DIRTY AND DANGEROUS:
Healthcare Waste Management (HCWM) within MSF settings

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1. Introduction

Despite all hygiene precautions taken, the prevalence of healthcare-associated infections in high-income countries varies between 3.5% and 12% according to the WHO (1,2). Not surprisingly, the risk of healthcare-associated infections is even higher in low- and middle-income countries (LMIC); at any given time, the prevalence of healthcare-associated infection varies between 5.7% and 19.1%. Within specific areas, like the Intensive Care Units, these figures are even drastically higher (1,2). The main reasons for healthcare-associated infections are, regardless of the resources available:

- prolonged and inappropriate use of invasive devices and antibiotics;
- high-risk and sophisticated procedures;
- immuno-suppression and other severe underlying patient conditions;
- insufficient application of standard and isolation precautions.

However, low- and middle income countries have a whole series of other determinants which are specific for their limited resource settings, of which two factors seem to be the inadequate environmental hygienic conditions and **waste disposal** (2).

Medical staff are also at risk of healhcare-associated infections: many studies emphasise the risk of transmission of HIV and other blood-borne viruses like Hepatitis B through needle stick injuries: up to 40% of injuries occur when re-sheathing a used needle (3).

Box 1: Virus transmission risks following needle-stick injuries (3)

Hepatitis B:	1 in 3
Hepatitis C:	1 in 30
HIV:	1 in 300

The risk of needle stick injuries is also an important factor among non-medical staff when handling the waste, because they are unaware of the potential risks and do not apply or are not provided with appropriate protective measures / equipment (4). The risk for hepatitis B, which can survive at least several weeks in the ambient environment, is therefore a reality. An additional problem is encountered by injuries provoked by sharps that serve as entry points for other infections, especially when handling highly contaminated dressings, fluids or body parts.

Typical contamination and transmission routes of diseases related to healthcare waste are:

- **Direct contact with waste:** needle stick injuries, ingestion of pathogens through hand-mouth contact after having touched untreated / recycled waste or contaminated residues following incineration at low temperature.
- **Airborne transmission:** fungal diseases, smoke emissions containing pathogens and hazardous by-products (e.g. dioxins, furans) when waste is incinerated at low temperatures in a poorly designed incinerator or when the treatment is not properly conducted.
- **Pollution of water resources and the environment:** untreated waste polluting surface / groundwater and/or soil with chemical substances or pathogens (e.g. faecal coliforms and tetanus, polio and hepatitis).
- **Contact through vectors:** breeding in badly disposed waste.

Multiple routes of transmission suggest that many categories of people are at risk, including:

- **Medical staff** working in health centres;
- **Patients** (in particular if immuno-compromised) and their **visitors**;
- **Cleaners and Healthcare Waste personnel** handling waste inside and outside health centres;
- **People recycling or utilizing** used medical material;
- **The population, especially children living in the direct neighbourhood** where healthcare waste is dumped or left adjacent to incinerators;
- **The community**, through contaminated water, or vectors.

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The potential hazards associated with Healthcare Waste Management justify considering this issue as a public health concern.

MSF's HCWM was initially designed for short, emergency interventions. With the spread of HIV, increasing involvement in (peri-)urban settings, chronic instability, the use of more sophisticated medical equipment, longer-term programmes and environmental awareness, MSF has continuously been refining since 1997 its approach towards HCWM for low- and middle-income countries. This has resulted in pragmatic HCWM methods that can be used for different health structures within all kinds of LMIC settings by utilizing available facilities or introducing appropriate technologies, adaptable according to the emergency degree. Further adaptations to this general approach may be required according to the national legislations and/or the local constraints and contexts like outbreaks of very infectious diseases.

2. Approach

2.1. Definition of Healthcare Waste

Healthcare waste refers to all waste generated in the different kinds of healthcare structures including excreta, wastewater (sullage and sewage) and medical related waste. In high-income countries, the generated medical waste is classified in different categories, of which certain are subjected to extremely rigorous regulations that often demand complicated and expensive destruction and disposal methods with high-tech solutions.

These solutions are all too often projected onto low- and middle-income countries without considering if they are appropriate or not. Because these countries vary greatly in level of available resources, it is not surprising that correct HCWM, which is not even perfect in high-income countries, often fails. For this reason, Médecins Sans Frontières proposes the implementation of simplified, affordable, efficient and therefore, often more appropriate HCWM methods for low- and middle-income countries, which still are safe and do respect the Basel, Stockholm and Minamata Conventions, with the least negative environmental degradation possible considering their limited available resources (responding to the Best Available Techniques (BAT) principle of the Stockholm Convention).

