Baseline and Benchmarking Assessment of Health Care Waste Management Systems in Southwest Asia

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Contents

List of Tables

List of Figures

Acronyms and Abbreviations

BAT	Best available technology
BEP	Best environmental practice
COVID 19	Coronavirus disease 2019
DGHS	Directorate General of Health Services
HCF	Health care facility
HCWH	Health Care Without Harm
HCWM	Health care waste management
HECAF360	Health, Environment and Climate Action Foundation
HHG	HIV and Health Group
HPA	Health Protection Agency
IPC	Infection prevention and control
MoH	Ministry of Health
MoHFW	Ministry of Health and Family Welfare
NEC	National Environment Commission
PPE	Personal protective equipment
SOP	Standard operating procedure
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNICEF	United Nations Children's Fund
WASH	Water, sanitation and hygiene
WHO	World Health Organization

Executive Summary

To be truly effective, health care necessitates the delivery of services along with safeguarding environmental sustainability—all while being underpinned by the principles of patient safety, infection prevention and control, and quality health care outcomes. One of the ways in which environmental sustainability and public health overlap is through the proper management of health care waste. It is therefore imperative that health care facilities (HCFs) at all levels prioritize comprehensive and sustainable approaches to health care waste management (HCWM). However, despite its importance, proper HCWM is often overlooked in light of other pressing issues in HCF operations, such as ensuring the availability of medical supplies, managing the workforce and maintaining facility infrastructure.

This challenge is not unique to the Southwest Asia region. Countries in the region face significant challenges in managing health care waste effectively – challenges that are exacerbated by rapid urbanization, population growth and inadequate infrastructure. The region's health care systems generate substantial volumes of waste, comprising infectious, hazardous and non-hazardous materials. A literature review on health care waste generation finds that significant amounts of hazardous waste are generated at HCFs. In many cases, studies suggest that the identified portion of hazardous waste exceeds the World Health Organization's (WHO) estimated 10–25 percent share of total HCF waste.

To address the development challenges in HCWM, the 'Project for the Improvement of Infectious Waste Management in Southwest Asia' is being implemented in Bangladesh, Bhutan and Maldives. The project is funded by the Government of Japan and aims to deliver sustainable solutions to HCWM by deploying locally appropriate, gender-sensitive, safe and sustainable practices and technologies. It also aims to facilitate dialogue between governments and national stakeholders to shape their HCWM frameworks according to their unique contextual factors.

Baseline and benchmarking of HCWM in Bangladesh, Bhutan and Maldives

In support of the broader project objectives, the United Nations Development Programme (UNDP) HIV and Health Group (HHG) at the Bangkok Regional Hub (BRH) commissioned a baseline and benchmarking assessment of the HCWM systems in Bangladesh, Bhutan and Maldives. This report presents the findings of the assessment, following a framework based on the Gavi HCWM Maturity Model, which examines different parameters, including:

1. Awareness, training and supportive supervision;
2. Adherence and compliance;
3. National policy and strategic plans;
4. Budget and planning;
5. Practical guidance;
6. Availability and use of technology and equipment.

Based on the results of the assessment, country-specific and regional-level actions for strengthening HCWM are recommended.

The assessment framework analysed HCWM practices and adherence to international guidelines across the three countries using country-specific data and secondary sources, including waste generation rates, statistics and historical practices. Country-specific data sources included national legislation, technical guidelines, institutional arrangements and relevant studies. Primary data collection was limited to key informant interviews. The baseline and bench-marking assessments for each country were documented in individual country reports, validated by key government authorities and stakeholders for accuracy and relevance.

Policy and operational guidelines for HCWM

Fundamentally, a review of the HCWM regulatory framework in the three countries shows that there are established policies and guidelines on HCWM, often involving cooperation between health and environment ministries, reflecting the interdisciplinary nature of HCWM and the need for coordinated efforts to address environmental and public health concerns. This indicates that each country is implementing some level of commitment or strategy to ensure appropriate and safe HCWM. While all three countries have established HCWM standards, as indicated by their inclusion in the WHO/UNICEF Joint Monitoring Programme for Water Supply, Sanitation and Hygiene country progress tracking, full-scale implementation remains a challenge. Efforts made in this regard are either integrated with broader infection prevention and control (IPC) initiatives implemented at various levels or are reflected in the functions of relevant committees and staff at the facility level. Sources of funds and mechanisms for funding HCWM activities vary, but no information is available on how funds are apportioned between the different IPC and HCWM activities. In some cases, external donor-supported initiatives provide significant advancements in HCWM implementation such as for planning and raising awareness, but these are generally allocated based on specific short-term project objectives that do not sustain basic operating costs.

Another notable observation from the policy review is the lack of emphasis on prohibiting incineration of health care waste, except for designated hazardous waste. It is important to note that WHO HCWM guidelines and international best practices advocate for non-incineration treatment methods, aligning with global initiatives to balance effective waste treatment with environmental responsibility in the health care sector.

Adherence and compliance for safe HCWM

While each country's context varies, the assessment results reveal common challenges across Bangladesh, Bhutan and Maldives, especially regarding proper segregation, treatment and disposal of health care waste. Despite these challenges, positive efforts are under way, including training and capacity-building initiatives for health care personnel, and the dissemination of guidance materials. However, these efforts often face limitations due to resource constraints, leading to infrequent or limited implementation. Furthermore, the absence of comprehensive compliance monitoring mechanisms exacerbates the challenges in ensuring adherence to best practices in HCWM.

The study's reliance on secondary data limits the analysis of gender-based indicators in HCWM activities in the three countries. Although gender imbalances are recognized in the health care sector, data on gender-sensitive training, female leadership representation and gender-specific health risks are insufficient. Future studies should therefore prioritize collecting primary data to fill these gaps and deepen understanding of gender issues in HCWM in these countries.

Technology and equipment for HCWM

The assessment of the availability and use of treatment technology across the three countries reveals significant differences. While some facilities have advanced systems in place, many others face challenges due to inadequate resources for waste management. External assistance is often essential in addressing these technological deficiencies. These disparities highlight the different approaches to HCWM across the facilities and countries, usually influenced by factors such as infrastructure, resource availability and regulatory frameworks.

Key measures to strengthening HCWM in the region

Following the baseline and benchmarking activity, several action points that can be taken up by all three countries are recommended:

- Implement a comprehensive and inclusive training programme on HCWM tailored to different audiences and including pre-service training, and which incorporates a monitoring and evaluation system to ensure continual improvement and effectiveness.

- Allocate dedicated resources, including personnel, equipment and funding, specifically for monitoring HCWM processes at facility, district and central levels to encourage compliance with regulations and establish accountability throughout the HCWM process.
- Review key HCWM policies and strategic plans regularly to ensure they remain relevant and effective considering evolving circumstances and advancements in waste treatment technologies, while also conducting regular audits to collect accurate data and continuously improve HCWM practices.
- Invest in capacity-building for budgeting and planning at national and subnational levels, as well as for the procurement and maintenance of sustainable technologies and equipment at the facility level.
- Establish standardized procedures and mechanisms for ongoing monitoring and evaluation to ensure consistency in waste management practices across HCFs.
- Promote sustainable practices and adopt environmentally friendly and efficient technologies for long-term benefits in HCWM. Ensure adequate maintenance of infrastructure and equipment for effective implementation.

To complement these measures, the following activities are recommended for regional development partners to support countries in the region:

- Support countries in reviewing national HCWM policies, strategies and regulatory frameworks and aligning them with international guidelines, ensuring gender responsiveness and developing risk reduction strategies for climate resilience during emergencies.
- Support countries in identifying and addressing gaps in waste minimization, procurement, supply chain management, and integration with municipal waste management, while providing tailored technical support to enhance policy implementation.
- Strengthen collaboration among regional partners across the health, environment, disaster risk reduction and development sectors to share knowledge and align support for countries in the region.
- Support low- and middle-income countries in strengthening capacities for planning, monitoring and evaluating HCWM systems, and promote uniform definitions and methodologies for data collection to ensure consistency and comparability across jurisdictions.
- Promote policies and economic measures encouraging the reduction of health care waste volumes such as the shift to reusable personal protective equipment or non-burn treatment technologies.
- Advocate for appropriate technologies for HCWM, particularly non-burn options, by developing and sharing best practices across the region.
- Strengthen countries' capacities to sustain HCWM technologies through adherence to standard operating procedures and robust maintenance practices, while incorporating gender-sensitive approaches to education and training.
- Advocate for clear and standardized funding mechanisms for HCWM, covering investment, operation, maintenance and repair.
- Support the institutionalization of a national HCWM capacity-building and training system in universities, medical schools and HCFs.

1. Background

The threat posed by inadequate health care waste management (HCWM) systems requires urgent attention to protect human health, and to minimize environmental and social impacts. Improperly managed health care waste is a significant source of pollutants: untreated health care waste in open dumps and landfill sites can cause soil and water contamination, while incineration and open burning of health care waste can lead to the release of air pollutants, including persistent organic pollutants such as dioxins and furans.

Many low- and middle-income countries have historically had limited public and private investments in sustainable waste treatment systems. This issue was starkly highlighted during the COVID-19 pandemic, which saw an unprecedented increase in the generation of health care waste, particularly of infectious waste, and brought about significant waste management challenges, particularly in resource-constrained settings. According to the World Health Organization (WHO), this increase was compounded by uncertainties surrounding the risks posed by COVID-19-related waste, resulting in the unnecessary use and overuse of personal protective equipment (PPE). Ultimately, the COVID-19 pandemic serves as a learning opportunity on ways to improve HCWM systems and to mitigate the risks and consequences of future health emergencies. The WHO's 2022 publication on the COVID-19 waste situation offers some practical, scalable and sustainable HCWM solutions, applicable from the global level down to individual facilities.[1]

This situation is the same for the South Asia region, including for Bangladesh, Bhutan and Maldives. Gaps in the implementation and enforcement of regulations and guidelines, infrastructure and awareness among health care workers of the risks of unsafe HCWM existed even before the COVID-19 pandemic and have since been exacerbated by the crisis.

Funded by the Government of Japan, the 'Project for the Improvement of Infectious Waste Management in Southwest Asia' aims to deliver sustainable HCWM solutions in Bangladesh, Bhutan and Maldives, thereby contributing to building strong and resilient health systems. The overall goal is to address development challenges of inadequate HCWM in national and local government health care institutions in Bangladesh, Bhutan and Maldives through the deployment of locally appropriate, gender-sensitive, safe and sustainable HCWM practices and technologies. The project will also contribute to fostering dialogue between governments and national stakeholders to shape the future of HCWM in the countries.

More specifically, the project aims to:

- Enable procurement of non-incineration equipment, machinery and vehicles for the treatment and transportation of health care waste;
- Build the capacity of health care facility (HCF) workers and health care waste handlers on safe waste handling and disposal practices;
- Ensure HCWM practices follow standard monitoring and regulatory frameworks, and that appropriate policy is in place;
- Implement digital technology for monitoring and enhancing HCWM practices;
- Foster South-South knowledge sharing and collaboration on good practices of HCWM to meet international standards and conventions.

In support of these objectives, the United Nations Development Programme (UNDP) HIV and Health Group (HHG) at the Bangkok Regional Hub (BRH) commissioned a baseline and benchmarking assessment of HCWM in the three countries.

1.1 Baseline and benchmarking assessment objective

The objective of the assessment is to establish baseline conditions in the HCWM systems of each of the three countries, considering both policy and practice. This assessment serves as a benchmark of the current conditions measured against international best practices. The results of the benchmarking exercise highlight the areas requiring the most attention and form the basis of the recommendations at country and regional levels.

1 World Health Organization, 'Global analysis of healthcare waste in the context of COVID-19: Status, impacts and recommendations', WHO, Geneva, 2022. https://washinhcf.org/wp-content/uploads/2022/02/Health-care-waste-COVID-19-context_Final.pdf.

1.2 Methodology

The assessment was conducted by a team involving a lead consultant and three national consultants from the three countries in the collection and analysis of data and information. This process was carried out under the guidance and supervision of UNDP BRH and in coordination with the respective UNDP Country Offices. This study follows the approach adopted in a previous UNDP study on the HCWM practices and disaster risk reduction capacities of HCFs in Cambodia, Lao PDR, Myanmar, Nepal and the Philippines. [2]

Assessment framework

A systematic plan for the assessment was designed based on international guidelines and best practices on HCWM, with parameters including policies, regulations, waste management practices, training of health care workers and technologies used in the process. The benchmarking exercise adopted the Gavi HCWM Maturity Model,[3] which takes a holistic systems approach to strategic-level assessment. The model examines six key areas of HCWM, as presented in Box 1.

Box 1. Six key areas of assessing the maturity of HCWM systems under the Gavi HCWM Maturity Model

People

1. **Awareness, training and supportive supervision**
   Looks at the availability of training for health care workers and waste handlers on HCWM (both pre-service and in-service) and the level of integrated supervision that incorporates HCWM; and tracks comprehension of best practices in HCWM.
2. **Adherence and compliance**
   Assesses the level of adherence to HCWM best practices across the entire process, from point of generation to point of disposal. Monitoring and evaluation frameworks and key performance indicators in place and supported through supervision.

Processes

3. **National policy / strategic plans**
   Includes national policies and strategic plans for HCWM (including any specific immunization policies or guidance); laws and regulations related to HCWM; and environmental impacts and policies on environmental sanitation and hygiene, among others.
4. **Budget and planning**
   Reflects the country having developed an appropriate budget that is fully funded and supports realistic needs. Budgets should be linked to resources and tools needed across all steps of HCWM, such as colour-coded bags at the facility level, waste transport, treatment and disposal sites, and maintenance of HCWM equipment.
5. **Practical guidance**
   Looks at the hands-on tools such as standard operating procedures (SOPs), communication guidance and job aids for health care workers and waste handlers directly involved in generating and managing waste.

Technology

6. **Availability and the use of technology and equipment**
   Beyond equipment for treatment and disposal, this key area also incorporates all of the tools and supplies needed for HCWM. This includes colour-coded collection technology at point of generation of waste, resources for occupational health and safety such as personal protective equipment, and the entire management process until disposal. This area should also consider maintenance of equipment to ensure functionality and overall sustainability.

2 United Nations Development Programme, 'Benchmarking Health Care Waste Management and Disaster Risk Reduction Capacities in Five Asian Countries', UNDP, Bangkok, 2023. https://www.undp.org/asia-pacific/publications/benchmarking-health-care-waste-management-and-drr-capacities-five-asian-countries.

