

arcenciel.org
engage in development

Guide of the Healthcare Waste Management Lebanon 2014 Edition



REPUBLIC OF LEBANON
MINISTRY OF PUBLIC HEALTH



الجمهورية اللبنانية
وزارة البيئة



COUNCIL FOR DEVELOPMENT
AND RECONSTRUCTION



AGENCE FRANÇAISE
DE DÉVELOPPEMENT



Université Saint-Joseph



Guide of the Healthcare Waste Management - Lebanon
2014 Edition

Design: Guillaume Moraël and Sylvain Nassar

All rights reserved
© arcenciel

Acknowledgements

arcenciel would like to thank

L'Agence Française de Développement (AFD)

Saint Charles Hospital

Hôtel Dieu-de France Hospital

Ministry of Public Health

Ministry of Environment

Lebanese Council for Development and Reconstruction

Without whom the realization of this guide would not have been possible.

Members of work and proofreading team

Members of the work team

Dominique Salameh

Research professor and Head of Chemistry Department, Faculty of Science, Saint Joseph University, Beirut, Lebanon

Olivia Maamari

Head of "Research and Development", Environment program, arcenciel association, Lebanon

Myriam Mrad Nakhlé

Head of "Quality and Training", arcenciel association, Lebanon

Members of the proofreading team

Rita Karam

Director, Pharmaceutical Products Quality Insurance, Ministry of Public Health, Lebanon

Roger Lteif

Director, Technological Health Pole, Saint Joseph University, Beirut, Lebanon

Marie-José Aoun

In charge of the Hygiene and the Environment, Saint Charles Hospital, Beirut, Lebanon

Rouba Rassi El-Khoury

Quality Director, Hotel Dieu de France Hospital, Beirut, Lebanon

Table of contents

Important keywords	.....	p.6	6. Minimization of the quantities	.....	p.39
1. Introduction	.....	p.7	7. Sorting at source	.....	p.45
2. Definition and classification	.....	p.9	8. Internal collection, transportation inside the hospitals and storage	.....	p.63
3. Sanitary and Environmental risks	.....	p.18	9. Treatment and elimination	.....	p.77
4. Conventions, laws and regulations	.....	p.28	10. Protection of the personnel	.....	p.89
5. Implementation of a general structure for the Healthcare Waste Management	.....	p.33	11. Training	.....	p.97
			• Annex	.....	p.103
			• List of figures and tables	.....	p.104
			• References	.....	p.132

Important keywords

HCW : Healthcare Waste

Healthcare Waste Assimilated to Household Waste

HCRW : Healthcare Risk Waste

IHCW : Infectious Healthcare Waste

Other Healthcare Risk Waste

WHO : World Health Organization

1. Introduction

Healthcare activities protect and rehabilitate the patient's health, heal them and save their lives. Nevertheless, these activities produce waste that can be hazardous for the health.

In fact, by their activities, the care establishments produce a growing quantity of waste, from different kinds, which are defined as "Healthcare Waste" that should be managed in a specific way especially because of their infectious nature.

The healthcare establishments are responsible of the waste they are producing and they have the obligation of managing it, to protect the public health and the environment.

Waste management is an integral part of the continuous quality improvement policy.

It helps to improve the security of the patients and the staff and to reduce the nosocomial infections.

A key element of the social responsibility of the health establishments is to reduce their negative impact on the community and the environment, similarly to the improvement of their client satisfaction, their care services and their performance. The objective of this guide is to help healthcare establishments to establish

an efficient, safe, economic and sustainable healthcare waste management system. It provides useful, practical and easy methods to implement recommendations and tools in accordance with the Lebanese regulations, adapted to the Lebanese context. Special attention is given to Infectious Healthcare Waste, because it forms the largest part of the healthcare risk waste. This guide particularly tackles the management of the solid waste even if certain recommendations are mentioning liquid waste. By implementing healthcare waste management

policies, that include the components mentioned in this manual, care establishments will start to set up a healthy and safe environment for their employees, their clients and the communities. This guide is addressed to administrative, technical, medical and paramedical hospital staff.

The main issues related to healthcare waste management inside the care establishments are: the lack of awareness and information of healthcare waste risks, unsuitable or insufficient training of efficient waste management, the absence of management and treatment systems, and the lack of prioritization of waste management issues.

The improvement of the healthcare waste management is based on multiple elements: The foundation of an efficient management system is based on the establishments' needs to insure their activities respect the environment and public health, by sorting, collecting, transporting,

storing and treating the medical waste. This system has to provide a clear allocation of tasks and responsibilities, and a realistic distribution of resources. Then, adequately training the staff is in order to reach a suitable healthcare waste management system. Finally, constant follow up is required, as well quality control of system implementation.

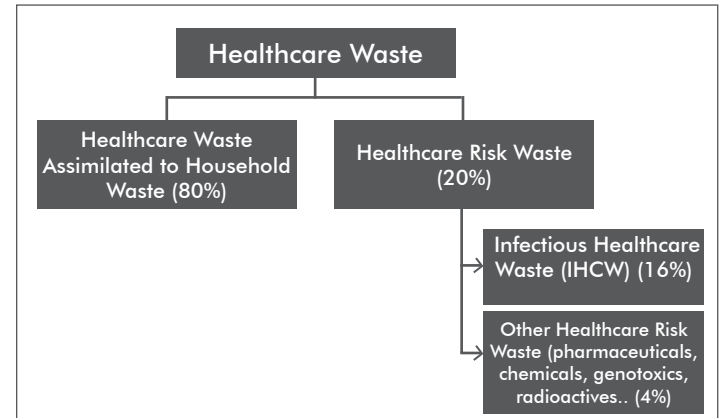
This guide provides useful information about the major stakeholders involved in the collection and the treatment of medical waste.

The guide was elaborated by Arcenciel, in collaboration with the "Agence Française de Développement", the Ministry of Environment, the Ministry of Public Health, the "Lebanese Council for Development and Reconstruction" and Apave. The information has been tested and validated with two prototype Lebanese hospitals.

2. Definition and classification

- Lebanese law and World Health Organization define healthcare waste as the waste produced by the healthcare institutions.
- The main sources of healthcare waste are :
 - Hospitals
 - Clinics and health centers
 - Laboratories
 - Blood banks
 - Medical research centers
 - Retirement homes
- Smaller sources include care provided at home for diabetic patients, for people suffering from kidney failure, respiratory failure, virus carriers such as herpes, hepatitis, HIV in addition to the medical tests conducted at home. This waste is characterized by the production of very small quantities which are scattered geographically.
- The healthcare waste typology is based on the presence or the absence of risks.

Figure 1 : Healthcare Waste categories



- We distinguish the following typologies:

Waste assimilated to household waste: It is often called domestic waste. It covers 80% of the total healthcare waste. It includes waste from secretariat, restoration, maintenance and material wrapping. They don't present a particular risk and can be eliminated by the same network as the household waste.

Healthcare risk waste: It covers around 20% of the total healthcare waste. They are considered as hazardous waste and can present different types of risk, including:

- Infectious Healthcare Waste (IHCW)
 - Pharmaceutical waste
 - Genotoxic waste
 - Radioactive waste
 - Chemical waste
-
- The average quantity of Infectious Healthcare Waste produced in Lebanon is of 0.50 kg/occupied bed per day, which represents an average of 0.87 kg/occupied bed per day, if we consider that the average level of occupation is 60%. Therefore the estimated total quantity of healthcare waste is 4kg/occupied bed per day

¹ This average quantity was calculated based on monthly quantities of IHCW, collected by arcenciel.

Infectious Healthcare Waste is defined by WHO (World Health Organization) as a waste which contains pathogens (bacteria, parasites, virus, fungus) in relative quantities or concentrations sufficient to cause illness for sensitive hosts. Practically, it is a waste which contains blood, secretions or excretions presenting a risk of contamination.

- Infectious healthcare waste includes:

- Biological fluids (blood, urine, feces, vomiting etc.)
- Every equipment (gloves, compresses, catheters, urine bag holder, blood bags, contaminated bandage, sterile towel, tubes, filters...) contaminated with blood, containing blood or any other biological liquid (pleural fluid, peritoneal, pericardioamniotic, synovial fluid, etc.)
- Sharps, cutting waste, or waste being able to cut the surface of the skin (wound, stab), with a risk of infection (needles, scalpels, shaver, piping, lancet blade, microscope slide, vials or broken glass vials, etc.); being in contact or not with a biological product.
- Culture media and stocks containing biological pathogens, coming especially from laboratories.
- Samples of biological fluids.
- Every waste produced from a patient being placed in an isolation unit.
- Anatomical pieces: organs, members or pieces of organs or members, easily identified by a non-specialist (organs, members, fetus, etc.).

Information inserts # 1 :

Anatomical pieces have to be taken care of differently than Infectious Healthcare Waste, for ethical, cultural and regulatory reasons.

Genotoxic waste is a very hazardous waste, mainly composed of cytotoxic medicines, that are used in the treatment of cancer, and metabolites of these wastes.

From a technical perspective, genotoxic is defined as toxic for the Deoxyribonucleic Acid (DNA); cytotoxic means toxic for the cells; cytostatic means stopping the growth and the multiplication of cells; antineoplastic means refraining the development and the growth of abnormal tissues; chemotherapeutic means the use of chemicals in a treatment, including treatments for cancer.

Cytotoxic medicines, the main substances of this category, have the unique particularity to kill cells or to stop their growth. They are substances mainly used with chemotherapy for cancers, but they can also be used as immunosuppressant drugs in organ transplantations, as well as in the treatment of different auto-immune illnesses. They are mainly used within oncology and radiotherapy units but their use is increasing in other departments and even outside hospitals.

Cytotoxic waste is the waste produced during the preparation and use of cytotoxic medicines in the treatment of cancer by chemotherapy.

The main types of cytotoxic waste generated during the preparation of the medicine and while giving it to the patient, are the following:

- Solution residues or suspension of cytotoxic medicines being prepared in order to be administered to patients.
- Expired cytotoxic medicines.
- Every equipment that is contaminated during the preparation and administration process of the cytotoxic medicines: syringes, needles, empty bottles, piping, compresses, cottons, manipulators gloves, contaminated bandages, vials, ventilation systems for hoods and isolators, etc.
- Excretions (vomiting, feces, urines) of treated patients.

Pharmaceutical waste includes expired or unused pharmaceutical products, in addition to containers which used to contain medicine (bottles, tubes, syringes ...), except for cytotoxic medicines.

Healthcare facilities use a growing quantity of products which are carrying one or more hazardous criteria due to their chemical properties.

Formaldehyde is a significant source of chemical waste in hospitals. It is mainly used for the conservation of samples.

Chemical solvents are used in different hospital departments, especially in laboratories (histology, autopsy...). They contain halogenated and non-halogenated compounds. Chemical organic waste is mainly composed of cleaning and disinfecting solutions, in addition to insecticides, while non-organic waste includes mainly base and acid, oxidants and reducers.

Chemical waste also includes broken thermometers or sphygmomanometer gauges with mercury; equipment which was used to remove falling mercury and dental

amalgams containing mercury.

The quantity of waste with mercury is regressing with the new trend which aims to substitute it with mercury free equipment.

Chemical waste also consists of radiography containing silver, salt, batteries, and also metals (nickel, cadmium, mercury, lead, iron, zinc or lithium), which can be toxic and harmful for the environment.

Table 1 : Main chemical waste coming from healthcare activities

Chemical waste	Examples
Halogenated solvents	Chloroform, methylene chloride, perchloroethylene, polyethylene glycol, trichloroethylene
Non-halogenated solvents	Acetone, acetonitrile, ethanol, ethyl acetate, formaldehyde, isopropanol, methanol, toluene, xylene
Halogenated disinfectants	Calcium hypochlorite, chlorine dioxide, iodine solution, iodophor, sodium dichloroisocyanurate, sodium hypochlorite (bleach)
Aldehydes	Formaldehyde, glutaraldehyde, orthophthaldehyde
Alcohols	Ethanol, isopropanol, phenols
Other disinfectants	Hydrogen peroxide, peracetic acid, quaternary ammonium
Metals	Arsenic, cadmium, chromium, lead, mercury, silver
Acid	Acetic acid, chromic acid, chlorhydric acid (or hydrochloric acid), nitric acid, sulfuric acid
Base	Ammonium hydroxide, potassium hydroxide, sodium hydroxide
Oxydants	Javel water, hydrogen peroxide, potassium dichromate, potassium permanganate
Reducers	Sodium sulfite, sodium bisulfite
Miscellaneous	Anesthetic gases, asbestos, ethylene oxide, herbicides, paint, pesticides, used oils

Source: "Safe Management Of Wastes from health-care activities" 2nd edition, World Health Organization, 2013.

In healthcare locations, radioactive substances are used during in vitro analysis of tissues, in diagnostic imaging, during different diagnostic or therapeutic practices (nuclear medicine), as well as in research laboratories. The waste, in this case, is the residue produced from radioactive liquids or objects contaminated by these liquids (syringes, glass bottles, etc), as well as excreta of patients treated with radionuclides.

Sources used in healthcare locations can have two aspects:

- Unsealed sources: liquids which are usually applied immediately.

- Sealed sources: radioactive substances which are present in certain equipment parts or encapsulated in objects.

Two levels of radioactive waste can be distinguished based on their life time:

- Waste with a short radioactive period (radioactive decreasing period less than 100 days) and with weak specific activity.
- Waste with a longer radioactive period (radioactive decreasing period more than 100 days).

The large majority of radioactive waste produced in hospitals has a short life time (few hours to few days) and loses its radioactivity quickly. Some specialized therapeutic procedures use radionuclide with a longer life time through small objects placed on the patient's body or inside the patient's body. This radionuclide can be reused after sterilization.

Waste in the form of sealed sources has a strong radioactivity but is generated in small quantities, in large medical and research laboratories. It is usually returned to the supplier.

Information inserts # 2 :

Radioactive waste which is generated from healthcare and research activities includes the following categories:

- Solid waste with low activity (like absorbent paper, glassware, syringes and bottles)
- Residues from radioactive material and unused radionuclide solutions with diagnostic or therapeutic purposes
- Residues used for radioimmunoassay
- Excreta of patients, after treatment or testing with unsealed radionuclide
- Waste coming from spillage or decontamination of radioactive disposal
- Liquid waste with low activity (like the one coming from washing devices)

3. Sanitary and environmental risks

HCRW presents risks for the health and the environment. These risks are caused by one or many of the following:

- the presence of infectious agents
- a genotoxic or cytotoxic composition
- the presence of chemical toxic substances, dangerous or aggressive pharmaceutical products
- the presence of radioactivity
- the presence of sharp or cutting material

The reduction of the risks starts by:

- Informing and training everyone at the hospital
- Adopting appropriate equipment and practices to reduce risks during exposure
- Adopting hygiene and security measures control throughout the management network
- Doing suitable elimination and treatment of waste

The sanitary risks

Everyone who is in contact with waste is exposed to the danger of HCWR . The main exposed groups are:

- Inside the hospital:
 - the healthcare staff (doctors, nurses, healthcare assistants)
 - the scientific, technical and logistic staff (cleaners, laundry staff, people in charge of waste, waste collectors, maintenance and cleaning staff, pharmacists, laboratory technicians)
 - Patients, their families and visitors
- Outside the hospital:
 - drivers and help-drivers in charge of transporting waste, the operators in the treatment or elimination facilities
 - the general population (including waste pickers, the adults or children who collect some object found around the hospital or in the uncontrolled landfills.)



Infectious Healthcare Waste

This kind of waste represents a risk of infection. They may include microorganisms (bacteria, viruses, non-conventional transmissible agents, fungus, endoparasites...) being able to infect patients, the healthcare center staff and the general public. The risk of infection also includes dissemination of resistant microorganisms issued from healthcare establishments in the environment. In addition, the contact with sharp and cutting wastes (needles, scalpel blades...) can cause lesions and injuries.

The exposure to microorganisms which are present inside Infectious Healthcare Waste can happen all along the management network (conditioning, collection and transportation, treatment and elimination).

There are three ways of exposure:

- by inoculation cutaneo-mucosa, after cutting with sharp or cutting material or equipment, projection or direct contact with skin or mucosa that was previously damaged
- by inhalation
- by ingestion through contaminated hands (manipulation

- of waste without precaution, bad hygiene of the hands, smoking...).

The Human Immunodeficiency Virus or Hepatitis B (HBV) or C (HCV) constitutes the major transmission risk around the world.