MSF classifies all medical related wastes based on their **"common final disposal properties**" (see further):

- **Sharps**: these can result in perforations or cuts; e.g. needles, scalpels, ampoules, vials, (broken) glass like microscope slides.
- **"Soft" waste**: comprises all "solid" medical waste other than sharps, organic or hazardous waste and which is combustible, including dressings (wet or dry), packaging (paper, cardboard, plastic), gloves, surgical masks, respirators, syringes without needles, etc. A separation between contaminated and non-contaminated soft waste is normally not recommended for low- or even middle-income countries, as it can be complicated to implement and demands extreme supervision, and which in the end will all be treated in the same manner anyway.
- **Organic waste:** these will decompose by themselves and include placentas, aborted foetus, amputated limbs, blood and food residues from health structures (the latter is not considered as medical organic waste but might be disposed of in the same manner if it's generated in small quantities).
- **Hazardous Waste**: includes laboratory waste (chemicals and bio-hazardous), diagnostic testing waste, pharmaceutical waste, X-ray related waste, pesticides used in health structures, radioactive waste and specific waste (e.g. engine oil and batteries from ambulances, broken or unused appliances and bio-medical equipment containing dangerous substances like mercury for instance).

2.2. Objectives of Healthcare Waste

Health structures should be responsible for ensuring that all their healthcare waste is harmless to all populations potentially at risk.

Good Healthcare Waste Management results in waste being:
⇒ **non-infectious / not harmful;**
⇒ **and/or inaccessible** for the population**.**

Waste is most safely disposed of when all conditions are fulfilled.

3. Where, When and by Whom?

Correct hygiene and Healthcare Waste Management should be implemented and promoted in all health structures, from the smallest health post to the biggest hospital, including structures such as nutritional feeding centres, cholera treatment centres, medical laboratories, isolation centres and during mass vaccination campaigns. Furthermore, this should be done in all situations, from the onset of an emergency throughout the duration of long-term projects. HCWM should even be foreseen as part of emergency preparedness.

Statistics from high-income countries show that waste handlers manipulating the waste outside the health structure will have up to a 4 times greater chance of becoming infected by HIV than staff working inside the medical facilities (5). Therefore, with the less restringing legislation on HCWM and the lack of appropriate vehicles for waste transport in most low- and even middle-income countries, the possible treatment and final disposal should preferably be done at the health centre itself, in a well-defined area being the **waste zone**. This principle has following advantages:

- Waste remains under the control of properly trained staff within the medical facility, which reduces waste fraud outside of the health structure.
- Treatment and final disposal of the residues can be done in a protected waste zone by clearly defined, well-trained and supervised persons equipped with the right protective gear.

If waste must leave the compound (e.g. soft waste that cannot be incinerated in an (peri-) urban area), at least it should be safely transported towards the external treatment / disposal area with an appropriate vehicle, including a system of waybills. Ideally, it should be rendered harmless beforehand, preferably through sterilisation by autoclaving / microwaving.

All personnel, as well the medical as the non-medical staff, who are involved in hygiene activities and come in contact with healthcare waste should be exposed to correct waste management training and promotion. In addition, the waste component should be included within the Health Promotion towards patients, attendants and visitors.

4. Recommendations (6)

The three main MSF categories of medical waste that will be found in nearly every health structure are **sharps, "soft" waste, and organic waste**. New diagnostic testing methods, using potentially harmful chemicals, are being introduced in more and more MSF health structures, resulting in several different **hazardous wastes** that are being generated more commonly as well. They demand extra attention because of the specific technical requirements for their disposal (specialist advice can be asked at MSF headquarters as there is a constant research for appropriate solutions for these newly 'emerging' wastes in LMIC).

To achieve correct Medical Waste Management, several technical steps must be considered: **segregation, collection and possible temporary storage, (thermal) treatment and/or final disposal**. The entire technical process should preferably be done on the compound of the health structure, with the least manipulations possible, to limit potential accidents (e.g. needle stick injuries).