3 Gavi, The Vaccine Alliance, 'Health Care Waste Management Maturity Model', Gavi, Geneva and Washington, DC, May 2020. https://www.gavi.org/sites/default/files/programmes-impact/support/HCWM-Maturity-Model-May-2020.pdf.

Each of the six areas of assessment was assigned a score from 1 to 5, with 1 being the lowest possible assessment and 5 the highest (Box 2).

Box 2. Description of the five levels of maturity under each area of assessment

Area	Level 1	Level 2	Level 3	Level 4	Level 5
People					
Awareness, training and supportive supervision	Low level of awareness of risk associated with HCW (less than 40%).	Moderate awareness of risk associated with HCW; curriculum developed but not fully rolled out (implemented in 41–50% of facilities).	A significant proportion of health care workers and waste handlers (51–75%) are trained on the risks associated with HCW, and clear guidance on HCWM is available. at most facilities. at most facilities.	High level of awareness of HCW risk; 76–85% of health care workers and waste handlers have undergone training and have access to ongoing training.	More than 85% of health care workers and waste handlers are trained and are aware of risks associated with HCW and demonstrate BEP; HCWM is included in supportive supervision activities.
Adherence and compliance	Little insight into adherence to best practices for HCWM.	Have insight and best practice of HCWM available (SOPs and job aids) but not practised (fewer than 50% of facilities adhere and comply).	Best practices of HCWM being adhered to in at least half of the facilities; minimal M&E in place.	Significant compliance with HCWM best practices; M&E framework in place with some tracking of adherence.	Country fully adheres to HCWM best practices; M&E framework tracks adherence to policies and guidance.
Processes					
National policy / strategic plans	Policy is needed or is currently being developed; no recent HWCM assessment carried out (within the last 5 years).	Policy developed and / or reviewed within the last 5 years; HWCM assessment carried out within the last 5 years.	Policies and guidelines are disseminated and partially adopted.	Country can show that the policies and guidelines are fully implemented at all levels of the system.	Policies widely adopted across the country; evidence that waste management performance gaps are addressed in strategic planning and financing mechanisms at national and subnational levels.
Budget and planning	HCWM is not planned and budgeted.	HCWM is budgeted, but not directly linked to realistic needs or assessment findings.	At least half of facilities develop an HCWM budget and implement specific plans.	Budgets are available, funded and tracked at 75% of system levels.	HCWM is 100% budgeted at national and subnational levels.
Practical guidance	Needed or currently being developed.	Guidance developed but not fully in use (used in fewer than 50% of facilities).	Guidance developed and in use in 50–65% of facilities in the country.	Guidance available and being implemented at most (65–85%) system levels.	Guidance available and in use in more than 85% of facilities in the country.
Technology					
Availability and use of technology and equipment	Not aware of BAT and BEP; out-of-date, inefficient, non-environmentally friendly options for treatment and disposal.	Awareness of the recommended BAT and BEP options but still using out-of-date equipment and technology.	Some BAT equipment available at 50% of facilities (or 50% access services) and/or at least 50% of the waste generated is treated and disposed of using globally accepted technologies.	Globally accepted equipment is widely available (more than 51% of facilities); facilities are clustered and mapped to an acceptable treatment technology.	Only efficient and BAT used in HCWM; environmental monitoring of waste treatment and disposal done in compliance with national and/or global standards.

Notes: HCW: health care waste; BAT: best available technology; BEP: best environmental practice.

Scope and limitations

The framework used country-specific data to analyse the HCWM practices across the three countries, as well as their adherence to international guidelines and best practices. The assessment relied mainly on secondary sources of information, such as waste generation rates, statistics and historical HCWM practices. Country-specific data and information sources included national legislation and regulations governing HCWM, technical guidelines issued by the government, institutional or governance arrangements and key stakeholders, and any relevant studies on HCWM practices. In view of the limited time frame for conducting the study, primary data collection was limited to key informant interviews.

Gaps were identified where data and information were insufficient to complete the framework, and these were flagged as priorities for future research efforts. Recommendations were informed by expert interviews and reports by WHO/UNICEF[4] and the United Nations Environment Programme (UNEP)[5]. These sources were considered in particular in developing the recommendations for regional cooperation.

Each country's baseline and benchmarking assessment was documented in a country report, which was validated with input from key government authorities and other stakeholders to ensure accuracy and relevance.

4 World Health Organization and United Nations Children's Fund, 'Water, sanitation, hygiene, waste and electricity services in health care facilities: progress on the fundamentals 2023 Global Report', WHO, Geneva, and UNICEF, New York, 2023. https://www.who.int/publications/i/item/9789240075085.

5 United Nations Environment Programme and Institute for Global Environmental Strategies, 'Waste management during the COVID-19 pandemic: from response to recovery', UNEP, Nairobi, and IGES, Kanagawa, 2020. https://www.unep.org/resources/report/waste-management-during-covid-19-pandemic-response-recovery.

2. International Guidelines and Best Practices on HCWM

International guidelines and best practices have been developed to provide a comprehensive framework for HCFs and authorities in managing the waste generated from health care activities. These guidelines aim to establish standardized protocols that prioritize the safe handling, treatment and disposal of health care waste, minimizing potential risks to both human health and the environment.

Among these is the handbook developed by the WHO on 'Safe management of wastes from health-care activities', published in 2014. This handbook serves as the authoritative guide on HCWM and offers practical recommendations on the most appropriate processes and technologies for most types of HCFs, including during emergencies.[6]

2.1 Key principles in the management of health care waste

Segregation, storage and transportation

At its core, the WHO guidance on safe HCWM revolves around regulating the flow of waste from its generation to disposal. Box 3. provides an overview of fundamental management practices that serve as guidance for the segregation, storage and transport of health care waste.

Box 3. General principles of segregation, storage and transportation of health care waste

Health care waste is generated in a medical area and should be segregated into different categories based on their potential hazard and disposal route, by the person who produces each waste item.
Separate containers should be available in each medical area for each segregated category of waste.
Waste containers when filled should be labelled to help managers control waste production.
Closed local storage inside or near to a medical area may be needed if wastes are not collected frequently.
Hazardous and non-hazardous wastes should not be mixed during collection, transport or storage.
Collected waste is often taken to central storage sites before onsite or offsite treatment and disposal.
Staff should understand the risks of and safety procedures for the wastes they are handling.

Source: Based on Prüss, Annette, Jorge Emmanuel, Ruth Stringer, Ute Pieper, William Townend et al. (eds), 'Safe management of wastes from health-care activities', 2nd edition, WHO, Geneva, 2014. https://apps.who.int/iris/handle/10665/85349.

Treatment and disposal

Various treatment technologies for managing health care waste are available and are detailed in the WHO handbook, with key considerations for the selection of appropriate technologies[7] being made on account of waste characteristics, technological capabilities, environmental and safety considerations, and cost. Site-specific factors such as space limitations, availability of supporting infrastructure and operational requirements are also considered. Procedures for the safe management of radioactive, pharmaceutical, cytotoxic and other chemical waste emphasize waste minimization and protocols for returning waste to suppliers.

The ongoing trend in selecting suitable treatment technologies is driven by the imperative to reduce carbon emissions in health care settings. Organizations such as the WHO, UNICEF and other development partners actively advocate for non-burn technologies, aiming to contribute to the decarbonization of the health care sector and a long-term shift towards more sustainable practices (Box 4.).

The Pan American Health Organization (PAHO) has published technical recommendations to identify and address the water, sanitation and hygiene (WASH) and infection prevention and control (IPC) needs of HCFs in any setting, including during health emergencies and disasters.[8] Among the improvement measures in HCWM, it describes and prioritizes the different treatment technologies and disposal methods recommended for each type of health care waste.

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6 Prüss, Annette, Jorge Emmanuel, Ruth Stringer, Ute Pieper, William Townend et al. (eds), 'Safe management of wastes from health-care activities', 2nd edition, WHO, Geneva, 2014. https://apps.who.int/iris/handle/10665/85349.

7 These technologies include: thermal processes such as incineration and dry heat methods; chemical procedures encompassing disinfection and alkaline hydrolysis; biological approaches such as composting and vermiculture; microwave treatments; and mechanical methods such as shredding and encapsulation.

8 Pan American Health Organization, 'WASH PRESS: Soluciones de agua, saneamiento e higiene y medidas de prevencion y control de infecciones para la preparacion y respuesta de los establecimientos de salud en casos de emergencias de salud y desastres', PAHO, Washington, DC, 2021. https://iris.paho.org/handle/10665.2/54519.

Fundamentally, the process for selecting the treatment technology is based on factors such as national and international regulations, budget availability (for investment and maintenance), infrastructure (available space), available energy (electricity, water, fuel, etc.), and the type and quantity of waste generated. An overview of the suggested treatment options for each type of health care waste is presented in Annex 1.

Box 4. Opportunities for decarbonization in the health care sector

The 'Road Map for Health Care Decarbonization' developed by Health Care Without Harm (HCWH) identifies the implementation of circular economy principles in HCWM as a high-impact action for the health sector. The ways in which to contribute to this approach include:

- Design low-complexity medical devices to be disposable and recyclable, while high- and medium-complexity devices should be made to last longer and should use materials that can be processed and reused.
- Reduce the use of plastic products and packaging as much as possible, and adopt sustainable disposal practices such as proper segregation of waste for safe collection, sterilization for reuse and/or recycling.
- Phase out incineration in favour of sustainable waste management technologies such as autoclaving, recycling and biodigestion, which have lower emissions and environmental impacts.
- Encourage health care professionals to influence and implement sustainable practices, such as considering the necessity of using a product (e.g. gloves, uniforms, medical devices, etc.) and ensuring its proper disposal.

Source: Health Care Without Harm, 'Global road map for health care decarbonization', HCWH, 2021. https://healthcareclimateaction.org/roadmap.

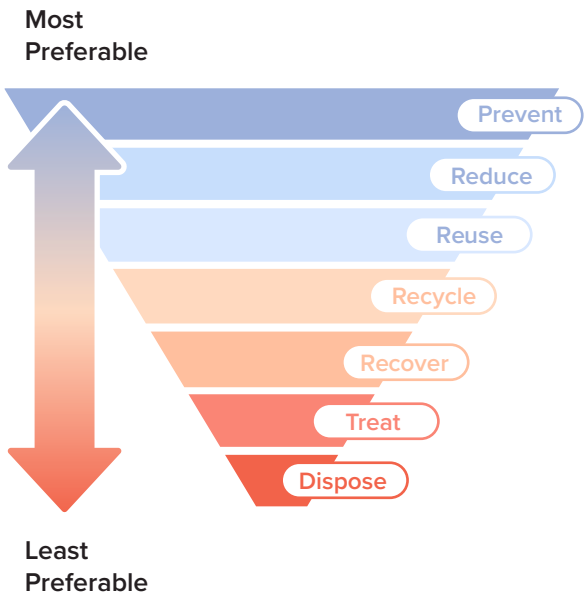
2.2 Waste minimization

In the same handbook, the WHO advocates for adopting a waste management strategy that aligns with the principles of the '3Rs' (i.e. reduce, reuse and recycle) as much as possible. This concept is represented as a 'waste hierarchy' that describes the order of preference for each method based on its impact on the environment and public health, as well as financial feasibility and social acceptability (see Figure 1).

Within this framework, best practices involve minimizing health care waste generation within a facility. The optimal approach is to prevent waste generation through strategies such as green and sustainable procurement, effective stock management to prevent product damage and expiration, and minimizing unnecessary medical procedures that generate waste, such as injections and pharmaceutical prescriptions.

Recommendations for the safe reuse, recycling and recovery of specific products and materials are also outlined. Certain items such as disposable face masks and gloves, labelled as single-use devices, should never be reused due to their inability to be thoroughly cleaned and disinfected, posing a risk of infection to subsequent users. To mitigate the risk of spreading infectious diseases, syringes, needles, sharps and catheters should not be reused.

Figure 1. Waste Management Heirarchy



Source: Prüss, Annette, Jorge Emmanuel, Ruth Stringer, Ute Pieper, William Townend et al. (eds), 'Safe management of wastes from health-care activities', 2nd edition, WHO, Geneva, 2014. https://apps.who.int/iris/handle/10665/85349.

2.3 Best practices in HCWM

As health care activities continue to expand globally, so does the volume of waste produced, placing increasing pressure on waste management systems, and necessitating the adoption of sustainable practices. Some case studies on practical and innovative solutions for HCWM adopted in various contexts are outlined in Box 5.

ACCRA, GHANA
Private Sector Cooperation for Waste Treatment

In the densely populated Greater Accra Region of Ghana, inadequate HCWM leads to environmental pollution due to a lack of treatment infrastructure. To address this issue, the Government of Ghana initiated a public–private partnership with support from the Government of Türkiye, and established **ZoomPak** to provide HCWM services to HCFs in the Greater Accra Region. The facility had sufficient treatment capacity to accommodate all the biohazardous waste in the area but was underutilized, operating only a few hours per week and serving fewer than 10 HCFs. It was expected to continue operating below its full capacity until regulations on medical waste management were fully enforced. With the UNDP – Global Environment Facility (GEF) 'Healthcare Waste Project', it was determined that no new health care waste treatment facilities would be established in Accra but that the existing **ZoomPak** treatment facility would be used as a central treatment plant instead. This enabled the UNDP GEF project objectives to be achieved while simultaneously enhancing the safe and environmentally sound treatment of waste by **ZoomPak**. This partnership was also enhanced through a review of the Ministry of Health (MoH) policy and guidelines on HCWM, which emphasized the adoption of best available technology (BAT) and best environmental practice (BEP).

Key insights from this project include:

1. Access to environmentally safe health care waste treatment services requires financial support to use these services effectively.
2. Efficient segregation of health care waste, coupled with trained personnel and effective use of waste management technologies, can reduce the financial, health and environmental costs.
3. Practical guidelines along with robust monitoring and inspection systems are needed for the implementation of BAT and BEP in HCWM.

Source: TechNet-21, 'UNDP/GEF Project Case Study: Cooperation with the Private Sector – ZoomPak Central Treatment Facility in Accra', TechNet-21, no date. https://www.technet-21.org/en/resources/case-study/gef-project-case-study-cooperation-with-the-private-sector-zoompak-central-treatment-facility-in-accra.

