International Journal of Innovation Scientific Research and Review
Vol. 08, Issue, 05, pp.9913-9922, May 2026
Available online at http://www.journalijisr.com
SJIF Impact Factor 2025: 7.913

Research Article

ISSN: 2582-6131

SANITATION AND HEALTHCARE WASTE MANAGEMENT SYSTEMS AND THEIR EFFECTS ON HEALTH SERVICE DELIVERY IN HEALTHCARE FACILITIES IN UPPER NILE STATE, SOUTH SUDAN

[1,] *Samuel Madul Anyiethgai, [2]Faustino LataruOrach-Meza, [3]Miph B. Musoke, [4]Martin Odoki, [5]Simon Peter Kaweesa

[1, 2, 3, 4] Nkumba University, Entebbe P.O. Box 237, Entebbe, Uganda.
[5]King Ceasor University, Kampala, Uganda.
[5]Maseno University, Maseno, Kenya.

Received 15th March 2026; Accepted 16th April 2026; Published online 30th May 2026

ABSTRACT

This study evaluated the status of Water, Sanitation, and Hygiene (WASH) services, focusing on sanitation infrastructure and healthcare waste management practices, and to determine their implications for infection prevention and quality of healthcare delivery in a conflict-affected setting. A mixed-methods cross-sectional design was employed, combining quantitative facility-based observations and qualitative key informant interviews. A total of 20 healthcare facilities (PHCCs and hospitals) were assessed. In addition, 64 key informant interviews were conducted with healthcare workers, inpatients, and lactating mothers. Quantitative data were analyzed using descriptive statistics, cross-tabulations, chi-square tests, and ordinal logistic regression, while qualitative data were analyzed thematically in line with established qualitative analysis frameworks. The findings revealed severe deficiencies in sanitation and waste management systems. Most facilities (85%) provided only limited sanitation services, while 15% had none. Although 75% had at least one usable toilet, only 25% were clean, and none had menstrual hygiene management facilities. Only 15% had gender-separated toilets, and 70% lacked staff toilets. Waste management systems were critically weak, with 100% of facilities failing to meet waste segregation standards, lacking PPE for waste handlers, and not using WHO-compliant incinerators. Regression analysis showed that facility type significantly influenced sanitation adequacy ($p = 0.022$), while the availability of staff toilets, functional cubicles, and waste kits significantly improved sanitation outcomes. However, no significant association was found between facility type and overall sanitation service level ($p = 0.348$), indicating systemic deficiencies across both hospitals and PHCCs. Qualitative findings confirmed these results, highlighting experiences of poor hygiene, lack of privacy, unsafe waste disposal, and occupational risk among healthcare workers. The study concludes that sanitation and waste management services in Upper Nile State are critically inadequate. These gaps reflect systemic health system weaknesses exacerbated by conflict and resource constraints. The study recommends urgent investment by the Ministry of Health, supported by development partners such as the World Health Organization and UNICEF, to strengthen WASH infrastructure, ensure provision of gender-sensitive sanitation facilities, establish proper waste management systems, and provide PPE and training for healthcare workers. Strengthening facility-level accountability and integrating WASH into health system recovery strategies are essential for improving healthcare quality and resilience in Upper Nile State.

Keywords: Water, Sanitation and Hygiene (WASH); Healthcare facilities; Waste management; Infection prevention and control; Upper Nile State; Health system strengthening.

BACKGROUND OF THE STUDY

Globally, healthcare waste management is recognized as a critical component of safe and effective health service delivery due to its direct implications for infection prevention and environmental safety (World Health Organisation, 2014). In high-income regions such as Europe and the United States, structured healthcare waste systems are guided by strict regulatory frameworks that enforce segregation, treatment, and disposal standards to reduce occupational and environmental risks (European Commission, 2018; United States Environmental Protection Agency, 2020). These systems have significantly improved hospital safety outcomes and reduced nosocomial infections through standardized protocols and advanced waste treatment technologies (World Health Organization, 2014; European Centre for Disease Prevention and Control, 2019). However, despite these advancements, challenges such as high generation rates of hazardous waste and cost-intensive treatment processes continue to pressure healthcare systems, particularly in large urban hospitals (United States Environmental Protection Agency, 2020; World Health Organization, 2014).

***Corresponding Author: Samuel Madul Anyiethgai,**
1Directorate of Postgraduate Studies and Research, Nkumba University, and P.O. Box 237, Entebbe, Uganda.

In Europe and other developed healthcare systems, sanitation and healthcare waste management are integrated into hospital quality assurance frameworks that emphasize sustainability and patient safety outcomes. Studies indicate that effective waste segregation and disposal systems significantly reduce infection transmission risks within healthcare environments (European Commission, 2018; European Centre for Disease Prevention and Control, 2019). Furthermore, healthcare facilities with advanced waste incineration and recycling technologies demonstrate improved environmental compliance and reduced ecological footprints (World Health Organization, 2014; United States Environmental Protection Agency, 2020). Nevertheless, rising healthcare service demand and environmental concerns have led to continuous reforms aimed at improving waste minimization and circular economy integration in hospital systems (European Commission, 2018; World Health Organization, 2014).

In the African context, healthcare waste management systems remain largely inadequate, with many countries facing challenges related to infrastructure, training, and regulatory enforcement. Studies in Nigeria and Ghana reveal that poor segregation practices and insufficient waste treatment facilities contribute to increased occupational exposure risks among healthcare workers (Abah & Ohimain, 2011; Odonkor & Mahami, 2020). Similarly, inadequate policy implementation and weak institutional capacity have been identified

as major barriers to effective healthcare waste management across sub-Saharan Africa (Oyekale & Oyekale, 2017; Ezeudu *et al*., 2022). These systemic weaknesses negatively affect healthcare service delivery by increasing infection risks, reducing staff efficiency, and compromising patient safety outcomes (Chisholm *et al*., 2021; Odonkor & Mahami, 2020; Muzaale, 2021).

In East Africa, particularly in countries such as Uganda and Tanzania, healthcare waste management practices vary widely across rural and urban health facilities (Kwikiriza *et al.,* 2019). Research in Uganda shows that improper waste segregation and inadequate training among healthcare workers significantly increase infection risks and environmental contamination (Wafula *et al*., 2019; Kwikiriza *et al*., 2019). Similarly, regional studies highlight that limited infrastructure, such as lack of incinerators and poor waste storage systems, undermines effective healthcare waste disposal across East African health systems (Tadesse & Kumie, 2014; Kwikiriza *et al*., 2019). These deficiencies have been linked to reduced efficiency in healthcare service delivery and increased vulnerability to healthcare-associated infections (Wafula *et al*., 2019; Tadesse & Kumie, 2014).