Box 2: Medical waste			
Segregation	**Sharps** ▼	**Soft waste** ▼	**Organic waste** ▼
Collection & Temporary storage	Yes ▼	Yes ▼	Yes No ▼
Treatment (Incineration)	No ▼	Yes ▼	No ▼
Final disposal	Sharps pit	Refuse pit	Organic pit

4.1. Segregation

Medical waste should be segregated according to the different categories at the time when, and at the place where they are generated, thus by the (Para-) medical / laboratory staff. Attempting to segregate medical waste at any other place or time introduces additional and non-acceptable risks. However, expired hazardous products and substances must be segregated by specifically trained staff, potentially in an interim storage.

4.2. Collection and temporary storage

The medical waste collection should be done by the cleaners, or ideally by one or two waste zone operators who are responsible for and specialised in HCWM. It is important that the cleaners and waste zone operators receive adequate training, and use the necessary Personal Protective Equipment (PPE) such as boots, overall, leather apron, heavy-duty gloves, face shield and mask / respirator (the face protection to be used in the waste zone or when dealing with very contagious waste), and working tools like a wheelbarrow, brooms, scoops, etc.

4.3. *Treatment*

Few high-tech waste treatment methods are available and/or are appropriate in LMIC because too expensive to purchase and/or to operate, or they break down too easily. Shredders followed by autoclaving or microwaving will create less air pollution than incinerators but will produce a lot more residues like plastics that cannot be recycled because the appropriate facilities are often lacking in low- and middle-income countries. Hence, the residues are frequently dumped, creating another kind of pollution.

Burning or preferably incineration often remains the most suitable treatment method for soft waste in many low- and even middle-income countries. This may not be possible however in (peri-) urban situations where space to build / install an incinerator is limited, or the exhaust gasses being generated would not be acceptable. Small rural health structures could also be an exception where the production of medical waste is very limited and the available space on the compound is sufficient for on-site landfilling.

As soft waste represents the biggest volume of all medical waste being generated in a health structure, it must in most cases drastically be reduced in size before final disposal within the residues pit to save space. Burning the soft waste with a temporary volume reducer (drum) can achieve this objective in emergencies and in very small rural health posts. However, burning with a low temperature volume reducer does not achieve the other objectives of treating soft waste, which is to render it:

- decontaminated (its exhaust gasses and solid residues);
- inoffensive (rendering solid residues unrecognisable and exhaust gasses as non-toxic as possible).

For normal health structures in mid- and long-term settings, a permanent (auto-combustible) incinerator is recommended. For good durability and performance, these double combustion chambers incinerators should preferably be built with refractory (heat-resistant) bricks. They should always be pre-heated to get the best performance possible with limited means (7, 8).

Incineration means the complete reduction of waste into ashes. The safe destruction of sharps by incineration demands very high temperatures, which are impossible to reach with auto-combustible or even dual chamber (semi-industrial) incinerators. The incineration of organic waste would also require the addition of lots of fuel, which makes the treatment process unaffordable for low- and middle- income countries. Therefore, MSF recommends that sharps and organic waste are not incinerated with the (rather) simple means available in the field, except in very specific cases (to be discussed with the technical HQ referent).

4.4. Final disposal

If possible, every health structure should have a waste zone composed of several facilities (9):

- A temporary storage area for the soft and potentially hazardous waste;
- An incinerator (or a volume reducer for acute emergencies and small health posts);
- Different waste pits (sharps pit with potentially a Safety Box Reducer and a glass crusher, residues / ash pit, organic waste pit);
- A place to wash the emptied waste recipients;
- Storage of the preheating material for the auto-combustion incinerator, the tools and Personal Protective Equipment of the waste zone operators.

The dimensions of the waste zone depend on the capacity of the health structure (size and number of interventions). The different treatment / disposal facilities must be kept close together, to provide a practical working environment for the waste zone operator and to limit the contaminated area. However, sufficient space should be foreseen to extend the waste zone when old pits are getting full.

4.5. Management of the medical waste categories (10)

4.5.1. Sharps

Needles should not be re-sheathed and must be discarded in the sharps container without the syringe (which is considered as soft waste and a very good combustible helping to reduce incineration costs), except for Enlarged Programs of Immunisation (EPI) and mass vaccination campaigns where mainly Auto-Disable (AD-) syringes are used (11).

The sharps containers, which should be available in each room where sharps are generated, must be puncture-resistant and have a lid with a hole small enough to prevent this waste from spilling out. Empty sturdy plastic drugs containers, often readily available in low- and middle-income countries as it is waste and thus affordable, can be reused as single-use sharps containers. A small triangular opening can be made in their lid that should be glued to the container.