Box 5. Best practices in HCWM

KERALA, INDIA
Recycling PPE Scraps

In response to the urgent need for mattresses during the peak of the COVID-19 pandemic in Kerala, India, Lakshmi Menon, a fashion designer, devised an innovative solution using waste materials from PPE manufacturing. Instead of disposing of the leftover plastic scraps, Menon and a team of women braided them into mattress-like structures, providing a hygienic and affordable bedding option for COVID-19 care centres. This innovative solution demonstrated the potential for environmentally sustainable practices to address the public health crisis as well as social challenges, namely the lack of adequate bedding for homeless individuals and employment opportunities for women in rural communities.

Source: The Guardian, 'Project turning India's PPE offcuts into mattresses for Covid patients', The Guardian, 4 January 2021. https://www.theguardian.com/global-development/2021/jan/04/project-turning-india-ppe-offcuts-mattresses-covid-patients.

KATHMANDU, NEPAL
Instituting a safe HCWM system at Tribhuvan University Teaching Hospital

A joint project by **Tribhuvan University Teaching Hospital (TUTH),** WHO Nepal, the Health, Environment and Climate Action Foundation (HECAF360) and HCWH aimed to improve the hospital's HCWM system. It involved several phases of implementation, beginning in 2014 with an initial assessment of the existing handling practices, occupational health and safety status of staff, and quantification of the waste generated. HECAF360 and HCWH provided technical support in developing a HCWM plan, as well as training and capacity-building on proper handling and the operation and maintenance of treatment technologies. The hospital was also fitted with a biodigester to handle pathological and organic waste and provided a source of biogas which served as cooking gas for use in the kitchen.

With proper segregation, the amount of waste sent for municipal disposal was reduced to 22–28 percent of the total generated, while a further 34–44 percent was biodigested, and 30–40 percent recycled by 2019. An analysis of the 2019 income generated from recyclables sold showed that plastics represented 63 percent of the recyclables sold but contributed to 90 percent of income.

Source: Health, Environment and Climate Action Foundation, Health Care Without Harm and Institute for Global Environmental Strategies, 'Health care waste management towards the circular economy: A case study at Tribhuvan University Teaching Hospital in Nepal', HECAF360, HCWH and IGES, November 2021. https://www.iges.or.jp/en/publication_documents/pub/workingpaper/en/12035/Napal+case+study_web.pdf.

Box 6. Adapting HCWM strategies for health emergencies

The landscape of health care has undergone significant changes in the wake of the unprecedented challenges posed by the COVID-19 pandemic. During this period, various guidelines were issued, all sharing the common goal of offering practical recommendations aligned with established measures for managing infectious waste, including from immunization activities. To a large extent, adhering to these guidelines from reputable organizations will ensure consistency and effectiveness in waste management practices. In the future, a proactive approach to developing strategies should be considered in anticipation of health emergencies.

Annex 2 provides a summary of the key recommendations of these guidelines. They fundamentally indicate the need for an integrated waste management system that includes proper segregation, handling, treatment and disposal of waste generated during such events, as well as for allocating adequate resources for infrastructure, equipment and human resources to support safe waste management practices.

3. Overview of Waste Classification and Generation

3.1 Health care waste categories

The WHO handbook provides a comprehensive and universally accepted definition of health care waste, along with categorizations that serve as a standardized reference. Specifically, the handbook outlines the eight distinct categories that include general (non-hazardous) waste, sharps, infectious waste, pathological waste, pharmaceutical waste, genotoxic waste, and chemical and radioactive waste. Descriptions of each category are presented in Table 1.

Based on these established classifications of health care waste, it then offers a clear set of recommendations on the management practices for the purpose of enhancing safety, efficiency and environmental responsibility in health care settings.

Table 1. Health care waste categories defined in the WHO handbook

Waste Category	Description and Examples
HAZARDOUS HEALTH CARE WASTE	
Sharps waste	Used or unused sharps (e.g. hypodermic, intravenous or other needles; auto-disable syringes; syringes with attached needles; infusion sets; scalpels; pipettes; knives; blades; broken glass).
Infectious waste	Waste suspected to contain pathogens and that poses a risk of disease transmission (e.g. waste contaminated with blood and other body fluids; laboratory cultures and microbiological stocks; waste including excreta and other materials that have been in contact with patients infected with highly infectious diseases in isolation wards).
Pathological waste	Human tissues, organs or fluids; body parts; foetuses; unused blood products. Recognizable human or animal body parts are sometimes called anatomical waste.
Pharmaceutical waste, cytotoxic waste	Pharmaceuticals that are expired or no longer needed; items contaminated by or containing pharmaceuticals. Cytotoxic waste containing substances with genotoxic properties (e.g.waste containing cytostatic drugs—often used in cancer therapy; genotoxic chemicals).
Chemical waste	Waste containing chemical substances (e.g. laboratory reagents; film developer; disinfectants that are expired or no longer needed; solvents; waste with high content of heavy metals—e.g. batteries; broken thermometers and blood-pressure gauges).
Radioactive waste	Waste containing radioactive substances (e.g. unused liquids from radiotherapy or laboratory research; contaminated glassware, packages or absorbent paper; urine and excreta from patients treated or tested with unsealed radionuclides; sealed sources).
Non-hazardous or general health care waste	Waste that does not pose any particular biological, chemical, radioactive or physical hazard; further categorized as recyclables, non-recyclables and compostable.

According to the review, the health care waste classification in each of the three countries is found to be generally consistent with the above-mentioned categories with regard to three broad types of health care wastes: hazardous waste, infectious waste and general or non-hazardous waste (see Table 2).

The WHO handbook recommends a minimum approach to segregation, storage and transport (‘three-bin system’), wherein separate containers and appropriate handling of infectious, used sharps and general waste are to befollowed. Based on the classification system adopted by each country, the three-bin system may be a feasible course of action for a simplified implementation in cases where proper waste segregation procedures are lacking or disregarded.

Table 2. Health care waste categories adopted in the countries

WHO Handbook	Bangladesh	Maldives	Bhutan
Non-hazardous or general health care waste	General waste Reused general waste	General waste	General waste
Sharps waste	Sharps waste	Sharps waste	Infectious waste
Infectious waste	Infectious / Bacterial waste	Infectious waste	
Pathological waste	Anatomical waste Pathological waste	Pathological waste	
Pharmaceutical waste, cytotoxic waste	Pharmaceutical waste	Pharmaceutical waste Genotoxic waste	Hazardous health care waste
Chemical waste	Chemical waste Pressurized waste	Chemical waste Pressurized Containers Heavy Metals E-Wastes	
Radioactive waste	Radioactive waste	Radioactive waste	
	Liquid waste		

3.2 Waste generation from health care activities

Levels of HCFs

The types and nature of services offered in an HCF are important determinants of the quantity and composition of health care waste being generated and are fundamental to the design of effective waste management strategies. This includes considerations for resource allocation, waste storage, waste transport, treatment and disposal methods, as well as emergency preparedness.

The distribution of the different levels of HCFs in the three countries is presented in Table 3. Primary HCFs are more commonly expected to generate some types of waste more than others, such as infectious, sharps, pharmaceutical and general non-hazardous wastes, whereas larger and specialized hospitals will likely have additional waste classes such as chemical and radioactive waste.

Table 3. Distribution of levels of HCFs in the three countries

	LEVELS OF HCFs		
	Primary	Secondary	Tertiary
Bangladesh	16,128	206	67
Bhutan	778	50	4*
Maldives	409	20	8

*Note: * Three referral hospitals and the Royal Centre for Disease Control, which carries out testing for any disease of public health concern.*

Health care waste data

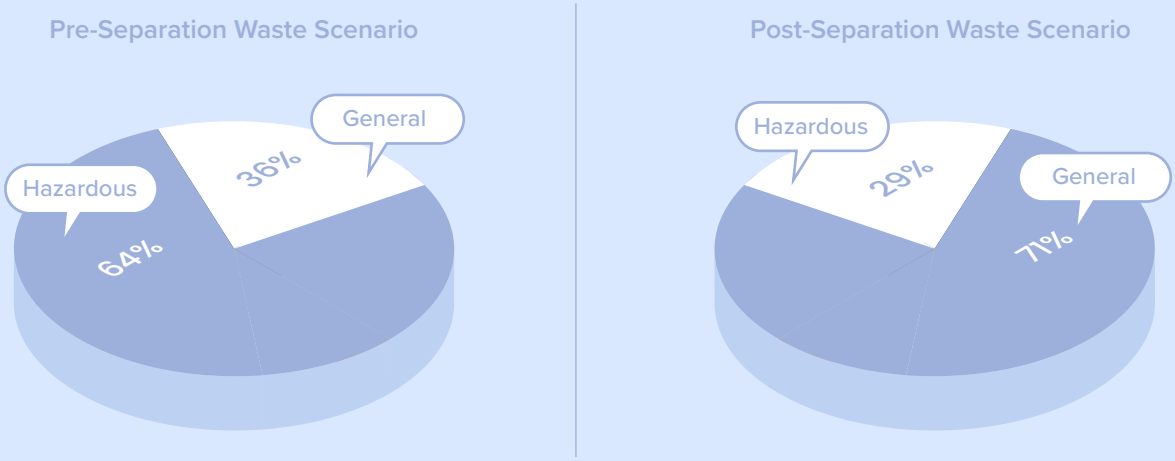
One of the most important factors for identifying areas where enhancements in the HCWM system need to be made lies in the insights gathered from health care waste data. Their significant value is inherent in efficient waste management planning and resource allocation, whether at the institutional or higher levels.

According to the WHO,[9] most of the waste generated from health care settings may be considered as general or municipal waste, while only **10–25 percent of the total waste is regarded as 'hazardous'.** This small portion of hazardous waste should be properly managed to minimize its health and environmental risks. Where poor segregation practices occur, any non-hazardous waste will be needlessly rendered as hazardous waste and can lead to an overburdened waste management infrastructure (see Box 7).

In the three countries reviewed, there are limited data on health care waste generation rates, due to a combination of a lack of long-term data collection and waste audit procedures. The best efforts of the review identified some ad hoc studies and national-level reports from the government that provided insights into the amount and composition of health care waste. An overview of selected studies and reports on health care waste generation data from the three countries is presented in Table 4.

Box 7. Assessment of health care waste composition at the Lao National Children's Hospital

A 2015 study on the waste composition generated from the Lao National Children's Hospital revealed that improper segregation of general and hazardous wastes resulted in designated **hazardous waste comprising 64%** of total waste. Following the implementation of proper segregation, this proportion **decreased significantly to 29%.**



Source: Water and Environment International, unpublished report on an assessment of the HCWM system of the Lao National Children's Hospital, 2015.

9 Safe management of wastes from health-care activities, 2nd ed.: https://www.who.int/publications/i/item/9789241548564.

Table 4. Summary of findings from reports on health care waste generation data

Health Care Waste Data	Remarks
BANGLADESH	
Area: Dhaka South City Corporation (DSCC) Total health care waste: 27 tons/day Hazardous: 7.13 tons/day	A 2012 study covering 1,012 HCFs, including hospitals, clinics, dental clinics and diagnostic centres.[10]
Area: Dhaka North City Corporation (DNCC) Total health care waste: 22.7 tons/day Hazardous: 5.8 tons/day	
Area: DNCC Total health care waste: 3.3 tons/day	2018 data on 486 HCFs, including public and private hospitals, diagnostic centres and dental clinics.[11]
6.8 tons/day (hazardous waste)	A 2017 study covering 50 private HCFs, including hospitals, clinics, dental clinics and pathology labs in Dhaka. Waste generation rate varied with the type of HCFs selected and seasonal variation. Least waste produced in April, and most in June.[12]
Area: Noakhali District Total health care waste: 1.81 tons/day	Data for 2020 based on a total 109 HCFs, including public and private hospitals, clinics and diagnostic centres. 23% of the total waste was hazardous (of which 47% was infectious, 12% pathological, 9% sharps and 29% pharmaceutical). 80.7% of HCFs did not have any proper segregation method or standard treatment procedure, 17.4% had partial treatment procedure, and only 2% had proper disposal procedures.[13]
Area: Jhenaidah District Total health care waste: 2.2 tons/day	Data for 2021 based on seven HCFs, including public and private hospitals and clinics. 4.9% of the waste generated in HCFs was found to contain infectious, sharp, pathological and plastic substances. Only 46% of generated waste was found to be disposed of by municipal authorities or a contractor.[14]
BHUTAN	
622 tons	46% of all waste generated in 2020 was considered general waste, and 54% was infectious waste.[15]
690 tons	In 2021, 39% was considered general waste, and 61% was infectious waste.[16]

10 H. M. Nuralam, Z. Xiao-lan, B. K. Dubey, D. Wen-Chuan, Healthcare waste management practices in Bangladesh: A case study in Dhaka City, Bangladesh, International Journal of Environmental and Ecological Engineering Vol:11, No:6, 2017, https://www.researchgate.net/profile/Md-Hossain-143/publication/317379500_Healthcare_Waste_Management_Practices_in_Bangladesh_A_Case_Study_in_Dhaka_City_Bangladesh/links/5f4fcb69a6fdcc9879c30dc6/Healthcare-Waste-Management-Practices-in-Bangladesh-A-Case-Study-in-Dhaka-City-Bangladesh.pdf ?origin=scientificContributions

11 DNCC, 'Waste Report 2018-2019 (Annual Report)', Dhaka North City Corporation, 2019.

12 Rumi, M. Y., & Karim, R., Determining the Hazardous Medical Waste Generation Rates of Private Health Care Facilities-Case Study from Dhaka City of Bangladesh, Americal Jouranal of Environmental Sciences, 14, 203-211, 2018, Retrieved from https://thescipub.com/abstract/10.3844/ajessp.2018.203.211

13 Rahman, M. B.-D., Biomedical waste amid COVID-19: perspectives from Bangladesh, The Lancet Global Health, 8, 2020.

14 Khan, T. A., An analysis of existing medical waste management and possible health hazards in Jhenaidah municipality. 6th International Conference on Engineering Research and Education School of Applied sciences & Technology, SUST, Sylhet. Sylhet, 2021.

