



Safe management of wastes from health-care activities

A summary



World Health
Organization

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Acronyms and abbreviations

AMR	antimicrobial resistance	PCDDs	polychlorinated dibenzo-p-dioxins
BAT	best available techniques	PCDFs	polychlorinated dibenzofurans
BEP	best environmental practices	POPs	persistent organic pollutants
ESM	environmentally sound management	PPE	personal protective equipment
HBV	hepatitis B virus	PVC	polyvinylchloride
HCV	hepatitis C virus	SDGs	Sustainable Development Goals
HCWM	health-care waste management	TEQ	toxic equivalent
HEPA	high efficiency particulate air	UN	United Nations
HIV	human immunodeficiency virus	UNEP	United Nations Environment Programme
IPC	infection prevention and control	UNICEF	United Nations Children's Fund
ISWA	International Solid Waste Association	WASH	water, sanitation and hygiene
JMP	WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation	WHA	World Health Assembly
PCBs	polychlorinated biphenyls	WHO	World Health Organization

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Benedetta Allegranzi, WHO, Geneva, Switzerland
Arshad Altaf, WHO, Geneva, Switzerland
Sophie Boisson, WHO, Geneva, Switzerland
Edith Clarke, Ministry of Health, Accra, Ghana
Nizam Damani, Queens University, Belfast, United Kingdom
Fabrice Fotso, UNICEF, Dakar, Senegal
Beatrice Giordani, NEWSTER Group, City of San Marino, San Marino

Roland Katschnig, METEKA GmbH, Judenburg, Austria

Edward Krisiunas, WNWN International, Burlington, United States of America

Jan-Gerd Kühling, ETLog Health Consulting GmbH, Kremen, Germany

Miquel Lozano, Tesalys, Saint-Jean, France

Slobodanka Pavlovic, Independent University Banja Luka, Banja Luka, Bosnia and Herzegovina

Michaela Pfeiffer, WHO, Geneva, Switzerland

Raj Rathamano, Manitoba Sustainable Development, Winnipeg, Canada

Omar Fernández Sanfrancisco, ATHISA GROUP, Peligros, Spain

Ruth Stringer, Health Care Without Harm, Exeter, United Kingdom

Carolyn Vickers, WHO, Geneva, Switzerland

Anne Woolridge, Independent Safety Services Ltd, Sheffield, United Kingdom

1. Introduction

Safe health-care waste management is fundamental for the provision of quality, people-centred care, protecting patient and staff safety and safeguarding the environment. As part of broader water, sanitation and hygiene (WASH) and infection prevention and control (IPC) efforts, safe management of health-care waste reduces health-care-related infections, increases trust and uptake of services, increases efficiency and decreases cost of service delivery. In line with the UN Sustainable Development Goals (SDGs), particularly SDG 3 on health, SDG 6 on safely managed water and sanitation and SDG 12 on sustainable consumption and production, the *Water, sanitation and hygiene (WASH) in health care facilities: Global action plan* aims to ensure that all health-care facilities have basic WASH services by 2030 (WHO & UNICEF, 2015a). This includes safe health-care waste management involving segregation, collection, transportation, treatment and waste disposal.

The WHO/UNICEF Joint Monitoring Programme (JMP)¹ has the official mandate of reporting on progress towards achieving SDG 6 on safely managed water and sanitation. This will involve capturing and reporting data from households, schools and health-care facilities. Harmonized monitoring indicators to assess WASH services in health-care facilities include one on health-care waste and specifically, proper segregation and safe treatment and disposal.² WHO and UNICEF are working with partners to ensure these indicators are used in national health facility assessments and health monitoring information systems.

This document highlights the key aspects of safe health-care waste management in order to guide policy-makers, practitioners and facility managers to improve such services in health-care facilities. It is based on the comprehensive and detailed WHO handbook *Safe management of wastes from health-care activities* (WHO, 2014), and also takes into consideration relevant World Health Assembly (WHA) resolutions, other UN documents and emerging global and national developments on WASH and IPC.

Five guiding principles are widely recognized as the basis for effective and controlled management of waste. These principles have been used in many countries when developing their policies, legislation and guidance: the “polluter pays” principle; the “precautionary” principle; the “duty of care” principle; the “proximity” principle; and the “prior informed consent” principle.

1. To learn more about JMP and read recent reports visit: <http://www.wssinfo.org/>

2. To view the indicators please visit the WASH in health-care facilities knowledge portal: <http://www.washinhcf.org/resources/tools/>

Ideally, all health-care waste management practices seek to implement environmentally sound management (ESM) of hazardous waste or other waste,³ best environmental practices (BEP)⁴ and best available techniques (BAT)⁵ in accordance with the Basel and Stockholm conventions and relevant national regulations and requirements. Nevertheless, changes and improvements to waste management practices must be made within the financial and technical capacity of any health-care system. This might include making small, incremental improvements, as well as planning for more significant, longer term improvements to obtain optimal options, which may only be possible once certain conditions have been reached.