At the national level in South Sudan, healthcare waste management systems remain underdeveloped due to weak institutional capacity, limited funding, and inadequate policy enforcement. Reports indicate that most healthcare facilities rely on rudimentary waste disposal methods, often mixing infectious and non-infectious waste due to lack of segregation infrastructure (World Health Organization, 2014; Chisholm *et al*., 2021). Furthermore, the absence of standardized training programs for healthcare workers contributes to poor compliance with safe waste handling practices, increasing occupational and environmental health risks (Ezeudu *et al*., 2022; Oyekale & Oyekale, 2017). These challenges significantly affect the overall quality of health service delivery and patient safety outcomes in the country (Abah & Ohimain, 2011; Odonkor & Mahami, 2020).

In the specific context of Upper Nile State, healthcare facilities face severe operational constraints that limit effective sanitation and healthcare waste management systems. Studies from similar fragile health systems in sub-Saharan Africa suggest that inadequate waste segregation, poor infrastructure, and lack of protective equipment expose healthcare workers and patients to preventable infections (Kwikiriza *et al*., 2019; Wafula *et al.,* 2019). Additionally, the absence of consistent waste treatment systems such as incineration or secure landfill disposal further exacerbates environmental contamination and hospital inefficiencies (Tadesse & Kumie, 2014; Ezeudu *et al.,* 2022). Consequently, these systemic weaknesses directly undermine health service delivery by increasing infection rates, reducing staff productivity, and compromising overall healthcare quality in Upper Nile State (Odonkor & Mahami, 2020; Chisholm *et al*., 2021).

Statement of the Problem

Ideally, healthcare facilities are expected to operate under safe and well-structured sanitation and healthcare waste management systems that ensure proper segregation, collection, treatment, and disposal of medical waste in line with World Health Organization standards. In such systems, infectious and non-infectious wastes are separated at the point of generation, health workers are adequately trained, and functional infrastructure such as incinerators, color-coded bins, and protective equipment is consistently available. These measures are designed to protect healthcare workers, patients, and the surrounding community from hospital-acquired infections and environmental contamination while improving the overall efficiency and quality of health service delivery (Abah & Ohimain, 2011; Odonkor & Mahami, 2020). However, in reality, healthcare facilities in many low-resource and fragile settings, including South Sudan, operate far below these standards. In Upper Nile State, sanitation and healthcare waste management systems are weak, fragmented, and inconsistently implemented. Waste is often mixed at the point of generation due to inadequate segregation materials and limited staff training. In many facilities, disposal methods remain rudimentary, relying on open burning or unsafe dumping because of the absence of functional incinerators and regulated waste treatment systems. These challenges are compounded by shortages of protective equipment and weak enforcement of infection prevention and control policies, exposing both healthcare workers and patients to preventable health risks (Wafula *et al.,* 2019; Chisholm *et al*., 2021). The gap, therefore, lies between the expected standard of safe, efficient, and regulated healthcare waste management systems and the actual practices observed in healthcare facilities in Upper Nile State. This disconnect has contributed to increased risk of hospital-acquired infections, environmental pollution, and reduced efficiency in health service delivery. Despite the critical importance of sanitation and waste management in healthcare outcomes, there is limited empirical evidence specifically examining how these system failures affect service delivery in Upper Nile State, creating a significant knowledge and policy gap that this study seeks to address (Ezeudu *et al*., 2022; Oyekale & Oyekale, 2017).

Purpose of the Study

The purpose of this study is to examine sanitation and healthcare waste management systems and their effects on health service delivery in healthcare facilities in Upper Nile State, South Sudan. The study seeks to assess the existing waste management practices, identify system gaps, and determine how these practices influence the quality, safety, and efficiency of healthcare service delivery in the study area.

Objective of the Study

The objective of this study is to assess sanitation and healthcare waste management systems and their effects on health service delivery in healthcare facilities in Upper Nile State, South Sudan.

Research Question

How do sanitation and healthcare waste management systems affect health service delivery in healthcare facilities in Upper Nile State, South Sudan?

Significance of the Study

This study is significant because it provides evidence on how Water, Sanitation and Hygiene (WASH) conditions in healthcare facilities influence health service delivery in Upper Nile State, a conflict-affected and resource-limited setting. It helps to clarify how unsafe environments, weak infection prevention, and poor sanitation contribute to disease burden and reduced healthcare utilization. The findings will support policymakers in designing evidence-based WASH policies and targeted interventions. It will also guide prioritization of investments by identifying critical gaps in infrastructure and service delivery. Additionally, the study provides a baseline for monitoring and evaluating WASH improvements over time. Finally, it strengthens advocacy efforts by raising awareness among government, NGOs, and development partners on the urgent need to improve WASH services in healthcare facilities.

Scope of the Study

The study was conducted in Upper Nile State, South Sudan, focusing on government health facilities affected by conflict and infrastructural challenges. Geographically, it covered selected counties and the state capital, Malakal. Content-wise, the study assessed Water, Sanitation and Hygiene (WASH) conditions, including water supply, sanitation facilities, waste management, and hand hygiene practices, and their influence on health service delivery. The study focused on 20 health facilities, comprising 16 Primary Health Care Centers (PHCCs) and 4 hospitals, which provide advanced clinical services compared to PHCUs. The time scope covered literature and developments from 2015 to 2023, a period marked by global emphasis on WASH improvements in healthcare settings. The study adopted a cross-sectional design, assessing facilities at a single point in time to generate representative evidence on WASH status and service delivery outcomes in Upper Nile State.