15 Ministry of Health, 'SoP for Decontamination and Disinfection of COVID-19 Contaminated Area', 2020.

16 NEC, 'Bhutan State of the Environment Report 2022', 2022, www.nec.gov.bt.

Health Care Waste Data	Remarks
MALDIVES	
General waste per month: 28,200 kg *(Hdh. Kulhuduhfushi)* 1,800 kg *(Ha. Dhidhoo)* 800 kg *(AA. Rasdhoo)* 800 kg *(K. Dhiffushi)* 2,000 kg *(Ga. Villingili and Gdh. Thinadhoo)* Infectious waste, per day: 1350 kg *(Hdh. Kulhuduhfushi)* 900 kg *(Ha. Dhidhoo)* 600 kg *(AA. Rasdhoo)* 600 kg *(K. Dhiffushi)* 1,500 kg *(Ga. Villingili and Gdh. Thinadhoo)* Sharps waste per month: 450 kg *(Hdh. Kulhuduhfushi)* 600 kg *(Ha. Dhidhoo)* 150 kg *(AA. Rasdhoo)* 150 kg *(K. Dhiffushi)* 75 kg *(Ga. Villingili and Gdh. Thinadhoo)*	Based on a pre-assessment survey for the pre-installation of autoclave units, conducted in 2021:[17]
Data collected in 2023 ranged from **8 to 11 kg/day** for general waste and **1 to 4.5 kg/day** for infectious waste	Based on a feasibility study for the construction of infectious waste management facilities, conducted in 2023, for districts *Ha. Thuraakunu, Ha.Thakandhoo, Ha. Filladhoo, Ha. Vashafaru, Ha. Utheemu, Nolhivaranfaru, Sh. Komandoo, R. Dhuvaafaru, B. Dharavandhoo, Lh. Naifaru, K. Kaashidhoo, K. Dhiffushi, Th. Guraidhoo, Ga. Villingili, Ga. Maamendhoo, Gn. Fuvahmulah.*[18]

It should be noted that no standardized method of data collection and analysis was used for these studies that could allow for a comprehensive assessment of the health care waste generation in the three countries. To some extent, the findings highlight the issue of significant amounts of hazardous waste generated at HCFs and noted gaps throughout the waste management process. Compared to the WHO's estimated 10–25 percent share of hazardous waste in total HCF waste, these studies indicate that, in many cases, the proportion of hazardous waste identified exceeded this estimate.

In the context of a developing country, this issue underscores a potential challenge or concern regarding the management of hazardous or infectious waste in HCFs. The higher-than-expected proportion may indicate a need for enhanced waste management practices and infrastructure to ensure the safe handling and disposal of such waste.

17 Huda, A & Waheed, K, 'Pre- Assessment Survey Report for installation of waste equipment - Gaaf Alif & Gaaf Dhaal Atoll, Male', Maldives, 2021; Huda, A & Waheed, K, 'Pre- Assessment Survey Report for installation of waste autoclaves – Kaafu Atoll, Male', Maldives, 2021; Huda, A & Waheed, K, 'Pre- Assessment Survey Report for installation of waste autoclaves – Haa Alif Atoll, Male', Maldives, 2021; Huda, A & Waheed, K, 'Pre- Assessment Survey Report for installation of waste autoclaves – Haa Dhaalu & Shaviyani Atoll, Male', Maldives, 2021.

18 Riyan Private Limited (2023), 'Feasibility Study - Construction of Infectious Waste Management Facilities across 18 Island in the Maldives Feasibility Study Report – Lot 1, Male', Maldives, 2023; Riyan Private Limited, 'Feasibility Study - Construction of Infectious Waste Management Facilities across 18 Island in the Maldives Feasibility Study Report – Lot 2 & 3, Male', Maldives, 2023.

4. Overview of the HCWM Systems in Bangladesh, Bhutan and Maldives

This section provides an overview of the HCWM systems in Bangladesh, Bhutan and Maldives, using the six assessment areas adopted from the Gavi HCWM Maturity Model. These six areas are organized into key elements in the implementation of HCWM, namely:

- **Compliance strategies and initiatives**
  This benchmark examines the capacities of human resources to effectively carry out safe HCWM practices (awareness, training and supervision), as well as factors influencing compliance in HCFs (adherence and compliance).

- **Legal and operational framework**
  This benchmark examines the presence of regulatory measures and strategies (national policies and strategic plans), resource management (budgeting and planning) and technical guidance for implementation of safe HCWM practices (practical guidance).

- **Technology and equipment**
  This benchmark examines the availability and use of appropriate technologies for safe treatment and disposal of health care waste (technology and equipment).

4.1 Compliance strategies and initiatives for safe HCWM

Awareness, training, and supervision

The assessment on awareness-raising and training conducted in the countries relied primarily on the available literature and documented accounts of training and awareness-raising activities from implementing agencies. Table 5 presents an overview of the training activities carried out in each of the countries.

Table 5. Overview of training implementation in each country

	Activities Implemented	Gaps Identified
Bangladesh	Training programmes have been developed. 23,000 staff have been trained in 420 batches.* The Directorate General of Health Services (DGHS) is responsible for providing technical support to all government and private clinics, including facilitating training and dissemination of information, education and communication materials.	Some studies conducted between 2012 and 2019** showed varying levels of knowledge and qualifications within and across institutions, but generally there is still inadequate knowledge among health care workers and waste handlers on safe HCWM practices.
Bhutan	The Ministry of Health (MoH) conducts training on infection control (IC) and waste management (WM) once a year. The trained IC focal person at the facility oversees all IC/WM activities and the personnel involved. Since 2020, training of trainers on IC/WM has been carried out. Between March 2023 and January 2024, 321 people were trained on IC/WM.	There is no regular awareness-raising or training on HCWM; activities are carried out based on the availability of funds. The high turnover rate of personnel presents a challenge in sustaining a knowledge base.

	Activities Implemented	Gaps Identified
Maldives	The Health Protection Agency (HPA) conducts awareness sessions for public health focal points of HCFs, who are then responsible for training the health care waste handlers in their respective HCF. Limited training has been carried out, and the last was conducted prior to the COVID-19 pandemic. A national training package on HCWM is currently in development.	No studies have been conducted in Maldives regarding awareness of HCWM practices among health care workers. No curriculum has been developed for HCWM, and HCWM is not included in the academic training of health care workers.

Sources: Uddin, Mohammed Nasir, Mohammed Rashedul Islam and Khadiza Yesmin, 'Knowledge on hospital waste management among senior staff nurses working in a selected medical college hospital of Bangladesh', Journal of Waste Management, 2014, article 573069. https://doi.org/10.1155/2014/573069;
Jahan, Israt, Md Ranzu Ahmed, M.H. Faruque, Dipal Lal Banik and Sk Ahktar Ahmad, 'Knowledge, attitude and practices on bio medical waste management among the health care personnel of selected hospitals in Dhaka City', International Journal of Advancements in Research and Technology, 2018; 7(2): 8–17. https://www.researchgate.net/publication/323550709_KNOWEDGE_ATTITUDE_AND_PRACTICES_ON_BIO_MEDICAL_WASTE_MANAGEMENT_AMONG_THE_HEALTH_CARE_PERSONNEL_OF_SELECTED_HOSPITALS_IN_DHAKA_CITY;
Sarker, Mohammad A.B., Md Harun-Or-Rashid, Tomoya Hirosawa, Mohammad S.B.A. Hai, Md Rashedul F. Siddique, Jun Sakamoto and Nobuyuki Hamajima, 'Evaluation of knowledge, practices, and possible barriers among healthcare providers regarding medical waste management in Dhaka, Bangladesh', Medical Science Monitor, 2014; 20: 2590–2597. https://doi.org/10.12659/MSM.890904;
Bhattacharjee, Shubhra, and Bohnni Saha, 'Study of knowledge, attitude and practices regarding biomedical waste management among healthcare personnel in Gazipur, Bangladesh', Life Sciences International Journal, 2015; 1(1). https://airccse.com/lsij/papers/1115lsij01.pdf; Akter, Kazi Shamima, and Shaikh M.S. Reza, 'Awareness on medical waste management and occupational health safety among the employees related to medical services at upazila level in Bangladesh', Journal of Environmental Treatment Techniques, 2019; 7(3): 282–288. https://www.researchgate.net/publication/333701040_Awareness_on_Medical_Waste_Management_and_Occupational_Health_Safety_among_the_Employees_Related_to_Medical_Services_at_Upazila_Level_in_Bangladesh.
Notes: * Data as of July 2023 presented at the 'Regional meeting on health care waste management in the WHO South-East Asia Region', Bangkok, Thailand, 24–27 July 2023. ** A summary of research findings is described in the Bangladesh country report.

It is important to note that the use of secondary data sources has limited this study's ability to conduct a comprehensive analysis of gender-based indicators for HCWM activities in Bangladesh, Bhutan and Maldives. Although there is a broad understanding of gender imbalances in the health care sector across these countries, specific data related to gender-sensitive training programmes, representation of women in leadership roles, and gender-specific health and safety risks are insufficient or unavailable. Efforts should therefore be made to prioritize the collection of primary data to fill these knowledge gaps and provide a more nuanced understanding of gender issues in HCWM.

Adherence and compliance

The information on adherence to and compliance with HCWM best practices presented in Tables 6 to 8 are based on available literature and documents or from key informant interviews. The measures presented here are defined for each step of the HCWM process to the best extent possible.

Table 6. Overview of existing adherence and compliance in Bangladesh

Bangladesh	
Waste classification and segregation	The use of specific coloured bins for health care waste segregation is limited, lacking uniformity across facilities. Proper segregation is not practised consistently, and it is often carried out by sweepers, requiring additional monitoring and quality control.[19]

19 MOHFW, Health Sector Support Program, 2018, https://hsd.portal.gov.bd/sites/default/files/files/hsd.portal.gov.bd/page/ed8aec32_6b62_495b_b175_ca0f0d9a62f6/Health-4-EMF.pdf

Bangladesh

Waste collection transport, storage, treatment and disposal	Waste collection, transport and treatment from large HCFs in Dhaka and Chattogram (formerly Chittagong) are contracted out. Small to medium-sized HCFs use in-house waste management, with a certain proportion of health care waste being processed along with municipal solid waste. In Dhaka, a waste management company employs specialized vehicles, incinerators, autoclaves, pits and a chemical disinfection unit for the transportation, treatment and disposal of medical waste. Wet medical waste undergoes autoclave disinfection before landfill disposal. Sharp items and body parts are buried at designated sites in the Matuail landfill. Recyclable plastic items are chemically treated, shredded and sold as raw materials to plastic factories. Other dry medical waste is incinerated, and the resulting ash is buried at the landfill. In Chattogram, a fumeless incineration facility with a daily capacity of 4.8 tons has been installed by Chattogram City Corporation. The waste management company collects health care waste from 163 out of a total of 283 primary health care centres, amounting to approximately 1.5 tons/day, which undergoes incineration. Common procedures for the treatment and final disposal of hazardous health care waste include incineration, autoclaving, burial, pit burning and landfilling. At upazila-level* HCFs, the directive states that for temporary arrangements, health care waste should be disposed of by the HCF in pits on their premises until such time as the municipal government has developed a permanent solution.[20]
Wastewater treatment and disposal	Hospitals typically dispose of their liquid pharmaceutical and chemical waste into general sewers or drains, as there is no proper liquid waste management system in place. Liquid waste originates primarily from patient service units, operation and surgical units, laboratories and other HCFs.[21]
Vaccination waste management	Generally, health care professionals adhere to the government's immunization waste management plan outlined in the National Deployment and Vaccination Plan, revised in February 2021. Studies indicate that HCFs have established separation techniques for vaccine-related waste, maintain a separate safety box for sharps and syringes, allocate sufficient space for personal waste disposal/ treatment, designate a separate storeroom for waste collection, and employ experienced staff in the management of vaccine waste.[22] Several guidelines and SOPs for managing COVID-19 waste have been established, namely: ● 'Guideline for COVID-19 Related Waste Management in Hospital'. [23] ● 'National Guideline for Health Care Provider on Infection Prevention and Control of COVID-19 Pandemic in Healthcare Setting'.[24] ● 'Guideline for COVID-19 Disinfection and Environmental Infection Prevention'.[25]

*Note: *Third-level (subdistrict) administrative division.*

20 MOHFW, Health Sector Support Program, 2018, https://hsd.portal.gov.bd/sites/default/files/files/hsd.portal.gov.bd/page/ed8aec32_6b62_495b_b175_ca0f0d9a62f6/Health-4-EMF.pdf

21 Dana, T., 'Hospital Waste Management: Bangladesh, OIDA International Journal of Sustainable Development, 2011. https://oidaijsd.com/wp-content/uploads/2019/03/02-09-03.pdf

22 Rayhan, M. R., 'Assessment of COVID-19 vaccination-related medical waste management practices in Bangladesh', PloS one, 2022, doi:https://doi.org/10.1371/journal.pone.0273053.

23 DGHS and the National Institute of Preventive and Social Medicine [NIPSOM], 2020.

24 DGHS, I. a., 'Guideline or SOP for Covid 19 disinfection and environmental infection prevention', DGHS, MOHFW, the Government of the People's Republic of Bangladesh, Institute of Epidemiology, Disease Control and Research, and WHO, 2020, Retrieved from https://www.dghs.gov.bd/images/docs/Notice/21_03_2020_SOP_Environmental%20Disinfectant%20210320.pdf

25 DGHS, Institute of Epidemiology, Disease Control and Research (IEDCR), and WHO, Guideline or standard operating procedure for Coronavirus disinfection and environmental infection prevention, Directorate General of Health Services, 2020.

Table 7. Overview of existing adherence and compliance in Bhutan

Bhutan	
Waste classification and segregation	Colour-coded bags and dustbins are supplied to all HCFs by the MoH.
Waste collection transport, and storage	Infectious and hazardous wastes are segregated and collected in red colour-coded plastic bags, while general waste is collected in green colour-coded plastic bags placed in dustbins. These wastes from health care units are then transported by trolleys to either the waste storage area on the premises or a designated disposal site.
Waste treatment and disposal	All infectious waste undergoes autoclaving and is then disposed of at the designated landfill sites by the respective Thromde* and municipal offices. While open burning of waste is discouraged, some primary health centres resort to this method due to the lack of facilities for transporting the waste to the landfill.
Wastewater treatment and disposal	Some pharmaceutical and non-recyclable chemical wastes are typically disposed of with regular waste or discharged into the sewer after dilution.
Vaccination waste management	The management of vaccination waste is outlined under the National Guideline on Infection Control and Medical Waste Management (2018) and the guideline for disposal of pharmaceutical waste from the Drug Regulatory Authority (2014). An SOP based on the national guideline was established for the management of COVID-19 waste.