Basel Convention (UNEP, 1989): The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal is the most comprehensive global environmental treaty on hazardous and other wastes. It has 184 Member Countries (Parties) and aims to protect human health and the environment against the adverse effects resulting from the generation, management, transboundary movements and disposal of hazardous and other wastes.

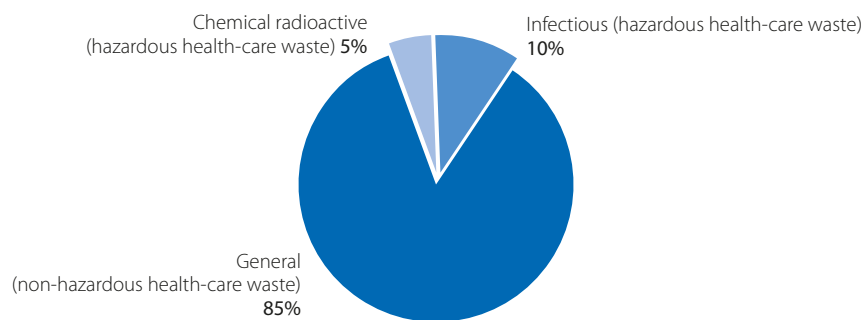
Stockholm Convention (UNEP, 2004): The Stockholm Convention on Persistent Organic Pollutants (POPs) is a global treaty to protect human health and the environment from highly dangerous, long-lasting chemicals, by restricting and ultimately eliminating their production, use, trade, release and storage. The Convention also addresses unintentional chemical by-products, including polychlorinated dibenzo-p-dioxins and dibenzofurans (PCDDs and PCDFs). It has 180 Member Countries (Parties).

-
3. ESM: Taking all practicable steps to ensure that hazardous wastes or other wastes are managed in a manner which will protect human health and the environment against the adverse effects which may result from such wastes (Basel Convention).
 4. BEP: The application of the most appropriate combination of environmental control measures and strategies (Stockholm Convention).
 5. BAT: The most effective and advanced stage approaches to preventing and, where that is not practicable, generally to reducing releases of chemicals listed in Part I of Annex C and their impact on the environment as a whole (Stockholm Convention).

2. Health-care waste categories and risks

About 85% of the waste produced by health-care providers is comparable to domestic waste and usually called “non-hazardous” or “general health-care waste”. It comes mostly from the administrative, kitchen and housekeeping functions of health-care facilities and may also include packaging waste and waste generated during construction and maintenance of health-care buildings. The remaining 15% of health-care waste is regarded as “hazardous” and can pose a number of health and environmental risks.

Figure 2.1 Typical waste composition in health-care facilities



Poor management of health-care waste exposes health-care workers, waste handlers and the community to infections, toxic effects and injuries. There is also a potential for spreading drug-resistant microorganisms from health-care facilities into the environment through poor health-care waste management (WHO, 2015a). In 2015, a joint WHO/UNICEF assessment found that just over half (58%) of sampled facilities from 24 countries had adequate systems in place for the safe disposal of health-care waste (WHO & UNICEF, 2015b). Sharps and, more specifically, needles are considered the most hazardous category of health-care waste for health-care workers and the community at large, because of the risk of needle-stick injuries which carry a high potential for infection (WHO, 2006).⁶

6. The risk of infection following a needle-stick injury with needle from an infected source patient is ~0.3% for HIV, 3% for hepatitis C and 6–30% for hepatitis B (WHO, 2003a).

Table 2.1 describes the different hazardous and non-hazardous waste categories (with examples) and the associated risks.

Table 2.1 Categories of health-care waste

Waste categories	Descriptions and examples
Hazardous health-care waste	
Infectious waste	Waste known or suspected to contain pathogens and pose a risk of disease transmission, e.g. waste and waste water contaminated with blood and other body fluids, including highly infectious waste such as laboratory cultures and microbiological stocks; and waste including excreta and other materials that have been in contact with patients infected with highly infectious diseases in isolation wards.
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.
Pathological waste	Human tissues, organs or fluids; body parts; foetuses; unused blood products.
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 specific biological, chemical, radioactive or physical hazard.