THEORETICAL FRAMEWORK

The study is guided by two major theories namely the Reduction and Prevention Theory and the Improvement Theory, which together explain the importance of Water, Sanitation, and Hygiene (WASH) services in healthcare facilities. The Reduction and Prevention Theory was largely propounded by the World Health Organization and UNICEF through global public health and infection prevention initiatives between 2015 and 2022, supported by researchers such as Eleni Gakidou in 2016 and Benedetta Allegranzi in 2017. The theory emphasizes that adequate WASH services help reduce infections and prevent disease outbreaks in healthcare settings. The Improvement Theory was mainly advanced by the World Health Organization beginning with its healthcare facility WASH guidelines in 2008 and later supported by researchers such as Awofeso in 2018 and Weber in 2019. This theory argues that WASH services are fundamental to improving the quality, efficiency, and effectiveness of healthcare delivery in health facilities. The Reduction and Prevention Theory, advanced mainly by the World Health Organization, UNICEF, and researchers such as Benedetta Allegranzi and Eleni Gakidou, emphasizes that adequate WASH services help reduce infections and prevent disease outbreaks in healthcare settings. The theory explains that access to clean water, proper sanitation, and hand washing facilities reduces diarrheal diseases, respiratory infections, neonatal infections, cholera, Ebola, and COVID-19 transmission among patients and healthcare workers. On the other hand, the Improvement Theory, promoted by the World Health Organization and scholars such as Awofeso and Weber, argues that WASH services are fundamental to improving the quality, efficiency, and effectiveness of healthcare delivery in health facilities.

The theories are highly applicable to this study because they directly explain the relationship between WASH services and healthcare delivery in Upper Nile State, South Sudan. The Reduction and Prevention Theory applies by demonstrating how inadequate water supply, poor sanitation, and limited hygiene practices increase the spread of communicable diseases and healthcare-associated infections in health facilities. Similarly, the Improvement Theory applies by showing that adequate WASH infrastructure improves the quality of care, enhances patient satisfaction, supports infection prevention and control, and increases healthcare workers' performance and safety. Since Upper Nile State is affected by conflict, weak infrastructure, and limited health resources, the theories provide an appropriate framework for understanding how WASH conditions influence healthcare service delivery in such fragile settings.

The Reduction and Prevention Theory mainly focuses on disease prevention and may overlook broader social, economic, political, and cultural factors that affect healthcare delivery in conflict-affected settings. Likewise, the Improvement Theory assumes that healthcare facilities have sufficient financial and institutional capacity to maintain WASH infrastructure, which may not always be realistic in low-resource and unstable environments such as South Sudan.

In the context of this study, the theories imply that improving WASH services in healthcare facilities is essential for strengthening healthcare delivery and improving health outcomes in Upper Nile State. The theories suggest that adequate water supply, sanitation facilities, waste management systems, and hygiene practices can reduce infections, improve patient confidence in healthcare services, protect healthcare workers, and increase the efficiency and quality of healthcare delivery. They further imply that government institutions, humanitarian organizations, and development partners should prioritize WASH interventions as part of healthcare system recovery and resilience-building efforts in conflict-affected areas. Therefore, the theories provide a strong foundation for assessing how deficiencies or improvements in WASH services affect healthcare delivery in Upper Nile State, South Sudan.

LITERATURE REVIEW

Effective sanitation services in healthcare facilities are a fundamental component of quality healthcare delivery, as they directly influence patient safety, dignity, and infection prevention and control. According to UNICEF (2022), adequate sanitation in health facilities includes the availability of usable, improved toilets, including at least one toilet for staff, sex-separated toilets with menstrual hygiene facilities, and accessible toilets for persons with disabilities. Similarly, WHO and UNICEF (2019) emphasize that sanitation systems in healthcare facilities must be functional, safe, and accessible to all users, including patients, staff, and vulnerable groups. These standards reflect global expectations that sanitation is not only about infrastructure availability but also usability and inclusiveness. However, a key gap exists in the limited empirical evidence on how many healthcare facilities in fragile and conflict-affected settings, such as Upper Nile State, actually meet these minimum sanitation standards and how deficiencies in sanitation infrastructure directly affect healthcare service delivery outcomes.

Sanitation systems are closely linked to healthcare waste management, which is essential for preventing hospital-acquired infections and environmental contamination. WHO (2014) highlights that proper segregation, collection, treatment, and disposal of healthcare waste are critical in reducing exposure to infectious materials among healthcare workers and patients. Abah and Ohimain (2011) further note that effective waste management systems require both infrastructure and trained personnel to ensure compliance with safety standards. Despite these requirements, many healthcare facilities in low-resource settings continue to struggle with poor waste segregation and unsafe disposal practices. The gap in the literature is that while global standards on waste management are well documented, there is insufficient localized evidence on the operational realities of healthcare waste handling practices in Upper Nile State and how these deficiencies impact infection control and service delivery efficiency.

Studies have shown that healthcare facilities are categorized using a sanitation service ladder that includes basic, limited, and no service levels, depending on the availability and functionality of sanitation infrastructure. WHO and UNICEF (2019) explain that a basic sanitation service requires functional, accessible, and sex-separated

toilets that meet the needs of both staff and patients, while UNICEF (2022) reinforces that these facilities must also support hygiene needs such as menstrual hygiene management. However, evidence from sub-Saharan Africa suggests that many healthcare facilities remain at limited or no service levels due to infrastructure deficits and poor maintenance systems. The existing gap is that although the sanitation ladder framework is widely applied at global level, there is limited context-specific assessment of where healthcare facilities in Upper Nile State fall within this classification and how their sanitation status influences overall healthcare delivery performance.

Waste management refers to the systematic collection, segregation, treatment, disposal, and monitoring of waste materials in order to reduce the spread of infectious and non-infectious diseases within healthcare environments (Kurup, 2022). Proper healthcare waste management is a core component of infection prevention and control (IPC) programmes because it reduces exposure to hazardous materials and enhances safety in clinical settings (WHO & UNICEF, 2022). Poor handling of healthcare waste has been strongly linked to occupational risks, particularly needle stick injuries, which affect over two million healthcare workers annually worldwide (Bouya *et al*., 2020). Although global guidelines emphasize safe waste handling, there remains a gap in understanding how consistently IPC-integrated waste management systems are implemented in fragile health systems such as Upper Nile State and how these gaps affect healthcare service delivery.

Plate 1: Colour coded health care waste containers (Kurup, 2022)

Waste minimization

Waste minimization, in summary, is the wasted waste minimization from sources and reused waste recycling. This aims to reduce the volume of hazardous waste sent for recovery, treatment and disposal as energy (Rosenfeld *et al*., 2011).