According to WHO, in 2000, injections with contaminated syringes were responsible of:

- 21 million infections from hepatitis B virus (HBV) (which represents 32% of new infections)
- 2 million infections from hepatitis C (HCV) (40% of all new infections)
- At least 260,000 infections from HIV (5% of all new infections)

A large number of these infections could have been avoided if healthcare waste was managed properly.

In developing countries, additional dangers are caused by waste picking practices, very frequent in Lebanon. These practices, by creating a direct contact with waste, increase the risk of being injected by contaminated syringe needles, by infectious or by toxic substances.

Table 2: Examples of diseases which can be caused by Infectious Healthcare Waste

Infection type	Causal agent	Transmission vector
Gastro enteric infections	Enterobacteria (Salmonella, Vibrio cholerae, Shigella, etc.)	Feces and vomit
Respiratory infections	Mycobacterium tuberculosis, streptococcus pneumonia, SARS (Severe Acute Respiratory Syndrome), measles	Inhaled secretions, saliva
Eye infections	Herpes virus	Eye secretions
Skin infections	Streptococcus, Staphylococcus	Pus
Anthrax	Bacillus anthracis	Skin secretions
Meningitis	Neisseria Meningitidis	Cerebrospinal fluid
HIV	The Human Immunodeficiency Virus	Blood, sexual secretions, other biological liquids
Hemorrhagic fever viruses	Lassa virus (LASV), Ebola, Marburg, Junin	Blood and secretions
Viral Hepatitis A	Hepatitis A Virus	Feces
Viral Hepatitis B and C	Hepatitis B and C Virus	Blood and other fluids



Genotoxic waste

Genotoxic waste is hazardous and can have carcinogenic, mutagenic or teratogenic properties.

- Mutagenic: which can lead to a genetic mutation. -
- Teratogenic: which can cause congenital anomalies.-
- Carcinogenic: which can cause mutation which can lead to the development of tumors.

In fact, many experimental studies have shown that several cytotoxic medicines can have properties mentioned above. In addition, a link has been found between certain forms of chemotherapy and the secondary neoplasm. Many studies highlighted the growing risk of spontaneous miscarriage for persons who have been exposed to genotoxic waste.

Also, cytotoxic waste can be irritating for eyes or the skin and can cause dizziness, nausea, headache and dermatitis.

Pharmaceutical waste represents a risk which is mainly related to the illegal trade of expired medicines and the propagation of antibiotic resistant pathogens in case of throwing them in the wastewater.



Chemical waste

Chemical waste can generate toxicity and physical lesions, especially chemical burns for humans, in addition to environmental pollution. Waste's risks vary and are in general identified by pictograms shown on packages. The labeling of products informs the user about dangers and precautions to be taken while using them.

Chemical waste coming from healthcare activities are considered as hazardous if they represent at least one of these properties:



Explosive: these are liquids or solids which can explode under a choc, a friction, a flame or heat.



Inflammable: components under this category can burn quickly, once in contact with a flame or a spark, fire through heat, a friction or exposed to air. Combustibles, lubricants and solvents, for instance, are part of this category.



Combustion agent: products being able to facilitate or activate the combustion of a combustible substance. They can cause a fire when they are in contact with wrapping material (paper, carton, wood) or other combustible substances.



Toxic: components of this category can lead to hazardous disorders, severe or chronic, or even death after inhalation, ingestion, absorption or penetration by dermal route.



Corrosive: products which can have destructive consequences on living tissues since they eat away skin and mucosa. In case of projection on the skin or in the eyes, they cause important chemical burns and irreversible lesions.

Chemical waste that is not hazardous doesn't have any of the properties mentioned above, like sugar, amino acids and certain organic salts which are used in perfusion fluids.

The intoxication can be the result of an acute or chronic exposure and is generally caused by the absorption of chemical substances through the skin, the mucus, by inhalation or ingestion. Lesions of the skin, eyes and the mucus can occur prior to a contact with chemical corrosive or reactive waste, like the formaldehyde.

Certain products have incompatibilities and can generate toxic gases when they are mixed together (like chlorine and acids).

Unlike industrial chemical waste, hospital chemical waste, whether solid, liquid or gas, is often very varied and complex; even its exact composition is unknown since it is the result of multiple mixtures of complex products.

It is the role of professionals to determine its danger level in order to facilitate its elimination in the best conditions.

In order to do it, risk properties have to be known, in addition to associated risks of the starting material and their usage steps.

In particular, **the mercury** (symbol Hg) is a metal which can be toxic for both humans and the environment. While it is liquid in pressure and standard temperature conditions, it is volatile and can remain one year in the atmosphere. When the mercury is in the atmosphere, it

can be transported by air currents and can accumulate in aquatic sediments.

In these conditions, it may be altered by a bacteria into an organic form known as methylmercury that will be accumulated in fish tissues. And this can have a negative impact on human health, through the food chain.

Mercury can be deadly if inhaled and hazardous if absorbed by the skin. In fact, 80% of the inhaled mercury steam can pass into the blood through the lungs. As a result, the respiratory, immune, digestive and nervous systems, in addition to the kidneys, can be damaged.

Also, **silver salts** which are based in silver radiographs are toxic for the environment.


Photography development liquids contain corrosive substances, suspected to be carcinogen for humans and very toxic for the environment.

Chloride base disinfectants, life bleach, widely used, can react with organic compounds in the liquid waste and can generate organochlorine toxic compounds.

Hydrogen peroxide or ozone base disinfectants, eventually associated to the usage of ultraviolet light, constitute an alternative which is efficient as well.

Figure 2 : Symbols of chemical risks
New pictograms of European Regulations – GHS (Globally Harmonized System).



PS: Since bottles are small, the manufacturer doesn't have to put all the pictograms, but obviously, a product which is  as well.



Radioactive waste

Risks which are related to radioactive waste produced in hospitals are in general relatively not very high, since they have a short half-life and a low radioactive level. However, they have to be manipulated carefully because they might present:

- A risk of external contamination due to the presence of radionuclides on the skin surface. A high dosage contamination can lead to skin burns and nausea.
- A risk of internal contamination due to the presence of radionuclides inside the body, which can be carcinogenic for certain organs when they are exposed to a high dosage.
- A risk of external irradiation after the exposure of the person to the radiation. This irradiation is measured with a dosimeter. The effects are not always predictable: certain people will suffer from cancer and others will give birth to kids with malformations. Effects will show sometimes several years after the irradiation. An external irradiation with a very high dose can lead to death because it destroys a very big number of cells
- The importance of these risks depends on characteristics of the radionuclide, on its radiotoxicity and on the type and time of the exposure.

Environmental risks

Healthcare waste can also represent a risk for the environment, through the contamination of water sources: for example when they are eliminated in a pit, which is non-isolated or close to a water source.

Pharmaceutical molecules discharged by patients are eliminated in the sewage. Since these molecules can't be completely degraded by wastewater treatment plant, they can be toxic for the fauna and the flora. The elimination of antibiotics in the sewage can increase the resistance to antibiotics. The inflow of genotoxic waste can have disastrous impact on the environment.

In addition to specific risks represented by different types of healthcare waste, there are other risks related to certain treatment technologies like incineration, especially when they are not sufficiently mastered or controlled.

In fact, incinerators emit gases which contain fine particulate matter, mercury and cadmium, dioxins, furans, nitrogen oxide, sulfur oxide and other different toxic pollutants. Exposure to fine particulate matter increases the risk of cardiovascular and respiratory diseases. Exposure to mercury and cadmium can damage the immune system, the nervous system, lungs and kidneys. Low intensity exposure for a long period of time, to dioxin and furan, can hit the immune system, led to abnormalities development of the nervous system, hit the endocrine system and reproductive

functions of humans. A high intensity exposure for a short period of time can lead to skin lesions and to the start of a liver failure. Dioxins are ranked by the International Agency for Research on Cancer (IARC) among the known human carcinogens.

Otherwise, dioxins and furans are ranked among the Persistent Organic Pollutants (POPs), which are persistent substances. They are not degradable in the environment and can accumulate in the food chain. Residues produced by the incineration process are toxic as well.

So, **the incineration must to be avoided**, especially in the treatment of infectious healthcare waste, knowing that other alternatives for this kind of waste exist, such as the autoclave.

Furthermore, a bad waste management system increases the presence of rodents and insects, such as rats, cockroaches, flies, which are passive vectors contributing to the propagation of pathogenic microorganisms in the environment.

4. Principles, conventions laws and regulations

Many international agreements mentioning fundamental principles related to public health, the protection of the environment and the secured management of hazardous waste were signed.

International agreements

Lebanon is bound by two international conventions on healthcare waste:

- Basel Convention: on the transboundary movements control of hazardous wastes and their disposal. It was signed on the 22nd of March 1989 and came into force on the 5th May 1992
- Stockholm Convention: on persistent organic pollutants. It was signed on the 22nd of May 2001, and came on force into the 17th of May 2004.

National legislation

Decree 2004/13389 is currently the reference decree regarding healthcare waste management. Hospitals accreditation system launched by the minister of public health also includes recommendations regarding healthcare waste management.

The Basel Convention on the control of transboundary movements of hazardous wastes and their disposal, (United Nations Environment Program, UNEP, 1992)

Stockholm Convention: on persistent organic pollutants (United Nations Environment Program, UNEP, 2004)

The polluter pays principle

The Basel Convention's main objectives are to reduce the production of hazardous waste to the minimum, to treat this waste at the nearest possible place from the production location, and to reduce and control movements of hazardous waste. It stipulates that the only legitimate transboundary passage of hazardous waste is the exportation of waste from a country that lacks expertise and safe elimination infrastructure to a country that has this expertise and safe elimination infrastructure

The aim of the Stockholm Convention is to reduce the production and the usage of persistent organic pollutants (POPs). The POPs are chemical substances that remain intact in the environment for a long period of time, and spread widely geographically. They accumulate in human tissues and are toxic. In particular, this convention aims to reduce dioxins and furans which are generated mainly by waste incineration.

The polluter pays principle was adopted by the Organization for Economic Co-operation and Development (OECD) in 1972. It stipulated that every waste producer is legally and financially responsible for the elimination of their waste in a safe way for both the environment and humans (even if certain jobs are outsourced).

Precautionary principle

The precaution principle was formulated for the first time in 1972, in the principle 15 of the Rio Declaration on Environment and Development. It stipulated that when there is a possibility of serious or irreversible damages on the environment, the lack of scientific proofs doesn't have to be considered as a reason to delay economic measures which help to prevent the environmental degradation

Proximity principle

The proximity principle recommended that the treatment and the elimination of hazardous waste are required to happen at the nearest place from their production location, in order to minimize risks related to the transportation.

Diligence principle

This principle stipulates that every individual who is involved in waste management has to take necessary measures which help to maintain an appropriate waste management from the production's point to the final elimination. The main responsibilities of the waste producer, in the context of the diligence principle are:

- To identify precisely the waste which is produced
- To complete and sign monitoring sheets for hazardous waste before transferring it to another part
- To condition the packaging in a safe way in appropriate packages
- To insure a safe storing of the waste
- To select an appropriate treatment and elimination method

Lebanese law 444 (Lebanese Ministry of Environment, 2002)

Lebanese decrees 8006-2002 and 13389-2004

This law on environmental protection includes environmental principles mentioned above: the polluter pays principle, the precaution principle and the preventive actions

- The 13389 decree, published on the 14th September 2004, amends the 8006 decree which was decreed by the Ministry of Environment on the 11th June 2002.
- The 13389 decree is the reference norm of national regulations regarding the elimination of healthcare waste
- The 13389 decree specifies waste categories and imposes the sorting of waste based on the treatment. It demands to act according to two aspects: preventive measures aspect and the downstream treatment aspect. The decree also mentions norms of storage and elimination.
- The decree designates different types of healthcare establishments that are concerned: hospitals, medical analysis laboratories, consultation cabinets, including dentist cabinets, health centers, veterinary cabinets, pharmaceutical warehouses, pharmacies, research and studies centers.
- The 2004 – 13389 decree gives the priority to principles of reduction of productivity and of the harmfulness of waste, the sorting, the reutilization, the recycling, the recuperation, and offers norms for the collection, the treatment and the elimination of waste. According to this decree, IHCW has to be sterilized in compliance with specifications established by the ISO 94/11134 norm and its amendments (sterilization by humid heat), or by alternative ways which help to insure a sterilization process as expected by this norm.

Hospital Accreditation

This sterilization has to be done in specialized bases of operation that previously had an authorization from the Ministry of Environment, after admission and approval of environmental impact assessments and according to clauses which were being fixed by the ministry.

Sterile waste can be eliminated afterwards, in the same way as household waste.

Anatomic pieces non recognizable easily by a non-specialist have to be managed in the same way as waste with a risk of infection.

Characteristics of each sterilization system have to be recorded in registers which will be kept for 5 years in healthcare establishments; these documents have to be given to health and environment authorities upon their request.

A periodic control of installations is assured by authorities to whom we have signaled the startup of the sterilization inside a healthcare establishment.

The administration of the healthcare establishment or of the establishment taking care of sterilization operations are responsible for these operations and their efficiency.

In the context of the health sector reform, the Ministry of Public Health has developed, in 2000, standards for hospitals in Lebanon. These standards were updated since then. They are divided in 40 chapters. One chapter concerns only waste management. It includes 8 standards.

- Find appendix 1: The Basel Convention p. 105
- Find appendix 2: The 13389 decree p. 105
- Find appendix 3: The diagnostic grid of waste management chapter – accreditation of hospitals p. 105

5. Implementation of a general structure for HCRW

Healthcare waste management is one of the aspects of struggle against infection's risks. Thus, a plan on healthcare waste management can be developed by the Committee for the Fight against Nosocomial Infections (CFNI). In big healthcare establishments, a committee specialized in healthcare waste management can be established.

An appropriate healthcare waste management lies on three fundamental elements:

- Good organization
- Active participation of the staff who has a sense of responsibility, informed and trained
- Adequate funding

These conditions are mandatory in order to insure a sustainable application of procedures and practices related to healthcare waste management, from the production's point till the final elimination, including the sorting process, transportation, storage, waste treatment network, control, and measures which have to be taken in case of accident or incident.

An adequate management of HCRW starts by creating a status report, which has to be written by the people in charge at the hospital. This report will help to identify the different departments that are producing waste in order to obtain an initial estimation of the types and quantities of waste generated, and to understand how the waste is generated and eliminated. Once the quantity of waste which is produced is specified, we can estimate the number and the capacity of waste containers and of the required storage room, the collection and transportation frequency, and we can study the adaptability of treatment solutions of the available HCRW. This will allow a better planning and budgeting. An evaluation of the situation, which combines observations, interviews and questionnaires will provide required information for the identification of problems and the implementation of solutions. The waste management system that is implemented can be improved and optimized by a regular evaluation of the sorting efficiency in different departments, the determination of recycling opportunities, and the sorting implementation and recycling programs of waste assimilated to household waste.