3. Segregation and collection of waste

The correct segregation of health-care waste is the responsibility of the health-care provider and/or patient and caregiver who produces each waste item. Health-care facility managers are responsible for making sure that there is a suitable segregation, transport and storage system in place and that all staff adhere to the correct procedures. Education and training must be provided to all staff who are responsible for both segregation and collection of waste. The appropriate waste receptacle (bags, bins, sharps boxes) should be available in each medical and other waste-producing area in a health-care facility. This allows for segregation and disposal of waste at the point of generation, and reduces the need to carry waste through a health service area. Posters showing the type of waste that should be disposed of in each container should be placed near to the bins (e.g. on the walls as appropriate) to guide staff and reinforce good habits.

3.1 Waste containers, colour coding and labels

Waste segregation practices should be standardized nationwide and should be informed by national guidelines/legislation for health-care waste management. Such waste segregation systems should rely on a uniform colour coding system which provides a visual indication of the potential risk posed by the waste in that container and makes it easier to put waste items into the correct container and to maintain segregation during transport, storage, treatment and disposal.

Labelling of waste containers is used to identify the source, record the type and quantities of waste produced in each area and allow problems with waste segregation to be traced back to the point of generation. A simple approach is to attach a label to each filled bag with the details of the medical area, date and time of closure of the bag and the name of the person filling out the label. It is also recommended to use an international hazard symbol on each waste bag if not already applied.

Figure 3.1 Biohazard symbol



Containers for infectious waste should not be placed in public areas because patients and visitors may use the containers and come into contact with

potentially infectious waste. Infectious waste bins should be located as close as possible to where waste is generated (e.g. nursing stations, procedure rooms or points of care). Placing sharps containers and segregation bins on treatment trolleys enables medical staff to segregate waste at the bedside or other treatment site. If the general waste container is close to the sink or under a towel dispenser it will encourage staff to place towels into the non-infectious receptacle.

Basic three-bin system: The simplest and safest waste segregation system is to separate all hazardous waste from non-hazardous general waste (which is generally of a larger quantity) at the point of generation. However, to ensure staff and patients are protected, the hazardous waste portion is very commonly separated into two parts: used sharps and potentially infectious items. Consequently, the segregation into separate containers of general non-hazardous waste, potentially infectious waste and used sharps is often referred to as the “three-bin system”.

Figure 3.2 Three-bin segregation system



3.2 Collection within health-care facilities

Collection times should be fixed and appropriate to the quantity of waste produced in each area of the health-care facility. Generally, pathological and infectious waste should be collected at least once per day. General waste should not be collected at the same time, or in the same trolley, as infectious or other hazardous wastes.

Figure 3.3 Exemplary bag tying



Waste bags/bins and sharp containers should be filled to no more than three-quarters full (or to the fill line on sharps bins when marked). Once this level is reached, they should be sealed, ready for collection. Plastic bags should never be stapled but may be tied in a knot or sealed with a plastic tag or tie. Replacement bags or containers should be available at each waste generation area.

Ideally, infectious waste bags should be labelled with the date, type of waste and point of generation to allow it to be tracked through to its disposal. Where possible, the weight of waste should also be routinely recorded. Anomalies between departments providing similar services or at one location over time can highlight opportunities for recycling or problems such as poor segregation and diversion of waste for unauthorized reuse like the reuse of syringes and needles. Most waste categories should be collected at least once a day. Sharp waste should be collected when containers are filled to the marked fill line or three-quarters filled if there is no line. Chemical, pharmaceutical and radioactive waste can be collected on demand. The colour coding may differ from country to country.

Table 3.1 WHO recommended segregation and collection scheme

Waste categories	Colour of container and markings	Type of container	Collection frequency
Infectious waste	Yellow with biohazard symbol (highly infectious waste should be additionally marked HIGHLY INFECTIOUS).	Leak-proof strong plastic bag placed in a container (bags for highly infectious waste should be capable of being autoclaved).	When three-quarters filled or at least once a day.
Sharp waste	Yellow, marked SHARPS with biohazard symbol.	Puncture-proof container.	When filled to the line or three-quarters filled.
Pathological waste	Yellow with biohazard symbol.	Leak-proof strong plastic bag placed in a container.	When three-quarters filled or at least once a day.
Chemical and pharmaceutical waste	Brown, labelled with appropriate hazard symbol.	Plastic bag or rigid container.	On demand.
Radioactive waste	Labelled with radiation symbol.	Lead box.	On demand.
General health-care waste	Black.	Plastic bag inside a container or container which is disinfected after use.	When three-quarters filled or at least once a day.