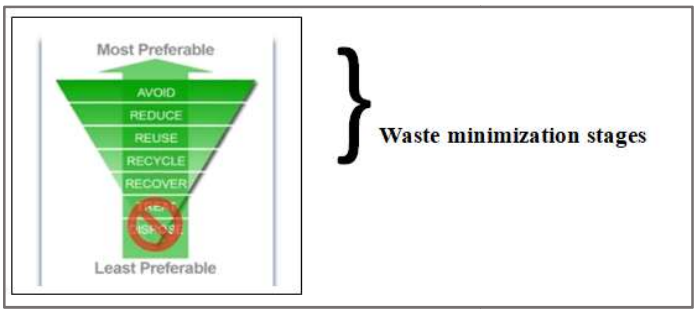

Figure 2: Waste minimization stages, Module 2: Source: The Healthcare Waste Management System (greenhealthcarewaste.org).

Collection

Effective segregation and management of sharps waste at the point of generation is critical in preventing transmission of blood-borne infections such as hepatitis B, hepatitis C, and HIV (WHO & UNICEF, 2022). WHO and UNICEF (2022) further emphasize that proper treatment and disposal of sharps waste can significantly reduce infection risks among healthcare workers and patients. In addition, unsafe waste practices such as uncontrolled burning or poorly managed incineration release toxic pollutants like dioxins and furans, which pose environmental and public health risks (WHO & UNICEF, 2022). However, despite these known risks, many healthcare facilities in low-resource settings continue to operate without adequate waste treatment infrastructure. The literature gap lies in the lack of facility-level evidence on whether healthcare institutions in Upper Nile State effectively implement safe sharps management practices and the resulting implications for occupational safety and environmental health.

Healthcare waste is generally categorized into infectious waste, sharp waste, and general non-hazardous waste, and proper segregation at the point of generation can reduce treatment volumes by up to 70% (UNICEF, 2022; WHO & UNICEF, 2022). This classification is essential for improving efficiency and reducing the cost and burden of waste treatment systems while ensuring environmental safety. UNICEF (2022) emphasizes that correct segregation is a fundamental step in minimizing infection risks and improving healthcare system performance. However, evidence from many low-income and conflict-affected settings suggests that waste is often mixed due to weak compliance and lack of training. The gap in the literature is the limited empirical assessment of whether healthcare facilities in Upper Nile State adhere to WHO-recommended waste segregation practices and how non-compliance affects infection control and overall healthcare service delivery.

METHODOLOGY

Research Design and Approach

This study adopted a mixed-methods research approach, combining both quantitative and qualitative methods to provide a comprehensive understanding of Water, Sanitation and Hygiene (WASH) and its influence on healthcare service delivery. According to Creswell and Plano Clark (2018), mixed methods allow researchers to integrate numerical trends with contextual insights, improving the depth and validity of findings.

A descriptive cross-sectional design was used to assess WASH conditions and their effects at a single point in time. This design is appropriate for studies aiming to describe existing conditions without manipulating variables (Creswell, 2014). Quantitative data were collected using structured questionnaires, while qualitative data were obtained through interviews and observations. Triangulation was applied to enhance validity by comparing multiple data sources (Denzin, 2017).

Study Area

The study was conducted in Upper Nile State, South Sudan, a conflict-affected region characterized by weak health infrastructure, flooding, and displacement challenges. According to WHO (2022), fragile health systems often experience severe gaps in WASH services, which directly affect healthcare quality and infection prevention. These conditions make Upper Nile State a suitable setting for assessing the relationship between WASH systems and health service delivery.

Unit of Analysis

The primary unit of analysis was healthcare facilities, where WASH systems are implemented and assessed. Secondary units included healthcare workers, patients, and lactating mothers, whose

experiences provided insight into how institutional WASH conditions influence service delivery outcomes. This aligns with WHO (2019), which emphasizes facility-based assessment of WASH in healthcare environments as a key indicator of service quality.

Study Population

The study targeted an estimated population of 1,320,360 people within healthcare facility catchment areas in Upper Nile State. This included both rural and urban populations relying on public health services. The target sample consisted of 410 respondents, including: 20 health facility administrators, 120 healthcare workers, 180 inpatients and, 90 lactating mothers. These categories ensured representation of managerial, clinical, and patient perspectives, consistent with WHO and UNICEF (2019) recommendations for inclusive WASH assessments in healthcare facilities.

Sampling Frame, Sample Size, and Sampling Techniques

The sampling frame included all functional government healthcare facilities in Upper Nile State, specifically Primary Health Care Centers (PHCCs) and hospitals, along with relevant stakeholders. The sample size was determined using purposive selection, information power, and data saturation principles, which are widely used in qualitative and mixed-methods research (Malterud *et al.*, 2016). A total of 84 participants were included in the final analysis to ensure depth and adequacy of data.

The study employed a combination of purposive and simple random sampling techniques. Purposive sampling was used to select healthcare facilities and key informants with relevant experience, while simple random sampling ensured fairness in selecting participants from eligible lists. This approach reduces selection bias and improves representativeness (Creswell, 2014).

Inclusion and Exclusion Criteria

Inclusion criteria covered operational public healthcare facilities, consenting adults, and individuals directly involved in healthcare service delivery or utilization. Exclusion criteria included PHCUs, private facilities, critically ill patients, individuals with mental incapacity, and non-consenting participants.These criteria ensured ethical compliance and data quality in line with the Belmont Report principles of respect for persons, beneficence, and justice (National Commission for the Protection of Human Subjects, 1979).

Data Collection Methods

Multiple data collection methods were used to ensure triangulation and reliability (Denzin, 2017).

Questionnaires

Structured questionnaires were administered to health facility administrators using KoBoToolbox, covering water supply, sanitation, hygiene, and waste management indicators. According to WHO (2022), standardized WASH tools are essential for comparable facility assessments.

Key Informant Interviews

In-depth interviews were conducted with healthcare workers, inpatients, and lactating mothers to capture lived experiences of WASH conditions. Qualitative interviews are essential for understanding perceptions and contextual realities (Patton, 2015).

Direct Observation

Facility observations were used to assess real-time WASH conditions, including sanitation status, hygiene practices, and waste handling. WHO (2019) recommends direct observation as a core method for validating WASH indicators in healthcare settings.

Water Quality Testing

Water safety was assessed using DPD chlorine residual testing, a standard WHO-recommended method for evaluating drinking water safety in healthcare facilities (WHO, 2017).

Document Review

Facility records on patient admissions, deliveries, and attendance were reviewed to link WASH conditions with service utilization trends. Document analysis provides historical and institutional context for validation (Bowen, 2009).