When the sharps container is almost full, it should be stored in a designated location of the ward / service for the waste zone operator to collect and transport it to the waste zone. The intact, unopened container should be disposed off directly into the sharps pit without prior treatment (e.g. burning or incineration). This encapsulation technique can be made out of concrete (rings) for long-term interventions, or a 200 L drum for emergencies.

An alternative to these single-use recipients is the MSF Reusable Sharps' Container (RSC). This temporary storage recipient, which has been designed for most kinds of sharps (except long needles and Auto-Disable syringes), has the advantages that it can be emptied safely in the sharps pit without the waste zone operator being exposed to its content, it can also be reused after cleaning and disinfection, and saves space within the sharps pit.

AD-syringes are used for Enlarged Programs of Immunization (EPI) and should be discarded in a Safety Box, which should be burnt in a Safety Box Reducer (SBR) constructed directly on top of the sharps pit (12) in order to save space. Such equipment should also be used for the more recent retractable sharps devices. A simplified version of the SBR can be made of metal 200 L barrels for mass vaccination campaigns (9).

Small glass waste can also be stored in the sharps container, but with bigger quantities it is recommended to collect them in a separate small plastic bucket with a lid, certainly when a glass crusher is installed on the sharps pit.

4.5.2. Soft waste

Plastic disposable bags are often considered as good soft waste recipients because they are easy to collect, to transport, and to dispose of. They are also indispensable if the installed incinerator has a front-loading door. However, strong plastic medical waste bags are often too expensive for low- and some middle-income countries and are therefore not always a good "sustainable" solution. They might also block the air / gas circulation between the primary and secondary combustion chambers of some incinerators (e.g. De Montfort), resulting in a bad combustion. Plastic buckets of 20 L volume, of good quality and with a tight-fitting lid can be a reusable alternative when using incinerators with a top or inclined loading door.

The number of buckets must be sufficient to allow rotation; at least once a day or when a bucket is almost full, the maintenance personnel or the waste zone operator must collect it. Each “full” bucket must immediately be replaced by an empty and clean one coming back from the waste zone. It is recommended to have at least one reserve bucket in every (treatment) room / ward.

The soft waste must be stored underneath a roof within the waste zone, if it is delivered between burning / incineration cycles. However, the temporary storage should not last longer than 24 h in hot and 48 h in cold regions. The empty buckets need to be washed and disinfected with a chlorine solution by the waste zone operator before they can be reused.

After burning or incineration, the residues should be disposed off in a refuse (ash) pit, which should be covered with soil (emergencies) or a lid. In order to avoid burn wounds, it is advised to empty the incinerator of the ashes when they have cooled down, so for instance before a new incineration cycle starts the next day.

4.5.3. Organic waste

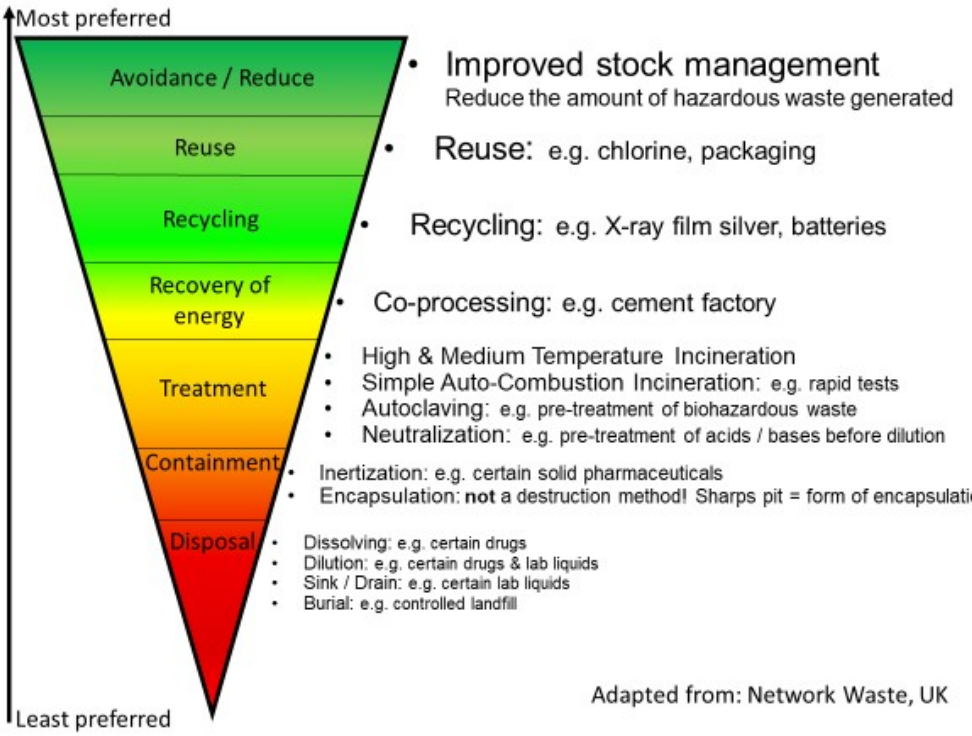
Organic waste contains a lot of liquids, making it difficult to be incinerated. Medical organic waste (e.g. placentas, amputations) can be put in (preferable biodegradable) plastic bags, although reusable plastic buckets with a tight-fitting lid are most often a better (more sustainable) alternative for LMIC. Organic waste must be collected as soon as possible after the medical intervention is completed, and ideally disposed of immediately in the ventilated organic waste pit without prior treatment. Some wood ashes can be added to the pit before its lid is closed, in order to reduce the bad odours of the decomposing organic waste. In hospitals where the amount of organic waste being generated would exceed its decomposition rate and therefore fill up the organic waste pit too fast, can be incinerated in dual chamber (semi-industrial) incinerators. But this will demand a lot of fuel and thus be very expensive.