4. Transport within health-care facilities

On-site transportation should take place whenever possible during less busy times (i.e. in the evenings or very early morning). Set routes should be used to prevent exposure to staff and patients and to minimize the passage of loaded carts through patient care and other clean areas. Depending on the design of the health-care facility, the internal transportation of waste should use separate floors, stairways or elevators from patients as far as possible. Regular transport routes and collection times should be fixed and reliable. Transport staff should wear adequate personal protective equipment (PPE) including gloves, closed shoes, overalls and masks. Education and training must be provided to all waste transport workers and include how to safely handle waste containers that leak or are broken.

Note:

Hazardous and non-hazardous waste should always be transported separately!

Health-care waste can be bulky and heavy and should be transported by using wheeled trolleys or carts that are not used for any other purpose. Waste, especially hazardous waste, should never be transported by hand due to the risk of accident or injury from infectious material or incorrectly disposed sharps that may protrude from a container. It is recommended that spare trolleys are available in the case of breakdowns and maintenance. The vehicles should be thoroughly cleaned and disinfected daily as per a written protocol.

Separate routes for transporting hazardous and non-hazardous waste should be planned and used. In general, a waste route should follow the principle from “clean to dirty”. Collection should start from the most hygienically sensitive medical areas (e.g. intensive care, dialysis, operating theatres) and follow a fixed route around other medical areas and interim storage locations. The frequency of collection should be refined through experience to ensure that there are no overflowing waste containers at any time.

5. Waste storage requirements

A storage location for health-care waste should be designated inside the health-care facility. Space for storing wastes should be incorporated into a building design when new construction is undertaken. These storage areas should be sized according to the quantities of waste generated and the frequency of collection. These areas must be totally enclosed and separate from supply rooms or food preparation areas. Only authorized staff should have access to the waste storage areas. Loading docks, space for compactors and balers for cardboard, staging areas for sharps boxes, recycling containers and secure storage for hazardous items such as batteries should all be provided. Equipment for accidental spill/leakage needs to be available.

General non-hazardous waste storage: General non-hazardous waste should be stored and kept for collection to the communal landfill/dumpsite or communal waste incinerator. It should be collected at least every week. The storage area should be enclosed, paved and connected to a public road. The gate should be big enough that the collection vehicles can enter.

Infectious and sharp waste storage: The storage place must be identifiable as an infectious waste area by using the biohazard symbol. Floors and walls should be sealed or tiled to allow easy cleaning and disinfection. Storage times for infectious waste (e.g. the time gap between generation and treatment) should not exceed the following periods:

- Temperate climate: 72 hours in winter/48 hours in summer.
- Warm climate: 48 hours during the cool season/24 hours during the hot season.

If a refrigerated storage room is available, infectious waste can be stored for more than a week cooled to a temperature no higher than 3°C to 8°C.

Pathological waste storage: Pathological waste is considered biologically active and gas formation during the storage should be expected. To minimize the possibility of this happening, storage places should have the same conditions as for infectious and sharps wastes. Where possible, waste should be stored under refrigerated conditions.

In some cultures, body parts are passed to the family for ritual procedures or are buried in designated places. Bodies should be placed in sealed bags prior to release to the family to reduce the risk of infection.

Pharmaceutical waste storage: Pharmaceutical waste should be segregated from other wastes. International and local regulations should be followed for storage. In general, pharmaceutical wastes can be hazardous or non-hazardous, liquid or solid in nature and each type should be handled differently. The classification should be carried out by a pharmacist or other expert on pharmaceuticals (WHO, 1999).

Storage of other hazardous waste: When planning storage places for hazardous chemical waste, the characteristics of the specific chemicals to be stored and disposed of must be considered (i.e. inflammable, corrosive, explosive). The storage area should be enclosed and separated from other waste storage areas. Storage facilities should be labelled according to the hazard level of the stored waste.

Radioactive waste should be stored in compliance with national regulations and in consultation with the radiation officer. It should be placed in containers that prevent dispersion of radiation, and stored behind lead shielding. Waste that is to be stored during radioactive decay should be labelled with the type of radionuclide, date, period of time before full decay and details of required storage conditions.

6. Treatment of health-care waste

In accordance with the Basel Convention, it is recommended that waste treatment techniques which minimize the formation and release of chemicals or hazardous emissions should be given priority. In general, chemical, pharmaceutical and radioactive waste should be included in the national strategy for hazardous waste and should be treated in accordance with international and local regulations. In general, the decontamination of infectious and sharp waste by steam (e.g. by autoclaving) or other non-burn technology should preferably be used in the treatment of infectious waste (UNEP, 2003). For detailed information on these techniques see the UNEP compendium of technologies for treatment/destruction of health-care waste (UNEP, 2012). However, in many low-resource settings, these options/technologies may not be readily available as they depend on reliable and regular water, energy and solid waste collection.