Data Analysis

Data analysis followed Creswell's (2014) sequential approach of organizing, coding, interpreting, and integrating data.

Quantitative Analysis

Quantitative data were analyzed using SPSS version 27, applying descriptive statistics, chi-square tests, t-tests, and regression analysis to determine relationships between WASH variables and service delivery outcomes.

Qualitative Analysis

Qualitative data were analyzed using thematic analysis, where responses were coded and grouped into themes and sub-themes (Braun & Clarke, 2006). Open Code 4.02 was used to support systematic coding and pattern identification.

Integration of Data

Findings from both datasets were merged during interpretation to provide a holistic understanding of WASH conditions and healthcare service delivery, consistent with mixed-methods integration principles (Creswell & Plano Clark, 2018). Bowen, G. A. (2009). Document analysis as a qualitative research method.

Table 6.1: Descriptive Statistics on the Status of Sanitation Facilities in Healthcare Facilities in Upper Nile State

Variable	Frequency	Percent	Valid Percent	Cum. Percent
Service Level for Sanitation				
Limited	17	85.0	85.0	85.0
No Service	3	15.0	15.0	100.0
Usable Toilet Available				
Yes	15	75.0	75.0	75.0
No	5	25.0	25.0	100.0
Staff Toilets				
Yes	6	30.0	30.0	30.0
No	14	70.0	70.0	100.0
Gender-				

Separated Toilets				
Yes	3	15.0	15.0	15.0
No	17	85.0	85.0	100.0
MHM Facilities				
Yes	00	0.0	0.0	0.0
No	20	100.0	100.0	100.0
Toilet Cleanliness				
Clean	5	25.0	25.0	25.0
Somewhat clean	6	30.0	30.0	55.0
Not clean	9	45.0	45.0	100.0
Toilet Cleaning Frequency				
Once per day	9	45.0	45.0	45.0
More than once a day	2	10.0	10.0	55.0
Less than once per day	1	5.0	5.0	60.0
Never	1	5.0	5.0	65.0
Don't know	7	35.0	35.0	100.0

Source: *Author's Computation from Primary Dataset, 2025.*

The findings in Table 6.1 indicate that sanitation conditions in healthcare facilities across Upper Nile State remain inadequate. Most healthcare facilities (85%) operated under limited sanitation service levels, while 15% had no sanitation services at all. Although 75% of facilities reported having at least one usable toilet, 25% lacked even basic usable toilet facilities, exposing patients and healthcare workers to serious health risks. In addition, only 30% of facilities had toilets designated for staff, implying that the majority of healthcare workers shared sanitation facilities with patients and visitors. These findings reveal significant infrastructural deficiencies in sanitation services within healthcare facilities in the state.

The study further established that gender-sensitive sanitation infrastructure was largely absent, as only 15% of healthcare facilities had gender-separated or gender-neutral toilets, while 85% lacked such provisions. More critically, none of the surveyed facilities had menstrual hygiene management (MHM) facilities, indicating complete neglect of the sanitation and hygiene needs of women and girls within healthcare settings. Regarding cleanliness, only 25% of toilets were observed to be clean, 30% were somewhat clean, and 45% were not clean at all. This suggests poor sanitation maintenance practices, which may contribute to increased risks of infection transmission and reduced confidence in healthcare services among patients and staff.

The findings also showed inconsistencies in toilet cleaning practices across facilities. While 45% of facilities cleaned toilets once per day and 10% cleaned more than once daily, some facilities cleaned less frequently or never cleaned at all, and 35% of respondents did not know the cleaning frequency. These findings support the Reduction and Prevention Theory, which emphasizes that proper sanitation reduces the spread of infections and communicable diseases in healthcare facilities. The findings also align with the Improvement Theory, which views sanitation as essential for improving quality of care, patient dignity, staff welfare, and healthcare efficiency. Therefore, the study implies that urgent investment in sanitation infrastructure, maintenance systems, and gender-responsive WASH services is necessary to strengthen healthcare delivery in conflict-affected areas of Upper Nile State, South Sudan. Only 15% of facilities had gender-separated or neutral toilets, while 85% lacked them. This extremely low mean score shows widespread neglect of gender-sensitive sanitation. The high standard deviation points to inconsistency across facilities.

Plate 6. 1: Four stances sex segregated VIP latrine shared by both staff and patients with handwashing facility.
Source: Author, (2025).

This is critical for women's safety, dignity, and comfort in healthcare settings. According to the Reduction and Prevention Theory, unsafe sanitation deters women from accessing care and increases their risk of infection. The Improvement Theory emphasizes that gender-sensitive infrastructure improves service utilization and the patient experience. Therefore, installing gender-separated toilets is essential to providing equitable healthcare, particularly in communities recovering from conflict where women's needs are often overlooked.

Table 6.2: Descriptive Statistics on the Status of Waste Management Practices in Healthcare Facilities in Upper Nile State

Variable	Frequency	Percent	Valid Percent	Cum Percent
Waste Segregation				
Meets waste segregation standard	0	0.0	0.0	0.0
Does not meet	20	100.0	100.0	100.0
Incinerator Use				
WHO-standard incinerator	0	0.0	0.0	0.0
Other	20	100.0	100.0	100.0
Sharps Waste Disposal				
Safe	11	55.0	55.0	55.0
Unsafe disposal (burning, pit)	9	45.0	45.0	100.0
PPE Availability				
PPE Available	0	0.0	0.0	0.0
No PPE	20	100.0	100.0	100.0
Fenced Waste Storage				
Not available	18	90.0	90.0	90.0
Fenced area available	2	10.0	10.0	100.0

Source: *Author's Computation from Primary Dataset, 2025.*

The findings in Table 6.2 reveal serious weaknesses in waste management practices across healthcare facilities in Upper Nile State. None of the healthcare facilities met standard waste segregation requirements, as all facilities (100%) lacked proper segregation systems such as labeled bins with lids for separating medical waste. Similarly, none of the facilities used WHO-standard

incinerators for infectious waste disposal, with all facilities relying on alternative disposal methods. These findings indicate a complete lack of compliance with recommended healthcare waste management standards and suggest severe infrastructural and operational deficiencies in handling infectious waste within the healthcare facilities.