#	Recommendations	Verification
R.1.1	<p>A clear and accurate policy of healthcare waste management is enacted by the general directorate. The policy includes:</p> <ul style="list-style-type: none"> • an engagement declaration, specifying the objectives of the policy • legal obligations related to waste management, health and security • procedures and instructions on waste management • roles and responsibilities of the staff involved all along the waste management chain • a waste management hierarchy • all the internal policies related to waste management, including staff responsibilities within the standards of health and security, the final treatment and the systems that will allow a control and a sustainable amelioration of the management system 	Policy
R.1.2	<p>A competent person in charge for the waste management is named by the director of the hospital in order to develop the plan of the waste management, and to manage and coordinate all daily activities related to waste management.</p>	Position profile of the person in charge

R1.3	<p>A committee is formed, including different key people in charge, being able to contribute to the establishment of a waste management strategy, its application and its follow up. Members of this committee usually include: the director, heads of departments, head nurses, people in charge of the infectious control, the pharmacist, people in charge of the radiology department, the engineer, the finance person in charge, the hygiene person in charge, the quality management person in charge and the waste management person in charge</p>	<p>List of the committee members with their signatures</p>
R1.4	<p>Responsibilities and tasks of each committee member and staff involved in waste management are assigned in writing, by the director of the hospital and then distributed</p>	<p>Request for proposal</p>
R1.5	<p>This committee has monthly or bi-monthly regular meetings, in order to evaluate obtained results in the waste management (matter), to discuss encountered issues and to fix new objectives</p>	<p>Agenda and minutes of the meeting</p>
R1.6	<p>A status report is prepared, in order to get a first evaluation of needs and resources. The status report includes an analysis of the national legislation, quantities of each category of healthcare waste management produced in each department, annual practices of waste management, needs in human resources, trainings, equipment, etc. The status report has to take into consideration factors that can lead to a peak in the production of HCRW, such as the onset of epidemics, emergency situations, seasonal illnesses, etc.</p>	<p>Filled status report document</p>

R1.7

A manual about waste management is elaborated by the person in charge of waste management through the information collected, discussed with the committee and signed by the general directory. It includes the following chapters:

- The current situation: waste management practices, the staff, the equipment involved, the quantity of waste produced...
- Possibility of minimization, re-usage, recycling and purchasing policy
- Sorting, collection, storage and transportation: location and specifications of the storage room (intermediate or central), bags, mini-collectors, garbage truck and disinfectants that are used in the cleaning process of the garbage truck, itinerary and frequency of the waste collection inside departments, etc.
- Identification and evaluation of options of treatment and elimination
- Diagram of the flow, the sorting process, the transportation, the storage and the network of treatment of different waste categories, procedures in case of emergency or accident, control procedures, contingency procedures and plan (in case of breakdown of one of the IHCW treatment equipment, in their original place (in situ for instance).
- Protection measures (gloves, masks, etc.)
- Identification and evaluation of options for the documentation and the traceability
- Training
- Cost estimation
 - Investment cost: storage location, garbage truck, uniforms, etc.
 - Operation cost: fuel, electricity, detached pieces, maintenance, salaries of the staff who is in charge of the healthcare waste collection

The manual of waste management

and its treatment in case this treatment was done in-situ, boxes, mini sharpbox, bags, individual protection equipment, training, etc.

- Implementation strategy
- Auditing and follow up
- Organizational chart related to waste management, (description of the tasks of people involved in the production and the management of healthcare waste)
- Names and phone numbers of people who have to be contacted in emergency situation cases

R1.8

The person in charge of waste management conducts a regular auditing on waste management inside the hospital at least once per week. The audit includes:

Sheets and audit reports

- all types of healthcare waste
- all components of waste management inside the hospital: sorting, wearing the protection equipment, collection, internal transportation, intermediate storing, central storage
- all departments / concerned services
- all staff categories who are involved

R1.9

The reason behind each non-conformity is defined. For each non-conformity, preventive and corrective measures are fixed

Sheets and audit reports

R1.10	A feedback concerning audit results is given to the administration, to heads of departments and service and to the medical staff	Sheets and audit reports, questions addressed to the staff
R1.11	Procedures related to waste management inside the hospital (sorting, transportation, storage and treatment network of different waste categories, procedures in case of emergency or accident, procedures of control...) are evaluated regularly	Procedures
R1.12	The waste management committee reviews, on a yearly basis, the waste management system and initiates necessary modifications which are going to improve the system, taking into consideration national and international recommendations. Intermediate reviews are possible too and, in this case, can be appended to the annual plan	Waste management handbook

Information inserts # 3 :

Audits constitute an ideal way of evaluation for procedures related to waste management inside the hospital

- Find appendix 4: Elements of a Model Facility Policy on Healthcare p. 106
- Find appendix 5: Examples of status reports p. 106
- Find appendix 6: Basic of the document's control p. 107

6. Minimizing waste quantities

The “waste hierarchy”, based on the 3R concept (reduce, reuse, recycle), is an approach which helps to manage the waste with respect to the sustainable development’s objectives.

The hierarchy of waste determines an order of preferences in waste management methods. The best practice is to minimize waste quantities produced, which means to avoid producing waste.

When the minimization is not possible, reuse is recommended wherever it is feasible. In fact, only medical equipment with no cross contamination risk (such as tensiometers) can be reused, in addition to the equipment that is originally designed to be reused (such as the surgical tools). The equipment using only tools (syringes, needles, catheters...) doesn’t have to be reused because it represents a significant risk of cross contamination. When

reuse is not applicable, we recommend recycling before passing to the treatment and to the elimination. Minimizing waste quantities that are produced is as well related to staff practices and to purchasing and store management policies.

Ideally, the quantification of waste is done by weighing bags of each waste type on a scale especially made for this. The recording of produced masses allows a control and a follow up of the waste generation inside the hospital.

#	Recommendations	Verification
R2.1	Purchases are centralized	A responsible of purchases is nominated
R2.2	Products which are generating less waste (less wrapping for instance) are encouraged	Examples of products, distributors offers, specifications of products
R2.3	Suppliers who take back containers for filling them (cleaning products) are encouraged	Examples of products, suppliers offers, specifications of products
R2.4	Recycled or easily recyclable products or recyclable packaging are promoted	Examples of products, suppliers offers, specifications of products
R2.5	Wasting is avoided (for instance, during the healthcare process or during cleaning activities).	Documents of awareness, documents of store control, practices observation

R2.6	Reusable equipment is encouraged whenever possible (washable dishes instead of disposable ones...), unless in the room of patients in isolation	Examples of products, offers, specifications of products, observations
R2.7	Suppliers who can deliver quickly small quantities of merchandises and offering the possibility to return non-used merchandises are encouraged	Examples of products, suppliers offers, specifications of products
R2.8	The expiry date of ordered drugs or other products is verified by the purchasing person in charge, upon receipt, and products which cannot be used prior to their expiry date are rejected	procedures
R2.9	The reception of donations or samples which cannot be used prior to their expiry dates is avoided	Documents of store control, procedures

R2.10	Stocks of chemical products and drugs are managed in such a way which will avoid expired or non-used products: stock management "first in – first out", control of expiry dates	Documents of traceability of the store management
R2.11	The purchase of mercury free devices (mercury free thermometers and tensiometers) are encouraged.	Observation of tensiometers and thermometers which are used in departments
R2.12	Less toxic products (such as cleaning products) are encouraged	Examples of products / specifications of products
R2.13	The staff is trained on minimizing waste generation	Contents, training

Figure 3 : Hierarchy of waste management

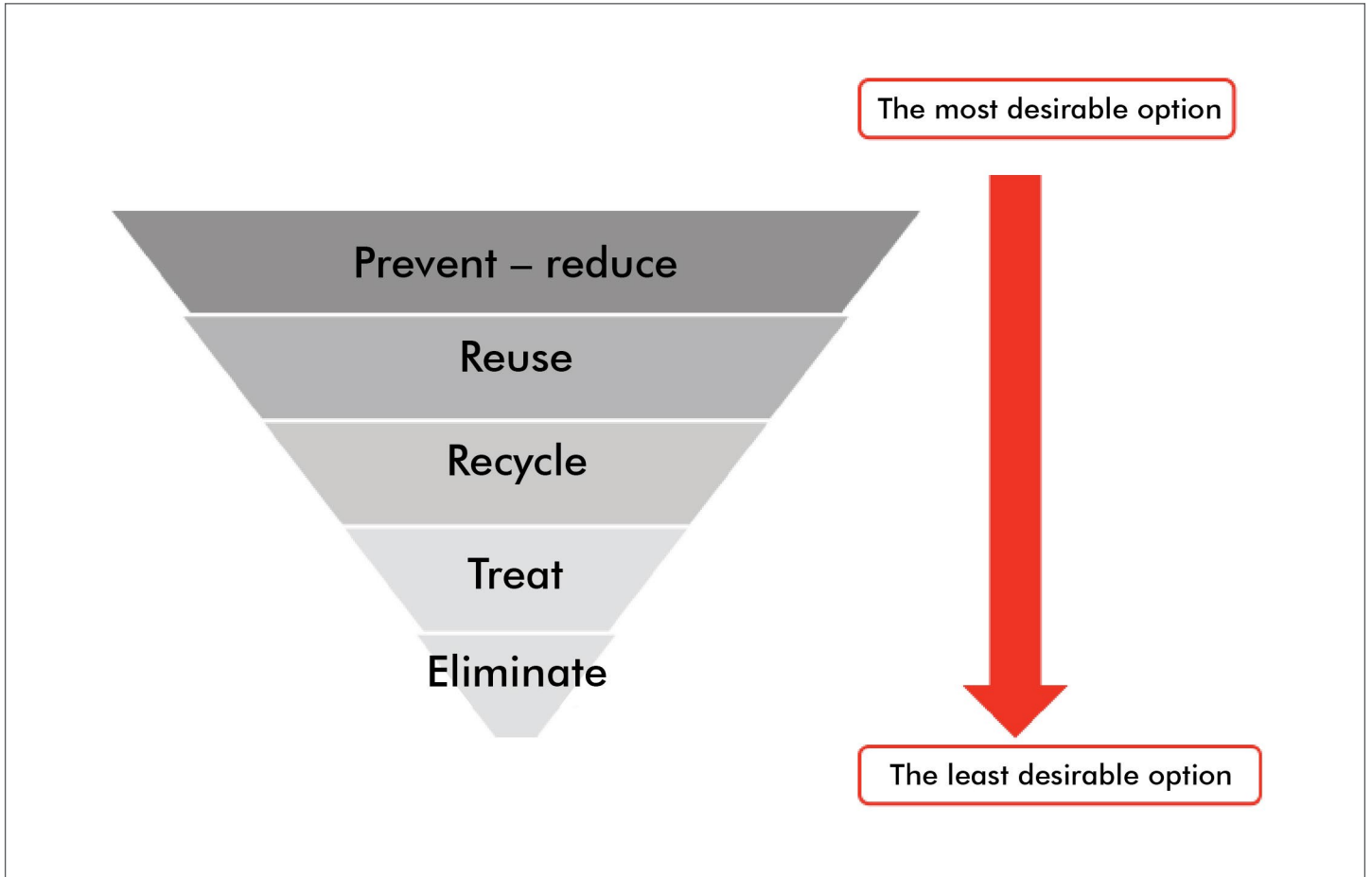









Table 3: Plastic types used in healthcare establishments

Plastic types usually used in healthcare establishments	Symbol	Recycling facility (service)
Polyethylene terephthalate	 1 PET	yes
High density Polyethylene	 2 HDPE	yes
Polyvinyl chloride	 3 PVC	no
Low density Polyethylene	 4 LDPE	yes
Polypropylene	 5 PP	yes
Polystyrene - Expanded polystyrene	 6 PS	no
Others	 7 o	no

7. Sorting at source

Sorting at source is a crucial stage that conditions the successive stages of collection, storage and elimination of waste. An efficient sorting process has to be set in order to guarantee the absence of hazardous waste in the waste assimilated to household waste, from one side, and, on the other side, to isolate the waste with chemical, toxic, radioactive risk from the IHCW.

Waste sorting is the best way of reducing the volume of hazardous waste that needs particular treatment. The sorting consists of a clear identification of the different waste categories and their separation in containers, or plastic bags.

The sorting allows:

- to prevent the propagation of potentially infectious germs
 - to insure the security of people (the healthcare staff, the staff in charge of the waste transportation, patients and the community)
 - to respect hygiene rules
 - to eliminate each waste type through the appropriate network, with respect to regulations
 - to reduce the economic impact of a bad waste management of HCRW or of the treatment of HCRW
- In fact, the cost of HCRW treatment such as IHCW is higher than the cost of the waste assimilated to household waste.

Sorting is a sensitive stage of waste management. Training, regular information and frequent controls are crucial in order to maintain a good sorting system. Sorting has to be maintained throughout the network (in the storage zones and during transportation). The sorting system is efficient only when it is practical and as a result, when it can be implemented easily by the staff.

In addition, protection and conditioning equipment have to be provided to the staff. Packaging of waste consists of putting waste in suitable bags or containers.

In fact, packaging makes a physical fence against hurtful waste and pathogenic microorganisms. They allow to guarantee the security of the people who might be exposed and especially to prevent risks of exposure to the blood of people involved in the elimination network of IHCW. Packaging is done simultaneously with sorting; it is determinant for the successive stages of IHCW management. Packaging has to be available without procurement rupture, inside the unit where waste is produced.

Conditioning has to be adapted to:








- Waste physical characteristics:
 - fluid
 - solid soft
 - soft (solid but no-perforated)
- the size of waste which has to be eliminated
- the flow of waste which is produced
- specifications of the elimination network

Therefore, hospitals have to provide their staff with different types of containers, with adapted capacities and dimensions:

Bags, sharp boxes for needles, sharps or cutting waste and barrels for fluid waste. It is important to involve the staff in the selection of bins and containers' location. In the past, most of recyclable healthcare waste assimilated to household waste was eliminated with other household

waste at the landfill site. The increase of awareness about sustainable development, impact of waste on both environment and health and economic opportunities presented by recyclable waste, has modified the management approaches of healthcare waste assimilated to household waste. It has also lead hospitals to sort their recyclable waste and to assign it to people who take care of recycling it.

Table 4: Recommendations of the Ministry of Environment in Lebanon regarding the sorting process:

Waste category	Color – symbol coding	Container type	
Healthcare waste assimilated to household waste	Black	Plastic bags	
IHCW, sharp or cutting	Yellow and 	Plastic containers for sharp and cutting waste	
IHCW Soft (no-perforated, no-sharp)	Yellow and 	Plastic bags	
Anatomical parts of the body	Grey and 	Plastic bags or boxes	













Waste category	Color – symbol coding		Container type	
Perforated, sharp or cutting cytotoxic waste	Purple and		Sharp containers	
Soft cytotoxic waste	Purple and		Plastic bag	
Pharmaceutical and chemical waste	Red and		Plastic bag	
Radioactive waste	Red and	<div style="display: flex; flex-direction: column; align-items: center;"> <div style="margin-bottom: 5px;">old symbol</div>  <div style="margin-bottom: 5px;">new symbol</div>  </div>	Plastic bag	

Table 5: Choice of the packaging based on the IHCW type

Type of packaging	IHCW Type		
	Sharp, cutting	Solid or soft (no-perforated)	Fluid
Plastic bags			
Mini collectors and sharp boxes			
A barrel for fluid waste			

Main common characteristics of IHCW packaging

- Single usage
- Heavy duty and water resistant
- Easy closure
- A yellow color, horizontal line indicating the filling limit
- Holds the pictogram of the biological danger

#	Recommendations [verification: observations and procedures]
R3.1	Healthcare waste is sorted at source, which means that it is done as soon as it is managed by the healthcare team who produced it
R3.2	Boxes and sharp boxes used for IHCW are placed next to the staff while they are generating IHCW. They can be placed, for instance, on a movable trolley, allowing to be at the staff's disposal when care interventions are done in the patient's room
R3.3	Plastic bags have a size which is compatible with the quantity produced and with the container. Their thickness is 70 μm – ISO 7765 2004 and they are of good quality (tear resistant). The size of barrels and sharp boxes are adapted to the quantity produced. They are also breakthrough resistant, water resistant and can be properly sealed.
R3.4	Universal risk labels and symbols are clearly visible on used containers : bags, sharp boxes, barrels, etc.
R3.5	Non-recyclable waste assimilated to household waste is sorted in black bags.
R3.6	The needles of the syringes are not recapped (the cap must not be replaced on the needle) nor disconnected by hand, but separated in the sharp boxes (refer to figure 4 p.55)
R3.7	Sharp or cutting IHCW is thrown in plastic yellow boxes immediately after use
R3.8	Soft IHCW is placed in yellow bags carrying the infectious symbol

R3.9

When containers of waste assimilated to household waste and of IHCW are required, they are placed, one next to each other, as close as possible, in order to have the same size. The staff tend to place waste in the biggest container

R3.10

Containers of IHCW aren't placed in public places, in order to avoid exposing patients and visitors to the risk of infection

R3.11

Anatomical waste that is easily recognized by a non-specialist (body parts, organs...) is sorted in gray bags or containers in order to be buried

R3.12

Sharp and cutting cytotoxic waste is placed in boxes with purple cover, labeled as "cytotoxic waste"

R3.13

Non-sharp and cutting cytotoxic waste is placed in purple bags labeled as "cytotoxic waste".