*Note: *Third-level (subdistrict) administrative division.*

Table 8. Overview of existing adherence and compliance in Maldives

Maldives	
Waste classification and segregation	Only a few facilities have colour-coded bags and dustbins for the segregation of health care waste. Separation of general waste and infectious health care waste is carried out in most HCFs, but further segregation is not commonly practised. Some colour-coded dustbins and bags have been provided via donor-financed projects, but only for a limited number of tertiary, regional and atoll hospitals.
Waste collection	General, infectious and hazardous wastes are collected in designated polyethylene bags and in dustbins.
Waste transport	Depending on the final disposal method, infectious waste is transported in these polyethylene bags to the final disposal site, mostly within the HCF. In some HCFs such as tertiary hospitals, regional and atoll hospitals, health care waste is transported to the final disposal site (landfills) using small pick-up lorries or electric buggies. General wastes are transported to the waste management centres on the respective island for final disposal or handover to municipal waste collection services that are operated by the Waste Management Corporation (WAMCO) or the island council.

Maldives	
Waste storage	In some HCFs, the collected infectious waste is stored in a dedicated storage area. Cytotoxic waste generated in the regional and atoll hospitals is stored in regiform boxes for final disposal. In some instance, general waste is stored for final disposal or collection along with municipal waste.
Waste treatment and disposal	Infectious and hazardous waste is often disposed of in makeshift incinerators, such as repurposed oil drums. Only about 10 percent of HCFs have autoclaves and shredders, which were obtained through donor funding. However, many of these autoclaves remain non-operational due to a lack of necessary infrastructure. In some HCFs, infectious waste is collected by municipal waste handlers without any disinfection process. Infectious waste is openly incinerated in landfills. General waste is collected by municipal waste handlers for final disposal. Depending on the type of general waste, it is either openly burned or managed using equipment such as balers, glass crushers and wood chippers.
Wastewater treatment and disposal	Disposal into the existing sewerage system on the island, or into septic tanks on islands where the sewerage system is not operational.
Vaccination waste management	The handling of vaccination waste is carried out by staff of the EPI programme. Separate safety boxes are used for sharps and needles in the vaccination centres/HCFs. Expired vaccines are disposed of at the K. Thilafushi landfill, with the majority originating from the central vaccine cold-chain facility in Malé city. An SOP on municipal solid waste management for COVID-19 was developed and published by the HPA in May 2020. This SOP was practised by waste handlers from WAMCO and island councils that were responsible for the management of municipal solid waste.

Of particular note, standards for wastewater treatment and disposal in the three countries require further scrutiny to align with best practices to prevent antimicrobial resistance (AMR). The potential for environmental contamination and public health risks is heightened particularly with the spread of AMR linked to a high concentration of antibiotics entering the waste stream. It is therefore imperative to address deficiencies in wastewater management, not only for effective HCWM but also to combat this growing threat, starting by updating standards and policies for the responsible disposal of pharmaceuticals and infectious waste.

4.2 Legal and operational framework for HCWM

National regulations and policies on HCWM are generally rooted in the overarching objective of mitigating the risks associated with health care waste to health care workers, the public and the environment. In practice, IPC and WASH policies for HCFs typically incorporate measures or guidelines for safe waste management. They are better defined in this context due to the interconnected nature of IPC, WASH and HCWM issues.

National policies and strategic plans

Based on the review of the HCWM framework in Bangladesh, Bhutan and Maldives, all countries were found to have the necessary fundamental policies and guidance for managing hazardous waste, as part of a broader environmental conservation, waste management or public health protection mandate. In the WHO/UNICEF Joint Monitoring Programme for Water Supply, Sanitation and Hygiene country progress tracking, all three countries have some form of HCWM standards in place, although these may not be implemented fully (indicated as 'practical steps underway or partially completed').[26] Tables 9 to 11 provide an overview of the relevant regulations and policies on HCWM in each country.

In Bangladesh, the management of health care waste is governed by a comprehensive framework of regulations and standards, each addressing specific aspects of HCF operations. These regulations cover various aspects such as waste classification, segregation, treatment, disposal, IPC and WASH practices. The Department of Environment (DoE), operating under the Ministry of Environment, Forest and Climate Change (MoEFCC), plays a crucial role in enforcing these regulations to ensure environmental sustainability and protect public health. Additionally, the Ministry of Health and Family Welfare (MoHFW) collaborates closely with the DoE to oversee the implementation and enforcement of these regulations in the health care sector.

Table 9. Relevant regulations and policies on HCWM in Bangladesh

Bangladesh	Implementing Authority
Medical Waste (Management and Treatment) Rules, 2008 This law establishes comprehensive guidelines and rules for the proper collection, management, transportation, treatment and disposal of health care waste. It covers classification, colour-coded segregation bins, symbols for packaging, guidelines for various treatment methods, standards for liquid waste and deep burial. Additionally, the law authorizes specific bodies and outlines punishments for violations. The DoE implements the rules and issues licences to organizations involved in HCWM.	DoE/MoEFCC
Hazardous Waste Management Rules, 2021 This incorporates the rules for waste treatment, collection, recycling and composting, and associated penalties for illegally handling both e-waste and hazardous medical waste produced in hospitals, manufacturing and households.	DoE/MoEFCC
National Health Care Standards, 2015 A set of standards applying across all health care organizations (primary, secondary and tertiary) to ensure the provision of health services that are both safe and of an acceptable quality, and includes specific requirements for infection control, hygiene and waste management.[27]	MoHFW
National Strategy for WASH in Healthcare Facilities 2019–2023: A Framework for Action A strategy document for strengthening the delivery of standardized and effective IPC services, including the improvement of the HCWM system for HCFs at all levels. It was developed with support from UNICEF, with targets and goals aligned with the Sustainable Development Goals.	MoHFW

26 Based on the reported indicator for HCWM standards found in the country progress tracker: https://www.washinhcf.org/country-progress-tracker/.

27 Ministry of Health and Family Welfare, 'National Health Care Standards', MoHFW, Dhaka, 2015. http://qis.gov.bd/wp-content/uploads/2019/04/2017_02_26_1488073894_902rds_.pdf

In Bhutan, the legal framework for HCWM is primarily overseen by two key agencies: the National Environment Commission (NEC) and the MoH. The NEC is responsible for regulating and overseeing environmental regulations, including those related to waste management practices. It sets standards and guidelines to ensure that health care waste is managed in an environmentally sustainable manner, minimizing adverse impacts on the environment and public health. On the other hand, the MoH plays a pivotal role in formulating policies and guidelines specific to HCFs. This includes overseeing the management of waste generated by HCFs, ensuring compliance with national regulations and standards, and promoting best practices in HCWM.

Table 10. Relevant regulations and policies on HCWM in Bhutan

Bhutan	Implementing Authority
National Environment Protection Act of Bhutan, 2007 A legislative framework that establishes the guidelines and regulations for sustainable and responsible environmental management in Bhutan. It stipulates that institutions must ensure proper waste disposal, must be responsible and accountable for their own waste management and must have comprehensive waste management plans.	NEC
Waste Prevention and Management Act of Bhutan, 2009 This Act safeguards human health and the environment by minimizing waste generation, promoting waste segregation, reuse and recycling, ensuring responsible disposal, and fostering collaboration among implementing agencies. Lead agencies are responsible for managing waste from the institutions under their jurisdiction.	NEC
Waste Prevention and Management Regulation, 2016 (Amendment) This comprehensive framework focuses on proper waste handling, reduction, recycling and responsible disposal practices. It mandates that all institutions submit their waste management compliance to District Heads, while HCFs report to the District Health Supervisory Officer, who updates the MoH annually. District Heads and the MoH are required to report annually to the NEC. HCFs, including private, military and regulatory authorities, are obliged to implement and adhere to comprehensive waste management regulations. HCWM institutions are required to handle sharps appropriately, employ proper disposal methods for infectious materials, adhere strictly to national guidelines for hazardous chemical wastes, secure funds for effective waste management systems, and maintain detailed records of waste-related activities and incidents.	NEC
Water Act of Bhutan, 2011; Water Regulations of Bhutan, 2014 The Act mandates the MoH to monitor the quality of drinking water in both urban and rural areas, which includes preventing water pollution from health care waste disposal.	MoH

In Maldives, the Health Protection Agency (HPA), operating under the MoH, plays a central role in formulating and implementing regulations pertaining to HCWM. The HPA is primarily responsible for ensuring that HCFs adhere to established HCWM protocols and standards, thereby safeguarding public health and environmental integrity. Concurrently, the Ministry of Climate Change, Environment and Energy (MCCEE) assumes a regulatory role by providing oversight and guidance on environmental standards and requirements. With a focus on environmental protection and sustainable development, the MCCEE works to ensure that HCWM practices align with broader environmental objectives.

Table 10. Relevant regulations and policies on HCWM in Maldives

Maldives	Implementing Authority
Public Health Protection Act (7/2012) This Act aims to establish policies safeguarding public health, identifying responsible individuals, defining implementation methods and limiting constitutional rights to protect public health. It provides waste management guidance and mandates the formulation of regulations specifying health standards and drainage systems. The regulation outlines policies for ensuring compliance, actions against offenders and procedures for enforcement.	HPA
Waste Management Act (Act No. 24/2022) The main provision of this Act includes definition of roles and responsibilities of institutions involved in waste management in Maldives, strategies for waste reduction, planning for waste management, provision for waste management service providers, the phase-out of single-use plastics, fees on plastic bags, establishment of waste management facilities, handling and transport of waste, hazardous waste, pollution prevention, data collection and waste audits, and punitive actions for non-compliance.	MCCEE
Waste Management Regulation (Regulation No. 2013/R-58) The regulation specifies standards for: waste collection, land and sea transport of waste, waste treatment, waste storage, management of waste disposal centres, landfilling and hazardous waste management. It states that: (1) burning hazardous waste is strictly prohibited; (2) hazardous waste may not be dumped anywhere in Maldives; (3) transportation of hazardous waste requires leak-proof and sealed containers; and (4) only vessels/vehicles approved by/registered with the Environmental Protection Agency may transport hazardous waste.	MCCEE
National Healthcare Waste Management Policy, 2016 The policy emphasizes enforcing segregation and collection of health care waste, ensuring proper storage facilities for high-risk health care waste, compliant transportation as per the Waste Management Regulation (2013), selection of treatment and disposal methods in line with environmental regulations, and mandatory Environmental Protection Agency approval and adherence to standards outlined in the Waste Management Regulation for waste disposal and treatment facilities such as landfills and incinerators.	MoH and HPA
National Health Care Waste Management Strategic Plan 2016–2021 Outlines the strategic approaches, priorities and an implementation plan including actions for improving HCWM in Maldives.	MoH and HPA

As described in the WHO handbook (2014), an effective HCWM system necessitates the inclusion of key elements in national regulations (as outlined in Table 12). This analysis of the legal framework governing HCWM in the three countries will assess how their regulations align with the essential elements mentioned. The analysis will provide insights into the robustness of each country's HCWM regulatory structure and its adherence to internationally accepted practices.

Table 12. Elements of the HCWM regulatory framework for each country

	Bangladesh	Bhutan	Maldives
Definition of hazardous health care waste and its categories	✓	✓	✓
Guidance on the legal responsibilities of health care waste producers for safe handling and disposal	✓	✓	✓
Specifications for record-keeping and reporting	✓	✓	-
Procedures for permits or licences for waste treatment and handling systems	✓	-	✓
Specifications for an inspection system and regular audit procedures	✓	✓*	-
Designation of courts to handle disputes related to enforcement or violations of the law	-	✓	✓

*Note: * As part of an environmental impact monitoring requirement.*

Another observation drawn from the review is that most policies do not yet emphasize the prohibition of non-incineration methods for health care waste, except for designated hazardous waste. It should be noted that the WHO's HCWM guidelines and international best practices are advocating for non-incineration methods for treatment, as much as possible, in line with global efforts to balance effective waste treatment with environmental responsibility in the health care sector.

Budgeting and planning

To effectively comply with the requirements of any set regulation on HCWM, proper resource allocation and strategic planning are necessary to support the different stages of waste handling, from collection to disposal. It should facilitate the adoption and enforcement of standardized waste management practices across all levels, such as through infrastructure investments at a larger scale down to the facility level for the maintenance and repair of treatment systems. More often, however, HCWM implementation challenges persist in countries with limited resources and competing priorities.

Table 13 provides an overview of the planning and budget allocation at either the central level or facility levels for HCWM activities. The information presented offers insights into the commitment and strategic direction of the respective authorities and key stakeholders to handle and dispose of health care waste appropriately. Across the three countries, efforts are being made to uphold some HCWM standards. These efforts are either integrated with broader IPC initiatives and supported by national funds or may be initiated with some external support.

Table 13. Allocation and planning of HCWM

	Bangladesh	Bhutan	Maldives
Dedicated Budget for HCWM	Centralized fund for infrastructure development and training for government hospitals under two MoHFW projects.	Funding for HCWM activities mainly comes from external support or as part of the IPC programme. Prioritization of fund allocation per activity is done by the Ministry of Finance.	Budget allocated from the operational costs of HCFs and from external support for specific activities (e.g. awareness-raising campaigns, planning).
HCWM Plan	The Medical Waste Management Action Plan (2017–2022) was developed under the Health Sector Support Programme. Health care waste is also integrated in other action plans.	Available only for Thimphu, as part of the Thimphu Waste Management Plan 2019.	No HCWM plan developed at the national or HCF level.

Practical Guidance

Alongside the national regulations and policies, certain established international guidelines and best practices serve as a valuable framework for a standardized approach to HCWM. These protocols and guidelines aim to operationalize the national policies. The technical guidelines developed by the WHO cover all steps of the HCWM process and can be adopted in whole or in part and based on the local context.

Operationally, tools and reference materials such as SOPs and job aids for health care workers and waste handlers can be effective in allowing them to carry out the proper protocols in waste handling. The review of practical guidance in the three countries assesses the availability of facility-level guidelines, protocols, manuals or communication materials that will help facilitate the implementation of proper HCWM measures. Communication materials translated into local languages are necessary for wider acceptance of the protocols and were noted in some of the cases. Tables 14 to 16 present the technical guidance currently available in each country.