In certain cultures, the tradition is for the family to take the placenta home. For very small health structures, the placentas can also be thrown in the latrines. These habits are certainly to be avoided for unborn foetuses and amputated limbs, which do not decompose completely.

4.5.4. Hazardous waste

Incorrect elimination of hazardous waste can be extremely harmful to the environment and represent a serious public health risk (e.g. contamination of potable water resources, emissions of dioxins and other toxic gasses). These wastes must be managed on a case-by-case basis. Therefore, it is recommended to verify if a country legislation exists, which should be WHO / UNEP compliant. When not existing or its content dubious, it is suggested to lobby with the authorities and contact specialists at MSF headquarters who know how the hazardous wastes can be disposed of correctly. This could be by one of the following manners:

Box 3: Appropriate disposal methods for hazardous waste



Obviously, the best way of reducing hazardous waste would be by **avoiding** it. In practice this won't be completely possible, but additional efforts must be done for **better stock / pharmacy management** in order to reduce the amount of products / substances expiring.

Certain goods can be **reused** within the health structure, like expired chlorine generating products that can be used to clean the floors of non-critical areas (e.g. hallways, but not for an operation theatre or a delivery room), or for disinfecting the waste bins before being reused.

Even in some low- and middle-income countries, specialized industries exist to **recycle** certain materials like heavy and/or precious metals (e.g. batteries, silver from X-ray films). If this is not the case, export to countries where these facilities are available must be investigated. Export isn't the cheapest nor the easiest solution as the **Basel Convention** must be respected, meaning that authorisations need to be obtained from all the countries that are being passed (even by air).

Co-processing is a form of incineration where the calorific energy **recovery** of the waste is being used for industrial processes. Typical examples of co-processing industries, also to be found in quite some low- and middle-income countries and endorsed by the **Stockholm Convention**, are cement factories. Depending where the waste is being introduced in the cement production process, medium or high temperature incineration can be obtained. Co-processing is not allowed however for electrical and electronic equipment, materials that can explode (e.g. aerosols), wastes containing asbestos or cyanide (depending on national legislation however), corrosive waste, entire batteries (big or small), equipment containing mercury, radioactive or nuclear waste, unsorted municipal garbage or general medical (infectious) waste.

Treatment of hazardous waste by **incineration** plants is not obvious in low- and middle-income countries as the specific high temperature incinerators are lacking. Also correct domestic waste incinerator plants functioning at medium temperature are not that common, although available in some middle-income countries. Some bigger hospitals might have a dual chamber (semi-industrial) incinerator working at high or medium temperature, but the amount of hazardous waste that can be introduced (on a yearly basis) is very limited. As such, they can be interesting for recurrently generated hazardous waste, but it is doubtful that their capacity will be sufficient for the (6-monthly) elimination campaigns of expired substances. Certain rapid tests and testing strips can be incinerated in an auto-combustion incinerator (e.g. De Montfort) however.

Pre-treatment like autoclaving of bio-hazardous waste is preferable before it is removed from the laboratory, and obligatory for all Bio-Safety Level 3 labs and above. Expired acids and bases can be used to neutralize each other as pre-treatment before being disposed of via the sink with plenty of water or be diluted (see further), but this should be left to people with experience in chemistry.