R3.14

Unused packed drugs (not yet extracted from their original packaging) are returned to the pharmacy

R3.16

Batteries are sorted and placed in red bags

R3.17

Chemical waste is sorted by a person who knows risks related to chemicals being handled (the laboratory chief for instance)

R3.18	Chemical waste is placed without being mixed, in customized red barrels (in general made of high-density polyethylene HDPE; for mineral acids which are very oxidant: PVC or glass), carrying a label which indicates its content, then placed in red bags
R3.19	Radioactive waste is sorted in red bags carrying the symbol of radioactivity and then placed in lead boxes
R3.20	Disposable syringes containing radioactive residues are emptied in containers made especially for storing radioactive liquid waste. Syringes and needles have to be conditioned in a rigid container, protected by a lead, in a location intended for radioactive decay. Once all residue radioactive activity is eliminated, syringes and needles will follow IHCW
R3.21	Radiographies are collected in waterproof labeled boxes
R3.22	Photographic liquids are collected in waterproof labeled barrels
R3.23	Mercury and glass broken pieces are collected, in case of spill, by avoiding any contact with the skin, in a non-metallic container (tightly closed because mercury steam is toxic), then placed in a red bag
R3.24	Liquid waste is conditioned in waterproof barrels
R3.25	Rigid containers, boxes, barrels and sharp boxes, are closed after each usage

R3.26

A stock of bags, sharp boxes and barrels should be available adequately where waste is produced

R3.27

Boxes and barrels for sharp and cutting IHCW are closed when they are two-thirds full, then they are placed in a yellow bag

R3.28

Bags are closed once they are two-thirds full, then put in a suitable bin

R3.29

Sharps containers, and bags are neither emptied nor reused, nor compressed in order to reduce the volume

R3.30

Bags are never emptied, nor piled, nor carried against someone's body. They are manipulated from the top, with gloves

R3.31

Healthcare waste remain separated based on their risk category until they reach their final elimination.

R3.32

Recyclable WASTE ASSIMILATED TO HOUSEHOLD WASTE (paper/carton, transparent glass, metal, plastic) are sorted in containers with different colors from other healthcare waste (in transparent bags or carton cases for instance), placed in specific bins and labeled in order to be recognized

Information inserts # 4 :

- Some IHCW need a case by case evaluation in order to decide about an elimination network. This decision depends on precautionary measures specific to the patient who received a treatment from which waste is produced. This decision is based on a confirmed or a possible infectious status
- Sanitary pads or diapers are not considered as IHCW, unless generated by a patient in isolation, or in case one of the healthcare staff considers that this waste needs to be generated and treated as IHCW. In this case, the evaluation of the infection risk is left to the medical staff
- The majority of used laundry is not considered as IHCW. It is considered as IHCW if the laundry is soiled to a point that the exposure and infection potential is high or when it holds pathogenic microorganisms presenting a high risk of disease propagation
- When a bin ASSIMILATED TO HOUSEHOLD WASTE is placed under the sink, or under the hand towel dispenser, it encourages the staff to place hand towels in a non-hazardous waste bin
- If non-hazardous material was placed by mistake in a container for waste imposing contamination risk, the waste should not be removed from the bag and becomes considered as hazardous waste
- If IHCW was mixed in the same container as non-hazardous waste, the whole waste will be considered as infectious and will have to be eliminated as an IHCW
- It is recommended to choose containers having the same size as the waste to be eliminated. Never force waste to fit in a container, and give particular attention during the filling and the manipulation of sharp boxes
- Perforating waste can't be put in plastic bags except if they are conditioned in advance in permanently closed sharp boxes
- When WASTE assimilated to HOUSEHOLD WASTE is thrown with IHCW, the cost of the treatment increases
- Bins for sorting recyclable waste (paper/ carton, metal, plastic, glass) can be located in places where their production is highest (Big bins in warehouses, waiting room, cafeterias or nurses relaxation room, small office bins, care room, etc.)

- Find appendix number 7: stickers for the sorting p 109

Figure 4 : Uncoupling of needles in sharps containers

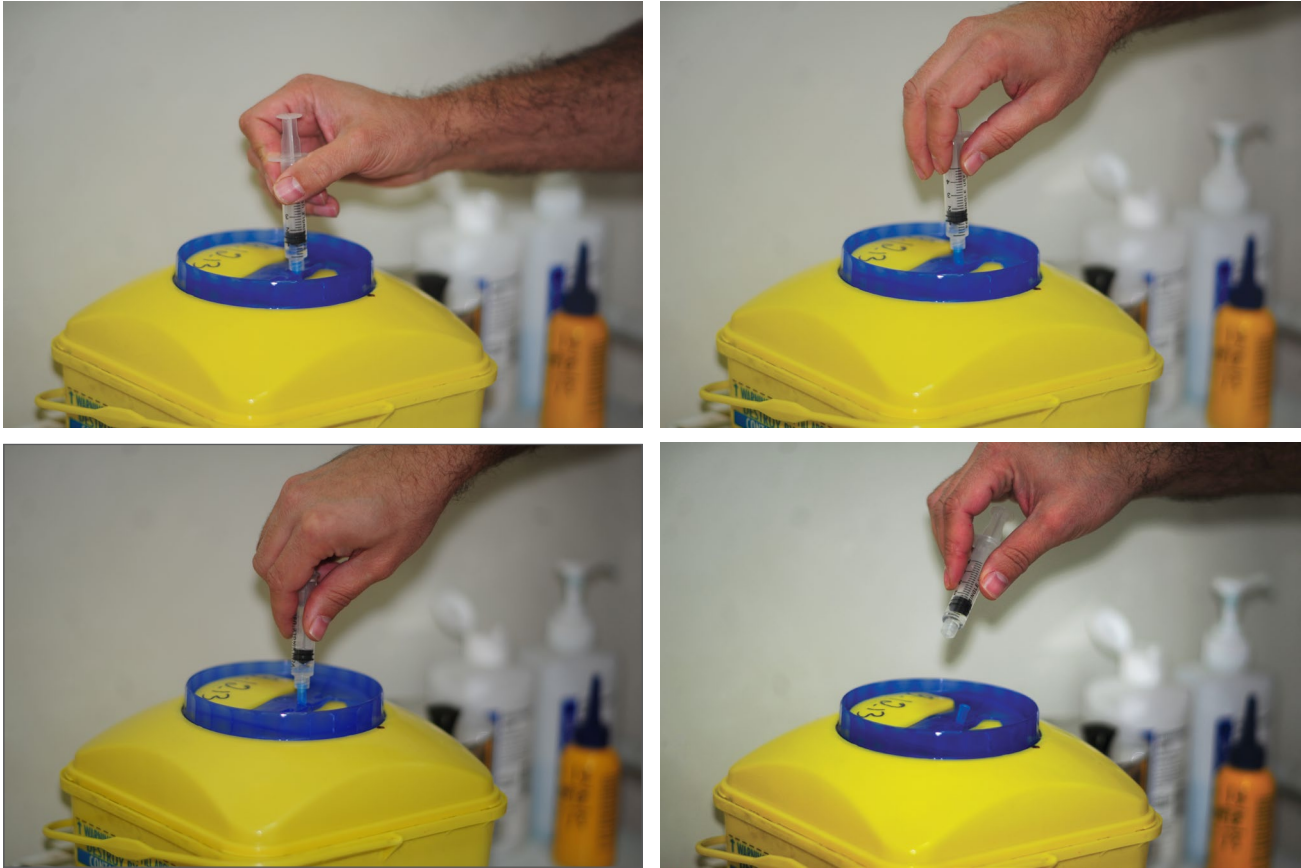


































Table 6: Few examples of waste sorting

<div style="text-align: right; padding-right: 10px;">Container</div> <div style="text-align: left; padding-left: 10px;">Waste</div>								
Expired drugs							✗	
Needles contaminated with non-cytotoxic drugs		✗						
Needles contaminated with cytotoxic drugs					✗			
Blood test needles		✗						
Syringe contaminated with blood			✗					
Syringe packaging	✗							

Waste / Container								
Prescription	✗							
Amputated body part				✗				
Cotton contaminated with blood			✗					
Gloves non contaminated with blood	✗							
Gloves contaminated with blood			✗					
Serum pocket with residues of cytotoxic drugs						✗		

Container								
Waste								
Compress packaging	✗							
Nappies, sanitary pads	✗							
Non recognized anatomic parts			✗					
Blood pocket			✗					
Blood sample			✗					
Urine sample			✗					
Test tubes packaging	✗							
Petri dish			✗					
Disposable hand towel	✗							

<div style="text-align: right; padding-right: 10px;">Container</div> <div style="text-align: left; padding-left: 10px;">Waste</div>								
Colostomy bag (unless it is contaminated with blood or in case of infection...)	✗							
Plaster (unless it is contaminated with blood or pus...)	✗							
Infusion line			✗					
Catheter			✗					
Cannula			✗					
Drain			✗					
Mandrel		✗						
Waste contaminated with radioactive fluids								✗
Placenta			✗					

Care trolleys with IHCW sorting containers



Table 7: Synopsis of the IHCW routing inside the hospital






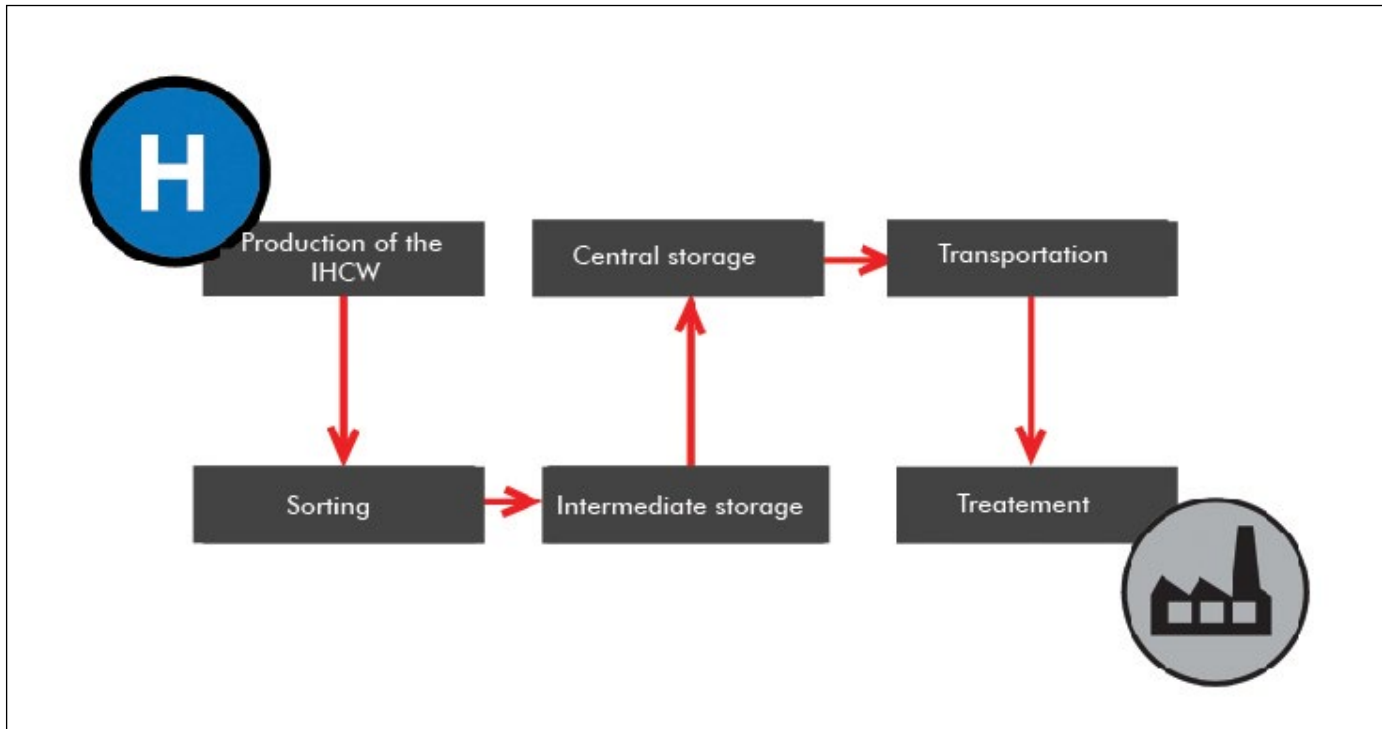
	Responsible	Stage
	Healthcare staff	Sorting
	Maintenance staff	Collection and transportation
	Maintenance staff	Warehousing
	Service provider	External transportation
	Service provider	Treatment

Figure 5: Main stages of the IHCW management



8. Internal collection, intra-hospital transportation and storage

Waste has to be collected regularly, and stored in a safe place before being treated and eliminated.

The intra-hospital transportation is the transportation of waste from one place to another, inside the hospital, where it has to follow a specific itinerary and schedule, in order to avoid moving waste containers inside clean zones, and to insure a compatibility with a daily production evolution.

For example, departments where the change of bandages take place in the morning, in the late morning collection of waste is preferred. As for the surgery room, it is recommended to collect waste at the end of every surgery. The best time to collect WASTE ASSIMILATED TO HOUSEHOLD WASTE and recyclable waste is at the end of visiting hours.

Prior to collection and treatment, waste is stored on 2 levels:

- The first level is an intermediate storage rooms. These collection points are inside the establishment and can also be used for storing products, the dirty laundry, and WASTE ASSIMILATED TO HOUSEHOLD WASTE. These rooms are located as far as possible from the care unit, and close to the elevator.
- The second level is in the central storage room where fully loaded waste bins are stored before being collected for treatment. This room is located away from hospital activity zones and far from windows and air intakes (example: air treatment system), in a place which is accessible to transportation vehicles.

#	Recommendations	Verification
R4.1	<p>A daily program and a collection system are planned and studied in a way to reduce the contamination or pollution risks:</p> <ul style="list-style-type: none"> • the internal transportation of waste is done during periods of low activity • the passing through clean zones (sterilization) sensitive zones (surgery room, intensive care) and public spaces is minimized (refer to figure 6 p. 74) • zones where the waste is transported are cleaned after each passage <p>The program takes into consideration:</p> <ul style="list-style-type: none"> • the volume of waste • the number of containers and their capacity • types of HEALTHCARE WASTE which is produced • the capacity of storage rooms • distances 	Observations and procedures
R4.2	Bags of waste, especially WASTE ASSIMILATED TO HOUSEHOLD WASTE, is collected not less than twice per day	Observations and procedures
R4.3	Waste cannot be accumulated in the same place where it is produced and filled bags of waste cannot be left in the room	Observations

R4.4	<p>During their manipulation and their transportation, bags of waste should never be:</p> <ul style="list-style-type: none"> transported by hand, in order to avoid risks of accidents and injuries due to IHCW, or due to the inappropriate disposal of sharp and cutting waste carried against the body 	Observations and procedures
R4.5	Bags should never be placed on the ground but in compatible and suitable stands adapted to the volume of bags, for an ergonomic manipulation and better cleaning	Observations
R4.6	Bins are maintained in good condition (rotation, water tightness, closure) and every defective bin is reported and replaced immediately (absence or deterioration of the closing system, defective wheels).	Observations and procedures
R4.7	Bins should not be filled to more than $\frac{3}{4}$ of their capacity	Observations and procedures
R4.8	<p>Before starting the internal collection:</p> <ul style="list-style-type: none"> the staff washes their hands then closes the tap with a disposable towel the staff wears thick gloves, industrial boots and a uniformle personnel the staff prepares new waste bags with stickers mentioning the date, the code of the department or service and the name of the establishment 	Observations and procedures

R4.9	Waste bags are collected in movable, waterproof, rigid, washable bins provided. Bins are resistant to disinfectants and it is forbidden to drop off waste without bags in them	Observations and procedures
R4.10	Each type of healthcare waste is collected separately	Observations and procedures
R4.11	If possible, bins and bags used for each type of waste are from the same color (example: yellow bin and yellow bags for IHCW). In all cases, the pictogram corresponding to each type of waste has to be clearly visible on the bin	Observations and procedures
R4.12	<p>The staff collects waste from patients' rooms by:</p> <ul style="list-style-type: none"> • knocking on the door with the back of their hand and opening it with their elbow • starting with the WASTE ASSIMILATED TO HOUSEHOLD WASTE • removing bags from the patient's room • opening the trash bin with their foot, using the pedal • ceiling the bag as follows: <ul style="list-style-type: none"> ○ twisting the upper part of the bag ○ folding the upper part of the bag ○ tying the bag with a plastic ribbon (refer to figure 7 page 75) • holding the bag from the upper part only and placing it in order to hold it by its upper part only • holding only one bag at once • placing the closed bag directly in the WASTE bin ASSIMILATED TO HOUSEHOLD WASTE, in the hallway, without putting it on the floor 	Observations and procedures