Table 14. Technical guidance and resources on HCWM for Bangladesh

Bangladesh
Manual for Hospital Waste Management, 2010 Intended for hospital managers, health providers, policymakers and all administrators responsible for ensuring the efficient and economical disposal of hospital waste, while minimizing environmental and health impacts as much as possible.
Hospital IPC Manual, 2018 Intended for use by all who are involved in hospital services, including health care workers, management and support staff in all health care settings, including hospitals, health centres/clinics, and government and private special care facilities.[28]
Healthcare Waste Management Guideline, 2015 With the vision of ensuring safe, sustainable and cost-effective HCWM to prevent public health and environmental hazards.[29]

Table 15. Technical guidance and resources on HCWM for Bhutan

Bhutan
National Guideline on Infection Control and Medical Waste Management, 2018 The principal document intended for use by all HCFs across the country. It is intended to be a valuable tool for health care providers, training institutions, private diagnostic centres, military hospitals and other stakeholders involved in designing, implementing, monitoring and evaluating infection control practices in Bhutan. Additionally, many HCFs have integrated this guideline into their own SOPs for infection control and waste management.

28 Ministry of Health and Family Welfare, 'Hospital IPC Manual', MoHFW, Dhaka, 2018. http://qis.gov.bd/wp-content/uploads/2019/05/Hospital-Infection-Prevention-and-Control-Manual.pdf

29 Directorate General of Health Services, 'Healthcare Waste Management Guideline', DGHS, Dhaka, 2015. http://qis.gov.bd/wp-content/uploads/2019/12/চিকিৎসা-বর্জ্য-ব্যবস্থাপনা-গাইড-লাইড.pdf

Table 16. Technical guidance and resources on HCWM for Maldives

Maldives
Minimum Standard for Healthcare Waste Management in Health Facilities, 2008 Outlines the classification of health care waste and guidelines for HCWM. It includes seven steps which need to be followed by HCFs: • Waste Minimization • Segregation and Containerization • Intermediate Storage • Internal Transport in the HCF • Centralized Storage • Treatment • External Transportation and Final Disposal
Standards for Handling, Storage, Transport and Treatment of Cytotoxic Waste, 2020 Provides information on handling, storage, transport and treatment of cytotoxic waste in HCFs
The National Guideline for Infection Prevention and Control, 2022 Outlines standard precautions, transmission- based precautions, outbreak response in health care settings, and environmental impacts of health care-associated infections**.**

In Maldives, the HPA is currently working on the development of awareness and communication materials (posters and videos) on specific topics, namely:

- Colour-coded waste segregation;
- Pharmaceutical waste collection, handling and disposal;
- Infectious waste collection, handling and disposal; and
- Cytotoxic waste collection, handling and disposal.

4.3 Technology and equipment availability and use

One of the crucial requirements for safe HCWM, apart from robust policies and regulations, are appropriate and adequate technological infrastructure and equipment. In examining the HCWM landscape of the three countries, it is evident that the availability and use of technology and equipment vary significantly across and within countries (see Table 17). While some individual facilities have more advanced systems than others, most still have inadequate technologies and resources to handle waste. In many instances, external support has contributed to bridging these technological gaps.

Table 17. Use of HCWM technology and equipment in the three countries

Equipment / Technology	Bangladesh	Bhutan	Maldives
Incinerators	Operated and maintained by HCWM contractor.	Four units located at landfill sites (including one non-operational unit).	Most HCFs primarily dispose of health care waste by incineration in oil drums or makeshift burning apparatus without emission controls.
Autoclaves	Operated and maintained by HCWM contractor.[30]	Provided to 54 hospitals and 186 primary health centres; procured with external support.	Around 90% of primary HCFs are provided with autoclaves with shredders, procured with external support; only 20% of these units are in operation, and most remain non-operational due to insufficient infrastructure (i.e. waste handling sheds).
Shredders			
Others Technology		Steam sterilizer (3 hospitals and 24 primary health centres); GPS tracking system of municipal trucks for waste collection from HCFs.	

Incinerators and autoclaves are commonly used in all three countries, albeit with different specifications that are based on operational requirements. Shredders, on the other hand, are only used in Bhutan and Maldives, as no data are currently available to independently verify their use in Bangladesh.

These variations in technology and equipment highlight the diverse approaches to HCWM across the three countries, each influenced by factors such as infrastructure, resource availability and regulatory frameworks.

30 Dihan, M. R., 'Healthcare waste in Bangladesh: Current status, the impact of Covid-19 and sustainable management with life cycle and circular economy framework', ScienceDirect, 3, 2023

5. Benchmarking HCWM Systems: Highlights of the Assessment

The benchmarking scores and findings presented in this chapter offer insights into the current state of HCWM systems, including policies and practices, in Bangladesh, Bhutan and Maldives. While it is important to note that a facility-level assessment was not carried out, the findings broadly reveal both areas of strength and areas in need of improvement for each country.

5.1 The Gavi HCWM Maturity Model

The structured approach of the Gavi HCWM Maturity Model identifies the different aspects of HCWM practices which can then provide insights for facilities and countries into their gaps and prioritize interventions accordingly. The different levels are broadly described in Table 18.

Table 18. Maturity levels identified in the Gavi HCWM Maturity Model

Maturity Level	Description
Level 1	This level reflects a low level of awareness of the risks associated with health care waste and limited insight into adhering to best practices for HCWM. Policies for HCWM are either needed or under development, with no recent assessments conducted within the last 5 years. HCWM is not adequately planned and budgeted for. There is a lack of awareness of BAT and BEP, resulting in the use of outdated, inefficient and non-environmentally friendly options for treatment and disposal of health care waste.
Level 2	This level indicates a moderate awareness of the risks associated with health care waste, with a curriculum developed but not fully implemented (implemented in **41–50% of facilities)**. There is awareness and availability of best practices for HCWM in the form of SOPs and job aids, but these practices are not consistently adhered to **(fewer than 50% of facilities comply)**. Policies for HCWM have been developed and/or reviewed within the last five years, with a recent HCWM assessment conducted within the same time frame. While budgeting for HCWM is in place, it may not be directly linked to realistic needs or assessment findings. Guidance for HCWM has been developed but is not fully used **(used in fewer than 50% of facilities).** Despite awareness of recommended BAT and BEP, out-of-date equipment and technology are still being used.
Level 3	At this level, **a significant proportion of health workers and waste handlers (51–75%) are trained** on the risks associated with health care waste, and clear guidance on HCWM is available at most facilities. Best practices of HCWM are being adhered to in at least half of the facilities, although there is minimal monitoring and evaluation in place. Policies and guidelines for HCWM are disseminated and partially adopted. At least half of the facilities develop a HCWM budget and implement specific plans. Guidance for HCWM is **developed and in use in 50–65% of the facilities in the country.** Some BAT equipment is **available at 50% of facilities (or 50% access services), and/or at least 50% of the waste generated is treated and disposed of using globally accepted technologies.**
Level 4	At this level, there is a high level of awareness of health care waste risks, with **76–85% of health care workers and waste handlers trained** and having access to ongoing training. There is significant compliance with the best HCWM practices, and a monitoring and evaluation (M&E) framework is in place with some tracking of adherence. The country demonstrates that policies and guidelines are fully implemented at all levels of the system. **Budgets for HCWM are available, funded and tracked at 75% of system levels.** Guidance for HCWM is available and being implemented at most (65–85%) system levels. Globally accepted equipment is **widely available (more than 51%),** and most facilities are clustered and mapped to an acceptable treatment technology.
Level 5	At this level, **more than 85% of health workers and waste handlers are trained and aware** of the risks associated with health care waste, demonstrating BEP. HCWM is integrated into supportive supervision activities. The country adheres fully to the best practices of HCWM, with an M&E framework tracking adherence to policies and guidance. Policies for HCWM are widely adopted across the country, and evidence shows that waste management performance gaps are addressed in strategic planning and financing mechanisms at national and subnational levels. HCWM is fully budgeted at national and subnational levels. Guidance for **HCWM is available and in use at more than 85% of facilities** within the country. Only efficient and BAT are used to manage health care waste, and environmental monitoring of waste treatment and disposal is conducted in compliance with national and/or global standards.

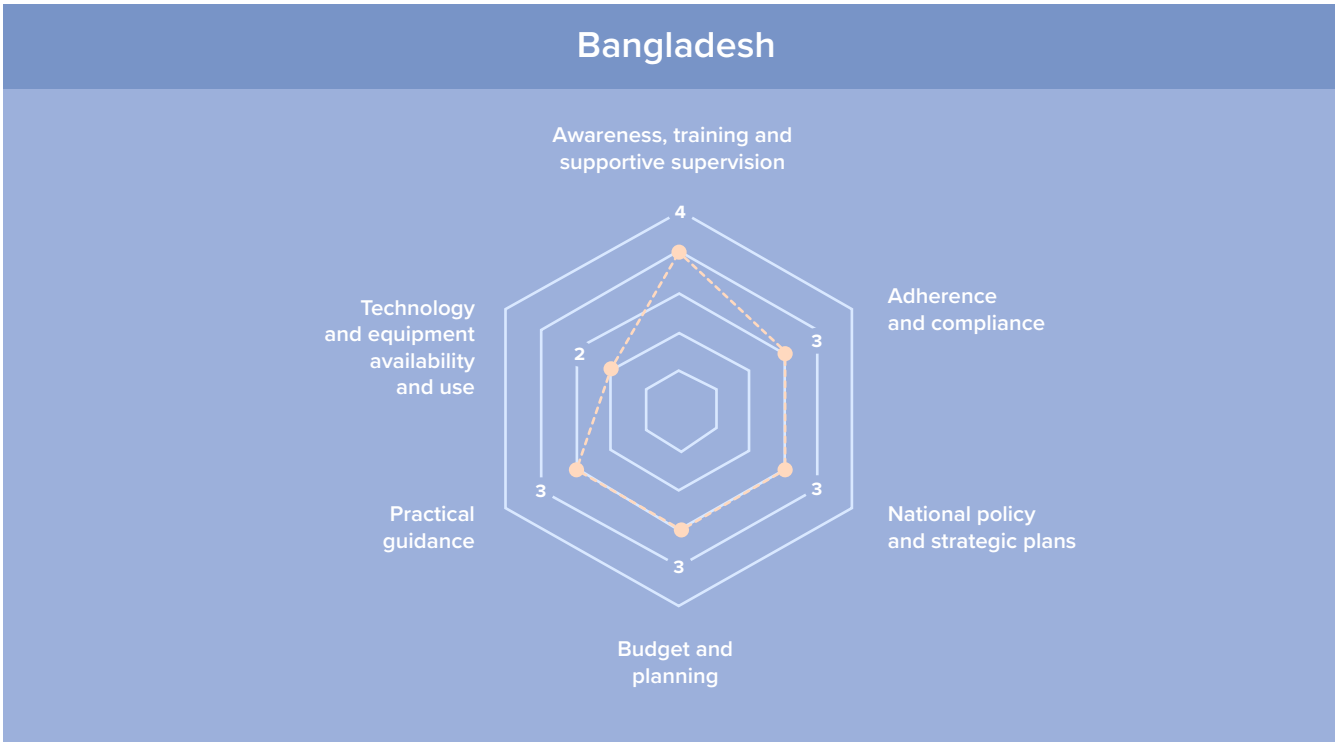
Bangladesh

The assessment findings for Bangladesh indicate a relatively higher level of awareness, training and supportive supervision, given that ongoing efforts are being made to deliver training and provide safety devices to personnel to carry out their work. Some measures and guidelines, including national strategies and plans, have also been established, although they are only partially being adopted. However, Bangladesh has a relatively lower score in terms of the availability and use of technology and equipment, which reflects a common issue in the majority of HCFs regarding a lack of facilities and equipment. For instance, according to the reports reviewed, over half of the HCFs in the country do not have standard storage facilities.

Table 19. Benchmark scores for the HCWM system in Bangladesh

	Area	Level Ranking
People	Awareness, training and supportive supervision	4
	Adherence and compliance	3
Processes	National policy and strategic plans	3
	Budget and planning	3
	Practical guidance	3
Technology	Availability and use of technology and equipment	2
	Total	18
	Number of Areas	/6
	Overall Score	3

Figure 2. Diagram of the benchmark scores for Bangladesh



Bhutan

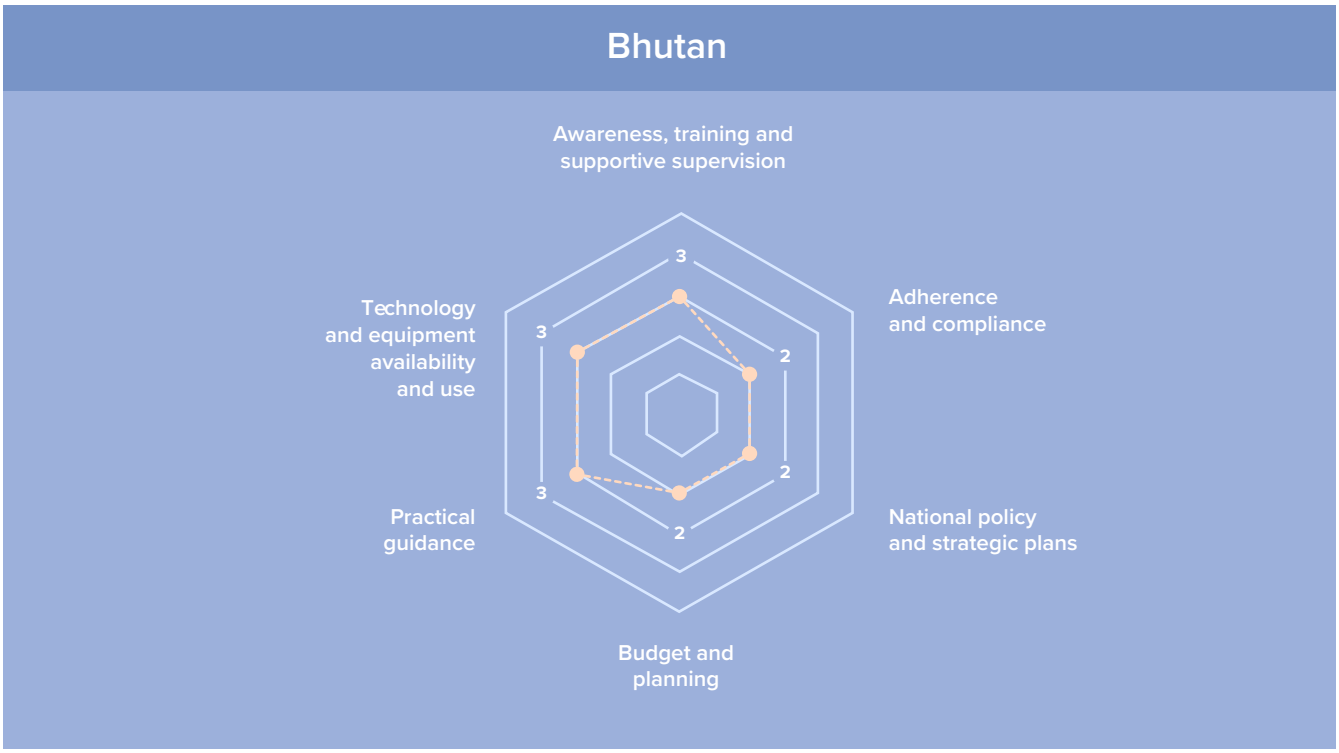
In Bhutan, the assessment found that training, practical guidance and equipment availability are progressively being implemented or have been a priority for the MoH with its dedicated infection control and HCWM programmes. Guidance materials and equipment are also available, although full adoption and implementation are yet to be achieved, due to accessibility issues or resource constraints. A significant weakness in the system is the widespread practice of open burning at primary health centres, coupled with uncertainty regarding subsequent disposal methods. The scores for each of these areas reflect this.