The study further established that waste disposal practices remained unsafe in many facilities. Although 55% of healthcare facilities disposed of sharps waste safely, 45% still used unsafe methods such as open burning or disposal in unprotected pits. In addition, none of the facilities had personal protective equipment (PPE) available for waste handlers, exposing healthcare workers to direct contact with hazardous and infectious materials. Furthermore, 90% of the healthcare facilities lacked fenced or protected waste storage areas, while only 10% had designated fenced waste storage spaces. The absence of safe storage facilities increases environmental contamination and the risk of accidental exposure to hazardous waste among patients, staff, and nearby communities.

These findings support the Reduction and Prevention Theory, which emphasizes that proper waste management practices are essential for preventing healthcare-associated infections and minimizing disease transmission in healthcare settings. Poor waste segregation, unsafe sharps disposal, lack of PPE, and inadequate waste storage increase the risk of infections such as hepatitis, HIV/AIDS, and other communicable diseases among healthcare workers and the surrounding population. The findings also align with the Improvement Theory, which views effective waste management systems as critical for improving healthcare quality, operational efficiency, environmental safety, and worker protection. Therefore, the study implies that urgent investment is required in waste management infrastructure, provision of PPE, standard incineration systems, and staff training to strengthen infection prevention and improve healthcare service delivery in conflict-affected healthcare facilities in Upper Nile State, South Sudan.

As shown in Table 6.2.2, only 10% of facilities have fenced and protected areas for waste storage, while 90% do not. The mean is low (0.10) with little variation, indicating that most facilities operate without secure waste containment systems.

Plate 6. 2: Unprotected incinerator site in Asosa PHCC.
Source: Author, (2025).

Unfenced storage areas increase the risk of exposure for animals, children, and the surrounding community, especially in rural or overcrowded environments. According to the Reduction and Prevention Theory, proper containment prevents environmental contamination and the spread of disease from unmanaged waste. From the Improvement Theory perspective, fencing is a basic infrastructure need that supports organized waste handling and reduces the likelihood of accidental exposure.

Table 6.3: Cross Tabulation between Facility Type and Sanitation Service Level in Healthcare Facilities in Upper Nile State

		Service Level for Sanitation		Total
		Limited	No Service	
Facility Type	**PHCC**	Count	13	3
		Expected Count	13.6	2.4
		% within Facility Type	81.3%	18.8%
		% within Service Level for Sanitation	76.5%	100.0%
	Hospital	Count	4	0
		Expected Count	3.4	.6
		% within Facility Type	100.0%	0.0%
		% within Service Level for Sanitation	23.5%	0.0%
Total		Count	17	3
		Expected Count	17.0	3.0
		% within Facility Type	85.0%	15.0%
		% within Service Level for Sanitation	100.0%	100.0%

Source: *Author's Computation from Primary Dataset, 2025.*

Table 6.3 shows that the majority of healthcare facilities were PHCCs, and both PHCCs and hospitals largely operated under limited sanitation service levels, indicating widespread inadequacy of sanitation infrastructure across all facility types in Upper Nile State.

Table 6.4: Chi-Square Test Results on the Relationship Between Sanitation Service Level and Facility Type in Healthcare Facilities in Upper Nile State

Chi-Square Tests	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.882a	1	.348		
Continuity Correctionb	.025	1	.876		
Likelihood Ratio	1.466	1	.226		
Fisher's Exact Test				1.000	.491
Linear-by-Linear Association	.838	1	.360		
N of Valid Cases	20				

a. 3 cells (75.0%) have expected count less than 5. The minimum expected count is .60.

b. Computed only for a 2x2 table

Source: *Author's Computation from Primary Dataset, 2025.*

Table 6.4 indicates that there was no statistically significant relationship between facility type and sanitation service level ($p = 0.348$), suggesting that both hospitals and PHCCs experienced similar sanitation challenges in healthcare facilities across Upper Nile State.

Table 6.5: Ordinal Logistic Regression Results on Predictors of Sanitation Service Adequacy in Healthcare Facilities in Upper Nile State

Predictor variable	Odds Ratio (OR)	Sig. value
Facility type	0.341	0.022*
Presence of staff toilets	2.124	0.041*
Number of functional cubicles	1.532	0.038*

Waste kit availability	2.475	0.016*
Gender-separated toilets	1.896	0.071

Source: *Author's Computation from Primary Dataset, 2025.*

Table 6.5 reveals that the presence of staff toilets, functional toilet cubicles, and waste transport kits significantly increased the likelihood of adequate sanitation services, while PHCCs were less likely to provide adequate sanitation compared to hospitals in Upper Nile State.

The qualitative findings strongly complemented the quantitative results by revealing how inadequate sanitation and waste management directly affect the dignity, safety, and wellbeing of healthcare users and workers in Upper Nile State. Quantitative findings showed that only 15% of healthcare facilities had gender-separated toilets and none had menstrual hygiene management (MHM) facilities, disproportionately affecting women, especially pregnant and postpartum mothers. Lactating mothers described experiences of shame, discomfort, and lack of privacy while accessing sanitation facilities. One mother explained, *"We shared the toilet with men and children. There was no privacy. I felt ashamed each time I went there"* (KII 14 – Lactating Mother, Maiwut PHCC), while another stated, *"During delivery, I had no place to change. There were no facilities for women like us. It was humiliating"* (KII 22 – Lactating Mother, Oriny PHCC). These narratives reinforce the quantitative evidence that the absence of gender-sensitive sanitation undermines women's dignity, discourages healthcare utilization, and reflects systemic neglect of gender-responsive WASH services in healthcare facilities.

Experiences shared by inpatients further illustrated the consequences of inadequate sanitation infrastructure. Although 75% of facilities had at least one usable toilet, 25% lacked any functioning toilet, and only 25% of toilets were considered clean. Patients described exposure to unhygienic and unsafe sanitation conditions, with some resorting to using bushes or containers due to inaccessible or overflowing latrines. One inpatient reported, *"The toilets were full and smelly. We had to use the bush behind the ward. Even staff would tell us they had no solution"* (KII 32 – Inpatient, Baliet PHCC). These findings are consistent with the Reduction and Prevention Theory, which emphasizes that poor sanitation, increases the spread of infections and negatively affects health outcomes. The findings also demonstrate how poor maintenance, lack of cleaning schedules, and inadequate infrastructure compromise infection prevention and patient safety in conflict-affected healthcare settings.