R4.13	The staff removes the bag from bathrooms according to the same procedure described in R4 12 (Refer to figure 7 p.75)	Observations and procedures
R4.14	Waste bins are weighed separately on a provided scale for this purpose	Procedures and tracking documents
R4.15	The person in charge of the collection fills and signs a form mentioning their name, the date, the time of collection and weighted quantities	Procedures and tracking documents
R4.16	After collecting black bags from patients' rooms and bathrooms, and after placing them in the WASTE bin ASSIMILATED TO HOUSEHOLD WASTE, the staff removes their gloves (from the inside to the outside), washes their hands with soap and a hydro-alcoholic solution and wears new gloves	Observations and procedures
R4.17	The staff places new bags in patients' rooms	Observations and procedures
R4.18	The staff transports collected bags in the WASTE bin ASSIMILATED TO HOUSEHOLD WASTE to the intermediate storing room (also called utility room).	Observations and procedures
R4.19	After transporting waste to the intermediate storage room, the staff removes their gloves, washes their hands with soap and a hydro-alcoholic solution and wears new gloves	Observations and procedures

R4.20	IHCW is collected in matching bins by adopting recommendations R4.12 to R4.19	Observations and procedures
R4.21	Other pharmaceutical and chemical waste is collected separately in specific boxes	Observations and procedures
R4.22	Before collecting a bag of IHCW from the room of a patient undergoing a treatment including radioactive elements, the radioactivity of the bag is tested with a detector. If radioactivity is detected, the bag of waste is placed in a container made of lead and is managed by radioactive decay	Observations and procedures
R4.23	<p>Anatomic parts that are recognized by a non-specialist are given to the patient's parents or to the cemetery where they are directly buried. When it is not possible, these anatomic parts are buried in a ground within the property of the hospital or next to the hospital building.</p> <p>In this case, a pit of 2 to 3 meters wide has to be dug. The bottom of the pit has to be more than 2 meters above the groundwater.</p> <p>A layer of clay has to be placed at the bottom of the pit. A soil hummock has to be built around the pit, in order to stop the water from entering it. Also, a fence must be set up around the zone in order to stop any unauthorized entry. In the pit, layers of waste have to be intercalated with 10 cm layers of soil or lime. When the level of the pit filling is around 50cm from the ground surface, waste has to be recovered with soil. The pit is then sealed permanently with cement and covered with metal fence</p> <p>In case anatomic parts cannot be buried immediately, they must be</p>	<p>Observations and procedures</p> <p>Convention with a cemetery</p> <p>Tracking report</p>

conditioned and placed in low temperature conditions, between 0 and 5°C, or frozen in an enclosure, exclusively prepared for this purpose. For instance, a specific locker in a mortuary room can be provided to keep these anatomic parts for a maximum of 8 days

R4.24

In the intermediate storing room, IHCW, the WASTE ASSIMILATED TO HOUSEHOLD WASTE, and conditioned pharmaceutical waste are stored separately, distant enough from each other, in order not to have any contact between the different categories. The intermediate storing room has to meet the following requirements for the reduction of the contamination risks or pollution:

- no direct connection with other premises
- close to care zones but apart from zones which are accessible to the public
- confined, with only limited access to the authorized staff (a "entry code" is recommended to access premises which might be accessible to the public)
- apart from food
- covered and protected from the sun
- washable floors and walls, chock resistant, and resistant to detergents and disinfectants
- good drainage system in place
- protected from rodents, birds and other animals
- easy access to internal and external means of transportation
- Well aerated (sufficient ventilation, either natural or mechanical)

Observations and procedures

- not heated
- brightly lit
- divided into small units (in order to separate different waste categories)
- equipped with hand washing spots or if not, an hydro alcoholic solution dispenser
- with signs on the door (access not allowed, toxic material or risk of infection, drinking, eating and smoking not allowed)
- spacious enough in order to insure that the different waste categories can be stored separately

R4.25

Radioactive waste of less than 100 days period, are placed in containers which are designed to stop the spread of radiations, always mentioning the type of radio nucleotide, the date, the decay period. They are stored behind a protection layer made of lead on the level of the premises that is dedicated to their decay. Premises have to meet the following requirements:

- built with non-flammable materials
- easily washable surfaces
- equipped with air extraction system and radioactivity control
- marked with the international symbol of radioactivity

The storing period depends on the half-life of the radioisotope: for a radioisotope half-life which is less or equal to 9 days, the storing period is generally equal to 10 times the half-life period.

Observations and procedures

R4.26

Chemical waste is stored in a closed room, separated from other waste, based on composing substances, taking incompatibilities into consideration:

Base – acid – halogenated solvents – non-halogenated solvents – oxidants – explosives – flammables – are stored in different labeled containers. Collecting trays have to be placed under containers in order to collect liquids, in case of spillage. Waste spillage kit, protection equipment, and first aid kit must be available in the room. The storing room has to be brightly lit, and equipped with a ventilation system in order to avoid the accumulation of toxic steam

Observations and procedures

R4.27

Photographic developer fluids are stored in barrels, without being mixed with other substances. The X-rays are also stored separately

Observations and procedures

R4.28

The transportation of healthcare waste inside the hospital is done in appropriate bins, following these requirements:

- easy to load, easy to push and easy to discharge
- without angles and sharp borders, in order to prevent the tearing of bags
- easy to clean
- easy to identify
- closed during transportation in order to avoid spillage
- inspected and disinfected on a daily basis

Observations and procedures

R4.29

The transportation of waste is done in a provided elevator, equipped with a device restricting its access

Observations and procedures

R4.30	Waste is transported separately in the elevator, starting with WASTE ASSIMILATED TO HOUSEHOLD WASTE, then HCRW, and finally other IHCW	Observations and procedures
R4.31	The elevator is cleaned after each transportation of waste, from the outside to the inside (doors, then internal surfaces). And from the top to the bottom (finishing with the floor), using an appropriate towel and disinfectant, abiding usage instructions mentioned on the disinfectant	Observations and procedures
R4.32	Prior to collection by concerned organizations, recyclable WASTE ASSIMILATED TO HOUSEHOLD WASTE has to be placed in a provided storage room. It has to be kept separated from other HCRW	Observations and procedures
R4.33	<p>While waiting to be treated, IHCW has to be stored in a central storage room, exclusively provided to this purpose, fulfilling requirements of the reduction of risk of contamination or pollution, and complying with the following criteria:</p> <ul style="list-style-type: none"> • no direct connection with other premises • confined, with limited access only to authorized persons (an “entry code” is recommended for premises which may be accessible to the public) • away from food storage units • covered and protected from the sun • good drainage • washable floors and walls, choc resistant, and resistant to detergents and to disinfectants • protected from rodents, birds and other animals • easy access to internal and external means of transportation • well aerated (sufficient ventilation, either natural or mechanical) • not heated and eventually refrigerated if the temperature is particularly high or if the storage time of IHCW exceeds 48 hours 	Observations and procedures

- brightly lit
- equipped with hand washing spots or with a hydro alcoholic solution dispenser
- with signs on the door (access not allowed, toxic material or risk of infection, drinking, eating and smoking not allowed)
- equipped with a system which allows the door to open from the inside, in order to avoid the trapping of people inside
- equipped with a water inlet
- equipped with round angles for the floor and the baseboard
- equipped with a cleaning and disinfecting zone nearby (in case bins were not cleaned and disinfected by the provider of the IHCW treatment)
- canalized water streams have to be poured again in the wastewater

R4.34

The maximum time of storage for IHCW is:

- one week in a refrigerated place (3 to 8 degrees)
- when the place is not refrigerated, the storing time of IHCW shouldn't exceed 24 hours

Observations and procedures

R4.35

There is a maintenance traceability of storage rooms and bins (identification of the person in charge, registration of the date and signature...)

Observations and procedures

R4.36

Healthcare waste has to be conditioned in bags when they are placed in (integration) the intermediate storing room

Observations and procedures

Figure 6 : Transportation circuit of IHCW inside the hospital

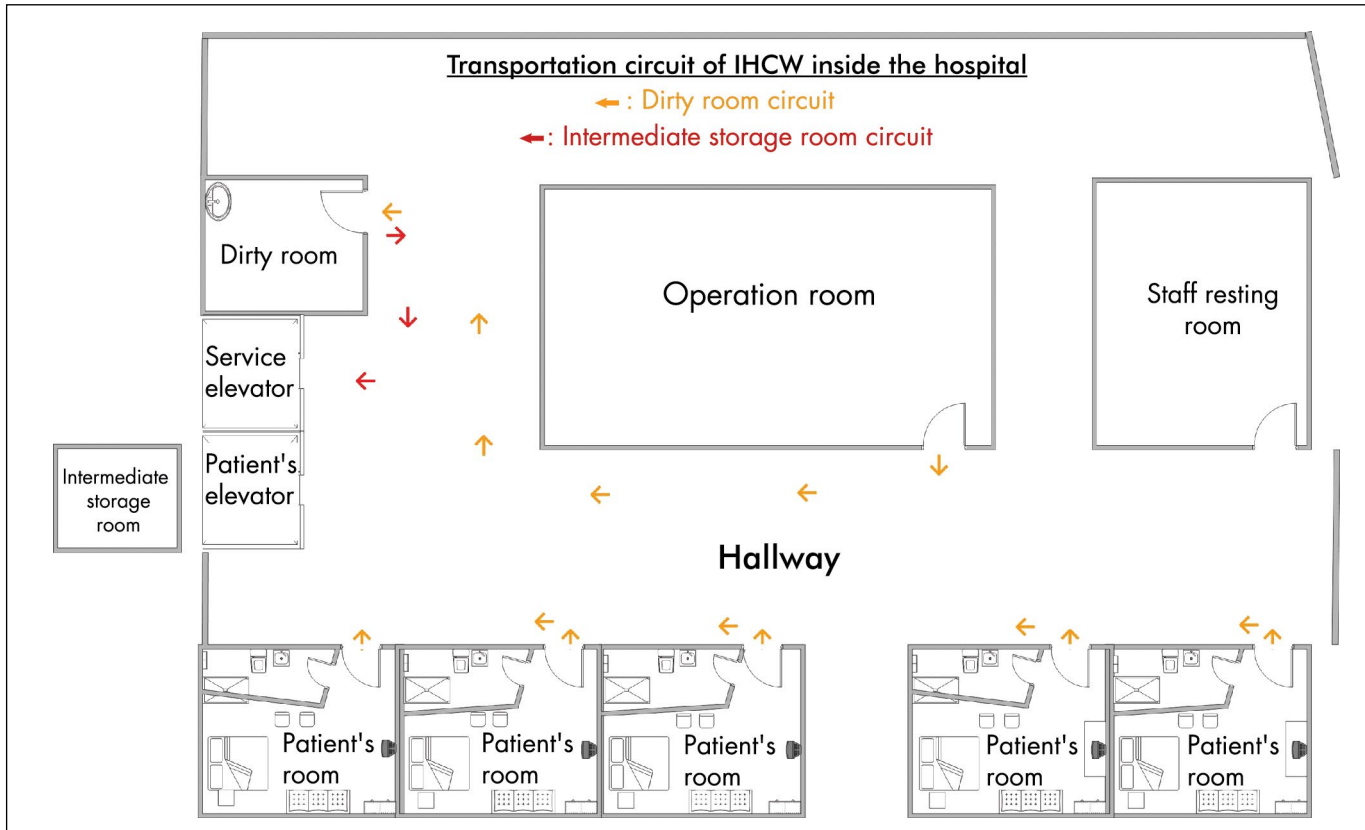


Figure 7 : Closure method of the bag



Inserted information # 5 :

- In the rooms of patients in isolation, all waste is considered IHCW. As a result, all bags which are used are yellow. The usage of garbage chutes in care establishments is not recommended because it increases the risk of infection.
- IHCW can't be frozen (except anatomic parts) and they cannot be compacted either.
- During warehousing, the presence of nutritious material and humidity, in addition to the temperature of waste, enhance the development of bacteria, yeast and mold.
- Formaldehyde (for instance, where anatomic parts are conserved) doesn't have to be placed in an autoclave. That is why it can't follow IHCW network.
Formaldehyde has to be eliminated gradually, by following these steps:
 - Wearing butyl or nitrile rubber gloves, a cotton blouse, a mask and protection glasses.
 - Diluting the formaldehyde solution at one centesimal under the extractor hood and stirring (approximately 100 ml of water per 1 ml of formaldehyde).
 - Throwing the mixture in the sink
 - The anatomic part can then follow the network of IHCW

Figure 8: Signs that have to be present at the entrance of the storage room



9. Treatment and elimination

According to the polluter-pays principle, each producer of waste is legally and financially responsible for the safe elimination of their waste regarding people and the environment, even if certain jobs are outsourced.

The choice of techniques for treatment and elimination depends on numerous parameters like the quantity and types of waste produced, the legislation, etc. The choice has to be made considering the main objective, which is the minimization of the negative impact on health and the environment. If sufficient financial resources are not allocated at short term in order to manage and treat HCRW (conveniently), HCRW will cause a bigger cost in terms of morbidity, mortality and environmental damages.

Table 8: Main solutions for the HCW treatment

Type of waste	Main treatment solutions	Treatment solutions available in Lebanon
IHCW	<ul style="list-style-type: none"> Controlled incineration at 850° C Sterilization by microwave Sterilization by autoclaving associated with grinding 	<ul style="list-style-type: none"> Sterilization by autoclaving associated with grinding
Pharmaceutical and cytotoxic waste	<ul style="list-style-type: none"> Return to the supplier if possible Incineration in rotary kilns, special waste incinerator (> 1200° C) 	<ul style="list-style-type: none"> Return to the supplier if possible Storage inside the hospital and exportation according to the Basel Convention

Chemical waste	<ul style="list-style-type: none"> • Return to the supplier • Treatment in a special waste treatment plant, in a rotary furnace • Throwing out the sewage water within exemption limits • Exportation (refer to the Basel Convention) 	<ul style="list-style-type: none"> • Storing inside the hospital, then exportation according to the Basel Convention
Recognizable anatomic waste	<ul style="list-style-type: none"> • Incineration in crematory ovens or special waste ovens • Burying in a provided place 	<ul style="list-style-type: none"> • Burying in a provided place
Mercury waste and batteries	<ul style="list-style-type: none"> • Return to the supplier • Recycling by a recycling firm authorized to receive mercury waste • Exportation according to the Basel Convention 	<ul style="list-style-type: none"> • Storing inside the hospital, then exportation according to the Basel Convention
Radiographies	<ul style="list-style-type: none"> • Recycling by a recycling company • Exportation according to the Basel Convention 	<ul style="list-style-type: none"> • Storing inside the hospital, then exportation according to the Basel Convention
Paper, glass, metal and plastic	<ul style="list-style-type: none"> • Recycling 	<ul style="list-style-type: none"> • Recycling
Green waste (kitchen and garden waste)	<ul style="list-style-type: none"> • Biological treatment (composting, anaerobic digestion ...) • Unloading 	<ul style="list-style-type: none"> • Composting (on site by the hospital) • Unloading (through municipal services)

Silver from the photography development bath

- For small quantities: thrown in sewage within exemption limits (mixing fixing baths with development baths, storing them for one day, then diluting them [1:2] and emptying them slowly in the sink.
 - Recycling
 - Incineration in a rotary furnace or a special waste incineration plant
 - Exportation according to the Basel Convention
- For small quantities: thrown in sewage within exemption limits (mixing fixing baths with development baths, storing them for one day, then diluting them [1:2] and emptying them slowly in the sink)
 - Storing inside the hospital then exportation according to the Basel convention

Radioactive waste

- Radioactive healthcare waste with a half-life of less than 100 days is stored in lead until it is considered as inactive. After a delay 10 times more than the radionuclide, and the verification of the residual activity level (which doesn't have to exceed twice the local ambient background noise), waste is directed as follows:
 - in the absence of infectious or chemical risks, towards the WASTE ASSIMILATED TO HOUSEHOLD WASTE network
 - in the presence of risk of infections, towards the IHCW network
 - in the presence of chemical and toxic risks, towards the network of waste with chemical or toxic risk
 - The radioactive healthcare waste with a half-life superior to 100 days are taken care by the national agency for radioactive waste management
- Storing in lead until they become inactive, then they will be directed as follows:
 - in the absence of infectious or chemical risks, towards the WASTE ASSIMILATED TO HOUSEHOLD WASTE network
 - in the presence of risk of infection, towards the IHCW network.
 - in the presence of chemical or toxic risks, towards the network of the waste with chemical or toxic risks.
 - Radioactive healthcare waste with a half-life superior to 100 days are usually returned to the suppliers of concerned radioactive substances, for an appropriate treatment under the control of the Lebanese Atomic Energy Commission (LAEC)

Since around 30 years ago, incineration became more controversial, since many types of hospital waste are difficult to incinerate or generate toxic emissions. Therefore, in 2011, the World Health Organization (WHO) noted that, in order to reduce the negative consequences on the environment, healthcare waste management has to be rational and adopt an alternative to the incineration

technique. As a consequence, many hospitals searched for alternative methods which could be safer for the environment, especially the steam disinfection of IHCW.