The choice of treatment system depends on local conditions and involves consideration of:

- Available resources including technical expertise.
- Relevant national regulations and requirements.
- Waste characteristics and volume.
- Technical requirements for installation, operation and maintenance of the treatment system.
- Safety and environmental factors.
- Cost considerations.

6.1 Steam-based treatment technologies

Steam-based treatment technologies are used to disinfect/sterilize highly infectious waste, infectious waste and sharp waste by subjecting it to moist heat and steam for a defined period of time, depending on the size of the load and the content. The combined action of saturated steam and heat kills microorganisms. Steam sterilization has been widely used for instrument sterilization as well as for infectious and sharp waste treatment and steam treatment devices are available in a wide range of sizes. To guarantee full decontamination of the infectious material, the process needs to be validated and regular biological, chemical and physical testing is necessary (WHO & PAHO, 2016). Steam treatment technologies need a reliable and stable electricity connection (220 V/380 V). Some technologies need water of specific quality and/or specific bags or containers. Offensive odours can be generated if there is a large amount of organic matter in the waste and

thus the location of the treatment and/or ventilation options should be considered.

Steam treatment can be combined with mechanical methods like shredding, grinding, mixing and compaction to reduce waste volume, however, it does not destroy pathogens. Shredders and mixers can improve the rate of heat transfer and expose more surface area of waste for treatment. Mechanical methods should not be utilized for infectious and sharp waste before the waste is disinfected, except if the mechanical process is part of a closed system that disinfects air before it is released to the surrounding environment.

Autoclaving: Autoclaving is the most common type of steam treatment and utilizes saturated steam under pressure to decontaminate waste. Potential infected air evacuated from the autoclave is filtered effectively (e.g. through a high efficiency particulate air (HEPA) filter). Autoclaves operate at temperatures of 121°C to 134°C. Autoclaves which do not have an integrated shredder should ensure that the air is removed from the autoclave chamber before the waste is decontaminated (e.g. by a vacuum pump), as air remaining in the waste can inhibit the decontamination efficiency of the autoclaving process.

Microwave: Microwaving technology heats the water contained in the waste by microwave energy. Some microwave based devices include transformation systems like blending or shredding. Some systems are designed as batch processes and others are semi-continuous. A typical semi-continuous system uses a HEPA filter to prevent release of airborne pathogens. Waste goes through a shredder, and the waste particles are conveyed through an auger (conveyor screw) where they are further exposed to steam and heated to 100°C by microwave generators.

Frictional heat treatment: This treatment is based on friction and grinding of the waste in a moist environment. The treatment process takes place inside a chamber by means of a high-speed rotor. The temperature rises to 150°C and is held for the time necessary to achieve sterilization. When all the liquid contained in the waste has evaporated, it is brought to dry, superheated conditions. The residue is a dry and unrecognizable product with reduced volume.

6.2 Incineration

Incineration is a high-temperature (850°C to 1100°C) dry oxidation process that reduces organic and combustible waste to inorganic, incombustible matter and results in a very significant reduction of waste volume and weight. In accordance with the Stockholm Convention, the best available technology should be used to

achieve an emission of lower than 0.1 ng toxic equivalents (TEQ⁷)/m³ of dioxins and furans. It is stated that primary measures for incinerators are two burning chambers (850°C/1100°C), auxiliary burner, 2 seconds' residence time of air in the second chamber, sufficient oxygen content, and high turbulence of exhaust gases. The primary measures described here should be a minimum standard. By applying primary measures, a performance around 200 ng TEQ/m³ of dioxin and furan can be achieved (UNEP, 2013a).

Dioxins and furans

Dioxins and furans are generated by the combustion of health-care waste which contains chlorine. Dioxins and furans are bio-accumulative and are highly toxic. They can cause reproductive and developmental problems, damage the immune system, interfere with hormones and also cause cancer. One source of chlorine in health-care waste is the plastic polyvinylchloride (PVC) in medical devices. For example, gloves or blood bags can consist of PVC. Therefore, the purchase of PVC-free devices is recommended.

This minimum standard should be followed by an incremental improvement approach, with which the requirements of the Stockholm Convention can be reached. In order to achieve emissions lower than 0.1 ng TEQ/m³ additional flue gas treatment systems are needed (secondary measures). These may be comparatively expensive for small and medium-sized incinerators, and this should be taken into consideration at the planning stage. Furthermore, air filters and waste water resulting from the filtering processes are considered as hazardous waste and need to be handled accordingly.