Health workers equally expressed concern regarding unsafe waste management practices and poor sanitation conditions within healthcare facilities. Quantitative findings indicated that none of the facilities met waste segregation standards, none used WHO-standard incinerators, and no facility provided personal protective equipment (PPE) for waste handlers. Healthcare workers described routine exposure to hazardous waste without protection and highlighted the use of unsafe disposal methods such as open burning. One health worker noted, *"We have no incinerator. We burn waste in open pits, sometimes behind the building. Children play nearby. It's risky"* (KII 53 – Health Staff, Wau Shilluk PHCC), while another stated, *"We don't segregate waste, it's mixed and burned in open. We lack color-coded bins"* (KII 50 – Health Staff, Maiwut PHCC). Others emphasized the lack of separate toilets for staff and patients, explaining that overcrowded and unhygienic sanitation facilities affected their dignity, comfort, and ability to maintain infection prevention standards during long working hours.

The discussion of findings revealed strong consistency between the present study and previous global evidence on WASH deficiencies in low-resource and conflict-affected settings. Similar to findings by World Health Organization and UNICEF, the study confirmed widespread inadequacies in sanitation services, toilet functionality, gender-sensitive sanitation, waste segregation, PPE availability, and safe waste disposal systems. The findings align with studies conducted in Ethiopia, Uganda, Sudan, and other low- and middle-income countries, which similarly reported poor sanitation infrastructure, lack of incinerators, inadequate staff sanitation facilities, and weak infection prevention systems. However, the Upper Nile context reflects even greater fragility due to conflict, displacement, infrastructural collapse, and limited institutional support. Overall, the findings emphasize that improving WASH infrastructure, strengthening waste management systems, providing PPE, and integrating gender-sensitive sanitation are critical for enhancing infection prevention, healthcare worker safety, patient dignity, and quality healthcare delivery in fragile and post-conflict health systems.

DISCUSSION

The findings of this study on sanitation and waste management in healthcare facilities in Upper Nile State strongly align with existing literature, confirming a widespread pattern of inadequate WASH systems in low- and middle-income countries. The observation that most facilities operate with limited or no sanitation services, lack functional toilets, and have no structured cleaning systems corroborates global evidence by World Health Organization (2019; 2022) and UNICEF (2019), which reported that a significant proportion of healthcare facilities in fragile settings lack basic sanitation infrastructure. Similar conditions were reported by Tadesse and Kumie (2014) in Ethiopia and Longe (2011) in Nigeria, where poor sanitation and inadequate maintenance systems were identified as major barriers to infection prevention. This study therefore confirms a consistent pattern across contexts that sanitation deficits are not isolated but systemic, especially in resource-constrained and conflict-affected health systems. However, the complete absence of menstrual hygiene management (MHM) facilities in Upper Nile presents a more severe situation compared to partial availability reported in some African contexts, indicating a deeper infrastructural collapse than documented in earlier studies.

The findings on waste management practices also show strong agreement with regional and continental evidence, particularly regarding poor waste segregation, absence of incinerators, and lack of personal protective equipment (PPE). The 100% failure rate in waste segregation aligns with studies by Abah and Ohimain (2011) in Nigeria, Oyekale and Oyekale (2017), and Mbongwe *et al*., (2008) in Botswana, all of which reported weak compliance with waste separation standards due to inadequate infrastructure and staff training. Similarly, the absence of WHO-standard incinerators corroborates findings by Kwikiriza *et al*., (2019) in Uganda and Kyomba *et al.,* (2021) in the Democratic Republic of Congo, who highlighted reliance on unsafe disposal methods such as open burning. The total lack of PPE in Upper Nile further confirms Odonkor and Mahami (2020) and Wafula *et al*., (2019), who identified occupational exposure risks as a persistent challenge in African healthcare waste systems. However, unlike studies that reported partial compliance or donor-supported improvements, the present study reveals a near-total system failure, suggesting that conflict dynamics and institutional breakdown in Upper Nile intensify deficiencies beyond levels observed in relatively stable settings.

The study's qualitative findings, analyzed using established thematic approaches consistent with Braun and Clarke (2006), Creswell (2014), and Patton (2015), further corroborate quantitative results by illustrating how infrastructure deficits translate into lived experiences of risk and exclusion. Mothers' experiences of humiliation due to lack of privacy and MHM facilities align with WHO (2019; 2022) and UNICEF (2022), which emphasize dignity and gender responsiveness as core components of WASH in healthcare settings. Inpatient accounts of using bushes and unsafe toilets confirm findings by Oyekale and Oyekale (2017), who noted that poor sanitation discourages healthcare utilization and increases infection risks. Health workers' testimonies of unsafe waste burning and lack of PPE reinforce Chisholm *et al.,* (2021) and Ezeudu *et al*., (2022), who identified governance gaps and weak enforcement of waste management policies as major constraints in Africa. Across all data sources, there is strong triangulation (Denzin, 2017; Creswell & Plano Clark, 2018), confirming that sanitation and waste management failures in Upper Nile are not only infrastructural but also systemic, policy-related, and exacerbated by conflict conditions, thereby reinforcing the need for comprehensive WASH system strengthening interventions.

CONCLUSION

The study concludes that sanitation and waste management services in healthcare facilities in Upper Nile State are critically inadequate, characterized by limited or absent of sanitation services, poor toilet functionality and cleanliness, absence of gender-sensitive and menstrual hygiene facilities, and extremely weak waste management systems including lack of segregation, incineration, PPE, and safe storage. These deficiencies are consistent across facility types and are not statistically associated with whether a facility is a hospital or PHCC, indicating a systemic health system failure rather than isolated institutional weaknesses. Consequently, these gaps significantly compromise infection prevention and control, endanger healthcare workers and patients, and undermine the overall quality, safety, and utilization of healthcare services in a fragile and conflict-affected setting.

Recommendation

The Ministry of Health of South Sudan, in collaboration with State Health Authorities in Upper Nile and supported by development partners such as World Health Organization and UNICEF, should prioritize urgent nationwide rehabilitation of sanitation infrastructure in healthcare facilities by ensuring the construction, upgrading, and maintenance of functional, clean, and gender-separated toilets in all PHCCs and hospitals. This should include mandatory integration of menstrual hygiene management (MHM) facilities as a standard requirement in all new and existing health facility designs. A dedicated WASH infrastructure funding stream should be established within the health sector budget to ensure sustainability, with priority given to conflict-affected and underserved counties in Upper Nile State.