In Lebanon, care establishments are often working with a service provider who is providing the transportation, the treatment by sterilization, in addition to the elimination of IHCW outside the hospital.

This outsourcing has many advantages, especially:

- no big investments in financial and human resources
- no need to invest in the surface area or specific location
- no need for a regular control on the efficiency of the treatment and the maintenance

When the hospital chooses to treat its IHCW on site, it is crucial to provide necessary human and financial resources in addition to an alternative network for scheduled (maintenance) or unscheduled (accident) stops.

In Lebanon, the only healthcare waste having a treatment solution at the national level are IHCW. arcenciel association has been managing the national network for the collection and the treatment of IHCW. The treatment technique which was adopted involves sterilization by autoclaving, the best until then for the environment, society and economy. This treatment aims to modify the appearance of waste and reduce their microbiological contamination. Autoclaving is a thermal process where a low temperature is used in order to put saturated steam

under pressure with direct contact to waste during an adequate time period for sterilisation in order to reach a temperature of 134°C, which is sufficient to destroy the *Geobacillus stearothermophilus*, the most thermo-resistant bacteria. The pressure has to be increased to approximately 2.5 bars. Biological or chemical efficiency tests have to be done regularly. In opposite to small autoclaves designated for everyday usage and the sterilization of medical equipment, autoclaves used for IHCW treatment can be relatively complex, including a shredder and a high level of technical expertise and maintenance.

Inserted information # 6 :

- The inappropriate sorting of chemical waste, which can be mixed with the flow of IHCW treated in autoclave, can cause emissions of toxic contaminants in the air, such as phenol and formaldehyde.
- Emerging technologies, such as the plasma pyrolysis, or the ozonation, still haven't demonstrated their efficiency and their safety in the field of HCRW treatment.
- The treatment of cytotoxic waste requires the adoption of specific incinerators, because the complete destruction of this waste requires incineration temperatures higher than 1200° C and a minimum retention time of 2 seconds in the second room of the incinerator. Incineration at lower temperatures in single chamber units incinerators can lead to cytotoxic steam emissions in the air.

For more information about the Basel Convention, please contact arcenciel foundation at the following address: environnement@arcenciel.org or the Ministry of Environment

#	Recommendations	Verification
R5.1	<p>If IHCW is not treated in situ, it is collected by a specialized body:</p> <ul style="list-style-type: none"> • in rigid and waterproof bins, marked with the risk of infection symbol, made of easy to wash material, and having an efficient closure • in specific vehicles especially provided for this purpose, meeting the standards of the World Health Organization for HCRW transportation. 	Contract with the service provider
R5.2	IHCW is treated by autoclaving associated with grinding, in a unit which is approved by the Ministry of Environment.	Tracking forms, procedures, contract with the service provider or observation of the treatment done in situ
R5.3	The center or the room where the treatment of IHCW is done, is designed in a way to avoid that untreated IHCW and sterilized waste take the same route and meet. There should be a door for the entrance of IHCW and another door for the exit of treated waste.	Observations, plans

R5.4

A trimester report has to be submitted to the Ministry of Environment by the entity in charge of IHCW management (the hospital itself if the treatment is done in situ, or the service provider if the treatment is outsourced). This report includes:

- general information (autoclave type, name of the entity who is treating the waste...)
- information related to the treatment cycle: the source of waste, quantities of treated waste)
- information allowing the evaluation of the autoclaving efficiency:
 - the details of the biological tests done once per week: location of the biological indicator in the autoclave, biological indicator mark, bacterial spores which are used, concentration, batch number of the biological indicator, expiry date, set-point temperature, exposure time at the autoclave's set-point temperature, pressure, time of the beginning of the cycle, time of the end of the cycle, results of the biological test
 - the details of chemical tests: Location of the chemical indicator in the autoclave, mark of the chemical indicator, batch number, expiry date, set-point temperature, exposure time at the autoclave's set-point temperature, pressure, duration of the cycle, results of the chemical test
- information allowing the evaluation of the environmental impact of the autoclaving
 - results of parameters to be tested every 6 months on the wastewater generated from the autoclave:

Trimester reports submitted to the Ministry of Environment

Chemical Oxygen Demand (COD), Biological Oxygen Demand (BOD), phosphorus compounds, suspended solids, total coliform bacteria

○ results of parameters to be tested once per year on the wastewater generated from the autoclave: total Copper (Cu) (mg/l); total Mercury (Hg) (mg/l); total Nickel (Ni) (mg/l)

○ results of parameters to be tested once per year on air emissions, from the boiler and the generator: Particulate Matter (mg/m³); Oxygen Correction (%); Carbon Monoxide (CO) (mg/m³), Sulfur oxides (SO_x) (mg/m³)

- the maintenance program

R5.5

Bins are cleaned and disinfected from the inside and the outside, each time they are emptied on the site of treatment of IHCW before their return to services or healthcare units:

Procedures and observations

- from the outside to the inside
- with an appropriate disinfectant, leaving it to settle for 3 minutes or more according to the prescribed usage manual
- by using a brush
- without missing wheels
- by washing with water under pressure
- by emptying cleaning water retained in the bin into the manhole

R5.6

When the treatment of IHCW is outsourced, a contract is established between the healthcare establishment and the service provider

Contract

R5.7	Pharmaceutical, chemical, cytotoxic waste is returned to the supplier whenever it is possible. Otherwise, they are stored and then exported according to the Basel Convention	Tracking forms, procedures, contract with the service provider
R5.8	Baths of photographic development, radiographies and batteries are delegated to organizations being able to recycle them or export them according to the Basel Convention. Small quantities of radiographic bath development can be thrown in sewage within exemption limits (mixture of fixing baths with development baths, storing for one day, then dilution [1:2] and emptying them slowly in the sink)	Tracking forms, procedures, contract with the service provider
R5.9	<p>Radioactive waste of a period less than 100 days, after a delay of 10 times more than the radionuclide and the verification of the residual activity level, don't have to exceed twice the local surrounding background noise, are conducted towards:</p> <ul style="list-style-type: none"> • non-hazardous waste process, in the absence of any infectious and chemical risks • IHCW process, in the presence of infectious risks • chemicals and toxics HCRW process, in the presence of any chemical or toxic risks 	Tracking forms, procedures
R5.10	Radioactive waste with a period more than 100 days have to be returned to the suppliers in order to get an appropriate treatment	Tracking forms, procedures, contract with the service provider

R5.11	Anatomic recognizable pieces are buried in private spaces	Tracking forms, procedures, contract with the service provider
R5.12	Paper, glass, metal and plastic are entrusted to organizations who can recycle them	Tracking forms, procedures, contract with the service provider
R5.13	Organic waste (kitchen and garden waste) are composted whenever possible and used as compost in green spaces or entrusted to organizations who can recycle them	Observation, tracking forms
R5.14	The quantity (in volume or in mass) of HWC, produced by each department and by the entire establishment, is calculated, reported and followed up each month	Tracking reports of quantities
R5.15	Quantities of recyclable waste which are collected are followed up and communicated periodically to the staff in order to motivate them	Procedures, questions to the staff

R5.16	<p>There are special forms for all recyclable HCRW and HEALTHCARE WASTE ASSIMILATED TO HOUSEHOLD WASTE whose treatment is resourced, including:</p> <ul style="list-style-type: none"> • type of waste • date of the collection • collected quantities • date of the treatment • treatment method • name of the operators • name and signature of the responsible of the treatment center in the hospital • name and signature of the responsible of the collection • name and signature of the responsible of the treatment 	Tracking forms
R5.17	Tracking reports are maintained for a minimum of 5 years	Forms
R5.18	A reference of HCRW is prepared for the establishment	Tracking reports of quantities of HCRW
R5.19	Monthly HCRW quantities are followed-up and compared to the average reference and the average of the establishment	Tracking reports of quantities
R5.20	In case of increase or diminution of the monthly quantity of HCRW, the reasons are diagnosed and measures are taken if needed	Tracking reports of quantities

- Consult annex 14: Regulations concerning the treatment of IHCW – circular 1/11 of the Ministry of Environment (2011) p 117

Many factors can influence the mass of IHCW that is produced:

- total number of beds
- average rate of occupation
- number of surgeries, especially the number of open heart surgeries
- number of isolated patients
- number of beds in intensive care unit
- number of beds in the dialysis service
- modifications in the purchase policy (one use material)
- arrival of new nurses or residents
- closure / opening of new services
- weighing tool
- staff delegated for weighing

For this reason, it is important to follow these factors at the same time during the monitoring of IHCW mass

10. Personnel protection

The manipulation of waste, throughout the network, includes risks for the health of the staff. Protection measures help to minimize accident risks or their consequences. The staff in direct contact with waste during any stage of waste management have to be protected from encountered risks. Preventive measures of protection and control have to be taken accordingly.

Employers have to:

- Evaluate risks presented by waste for employees
- Work on the elimination, the prevention and the control of these risks
- Involve employees in the identification of risks and recommendations for the prevention and the control of these risks
- Provide information, instructions and sufficient trainings for risks concerning their employees
- Provide health monitoring and vaccination of employees
- Provide written procedures for employees, concerning measures to be taken in case of incident or accident. In fact, appropriate procedures, respected by the healthcare personnel and controlled by the administration, can significantly reduce accident risks.

#	Recommendations	Verification
R6.1	The staff that could come in contact with waste, receives an appropriate vaccine protection, including the vaccination for the Hepatitis B and tetanus	Vaccination record, procedure
R6.2	The staff is informed about advantages of vaccination	Questions to the staff
R6.3	The healthcare, medical and paramedical staff is equipped with disposable gloves	Observation, procedure
R6.4	The cleaning , the collection and the waste treatment staff is equipped with strong protection gloves, coveralls and safety shoes during the transportation and the treatment of waste (when it is done on site)	Observation, procedure
R6.5	During contact with genotoxic waste, a mask, gloves, glasses and a waterproof jacket have to be worn in order to prevent the exposure of skin, eyes, or the inhalation of powder or aerosol	Observation, procedure
R6.6	Sinks with hot water and soap or hydro alcoholic solution dispensers are installed everywhere where waste is manipulated (intermediate storing room, central storing room and treatment)	Observation

R6.7	<p>The staff washes hands (if these are obviously soiled), or chooses rubbing by hydroalcoholic solution (if the hands are not obviously soiled):</p> <ul style="list-style-type: none"> • according to the method which is recommended by WHO (Refer to figure 9 p.95) • at the beginning and at the end of the service • after each contact with waste • after taking off the protective equipment • before and after everyday activities (eating, going to the toilet, blowing one's nose) 	<p>Observation, procedure</p>
R6.8	<p>The staff must have no contact with their hands and their mouth during their duty (smoking...)</p>	<p>Observation, signage</p>
R6.9	<p>Emergency measures to be adopted in case of accident with exposure to blood are known by the staff and displayed at their work place</p>	<p>Observation, questions to the staff</p>
R6.10	<p>Emergency measures to be adopted in case of spillage or contamination of surfaces are known by the staff and displayed at their work place</p>	<p>Observation, procedure, interrogation</p>
R6.11	<p>The director nominates a coordinator for emergencies (he is in general the director of the staff), who will be the first person to be contacted in order to take necessary measures in case of an accident</p>	<p>Procedure, profile of the position</p>

R6.12

There are kits for the spillage, immediately accessible to the staff, and they include:

- disposable gloves
- a mask
- a disposable apron or a laboratory coat
- containers for HCRW
- absorbent paper towels
- disinfectants
- tools allowing to collect sharp waste (a clamp, a broom and a shovel for instance)
- tools allowing to collect mercury (a syringe for instance)
- a mask for mercury steams
- protection glasses

Observations,
procedures

R6.13

Every wounded person has to go to the emergency room as soon as possible for examination, treatment and follow up

Procedures,
questions to the staff

R6.14

Every incident or accident is reported to the coordinator of emergencies (who is in general the director of the staff), and to the person in charge of the quality. The latter will do an investigation in order to know the reasons of the incident/accident and measures to be taken in order to ensure that it does not happen again

Procedure,
interrogation of the
staff

R6.15

Every incident or accident related to waste management, is documented (recorded) in a form where the following information is mentioned:

- the date of the incident/accident
- the concerned person and his position
- the type of incident/accident
- the location of the incident/accident
- the description of the incident/accident
- the reason(s)
- the consequence(s)
- corrective measures
- the medical follow up

Forms and reports of the work accident

R6.16

The analysis and investigations regarding the incident/accident are implemented. They allow an evaluation of causes, tendencies, costs related to the accidents/ incidents, the efficiency of preventive measures and fields of risk where measures were not yet taken

Procedures, reports on incident

Inserted information # 7:

- There is no vaccination up to now for Hepatitis C.
- The usage of disinfectants represents a risk by itself. The mode and circumstances of the disinfectants' usage has to be established by the committee of control of the infection risk and mentioned in the policies.
- Wearing protection equipment doesn't exempt staff from respecting hygiene measures, which are: no eating, drinking or smoking in work places and washing hands before and after all shifts and after contact with waste and bins.

- Consult annex 8: Example of a tracking report p 110
- Consult annex 9: Tracking tools of the IHCW production and calculation of the mass indicator/occupied bed/day. p 110
- Consult annex 10: Average production of IHCW by hospital category in Lebanon p 112
- Consult annex 11: Accounting matrix of IHCW treatment techniques p 113
- Consult annex 12: Criteria of vehicles that are used for the transportation of IHCWp 114
- Consult annex 13: Description of the sterilization technique by autoclaving p 115
- Consult annex 14: Regulations concerning treatment units of IHCW p 117

Figure 9 : Hands' hygiene

Hydroalcoholic hygiene, how?

Recommendations of the WHO, 2006, (http://www.who.int/patientsafety/events/05/HH_en.pdf?ua=1)

Use hydroalcoholic friction for the hygiene of hands when they are not obviously soiled



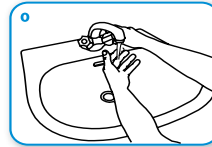
Hands' wash, how?

Recommendations of the WHO, 2006, (http://www.who.int/gpsc/tools/HAND_WASHING.pdf)

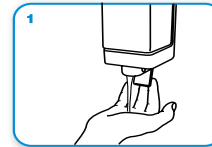
Wash hands with soap and water when they are obviously soiled



Duration of the entire procedure: 40-60 sec.



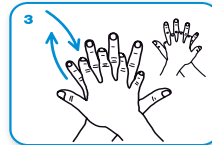
Wet hands with water



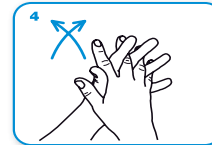
apply enough soap to cover all hand surfaces.



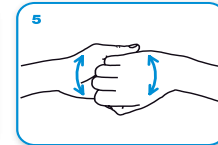
Rub hands palm to palm



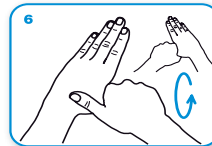
right palm over left dorsum with interlaced fingers and vice versa



palm to palm with fingers interlaced



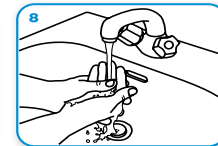
backs of fingers to opposing palms with fingers interlocked



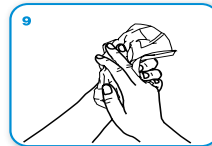
rotational rubbing of left thumb clasped in right palm and vice versa



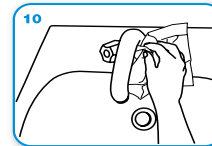
rotational rubbing, backwards and forwards with clasped fingers of right hand in left palm and vice versa.



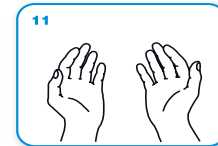
Rinse hands with water



dry thoroughly with a single use towel



use towel to turn off faucet



...and your hands are safe.