6.3 Other treatment methods

Automated chemical treatment: Fully automated chemical treatment methods mostly use disinfectants. These are problematic as they produce toxic effluents and increase the risk of exposure of such toxins to health-care waste workers. Two exceptions are ozone treatment and alkaline hydrolysis. Ozone is a strong gaseous disinfectant and can be generated on site, avoiding the need to transport and store it. Alkaline hydrolysis uses sodium or alkaline hydroxide at high temperature and pressure to destroy tissues and formaldehyde. It is also proven to destroy prion waste. Alkaline hydrolysis is also capable of destroying chemicals such as pharmaceuticals, but more research is needed on this subject (HCWH, 2017).

Biological treatment: These processes are found in natural living organisms but refer specifically to the degradation of organic matter when applied to health-

7. TEQ: Toxic equivalents report the toxicity-weighted masses of mixtures of polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) and polychlorinated biphenyls (PCBs).

care waste treatment. Some biological treatment systems employ enzymes to speed up the destruction of organic waste containing pathogens. Composting and vermiculture (digestion of organic wastes through the action of worms) are biological processes and have been used successfully to decompose hospital kitchen waste, as well as other organic digestible waste and placenta waste. The natural decomposition of pathological waste through burial is another example of a biological process.

6.4 Interim treatment approaches and emergency situations

In low-resource settings or emergencies, countries will need to rely on interim transitional methods while considering how to incrementally implement techniques which minimize human and environmental health risks and adhere to international regulations.

Small medical waste incinerators, such as single-chamber, drum and brick incinerators, are designed to meet a need for public health protection where there are no resources to implement and maintain more sophisticated technologies. This involves a compromise between the environmental impacts from controlled combustion with an overriding need to protect public health if the only alternative is uncontrolled dumping. These circumstances exist in many developing countries and small-scale incineration can be a transitional response to an immediate requirement (WHO, 2004). As far as possible, the burning of PVC plastics and other chlorinated waste should be avoided to prevent the generation of dioxins and furans.

Burning of health-care waste in a pit is less desirable, but if it is genuinely the only realistic option in an emergency, or if chosen as an interim solution in case no other solution is in place, it should be undertaken in a confined area. The waste should be burned within a dugout pit, followed by covering with a layer of soil (WHO, 2014).

7. Wastewater management

Typically, a system of sewer pipes linked together to form a sewerage system will collect wastewater from around a health-care facility and carry it below ground to a “centralized” wastewater system which also provides treatment for the wider community or municipality. The discharge of generated wastewater from a health-care facility into the municipal sewage system is a preferred method if it is ensured that the municipal sewage treatment plant fulfils the local regulatory requirements. Where a main sewerage system has not been constructed, wastewater may be collected from medical areas by a pipe system and passed into cesspits, septic tanks or container-based sewage systems for initial treatment. It is important that a facility carefully considers the best options for safeguarding human and environmental health, recognizing that in many low-resource settings, sewerage is not available and/or does not safely dispose of waste. A risk assessment following a “safety planning approach” should be conducted to identify potential health risks and implement measures to ensure wastewater from the health-care facility is safely managed throughout containment, collection, transport, treatment and disposal.

Antimicrobial resistance (AMR)

Antibiotics are used extensively for treatment in hospitals. These antibiotics and their metabolites are excreted with urine and faeces and end up in the wastewater stream. AMR threatens the effective prevention and treatment of an ever-increasing range of infections caused by bacteria, parasites, viruses and fungi.

Globally, 480 000 people develop multi-drug resistant TB each year, and drug resistance is starting to complicate the fight against HIV and malaria, as well. (WHO, 2016a).

Antibiotics are used extensively for treatment in hospitals. Hospital wastewaters are a source of bacteria with acquired resistance against antibiotics with a level of at least a factor of 2 to 10 times higher than in domestic wastewater.

Hazardous chemical waste and pharmaceuticals should not be discharged into wastewater but collected separately and treated as chemical health-care waste. For wastewater streams from departments such as medical laboratories, pre-treatment is recommended. This could include acid-base neutralization, filtering to remove sediments or autoclaving samples from highly infectious patients. Non-hazardous chemicals such as syrups, vitamins or eye drops can be discharged to the sewer without pre-treatment.

To remove grease, oil and other floating materials from kitchen wastewater, a grease trap can be installed. The trap and collected grease should be removed every two to four weeks.

Collected body fluids, small quantities of blood and rinsing liquids from theatres and intensive care can be discharged into the sewer without pre-treatment. Precautions against blood spatter (e.g. wearing PPE and standardized handling procedures) should always be used and care taken to avoid blood coagulation that could block pipes. Larger quantities of blood may be discharged if a risk assessment shows that the likely organic loading in the wastewater does not require pre-treatment. Otherwise, it should be first disinfected preferably by a thermal method or disposed of as pathological waste.