The compliance rate of HCFs is still an irresolute issue, however, as there is no monitoring system in place at the central level; while the IPC and quality assurance staff at HCF level are expected to take charge of monitoring, compliance data are often not available. Furthermore, a key constraint in the planning process is that budgeting is done at the central level by the Ministry of Finance, potentially contributing to underestimation or inflexibility in the resource allocation for HCWM activities.

Table 20. Benchmark scores for the HCWM system in Bhutan

	Area	Level Ranking
People	Awareness, training and supportive supervision	3
	Adherence and compliance	2
Processes	National policy and strategic plans	2
	Budget and planning	2
	Practical guidance	3
Technology	Availability and use of technology and equipment	3
	Total	15
	Number of Areas	/6
	Overall Score	2.5

Figure 3. Diagram of the benchmark scores for Bhutan



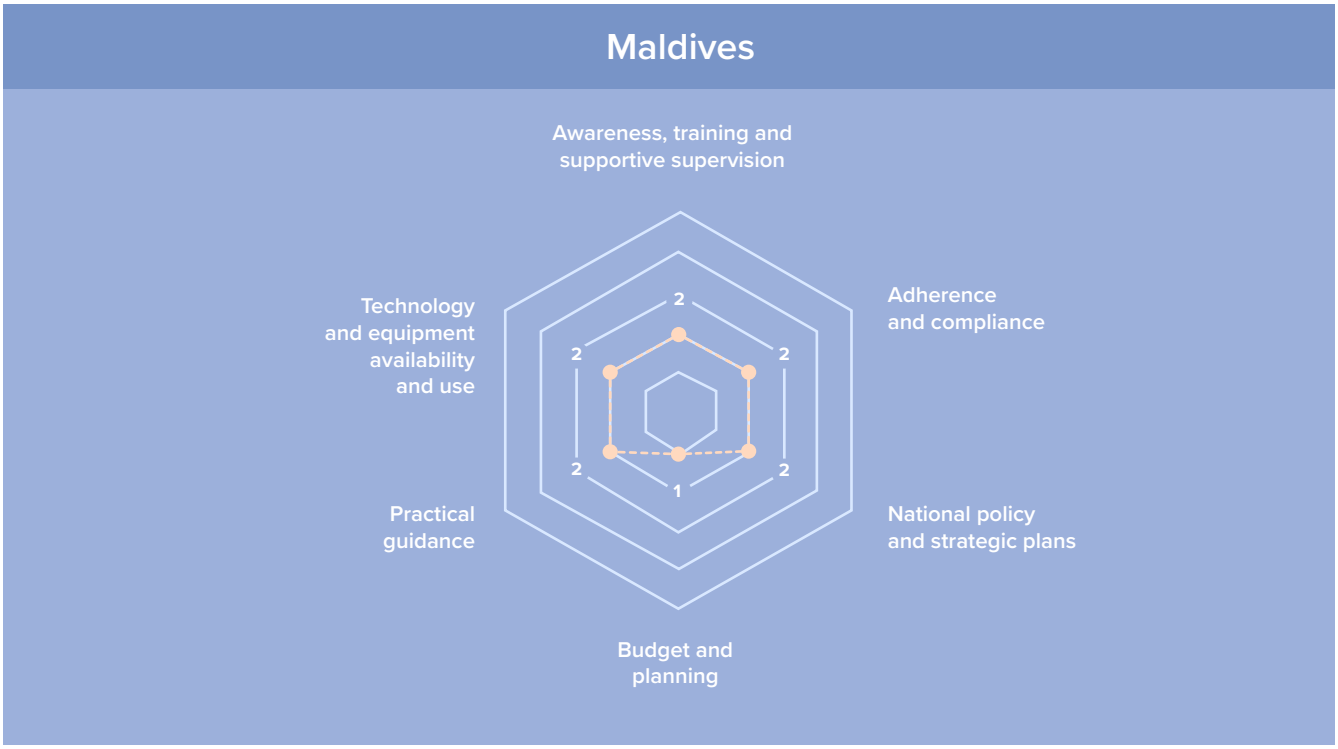
Maldives

Overall, the benchmark scores indicate that Maldives has an underdeveloped HCWM system. Some progress is currently being made, firstly with the review and updating of the national HCWM policy, including the guidelines for HCFs. Adherence and compliance are still below the desired level though, with fewer than half of all HCFs having insight into the best practices in HCWM, and open burning still being practised in most cases. In terms of training and the dissemination of HCWM protocols, the country appears to follow a train-the-trainer model wherein public health focal points who take the HPA's training programme are tasked with training health care waste handlers. An important issue, however, is that training is delivered infrequently, which can impact the sustainability of this approach. The assessment also found that budgeting and planning for HCWM are critically lacking, particularly in government HCFs.

Table 21. Benchmark scores for the HCWM system in Maldives

	Area	Level Ranking
People	Awareness, training and supportive supervision	2
	Adherence and compliance	2
Processes	National policy and strategic plans	2
	Budget and planning	1
	Practical guidance	2
Technology	Availability and use of technology and equipment	2
	Total	11
	Number of Areas	/6
	Overall Score	1.8

Figure 4. Diagram of the benchmark scores for Maldives



6. Recommendations for Enhancing the HCWM Systems

6.1 Regional perspective and recommendations for regional coorporation

Regional experts interviewed for this study were presented with the main preliminary findings that had emerged up until the time of the interviews. In general, the regional experts agreed on the following statements regarding the three countries assessed:

- Policies, regulations and technical guidance on HCWM are fairly well developed, although some gaps exist with respect to waste minimization, procurement of supplies and materials, supply chain management (including reverse logistics), extended producer responsibility, and integration of HCWM with municipal waste management and sanitary landfill operations. It is also worthwhile to consider developing and implementing facility specific policies on HCWM, to promptly address emerging issues in accordance with the unique challenges and requirements of the specific setting.

- Adherence to policies and compliance with regulations are often challenged due to weak capacity for enforcement, insufficient financial support, and insufficient numbers of skilled and knowledgeable workers assigned to waste management responsibilities.

- There is wide variation in the availability of data on indicators such as waste generation rates and waste management practices, and the available data in the countries cannot be easily compared due to differences in definitions, indicators and methodologies used for data collection and analysis.

- Other common issues include: little emphasis on waste minimization, unsafe waste handling practices, waste treatment equipment frequently absent or malfunctioning, poor waste treatment and disposal practices such as open burning and indiscriminate dumping, and little or no effective public education programmes.

Regional experts generally agreed that these issues were not unique to Bangladesh, Bhutan and Maldives but were commonly found in many other countries of Southwest Asia.

The following recommendations for cooperation among regional development partners are made:

- **Support countries in reviewing their national HCWM policy, strategy and regulatory frameworks, aligning them with international guidelines and strengthening national capacities to enforce compliance.** Additionally, ensure that these policies and frameworks are gender-responsive, taking into account the specific needs, roles and challenges faced by vulnerable groups involved in HCWM activities. Furthermore, support countries in developing risk reduction strategies and contingency plans to strengthen climate resilience of HCWM systems and ensure effective management of health care waste in the event of future pandemics or other disaster-driven emergencies.

- **Support countries in identifying and addressing gaps in issues such as waste minimization, procurement of supplies and materials, supply chain management (including reverse logistics), extended producer responsibility, and integration of HCWM with municipal waste management and sanitary landfill operations, and ensure interventions are gender-sensitive.** Following these assessments, provide tailored assistance and technical support to help countries address these identified gaps effectively, ensuring the development and implementation of robust policies, regulations and operational procedures to enhance the overall efficiency, safety and sustainability of HCWM systems.

- **Strengthen collaboration on HCWM among regional partners** focused on health, the environment, disaster risk reduction, and urban and rural development, including intergovernmental organizations, non-governmental organizations, green hospital networks,[31] universities and research institutes, for the purpose of sharing knowledge, information, experiences and tools, aligning their support with countries in the region and optimizing synergies.

31 For example, the Global Green Hospital Network and Practice Greenhealth.

- **Support low- and middle-income countries in strengthening capacities for planning, monitoring and evaluating HCWM systems, including data collection and analysis.** Promote the development of uniform definitions, indicators and methodologies for the collection and analysis of data. This will ensure consistency and comparability of data across different HCFs and jurisdictions. Key monitoring indicators for HCWM can be adopted from the WHO/UNICEF Joint Monitoring Programme for Water Supply, Sanitation and Hygiene for tracking progress against the Sustainable Development Goals (Section 3.4 'Core HCWM questions').

- **Promote the adoption of policies and economic measures that support reducing volumes of health care waste by encouraging the shift to reusable PPE or non-burn health care waste treatment technologies.** Policies and measures should prioritize both human health and environmental well-being in a balanced manner. An example would be the lowering of import tariffs on reusable PPE or non-burn treatment technologies.

- **Promote the use of appropriate technologies for health care waste treatment and disposal, particularly the use of non-burn technologies by developing and sharing a compendium of appropriate technologies and best practices across the region.**

- **Support countries in strengthening their capacities to sustain HCWM technologies through adherence to SOPs and robust operations and maintenance practices.** Improvements in the process such as the use of modern technologies may require gender-sensitive approaches to education and training.

- **Advocate for clear and standardized funding mechanisms for HCWM (including investment, operations, maintenance and repair).**

- **Support the institutionalization of a national HCWM capacity-building and training system for universities and medical schools, as well as HCFs.**

6.2 Way Forward

Several recommendations were developed that aim to address the unique and specific gaps and challenges of each country. Details on the country-specific recommendations are presented in Annex 1. The recommendations were formulated with the understanding that effective solutions must be tailored to each nation's context and requirements. These recommendations were validated by key stakeholders, and feedback was solicited to confirm that the proposed strategies are feasible and practical based on the current priorities of each country, thereby fostering greater ownership and commitment from relevant authorities and implementers.

Table 22 synthesizes the key actionable items following the benchmarking, based on the Gavi HCWM Maturity Model and the stakeholder consultations in the three countries. This synthesis outlines the immediate priorities and can also lay the foundations for a project with a broader scope aimed at enhancing HCWM practices regionally.

Table 22. Action points from benchmarking and stakeholder consultations in the three countries

People

Area	Key Action Items	Country-Specific Recommendations		
		Bangladesh	Bhutan	Maldives
Awareness Training and Supportive Supervision	A comprehensive and inclusive training and education programme, including pre-service training, on HCWM is essential for all levels of health care workers and personnel. Tailored training modules adapted to different audiences can enhance understanding and adherence to protocols throughout the HCWM process. Implementing a monitoring and evaluation system within training programmes will ensure continual improvement and effectiveness.	• Training on HCWM should be made mandatory for all health care professionals in both government and non-government hospitals. • A dedicated training module should be developed for training for different health care professionals based on their nature of work, such as a separate manual for cleaners in their native language with more details to maintain their safety and the environment, and a manual for senior nurses on how to manage waste in wards and how they should lead and guide their subordinates, etc. • Awareness-raising training should involve community leaders to empower multiple stakeholders and create mass awareness.	• Advocate for more funds to address budget and human resource shortages, allowing for regular training sessions and awareness-raising programmes. • Implement targeted training for new health care staff to integrate infection control and waste management practices effectively. • Collaborate with educational institutions and relevant organizations to strengthen the inclusion of infection control and waste management components in pre-service health care education for sustainability. • Implement a robust monitoring and evaluation system to continually improve training programmes and awareness-raising initiatives.	• Develop a national curriculum on HCWM and include training and tertiary educational qualifications for health care workers. • Allocate funds from the national budget for awareness-raising training on HCWM.

People

Area	Key Action Items	Country-Specific Recommendations		
		Bangladesh	Bhutan	Maldives
Adherence and Compliance	Dedicated resources, including personnel, equipment and funding, allocated specifically for monitoring HCWM processes at the facility, district and central levels, will help encourage compliance with regulations and establish accountability throughout the HCWM process.	• Along with annual assessment, a regular monitoring and evaluation framework should be developed for all hospitals. • A digital data repository should be established to store daily waste generation and deposition data for real-time monitoring. Moreover, this will help to practise data-driven decision-making. • Every facility should have one dedicated resource to monitor the entire HCWM process at the facility.	• Strengthen monitoring efforts by the MoH, NEC and district-level health officers to ensure consistent adherence to HCWM best practices. • Leverage IPC and QA focal points for monitoring, emphasizing compliance data documentation at the facility by making the task attractive. • Facilitate regular compliance reporting by HCFs using standardized templates. • Establish a feedback mechanism to communicate monitoring results, fostering continuous improvement. • Hold regular coordination meetings with stakeholders, particularly the NEC, MoH, and municipality and local governments, to streamline HCWM processes and contribute to more effective and sustainable initiatives. • Ownership and accountability for HCWM within and outside facilities (especially transportation to the landfill, release into the sewerage system and incineration) must be made clear and should be clearly defined.	• Considering financial constraints, invest in better municipal waste management facilities which can dispose of treated health care waste transported from HCFs. • Avoid outsourcing of the health care waste disposal to private parties through the revision of existing regulations dealing with health care waste and municipal solid waste.