11. Training

The purpose of the training is to educate the staff and to make them aware of modalities of waste management, and to highlight the role of each one. A maximum of 30 participants per session is recommended. The training has to be done by the person in charge of healthcare, the trainer, or by an outsourced agency.

Many reminders are often necessary in order to help employees to get used to place healthcare waste in the good packaging. Posters illustrating waste which needs to be thrown in different containers can be displayed above these containers.

#	Recommendations	Documentation control
R7.1	The program of healthcare waste management is organized by the person in charge of the committee of fight against nosocomial infections, in collaboration with members of the committee of waste management and the person in charge of trainings.	Training program
R7.2	A reminder training program is scheduled and implemented annually for all the healthcare , the maintenance and the administration staff, and during the recruitment of new employees or trainees. The program includes evaluations allowing the verification of the acquisition and the mastering of knowledge.	Procedures, training record, questions to the staff, evaluation results
R7.3	<p>The training includes the following dimensions:</p> <ul style="list-style-type: none"> • regulation aspects • classifications of HCRW • the impact of HCRW on health and the environment • procedures of sorting, collection, transportation, storing of HCRW: measures of protection and hygiene, responsibilities, technical instructions related to activities of each category of the staff, control, and traceability. • treatment techniques • emergency procedures in case of spillage of HCRW • emergency procedures in case of a contact with biological fluids • the evaluation of knowledge of the staff at the end of the session 	Program and content of the training

R7.4	Information sessions must be organized in case any modification may occur in the waste management plan	Procedures
R7.5	When IHCW treatment is done in the healthcare establishment itself, the staff in charge of treatment installations has to receive training treating modules which are mentioned in R7.3, in addition to the following topics: workflow of installations, maintenance, impact on the environment	Procedures/ questions to the staff, training record
R7.6	The presence of a training record, which will allow people responsible of the trainings to identify the persons who have to be informed and to insure that they have received the necessary information	Procedures/ training content
R7.7	Posters reminding of the importance and modalities of sorting	Observation
R7.8	The content of trainings is reviewed periodically with the person in charge of the committee of the struggle against nosocomial infections and also with service providers of waste treatment	Procedures/ training content

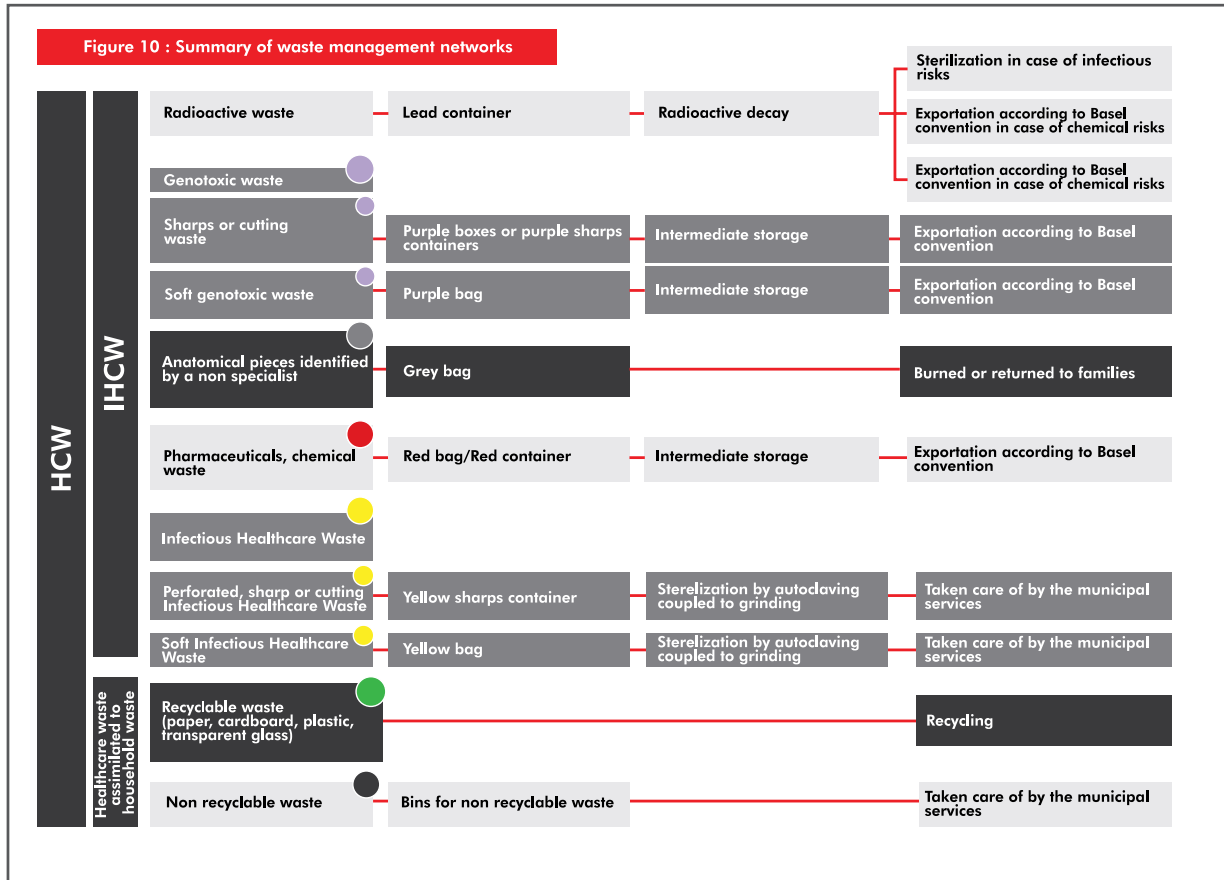
Information inserts # 8:

- Depending on the targeted audience, the highlight will be on different aspects of waste management (refer to table 9).

Table 9: Points to be developed in particular during the training, based on the category of each profession

Professional category	Points which need to be developed during the training
Healthcare staff	<ul style="list-style-type: none"> • Sorting • Management of sharp or cutting objects • Measures in case of accident/spillage • Treatment/ recycling of waste
Maintenance staff	<ul style="list-style-type: none"> • Sorting • Collection • Transportation • Cleaning • Personal hygiene • Protection equipment • Measures of protection during the manipulation of bags • Measures in case of accident or spillage • Treatment/recycling of waste
Administrative staff	<ul style="list-style-type: none"> • National legislations and international conventions • Responsibilities • Purchasing policies /minimization policies • Control and follow up of the procedure • Treatment /recycling of waste
<ul style="list-style-type: none"> • Consult annex 15: Instructions in case of mercury spillage p 118 • Consult annex 16: instructions in case of spillage of blood or other biological liquid p 126 • Consult annex 17: Examples of forms to be filled in case of incident/accident p 129 • Consult annex 18: Posters p 130 	

Figure 10 : Summary of waste management networks



Conclusion

This guide is the result of arcenciel's 10 years' experience in healthcare waste management. This expertise concerns both the implementation of a national network for the collection and the treatment of IHCW, and the support of arcenciel to healthcare establishments to improve their waste management system at the same time.

This tool provides guidelines and recommendations which are adapted to the Lebanese context as well as to most recent international standards. These recommendations can be adapted with procedures and instructions suitable to each hospital based on its rules and particularities. They will be updated based on the new local and international standards and requirements, in order to establish a continuous improvement of the healthcare services' quality and a better protection of the public health and the environment.

Annexes

1. The Basel Convention *p.105*
2. Decree 13389 related to healthcare waste management *p.105*
3. Diagnostic grid of the waste management chapter – hospitals accreditation *p.105*
4. Elements of a Model Facility Policy on Healthcare Waste Management *p.106*
5. Examples of status report sheets *p.106*
6. Basic of the documents control *p.107*
7. Stickers for the sorting process *p.109*
8. Examples of tracking form *p.110*
9. Tracking tools of the IHCW production *p.110*
10. Average production of IHCW by hospital category in Lebanon *p.112*
11. Accounting matrix of IHCW treatment techniques *p.113*
12. Criteria of vehicles which are used in the transportation of IHCW *p.114*
13. Description of the technique of sterilization by autoclaving *p.115*
14. Regulations concerning units of treatment of IHCW *p.117*
15. Instructions in case of mercury spillage *p.118*
16. Instructions in case of accident of blood spillage or other biological liquids *p.126*
17. Forms in case of accident/incident *p.128*
18. Posters *p.130*

List of figures and tables

- Figure 1: Healthcare waste categories *p.9*
- Figure 2: Symbols of chemical risks *p.25*
- Figure 3: Hierarchy of waste management *p.43*
- Figure 4: Uncoupling of needles in sharps containers *p.55*
- Figure 5: Main stages of IHCW management *p.62*
- Figure 6: Transportation circuit of IHCW inside the hospital *p.74*
- Figure 7: Closure method of the bag *p.75*
- Figure 8: Signage which has to be present at the entrance of the storage room *p.76*
- Figure 9: Hands' hygiene *p.95*
- Figure 10: Summary of waste management networks *p.101*
- Table 1: Main chemical waste coming from healthcare activities *p.15*
- Table 2: Examples of diseases which can be caused by IHCW *p.20*
- Table 3: Types of plastic generally used in healthcare establishments *p.44*
- Table 4: Recommendations of the Ministry of Environment in Lebanon regarding the sorting *p.47*
- Table 5: Choice of packaging based on the type of IHCW *p.49*
- Table 6: Few examples of waste sorting *p.56*
- Table 7: Synopsis of the IHCW routing inside a hospital *p.61*
- Table 8: Main solutions of healthcare waste treatment *p.77*
- Table 9: Points to be developed in particular during the training, based on the category of each profession *p.100*

Annex 1

Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal

Go to the website of the environmental program of arcenciel to consult the annex

<http://environnement-arcencielen.blogspot.com/>

Menu: waste management – section: Manual of waste management

Annex 2

Lebanese decree 13389 related to the healthcare waste management

Go to the website of the environmental program of arcenciel to consult the annex

<http://environnement-arcencielen.blogspot.com/>

Menu: waste management – section: Manual of waste management

Annex 3

Diagnostic grid of the waste management chapter – hospitals accreditation.

Go to the website of the environmental program of arcenciel to consult the annex

<http://environnement-arcencielen.blogspot.com/>

Menu: waste management – section: Manual of waste management

Annex 4

Elements of a Model Facility Policy on Healthcare Waste Management

Go to the website of the environmental program of arcenciel to consult the annex

<http://environnement-arcencielen.blogspot.com/>

Menu: waste management – section: *Manual of waste management*

Annex 5

Example of field assesement

Go to the website of the environmental program of arcenciel to consult the annex

<http://environnement-arcencielen.blogspot.com/>

Menu: waste management – section: *Manual of waste management*

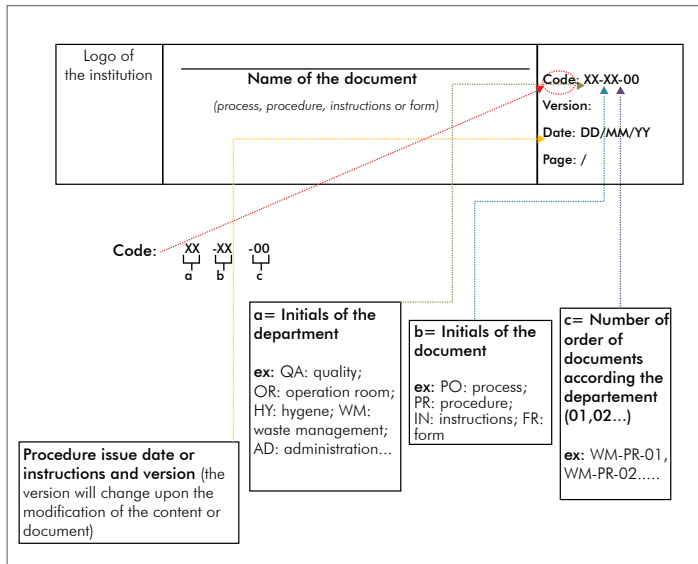
Annex 6

Basics of the documents' control

1. Pyramid of the document management



2. Code, date and version



3. Content of the procedure

- 1- **Objective:** Describe the general pertinent information and define the object of the document. Draw the reason why this procedure/or work instruction is written. Start with the following declaration: "the purpose of this document is to provide or describe the steps to follow for.../or the workflow..."
- 2- **Field of application:** write down in which department or service this procedure or instruction will be applicable.
- 3- **Responsibility:** Identify the staff who have a fundamental role in this procedure or instruction and describe their responsibilities for every steps.
- 4- **References:** list of resources which can be useful during the implementation of the procedure or instruction, examples of governmental standards... etc.
- 5- **Definitions:** Identify and define the terms or acronyms frequently used. Provide additional information and/or pertinent needed.
- 6- **Annexes:** Forms needed to the document which have to be filled in order to insure a good traceability work.
- 7- **Description:** Provide required steps in order to apply the procedure or the instructions by mentioning who is doing what, when, where, why, how.
The description can be a text or a flow chart. When it is a flow chart, a rectangle is used to symbolize an action, and a rhombus is used to symbolize a question or a decision



Annex 8

Example of a tracking form

Go to the website of the environmental program of arcenciel to consult the annex

<http://environnement-arcencielen.blogspot.com/>

Menu: waste management – section: Manual of waste management

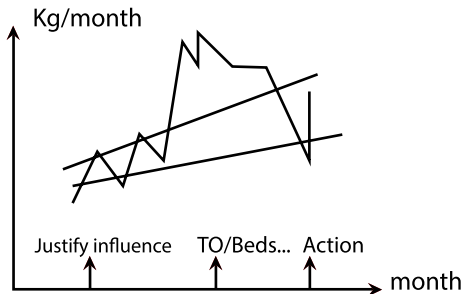
Annex 9

Tracking tools of the IHCW production

1. Calculation of the mass indicator/occupied bed/day

Monthly mass of IHCW (kg) = A	Occupancy rate (%) = B	Number of available beds/month = C	Number of occupied beds in isolation = D	Number of days in a month = E
Mass of IHCW/occupied bed/day (kg) $\frac{A}{(B * C * E) + D}$				

2. Tracking of the mass indicator of IHCW /occupied bed/day



The weight curve:

- In ordinate: mass of IHCW which is produced per month
- In abscissa: months of the year
- On the graph: actions taken and justification of variations by their factors which can have an impact on the indicator value.

Many factors can have an impact on the value of the indicator:

1. Total number of beds
2. Occupancy rate
3. Number of surgeries
4. Number of isolated patients
5. Number of beds in intensive care
6. Number of beds in dialysis services
7. Modification of purchasing policies (disposable material)
8. Arrival of new nurses or residents
9. Closure/ opening of new services
10. Weighing tools

3. Analysis of the weight curve

- The ideal is to reach a horizontal average
- Peaks which are going up gradually indicate the need for more tracking and training
- Peaks which are going down gradually indicate that new measures were adopted in order to enhance the sorting, or the need for more tracking and training
- Sharp changes indicate that one or many factors are affecting the weight
- The return to a normal level after a sharp change indicates a major error which has been rectified

Annex 10

Average production of IHCW by hospital category in Lebanon

The average production of IHCW by hospital category has been calculated, based on monthly quantities of IHCW which was collected and treated by arcenciel in 2009, 2010 and 2011.

Hospital category	Mass of IHCW (kg)/bed/day
Category A: private hospitals, number of beds >200 beds	2.20
Category B: public hospitals, number of beds >200 beds	0.51
Category C: private hospitals, 100 <number of beds ≤200	0.97
Category D: public hospitals, 100 <number of beds ≤200	0.47
Category E: private hospitals, number of beds ≤100	0.90
Category F: public hospitals, number of beds ≤100	0.16

Annex 11

Accounting matrix of IHCW treatment techniques

Sign (+) indicates a relatively high performance of the technique for the studied criteria.

Sign (-) indicates a relatively low performance for the studied criteria.

Treatment techniques Criteria	Autoclaving associated with shredding	Chemical disinfectants	Microwave	Incineration
Emissions and residues	+	-	+	-
Efficiency	+	+	+	+
Regulatory accounting	+	+	+	-
Reduction of the mass/ volume of waste	+	-	+	+
Marketing standard	+	+	-	+
Cost	+	+	+	-
Acceptation by employees and the community	+	-	+	-
Security and health	+	-	+	-

The autoclaving associated with shredding is an efficient technique at all levels; it was adopted for the treatment of IHCW at the national level in Lebanon.