Health facility managers and Infection Prevention and Control (IPC) committees should implement strict operational protocols for sanitation maintenance and waste handling, in line with World Health Organization guidelines on WASH in healthcare facilities. This includes enforcing daily toilet cleaning schedules, assigning trained sanitation focal persons, ensuring consistent availability of cleaning materials, and institutionalizing monitoring checklists for hygiene compliance. Facilities should also ensure strict waste segregation at source using color-coded bins, establish routine supervision mechanisms, and prohibit unsafe practices such as open burning of medical waste. Strengthening facility-level accountability will improve service quality and reduce infection risks among patients and healthcare workers.

The Government of South Sudan, donor agencies, and health workforce regulatory bodies should jointly invest in occupational safety and health protection for healthcare workers by ensuring continuous supply of personal protective equipment (PPE), installation of WHO-compliant incinerators, and construction of secure, fenced waste storage areas in all healthcare facilities. In addition, structured capacity-building programs should be implemented to train health workers on safe healthcare waste management practices, supported by enforcement of national waste management policies as highlighted by UNICEF and global waste governance frameworks. These interventions should be embedded within broader health system strengthening and post-conflict recovery programs to ensure sustainability, worker safety, and improved service delivery outcomes.

REFERENCES

Abah, S. O., &Ohimain, E. I. (2011). Healthcare waste management in Nigeria: A case study. Journal of Public Health and Epidemiology, 3(3), 99–110.
https://doi.org/10.5897/JPHE11.078
https://academicjournals.org/journal/JPHE/article-full-text/10.5897/JPHE11.078

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. Qualitative Research in Psychology, 3(2), 77–101.
https://doi.org/10.1191/1478088706qp063oa

Chisholm, J., et al. (2021). Healthcare waste governance in Africa: Policy gaps and implementation challenges. Waste Management & Research.
https://doi.org/10.1177/0734242X211029175
https://journals.sagepub.com/doi/10.1177/0734242X211029175

Creswell, J. W. (2014). Research design: Qualitative, quantitative, and mixed methods approaches (4th ed.). SAGE Publications.

Creswell, J. W., & Plano Clark, V. L. (2018). Designing and conducting mixed methods research (3rd ed.). SAGE Publications.

Denzin, N. K. (2017). The research act: A theoretical introduction to sociological methods. Routledge.

Ezeudu, O. B., Ezeudu, T. S., Ugochukwu, U. C., et al. (2022). Healthcare waste management in Nigeria: A review. Recycling, 7(6), 87.
https://doi.org/10.3390/recycling7060087
https://www.mdpi.com/2313-4321/7/6/87

Kwikiriza, S., Stewart, A. G., Mutahunga, R. E., & Dobson, A. E. (2019). A whole systems approach to hospital waste management in rural Uganda. Frontiers in Public Health, 7,136.
https://doi.org/10.3389/fpubh.2019.00136
https://www.frontiersin.org/articles/10.3389/fpubh.2019.00136/full

Kyomba, G. K., Numbi, J. N. K., Saila-Ngita, D., et al. (2021). Healthcare waste management in Kinshasa hospitals, Democratic Republic of Congo. Waste Management & Research, 39(10).
https://doi.org/10.1177/0734242X211048132
https://journals.sagepub.com/doi/10.1177/0734242X211048132

Longe, E. O. (2011). Healthcare waste management status in Lagos State, Nigeria. Waste Management & Research, 30(6), 607–614.
https://doi.org/10.1177/0734242X11412109
https://journals.sagepub.com/doi/10.1177/0734242X11412109

Malterud, K., Siersma, V. D., & Guassora, A. D. (2016). Sample size in qualitative research: Systematic analysis in interviews. Qualitative Health Research, 26(13), 1753–1760.
https://doi.org/10.1177/1049732315617444
Mbongwe, B., Mmereki, B. T., &Magashula, A. (2008). Healthcare waste management: Current practices in selected healthcare facilities in Botswana. Waste Management, 28(1), 226–233.
https://doi.org/10.1016/j.wasman.2006.12.019
https://www.sciencedirect.com/science/article/pii/S0956053X07000019
Mmereki, D., Baldwin, A., Li, B., & Liu, M. (2017). Healthcare waste management in Botswana: Storage, collection, treatment and disposal system. Journal of Material Cycles and Waste Management, 19, 351–364.
https://doi.org/10.1007/s10163-015-0429-0
Muzaale, T (2021). Management Function and Water Quality Service Concerns: Emerging Management Issues in Selected Town Councils in Uganda. African Journal of Governance and Public Leadership, 1(1), 52–67. https://ajogpl.kab.ac.ug/index.php/1/article/view/5
Odonkor, S. T., &Mahami, T. (2020). Healthcare waste management in Ghanaian hospitals: Associated public health and environmental challenges. Waste Management & Research, 38(8), 831–839.
https://doi.org/10.1177/0734242X20914748
https://journals.sagepub.com/doi/10.1177/0734242X20914748
Oyekale, A. S., & Oyekale, T. O. (2017). Healthcare waste management practices and safety indicators in Nigeria. BMC Public Health, 17, 740.
https://doi.org/10.1186/s12889-017-4794-6
https://bmcpublichealth.biomedcentral.com/articles/10.1186/s12889-017-4794-6
Patton, M. Q. (2015). Qualitative research and evaluation methods (4th ed.). SAGE Publications.
Tadesse, M. L., & Kumie, A. (2014). Healthcare waste generation and management practices in government health centers of Addis Ababa. BMC Public Health, 14, 1221.
https://doi.org/10.1186/1471-2458-14-1221
https://bmcpublichealth.biomedcentral.com/articles/10.1186/1471-2458-14-1221
UNICEF. (2019). WASH in healthcare facilities: Global baseline report. UNICEF.
UNICEF. (2022). Water, sanitation and hygiene in health care facilities. UNICEF.
Wafula, S. T., Musiime, J., &Oporia, F. (2019). Healthcare waste management among health workers in primary health care facilities in Kampala City, Uganda. BMC Public Health, 19, 203.
https://doi.org/10.1186/s12889-019-6528-4
https://bmcpublichealth.biomedcentral.com/articles/10.1186/s12889-019-6528-4
WHO. (2017). Water quality and safety in healthcare facilities. World Health Organization.
WHO. (2019). Water, sanitation and hygiene in health care facilities: Practical steps to achieve universal access. World Health Organization.
WHO. (2022). Global progress report on WASH in healthcare facilities. World Health Organization.

****