Containment methods like **inertization** can be interesting for some solid / powdered pharmaceuticals as it is a cheap and easy elimination method. **Encapsulation** on the other hand can be used for most hazardous wastes, but it is considered as a last resort as the waste isn't really destroyed and could potentially be recovered afterwards.

Certain liquid hazardous laboratory wastes are quite harmless and can as such be poured into its **sink**. Some other hazardous wastes being not that harmful can be **diluted** or **dissolved** before being disposed of in a completely closed sewer system or a big / fast flowing river.

As an illustration, pharmaceutical waste that has expired could be dealt with in the following manner:

- First of all, pharmaceutical waste should be left in its original packing and enclosed in a separate and locked stock.
- For the correct elimination procedures of drugs, a list of the expired products should be sent to headquarters. The following rules should be respected:
  - Items should be ranked according to the MSF pharmaceutical ordering list / expired drugs field list (per category and per alphabet; e.g. Oral drugs)
  - The following information should be included for each product:

International code	Description (Generic name / dosage)	Quantity
DORAALBE4T-	Albendazole 400 mg, tab	3000 pces
DORACLOF1T-	Clofazimine 100 mg, tab	1000 pces

Based on this information, the field will be provided with all the elimination options per pharmaceutical according to WHO recommendations (13), MSF's preferred option and the protocols for all the selected elimination procedures (14).

The above rules should also be respected as much as possible for all other hazardous waste. MSF has not only developed a list of all viable elimination options within low- and middle-income countries for every essential drug it has used in the field since 1999, but also for all its hazardous laboratory chemicals, and is preparing one as well for all the insecticides it has been / is using. So, the more information that is provided by the field from the start, the better and the faster recommendations can be given by headquarters.

5. Organisation and Planning

The main objective of a HCWM system is to improve safety. However, technical solutions alone are not sufficient for correct Healthcare Waste Management. The users and staff will be mainly interested in an easier and less time-consuming manner of working. Therefore, the management system must combine safety features with easy to use measures, adapted to the needs, working conditions, habits and culture of the users.

For correct planning and organisation of Healthcare Waste Management, it is necessary to follow all the different steps of the "Project Cycle":

- Assessment
- Problem analysis: with introduction to the Hygiene Committee
- Planning the strategy
    - Defining a strategy
    - Formulating a written agreement
    - Providing a budget
- Implementation:
    - "Technical" training of the staff
    - Supply and set up of the equipment
    - Start the "technical" process
    - Vaccination of the staff against Hepatitis B and tetanus (recommended)
    - Promote the correct disposal of their waste to the patients and their visitors
- Monitoring: from the start of the technical process
- Evaluation: mid-term and final

Box 4: Hygiene committee can be composed of:

- the hospital director,
- the head nurse,
- the head of the technical services,
- the head cleaner,
- a health authority representative,
- a government representative,
- a community representative,
- a MSF representative

MSF has developed the 'Hygiene and Healthcare Waste Management Promotion in Health Structures' manual (15), mainly inspired on the PHAST methodology, to deal with the Planning and Organisation of HCWM within the health facilities, focusing on assessments, training and consultation of staff.

6. Conclusions

Proper Healthcare Waste Management is important in all health structures within all contexts for guaranteeing maximal protection of patients, accompanying persons, medical and non-medical staff, the surrounding population and the community.

MSF has produced pragmatic recommendations for correct Healthcare Waste Management in low- and middle-income countries where appropriate (WHO / UNEP compliant) waste legislations wouldn't be available, including both technical solutions and related human behaviour information. The Basel, Stockholm and Minamata Conventions are as much as possible respected within the MSF alternative approach, with the intention to provoke the least negative environmental degradation possible considering the limited resources available.

Encouraging results have been obtained within the MSF missions, but also on wider scale as certain governments have been copying MSF's pragmatic approach on correct Healthcare Waste Management for low- and middle-income countries, and some have even been asking for assistance in developing their hazardous waste management policy. But continuous efforts in the field are necessary to improve Healthcare Waste Management even further.

As medical techniques are always evolving, also in low- and middle-income countries, the related wastes will change as well. Hence, MSF will have to continue working on a multi-disciplinary basis to keep all the consequences in mind and deal with them appropriately. Also, specific contexts like outbreaks of very contagious diseases might require some additional safety precautions.

Further reading (official publications & *internal documents*)

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