Processes

Area	Key Action Items	Country-Specific Recommendations		
		Bangladesh	Bhutan	Maldives
National Policy and Strategic Plans	1. Key HCWM policies and strategic plans should be reviewed to ensure they remain relevant and effective in light of evolving circumstances and advancements in health care waste treatment technologies and practices. 2. Regular audits to gather accurate data will help ensure that HCWM practices are continuously improved and optimized.	• National policies and strategic plans should undergo periodic review to ensure alignment with evolving technological advancements.	• Prioritize the timely review and revision of key documents. • Urgently develop a strategic plan for HCWM within the MoH. A strategic plan provides a road map for effective, long-term management and improvement of HCWM practices.	• Conduct regular HCWM assessments. • Allocate resources such as funding and equipment for health care waste audits to determine accurate waste generation rates in the country. • The review of the HCWM policy is ongoing and needs to be updated.
Budget and Planning	1. Investments should be made in capacity -building for budgeting and planning at the national and subnational levels, and in the procurement and maintenance of sustainable technologies and equipment at the facility level.	• National, divisional and subdivisional plans should receive adequate allocation in the fiscal year budget to support sustainable HCWM initiatives. • All HCFs should allocate funds for HCWM in their annual budgets, with mandates from the MOHFW. • Budget allocation should be done after assessment of the needs of each individual facility.	• Introduce an annual budget for priority activities and equipping HCFs with infrastructure and technology to effectively manage health care waste. • Strengthen the '3Rs' in HCFs through capacity -building, infrastructure and technology assistance. • Allocate funds for research to assist in planning and implementation.	• Allocate sufficient budget to HCFs for HCWM. • Introduce dedicated budgeting for HCWM in HCFs. • Increase the capacity of academia to conduct assessments and studies on HCWM.
Practical Guidance	1. Establishing standardized procedures and implementing mechanisms for ongoing monitoring and evaluation are essential steps in ensuring consistency in waste management practices across HCFs. These measures enable continuous assessment of HCWM processes against predefined goals and benchmarks, facilitating effective performance management over time.	• Regular on-the-job training sessions should be organized for staff members to familiarize them with available guidelines, manuals and SOPs, ensuring that their knowledge remains current and updated with any changes.	• Standardize SOPs across HCFs. • Develop and implement performance metrics for HCWM, such as waste segregation rate, proper disposal rate, training and compliance rate, and waste reduction and recycling rate, at facility level. • Integrate data on waste generation from HCFs into the National Waste Inventory, an NEC initiative, to facilitate data standardization and help the formulation or amendment of policy and regulations.	• Update national guidelines for HCWM. • Develop a nationwide SOP for HCWM.

Technology

Area	Key Action Items	Country-Specific Recommendations		
		Bangladesh	Bhutan	Maldives
Availability and Use of Technology and Equipment	1. Committing to sustainable practices and adopting environmentally friendly and efficient technologies are some of the clear steps towards realizing the long-term benefits of HCWM enhancements. Ensuring adequate infrastructure and equipment maintenance is imperative for these efforts to be truly effective.	• Considering resource constraints, the government should initiate more projects to introduce BAT in HCFs according to their need for proper HCWM.	• Prioritize the implementation of BAT equipment in primary health care centres to replace environmentally harmful practices such as open burning and improper disposal methods. • Advocate for and encourage non-burning technologies, especially the '3Rs', and explore low-emission alternatives.	• Ensure sustainable operation of waste autoclaves by investing in accompanying infrastructure such as \health care waste handling facilities. • Maintain a stock of spare parts for waste autoclaves at the MoH so that damaged waste autoclaves can be easily repaired and brought back into service as quickly as possible. • Invest in preventive maintenance of equipment. • Invest in capacity-building of staff handling waste autoclaves regarding the operation and maintenance of this equipment.

Annex 1. Treatment Technologies and Disposal Options for Health Care Waste

Treatment technologies that comply with international agreements: Treatment options in this category should be preferred, as they limit emissions to the environment.					Treatment technologies that can be used temporarily: These treatment options can be used as provisional solutions but are not the recommended technologies.			Combustion treatment technologies that are discouraged: These options should only be considered as a last resort in emergency situations or when no other viable options are available.	
	Steam-based Technologies	Dry Heat-based Technologies	Chemical-based Technologies	Incineration-based Technologies	Steam-based Technologies	Incineration-based Technologies		Incineration-based Technologies	
	Includes vacuum autoclaves, microwaves, friction heating. These rely on steam, either at atmospheric pressure or high pressure, to inactivate pathogens.	Dry heat technologies typically operate at higher temperatures than steam-based technologies.	They mainly use chemical disinfectants. These are problematic, as they produce toxic effluents.*	Double-chamber incinerator with gas treatment of emitted gases. They involve the chemical and physical decomposition of organic matter through processes of combustion, pyrolysis or gasification.**	Gravity displacement pressure autoclave.	Double-chamber incinerator without gas treatment of emitted gases.**	Single-chamber incinerator without gas treatment of emitted gases.**	Open burning.	Surface burning.
General Waste	⃠	⃠	⃠	Not recommended technology. Should avoid materials with PVC or pressurized containers.	⃠	Not recommended technology. Should avoid materials with PVC or pressurized containers.	Not recommended technology. Should avoid materials with PVC or pressurized containers.	If possible, should be avoided.	⃠
Pathological Waste	⃠	Yes	Yes	Not recommended technology and must not be mixed with sharps waste.	⃠	Temporarily, unless gas emissions are treated; not recommended technology.	Temporarily and in small quantities; not recommended technology.	⃠	⃠
Infectious Waste	Yes	Yes	Yes, in small quantities.	Should avoid materials with PVC or pressurized containers.	Temporarily, and should be previously shredded.	Temporarily, unless gas emissions are treated; not recommended technology.	Temporarily, unless gas emissions are treated; not recommended technology.	Temporarily; not recommended technology.	⃠
Sharps Waste	Yes, except for microwaves due to the metallic components.	Must be encapsulated afterwards.	Must be encapsulated afterwards.	Not recommended technology. Should avoid materials with PVC. Must not be mixed with pathological waste.	Must be encapsulated afterwards.	Not recommended technology. Should avoid materials with PVC.	⃠	⃠	⃠

Treatment technologies that comply with international agreements: Treatment options in this category should be preferred, as they limit emissions to the environment.					Treatment technologies that can be used temporarily: These treatment options can be used as provisional solutions but are not the recommended technologies.			Combustion treatment technologies that are discouraged: These options should only be considered as a last resort in emergency situations or when no other viable options are available.	
	Steam-based Technologies	Dry Heat-based Technologies	Chemical-based Technologies	Incineration-based Technologies	Steam-based Technologies	Incineration-based Technologies		Incineration-based Technologies	
Hazardous Waste (medications)	⊘	⊘	⊘	Yes, in small quantities.	⊘	⊘	⊘	⊘	⊘
Hazardous Waste (medications)	⊘	⊘	⊘	⊘	⊘	⊘	⊘	⊘	⊘

Source: Pan American Health Organization, 'WASH PRESS: Soluciones de agua, saneamiento e higiene y medidas de prevencion y control de infecciones para la preparacion y respuesta de los establecimientos de salud en casos de emergencias de salud y desastres', PAHO, Washington, DC, 2021. https://iris.paho.org/handle/10665.2/54519.

*Notes: *Such as treatment with dissolved chlorine dioxide, bleach (sodium hypochlorite), peracetic acid, alkaline hydrolysis, lime solutions, ozone gas or dry inorganic chemicals (e.g. calcium oxide powder). **The incineration of the following should be avoided: PVC plastics such as intravenous equipment, catheters or PVC containers for sharp objects; mercury thermometers (preferably collected for mercury recovery); and pressurized containers.*

Annex 2. Examples of Guidelines for Managing Health Care Waste During the COVID-19 Pandemic

WHO/UNICEF 'Water, sanitation, hygiene, and waste management for the COVID-19 virus: interim guidance'[32]	The WHO interim guidance note from 29 July 2020 complements its existing IPC documents by summarizing key recommendations on water, sanitation, hygiene and waste management pertaining to viral infections. Notably, the guidance emphasizes adherence to best practices for handling health care waste, stressing the importance of assigning responsibility and adequate resources for safe segregation, recycling and disposal. Importantly, it states that direct human contact during waste handling has not been shown to transmit the COVID-19 virus, and waste from facilities treating COVID-19 patients does not require additional treatment beyond existing recommendations. This means that managing health care waste during the pandemic aligns with WHO guidelines established in 2014. Additionally, the guidance addresses household-generated waste during quarantine or caregiving, advising that it be securely packed in sturdy bags and fully sealed before disposal. If municipal waste services are unavailable, temporary measures such as safe burial or controlled burning may be considered, as outlined by the WHO.
WHO/UNICEF 'Guidance on developing a national deployment and vaccination plan for COVID-19 vaccines: interim guidance'[33]	WHO and UNICEF also issued a guidance document on the deployment of COVID-19 vaccines. The guidance document underscores the need for comprehensive waste management protocols prior to vaccination activities. It emphasizes onsite waste segregation, collection, transport, storage, treatment and disposal in line with WHO guidelines, ideally using BAT. In the absence of adequate facilities, reverse logistics should be employed to safely return waste to suitable locations. Clustering vaccination sites with treatment and disposal facilities is recommended. Additionally, strict monitoring of vaccine vials and packaging is crucial to prevent illicit activities such as counterfeiting and illegal distribution, as highlighted in the guidance document.
UNDP/GEF/WHO/HCWH 'Decision tree for the treatment of COVID-19 waste'[34]	UNDP, the Global Environment Facility (GEF), WHO and HCWH devised a decision tree to assist authorities in selecting the most suitable treatment methods for COVID-19 waste across various scenarios. This decision-making tool operates on the principle that waste from COVID-19 patient care should be managed similarly to other health care waste, aligning with WHO interim guidance. It states that waste from facilities treating COVID-19 patients does not require special treatment. The decision tree advocates first segregating non-infectious waste from infectious waste and treating the former as municipal waste. For infectious waste, the preferred approach is onsite treatment using BAT, defined as autoclave or high-temperature incinerator with advanced air pollution control. Alternatives, in descending order, include centralized BAT facilities, transfer to other facilities with BAT capabilities, onsite incineration in level 3 or 2 incinerators, controlled burial in designated landfills, or burning in level 1 incinerators as interim measures. Lastly, in emergencies, simple onsite treatment methods such as barrel or pit burning may be considered, though these are the least preferable options.

32 World Health Organization and United Nations Children's Fund, 'Water, sanitation, hygiene, and waste management for the COVID-19 virus: interim guidance, 19 March 2020', WHO, Geneva, and UNICEF, New York, 2020. https://apps.who.int/iris/handle/10665/331499.

33 Health Organization and United Nations Children's Fund, 'Guidance on developing a national deployment and vaccination plan for COVID-19 vaccines: interim guidance, 1 June 2021', WHO, Geneva, and UNICEF, New York, 20201. https://apps.who.int/iris/handle/10665/341564.

34 United Nations Development Programme, 'Decision Tree for the Treatment of COVID-19 Waste', UNDP GEF Project on Reducing UPOPs and Mercury Releases from the Health Sector in Africa, 2020. https://greenhealthcarewaste.org/wp-content/uploads/2020/12/Decision-Tree-for-the-treatment-of-COVID-19-Healthcare-Waste.pdf.

UNEP/IGES 'Waste management during the COVID-19 pandemic: from response to recovery'[35]	During the early stages of the COVID-19 pandemic, UNEP and the Institute for Global Environmental Strategies (IGES) issued a guidance document focusing on health care waste and its impact on municipal solid waste services. Drawing from a literature review of official publications and a rapid survey conducted across 15 countries, including 10 in Asia, the document summarizes national policies and practices related to HCWM and municipal solid waste management. Additionally, it highlights best practices based on international guidelines and offers forward-looking recommendations for building sustainable HCWM systems and municipal solid waste services during the recovery phase. In conjunction with the guidance document, UNEP released a series of fact sheets addressing various aspects of COVID-19 waste management. These fact sheets cover topics such as national medical waste capacity assessment, selection of waste management technology for COVID-19 waste treatment, and policy and legislation related to pandemics, sanitation and wastewater management, among others.[36] The fact sheets provide practical advice on mitigating environmental impacts arising from the pandemic, including safe waste management practices and control of harmful chemical releases into the environment. Challenges highlighted in the fact sheets include insufficient data for strategic planning, limited knowledge and capacity among health care workers, and complexities in disaster and humanitarian settings.
ADB 'Managing infectious medical waste during the COVID-19 pandemic'[37]	The Asian Development Bank (ADB) issued guidance in April 2020 on managing infectious COVID-19 waste, advising national governments to assess existing medical waste management plans and strengthen municipal waste management services. This guidance aligns with recommendations from the WHO, UNEP and the Basel Convention. In this briefing note, ADB recommended managing medical waste in accordance with national legislation, anticipating increased waste volumes due to the pandemic. The note highlighted the importance of segregating infectious waste at the point of generation and avoiding intermediate handling to minimize infection risk. Treatment options include autoclaving, irradiation or incineration, with mobile equipment suggested for temporary relief in overwhelmed areas. Cement kilns and industrial furnaces are also proposed for temporary use, with treated waste recommended for disposal in licensed landfills. At the household level, ADB advised segregating face masks, wipes and tissues from other waste, double bagging them in yellow bags, and disinfecting the outside with chlorine solution.
Global Platform for Sustainable Cities/World Bank 'COVID-19 Vaccination and municipal waste management: technical brief'[38]	The World Bank published a technical brief in September 2021, addressing the impact of COVID-19 vaccine roll-outs on municipal waste operations. Emphasizing waste minimization and segregation, the brief highlights various types of waste generated by vaccination activities, distinguishing between hazardous and non-hazardous waste. Alongside needles, syringes and vaccine vials, vaccination activities produce non-hazardous waste such as packaging materials, refrigerant packs, wipes and disinfectants, manageable as municipal waste. Referring to WHO guidance on sharps and infectious waste management, the brief suggests the use of needle cutters/destroyers in vaccination programmes to significantly reduce sharps container volume.

35 United Nations Environment Programme and Institute for Global Environmental Strategies, 'Waste management during the COVID-19 pandemic: from response to recovery', UNEP, Nairobi, and IGES, Kanagawa, 2020.
36 United Nations Environment Programme, 'COVID-19 Waste management factsheets', UNEP, Nairobi, 2020. https://www.unep.org/resources/factsheet/covid-19-waste-management-factsheets.
37 Asian Development Bank, 'Managing infectious medical waste during the COVID-19 pandemic', ADB, Manila, 2020. https://www.adb.org/publications/managing-medical-waste-covid19.
38 Global Platform for Sustainable Cities and World Bank, 'COVID-19 Vaccination and municipal waste management: technical brief', Global Platform for Sustainable Cities and World Bank, Washington, DC, 2021. https://www.thegpsc.org/knowledge-products/solid-waste-management/covid-19-vaccination-and-municipal-waste-management.

UNDP HIV and Health Group