Larger health-care facilities, in particular those that are not connected to any municipal treatment plant, should operate their own wastewater treatment equipment. This could comprise physical, chemical and biological processes to remove contaminants from the raw sewage. The objective is to produce a treated effluent that is suitable for reuse or discharge back into the environment, usually surface watercourses.

8. Disposal options

General non-hazardous and hazardous waste should not be disposed on the premises of health-care facilities. Non-hazardous waste should be collected regularly by the municipality or transported by the facility to a known and safely managed public disposal site. All hazardous waste should be treated to eliminate the hazardous properties before disposal, or should be disposed in an engineered landfill designed for hazardous waste. The disposal of pathological wastes may be bound by sociocultural, religious and aesthetic norms and practices. A traditional option is the internment (burial) in cemeteries (WHO, 2014).

8.1 Transitional disposal options

8.1.1 General non-hazardous waste

In cases where general non-hazardous waste cannot be disposed at a public disposal site and there is sufficient space, an interim disposal site on the premises of the health-care facility might be established, which is secured to prevent unauthorized access and prevents humans and animals from entering the site. The waste should be disposed and covered daily with a layer of soil. Some health-care facilities may have neither a public disposal site nor sufficient space for disposal on the premises. As an interim (transitional) solution, the waste can be disposed in a burial area and burned. Open burning of waste results in the generation of greenhouse gases and should be avoided. The ash should be covered with a layer of soil after the burning process is finalized. The area should be secured against unauthorized access, for example with a fence. These solutions must be considered as short-term interim solutions while planning for a safer and more environmentally friendly option.

8.1.2 Hazardous waste disposal options

Developing and transition countries often lack proper facilities for hazardous waste. The following options may be implemented but should be considered transitional, interim solutions.

Pathological waste disposal: Placenta pits can be effective in low-resource settings. They need to be located at specific sites to avoid contamination of groundwater, locked and fenced for security. Natural degradation and draining of liquid into the subsoil greatly reduces the volume of waste in the pit and facilitates the inactivation of pathogens. Pathological waste may be disposed of at a landfill when no other treatment options are available. However, disposal should be in a

pre-specified area to prevent recyclers or scavengers coming into contact with the waste. Waste should also be covered as quickly as possible.

Disposal of hazardous ash: Fly ash and bottom ash from incineration is generally considered to be hazardous, because of the possibility of heavy metal content and dioxins and furans. It should preferably be disposed in sites designed for hazardous wastes, e.g. designated cells at engineered landfills, encapsulated and placed in specialized monofill sites, or disposed in the ground in an ash pit.

Sharp waste disposal: Even after decontamination, sharp waste may still pose physical risks. There may also be risk of reuse. Decontaminated sharp waste can be disposed of in safe sharp pits on the health-care facility premises or encapsulated by mixing waste with immobilizing material like cement before disposal. These procedures are only recommended in cases where the waste is handled manually and the landfill for general waste is not secured.

8.2 Disposal options in emergency situations

Disposing of hazardous wastes without prior treatment into a general non-hazardous landfill greatly increases the risks to human health and the environment. If the waste is not properly covered, or disturbed by any means, further risks will arise. It is therefore poor practice to dispose of hazardous waste directly into a non-engineered landfill.

In remote health-care facilities and resource-scarce areas, minimal approaches for health-care waste management need to be employed. In addition, interim minimal practices may also be necessary in emergency situations or temporary refugee encampments and areas experiencing exceptional hardship. Consequently, the safe burial of infectious and sharp waste on health-care facility premises or in a protected concrete pit may be the only viable option available in such locations. Open dumping of boxes/bagged waste should be avoided (WHO, 2006). Pharmaceutical waste and chemical waste should be stored until a safe disposal option has been identified.

9. Mercury in health care

In health care, mercury can be found in fever thermometers, sphygmomanometers (blood pressure measuring devices) and dental amalgam. Other sources of mercury in health care may include fluorescent lamps, canton tubes, dilators, mercury switches and some button batteries (WHO, 2015b).

Due to its high volatility, mercury vaporizes at typical room temperatures (WHO, 2003b). Health-care workers, patients and others in health-care facilities can thus be readily exposed to mercury vapour when mercury-containing measuring devices or equipment break or spill. The use of mercury spill kits can help ensure safe clean-up in such circumstances.

When inhaled, mercury vapour can affect the central nervous system and, depending on exposure levels, can impair cognition and in some cases cause death (WHO, 2015b). Elemental mercury toxicity among children can also manifest in swelling, painful, red skin peeling off fingers and toes and also high blood pressure (Bose-O'Reilly et al, 2010).

