Other		
Opportunities				
Policy		Policy level*; Coordination; Decentralization; Communication with other gov't officials*; Specific policy*	Policy level: International; National; district; facility / Communication with other gov't officials: Primary contact; Frequency of communication; Method of communication / Specific policy: Public Health Act; Draft Environmental Health Policy*; SDGs	
Preventive health	Distinct from IP: in context of prioritization of preventative vs curative care	Policy level; Coordination; Decentralization; Communication with other gov't officials; Specific policy		
Prioritization				
Recommendations				
Sanitation	Toilets/latrines/other	Sanitation maintenance; Sanitation reporting; Sanitation payment; Sanitation characteristics*; Sanitation access; Sanitation practices; Sanitation breakdown CLTS; ODF	Sanitation characteristics: Backup sanitation source; Cleanliness/quality of sanitation facilities; Primary sanitation source; Quantity of facilities; Sanitation facility type	
Season	Variability based on season	Wet season; Dry season; Cold season; Hot season		

Staffing	Human resources	Roles and responsibilities*; Qualifications; Contract type; Work conditions; Supervision	Roles and responsibilities: EH responsibilities; Job description	
Successes				
Sufficiency		Sufficient*; Insufficient*; absent	Sufficient: resources; access / Insufficient: resources; access	
Training	Not education: on-the-job training (past or current)	Training level*	Training level: National; District; Facility; Other	
Transportation				
Waste management		Waste transport; Waste segregation*; Waste treatment; Waste disposal; Waste-related injuries; Wastewater	Waste segregation: infectious waste; Non-infectious waste; Sharps; Placenta	
Water		Water maintenance; Water reporting; Water payment; Water use*; Water access; Water prioritization; Water system characteristics*; Hot water	Water system characteristics: Water source; Water quality; Water treatment; Water system type; Back-up water source; Water system reliability; Water system breakdown; water system repair; Non-HCF use of water system / Water use: bathing; Cleaning; Cooking; Drinking water	

APPENDIX H: PARTIAL CODE COUNT TABLE

Transcript	Training	Actor	Central government	Cleaner	Grounds laborer	Ward attendant
2017 08 15	6	1	0	1	0	1
2017 08 07	5	6	0	0	0	0
2017 08 04	7	3	0	0	0	0
2017 08 03	6	1	0	1	0	1
2017 08 03	5	5	0	1	1	0
2017 08 02	4	5	0	0	0	0
2017 08 01	5	6	0	1	0	1
2017 08 01	7	9	0	3	1	0
2017 07 31	7	12	0	5	0	0
2017 07 28	9	0	0	0	1	0
2017 07 27	9	1	0	1	0	1
2017 07 26	6	1	0	1	0	1
2017 07 26	4	2	0	1	0	0
2017 07 25	6	1	0	1	0	1
2017 07 25	8	2	0	2	2	0
2017 07 24	7	5	0	0	0	0
2017 07 19	8	6	0	1	1	0
2017 07 18	6	13	0	0	0	0
2017 07 17	8	5	0	0	0	0
2017 07 17	6	5	0	1	0	0
2017 07 14	6	9	0	0	0	0
2017 07 13	5	5	0	0	0	0
2017 07 13	6	11	0	0	0	0
2017 07 12	6	2	0	0	0	0
2017 07 12	12	12	0	0	0	0
2017 07 11	4	4	0	0	0	0
2017 07 11	7	3	0	1	0	0
2017 07 10	9	8	0	0	0	0
2017 07 10	6	5	0	0	0	0
2017 07 07	7	5	0	1	0	0
2017 07 06	6	2	0	0	0	0
2017 07 05	7	3	0	3	3	0
2017 07 04	5	9	0	3	0	0
2017 07 04	7	7	0	0	0	0
2017 07 04	5	8	0	0	0	0
2017 07 03	5	10	0	1	0	0
2017 07 03	9	6	0	0	0	0

2017 06 30	4	2	0	0	0	0
2017 06 29	6	7	0	0	0	0
2017 06 28	6	6	0	0	0	0
2017 06 27	3	1	0	1	0	0
2017 06 27	8	1	0	1	0	0
2017 06 23	7	5	0	0	0	0
2017 06 22	5	2	0	2	0	2
2017 06 22	7	1	0	1	1	0
2017 06 21	7	10	0	3	2	1
2017 06 19	5	2	0	2	0	1
2017 06 19	6	0	0	0	0	0
2017 06 16	4	4	0	0	0	0
2017 06 16	7	2	0	1	1	0
2017 06 15	2	4	0	1	1	0
2017 06 15	9	0	0	0	0	0
2017 06 14	7	0	0	0	0	0
2017 06 14	4	1	0	1	1	0
2017 06 12	9	1	0	1	0	1
2017 06 12	5	3	0	3	0	3
2016 06 23	5	0	0	0	0	1
Totals	**357**	**250**	**0**	**46**	**15**	**15**

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