Once released into the atmosphere, mercury persists in the environment, cycling between air, land and water, where it can be transformed into organic mercury, a form of mercury which readily bio-accumulates in the food chain. Due to its negative health effects, human consumption of mercury-contaminated fish and shellfish is therefore also a major public health concern. Long-term exposure to mercury is highly toxic, especially affecting the nervous system, the brain, the heart, the kidneys, the lungs and the immune system (UNEP & ISWA, 2015). Children, infants and developing foetuses are at particular risk as even extraordinarily low doses of mercury intoxication can impair their neurological development (WHO, 2015b).

The primary source of atmospheric emissions of mercury from health-care facilities is incineration of health-care wastes, and, in particular, incineration of wastes containing mercury-added products such as mercury thermometers and sphygmomanometers.

In 2013, as a result of growing global awareness and concern about the negative environment and health consequences of exposure to mercury and mercury compounds, a legally binding treaty on mercury – the Minamata Convention on Mercury – was adopted. In order to meet its objectives, the Convention includes measures to control anthropogenic mercury emissions from industrial activities. It also includes measures to phase out the manufacture, import or export of

mercury-added products by 2020 (UNEP, 2013b).⁸ Mercury-added dental amalgam used in health care is subject to a phase down in use.

Minamata Convention on Mercury

Article 4 of the Minamata Convention calls for the phase-out of the import, export and manufacture of mercury thermometers and sphygmomanometers used in health care by 2020 and the phasing down of dental amalgam. 128 countries have signed the Convention.

This Convention refers to the Basel Convention for further guidance on the management of mercury containing waste. The Secretariat of the Basel Convention has developed technical guidelines on the environmentally sound management of mercury waste (UNEP, 2013b).

For health-care facilities, the implications are that from 2020 onwards, it will not be possible to procure mercury-containing thermometers or sphygmomanometers. In contexts where such devices are in use, health ministries thus need to plan for the introduction of mercury-free alternatives. They also need to ensure the safe collection, handling and environmentally sound disposal of devices to be replaced or substituted. For more details on this process, see *Developing national strategies for phasing out mercury-containing thermometers and sphygmomanometers in health care, including in the context of the Minamata Convention on Mercury* (WHO, 2015b).

8. Or 2030 to those Parties afforded maximum exemptions.

10. Implementation of health-care waste management programme

At the global level, health-care waste management is being addressed through the WHO and UNICEF *Water, sanitation and hygiene (WASH) in health care facilities: Global action plan* (WHO & UNICEF, 2015a), as well as initiatives linked to climate change, renewable energy and greening the health sector, in line with the SDGs.

All health-care waste activities should be planned, implemented and monitored at local, regional and national levels. In order to develop a realistic plan, the health-care waste management system should be assessed before beginning any activities.

A policy document on national level planning provides an important basis for all further implementation plans and defines the aims, key priorities and roles and responsibilities (WHO, 2014). A well thought out implementation plan describes the actions to be implemented by authorities, health-care personnel and waste workers. Identification of the budget and resources required for implementing the plan is important. Safe and environmental health-care waste management needs financial support – not only to begin activities but investment is needed for operation and maintenance of equipment. Furthermore, health-care waste management policies and plans should include arrangements for the continuous monitoring of workers' health and safety. Additionally, a health-care waste management plan should also include an emergency response contingency plan that is known to all persons who will be assigned duties at the facility. This is to ensure that correct handling, treatment, storage and disposal procedures are being followed at all times.

At the facility level, the head of a hospital should formally appoint the members of the waste management team in writing, informing each of their duties and responsibilities. The head should appoint a waste management officer who will have overall responsibility for developing a facility-based health-care waste management plan, and for the day-to-day operation and monitoring of the waste treatment and disposal system. The waste management officer should be part of the infection prevention and control or WASH team of the health facility. Regular training and sufficient staffing are fundamental to improving and maintaining health-care waste management as part of WASH services in health-care facilities. It should be closely developed and delivered in tandem with training on infection prevention and control.

In addition to the WHO and UNICEF global action plan (WHO & UNICEF, 2015a), a number of recent global health initiatives and standards have incorporated the

safe management of health-care waste into their programmes and activities, including those on improving quality of care for mothers, newborns and children, the global learning laboratory on universal health coverage, core standards on infection prevention and control, the global action plan on injection safety and integrated efforts on vaccines and WASH (WHO & UNICEF, 2017; WHO 2016b; 2016c).

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Contact

Water, Sanitation, Hygiene and Health Unit
Department of Public Health, Environmental and Social Determinants of Health
World Health Organization
20 Avenue Appia
1211-Geneva 27
Switzerland
http://www.who.int/water_sanitation_health/en/