When IHCW is transported through public highway, some precautions have to be taken, in order to:

- limit risks in case of flow accident during the transportation of IHCW
- avoid accidental contact of anyone with IHCW
- reduce to the minimum the manipulation of packagings

The vehicle which is used for the transportation of IHCW has to fulfill the following criteria:

- Internal surfaces have to be waterproof, smooth, and free of straight angles and have to allow the easy implementation of the disinfection protocol.
- The vehicle's floor has to be waterproof and should include an evacuation device for the cleaning and disinfection of water.
- Vehicles or containers which are used for the transportation of IHCW must not be used for the transportation of any other material or traveler except the onboard staff.
- Outside loading and unloading operations, vehicles have to remain constantly closed.
- The driver's cabinet has to be separated from the section where IHCW is transported, by a rigid partition, which has to be washable and waterproof.
- A fixing device should enable the fixation of bins in order to prevent them from spilling .
- A section in the vehicle, separated from bins, has to be equipped with empty yellow plastic bags, protection equipment, cleaning equipment, disinfectants, in addition to tools allowing the collection of fluids.
- The sections are cleaned and disinfected after each unloading.
- The name and the address of the body which is transporting the waste have to be mentioned on the outside of the vehicle.
- The risk of infection label has to be displayed on the outside of the vehicle, with the emergency number

Sources:

Safe management of wastes from health-care activities, World Health Organization (WHO), 1999

Déchets infectieux, Elimination des DASRI et assimilés, Prévention et réglementation, Institut national de Recherche et de Sécurité (INSS), 2013

The purpose of the sterilization is to eliminate all germs and contaminants, including resistant spore forms.

The sterilizing agent is the temperature.

The moist heat sterilization with steam and under pressure constitutes an ecological sterilization method, reliable, easily controllable and economical.

The principle of steam sterilization consists in exposing the material that will be sterilized:

- to the action of saturated steam
- to the pressure
- to time/specific temperatures parameters

The pressurized steam process lies on a thermodynamic equilibrium between the pressure and the temperature. This equilibrium has to be maintained during different phases of the sterilization process.

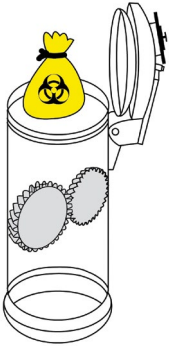
The autoclaving method aims to obtain steam by boiling water in a closed space, under pressure, in order to increase the water boiling point and consequently, the steam temperature. It will then reach a temperature of

134° C, which is sufficient to destroy *Geobacillus stearothermophilus*, which is the most thermoresistant bacteria; the pressure has to be increased of 2.5 bars approximately.

The destruction of microorganisms is obtained through the combination of heat and humidity. Meanwhile, the steam facilitates the penetration of the heat into the spore in order to reach nucleic acids.

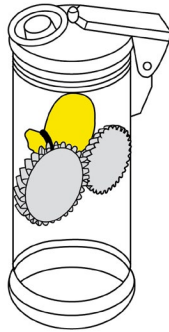
The operating system is different from an autoclave to another. As for autoclaves which are used at arcenciel, the process is summarized by the following steps:

Step 1



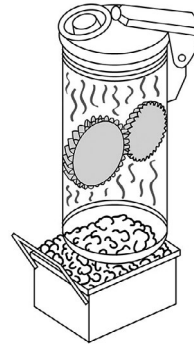
IHCW are placed as they are inside the sterilizer

Step 2



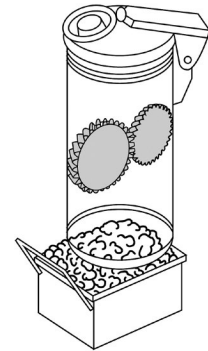
The compartment is tightly closed and waste is shredded

Step 3



The sterilization is obtained by maintaining, due to the steam, a level of 138°C and a pressure of 3,8 bars during 10 minutes

Step 4



Shredded and sterilized waste obtained is assimilated to household waste

Annex 14

Regulations concerning treatment units of IHCW

Go to the website of the environmental program of arcenciel to consult the annex

<http://environnement-arcencielen.blogspot.com/>

Menu: waste management – section: *Manual of waste management*

- Newsletter 1-11 concerning regular reports related to medical hazardous and infectious waste treatment (2001), which is a follow-up to the article 13 of the law 444 on the protection of the environment.
- Order 1-52: criteria and rates allowing the reduction of air, water and soil pollution (1996)
- Order 8-1: This order concerns criteria related to air pollutants and effluents which are generated by classified institutions and wastewater treatment plants (2001). It is a follow-up to the decree 4917 from 24/3/1994, modifying the classification of hazardous establishments and to the decree 2678 from 21/3/2000 (an approbation of a donation from the European Union through The United Nations Development Program (UNDP)), addressed to the Ministry of Environment for the execution of the project that allows strengthening the permit and surveillance rules in factories)
- Guidance on Microbiological Challenge Testing for Medical Waste Autoclaves September 2010

The best way to decrease risks associated to mercury is to limit the presence of items containing mercury.

Subject

A thermometer which is used in a laboratory can contain 1 to 3 grams of mercury. Calculations have demonstrated that, in optimum conditions, one gram of mercury is enough to create an immediate danger for life and health. Spilled over, the mercury can be divided in very small droplets and spread on big surfaces. These tiny droplets can volatilize so quickly that the ambient ventilation cannot dilute the mercury concentration. The small droplets of spilled mercury can enter in cracks, stick to the fabric of carpets, mix with dust, pass through the sewer, stick to the shoe sole and dissolve to form alloys with metals used in the manufacturing of watches and jewels.

That is why it is very important to insure that mercury is entirely collected in case of spillage. The subject behind the present document is to provide healthcare establishments with instructions on the cleaning and the temporary internal storing of mercury.

These cleaning instructions on the mercury spillage are used as a guide to help elaborating procedures in each establishment.

Each health establishment has to elaborate its own procedures based on what is convenient and available, while minimizing the danger for its patients and employees.

Application domain

These instructions provide guidelines on the cleaning of mercury spills, particularly those resulting from breakage of thermometers and mercury tensiometers.

Responsibilities

The hospital staff, and the care and maintenance staff in particular, have to be ready to interfere in case of mercury spillage.

Instructions

1. **Quickly determine the extent of the spill:** determine on what surfaces the mercury spilled and how far the mercury beads traveled.
2. **Immediately block off foot traffic:** do not allow anyone to walk across the contaminated site or to go near areas where the mercury traveled. If the extent of a small spill is not immediately obvious, block off traffic for a radius of about 2 meters around the center of the spill.
3. **Contain the spill:** if necessary, prevent the mercury beads from traveling further by blocking their path with rags or impervious material. Take steps to keep mercury

References

Guidance of the cleanup, temporary or intermediate storage, and transportation of mercury waste from healthcare facilities; UNDP-GEF, 2010.

- from falling into drains or cracks.
4. Check to see if anyone's skin, shoes or clothing was splashed with mercury. If shoes or parts of clothing were contaminated, they should be removed and left around the spill area before allowing the person to leave.
5. Skin that was in contact with mercury should be washed with an alkaline soap.

6. In case of someone gets mercury in their eyes, avoid direct contact. Wear chemical protective gloves, if necessary. Quickly and gently blot or brush away excess chemical. Immediately flush the eye(s) with lukewarm, gently flowing water for 5 minutes or until the chemical is removed, while holding the eyelid(s) open. Obtain medical advice immediately.

7. Evacuate the area: ask everyone to leave the room or the general area. Seek assistance to provide first-aid to anyone requiring immediate medical attention.

8. Minimize the spread of vapors to interior areas: close all interior doors that lead to other indoor areas (door of the bathroom ...). Turn off central ventilation, heating or air conditioning systems that circulate air from the spill site to other inside areas of the building.

9. Reduce vapor concentrations in the spill area: open the windows and exterior doors to outside areas. If necessary, seeking help from other staff persons, and then leave the area to prepare for cleanup.

10. Prepare for cleanup: remove jewelry, watch, mobile phones, and other metal-containing items. Get the mercury spill kit. It includes:

Personal protective equipment (PPE):

- Several pairs of rubber or nitrile gloves.
- Safety goggles or protective eyewear.
- Respiratory protection: fit-tested full- or half-face piece air-purifying respirator with mercury vapor cartridges,

or face mask with sulfur or iodide impregnated activated carbon, or other specialty mask or respirator designed particularly for mercury, or a face mask with a 0.3 micron HEPA filter to capture amalgam particles and mercury-laden dust.

- Coveralls, apron, and other protective clothing.
- Disposable shoe covers.

Containers:

- Sealable plastic bags (small and large sizes, thickness: 2 to 6 mils, or 50 to 150 microns).
- Rigid plastic container, hermetic, easy to open and to seal, small enough such that the weight of mercury is not too heavy to lift (a typical ergonomic weight limit is 23.5 kg) with some water or vapor suppression agent for collecting elemental mercury.
- Puncture-resistant, rigid plastic or steel jar or container with a wide opening for collecting mercury-contaminated broken glass.
- Plastic tray.

Tools for removing mercury:

- Flashlight (electric torch) to locate shiny mercury beads.
- Plastic-coated playing cards or thin pieces of plastic to push mercury beads into a plastic scoop or pan.
- Small plastic scoop or plastic dust pan to catch the mercury beads.
- Tweezers to remove small broken glass pieces.

- Eyedropper or syringe (without the needle) to draw up large mercury beads.
- Duct tape or sticky tape to pick up tiny mercury droplets.
- Vapor suppression agents:
 - o Sulfur powder to absorb mercury by forming mercuric sulfide.
 - o Zinc or copper flakes to absorb mercury by forming amalgams.
 - o Commercial absorbent pads or vapor suppressants.
 - o Brush to remove powder or flakes.
- Utility knife blade.

Materials for decontamination:

- Vinegar, hydrogen peroxide, and cotton swabs for final cleaning when using sulfur powder.
- Decontaminant solution.
- Piece of soap and paper towels.

“**Danger: Mercury Waste**” labels to put on waste containers.

11. Put on personal protective equipment (PPE): put on the apron or coveralls, disposable shoe covers, rubber or nitrile gloves, goggles, and face mask before re-entering the spill site. Make sure metal items such as eyeglass frames are covered by PPE.

12. Remove visible mercury beads and broken glass: place the jar and container on the plastic tray. Starting from

the outside of the spill site and moving towards the center, carefully remove visible mercury beads and broken glass. Use tweezers to remove broken glass pieces and place them in the jar or wide-mouthed container over the tray. Using a playing card or piece of plastic, slide the mercury beads onto the plastic dustpan or scoop, and away from any carpet or porous surface. Use a slow, short, sweeping motion to prevent spreading mercury droplets. Carefully place the mercury beads into the plastic container partially filled with water or vapor suppression agent. Do this over the tray to catch any spillage. You can also use an eyedropper or syringe for small beads. Hold the eyedropper or syringe almost parallel to the floor to draw in the beads and keep the eyedropper or syringe horizontal when transferring the beads to the plastic container so as to prevent the mercury from falling out.

13. Search for and remove tiny mercury droplets and glass: search for any remaining droplets and glass pieces by shining the flashlight at different low angles to the floor and looking for reflections from the shiny droplets and glass. For very tiny droplets, it may be easier to pick them up using sticky tape but be careful since they may not always stick. Place the sticky tape in the sealable plastic bag.

14. Clean up cracks and hard surfaces: sprinkle sulfur powder on cracks and crevices, and on hard surfaces that had come in contact with mercury; a color change in the powder from yellow to reddish brown indicates that mercury is still present and more cleanup is needed. If so, sprinkle zinc flakes or copper flakes to amalgamate any residual mercury. Use the brush or small broom to remove the powder and/or the metal flakes and place them in the sealable plastic bag. An alternative way to clean hard surfaces after adding sulfur powder is to wipe them with vinegar-soaked cotton swabs, followed by peroxide-soaked swabs. Place the swabs in a sealable plastic bag.

15. Remove contaminated soft materials: Carpets, carpet padding, upholstery, curtains, rugs, bedding, and other soft materials cannot be cleaned easily. Use the utility knife to cut out pieces of carpet, padding, and other soft materials that are contaminated with mercury. Place the contaminated materials in a sealable plastic bag.

16. Clean out contaminated drains: If mercury was spilled over a drain, sink or wash basin, work with the facility engineer to remove and replace the “J”, “U” or “S” trap.

17. Dispose of or decontaminate cleanup material: Place all contaminated materials used during the cleanup (including cards, paper towels, sticky tape, brush, tweezers, plastic scoop, tray, eyedropper, utility knife, etc.) into a leak-proof, sealable plastic bag, and affix a label: “Mercury: Hazardous waste” and include the type of mercury waste, the estimated volume and the date when mercury was placed in the bag.

18. Label and seal all contaminated material: ensure that the container are filled with enough water to cover the elemental mercury and broken glassware, close the container tightly, label, and place each in a re-sealable plastic bag. The container should be stored safely for future use. Place all sealed plastic bags with mercury-contaminated waste inside a second plastic bag. Seal the outer bag using duct tape, and affix a label: “Mercury: Hazardous waste” and include the type of mercury waste, the estimated volume and the date when mercury was placed in the bag.

19. Remove and dispose or decontaminate PPE: remove PPE beginning with the shoe covers which should be placed in another sealable bag. Then

remove the gloves by grasping one glove with the other, peeling off the first glove, sliding the fingers under the remaining glove at the wrist, peeling off the second glove, and discarding both gloves in the sealable plastic bag. Next, remove the goggles by the head band or ear pieces. Remove the apron or coverall without touching the front and turn inside out. Finally, remove the face mask or respirator without touching the front. Dispose of the gloves, shoe covers, apron (and regular face mask if used in lieu of a specialty mask) in the sealable plastic bag, which should be stored along with the mercury waste. Decontaminate goggles and respirators or specialty face mask using the decontaminant solution.

20. Wash hands and all exposed skin: use soap and water to scrub all exposed skin and rinse thoroughly.

21. Ventilate the spill area: place a fan next to the spill area to volatilize mercury and a second fan in a window or doorway to move air to the outside air for 48 hours or more. If this is not possible due to central heating or air conditioning, increase the air exchange rate for the building for several days to reduce any mercury vapor concentrations.

22. Medical monitoring: if the spill resulted in acute

exposure to a patient or health worker, conduct blood and urine tests, provide support for respiratory and cardiovascular function and, if necessary, initiate chelation therapy if the person is symptomatic of acute mercury poisoning.

23. Write a report on the spill incident: Document the incident in keeping with the procedures of the health facility. The report can be used to improve safety in the facility.

24. Whenever a spill kit is used, the most senior staff involved in the cleanup should take responsibility for ensuring that the contents are replenished as soon as possible. All spill kits should have a sheet attached indicating when they were used and verifying that the expended supplies have been replaced. The sheet should be signed and dated by the responsible staff.

25. Broken fluorescent lamps should be stored as mercury-containing waste.

26. Storage: mercury waste are stored in a temporary storage room for hazardous waste, until a solution will be available. The storage space should have:

- The entrance and exit doors of the storage space should be marked with warning signs, such as **“Danger: Hazardous Mercury Waste”** and the skull-and-crossbones symbol for toxic

or poisonous waste.

- The waste containers should be labeled “**Hazardous Mercury Waste**” along with a description of the contents and the initial date of storage.
- Mercury waste should be kept segregated from other types of waste.
- The exhaust vent from the storage space should not direct air towards crowded areas and should be far from any air intake vents.
- The storage space should have ventilation that can eject air from the space directly to the outside and ventilation controls that can stop air circulation from the storage space to the inside of the facility.
- If there is a drain in the storage space, it should have an easily accessible and replaceable drain trap to capture mercury in the event of a spill.
- The storage space should have bunding or barriers on the floor or a spill containment tray directly below the waste containers to prevent spills from spreading. The containment volume inside the bund wall or the containment volume of the tray should

be at least %125 of the total volume of liquid mercury stored.

- Personnel protection equipment, a spill kit, and wash areas should be located near (but not in) the storage space for easy access by authorized personnel.
- The storage space should be kept cool and dry (ideally below °25C to minimize volatilization and below %40 relative humidity to minimize corrosion if steel containers and shelves are used).

² The chelation is a physicochemical process which allows binding ions and heavy metals to a chelating agent. This process enables to isolate mercury from biochemical agents present in the body, and which are participating in organic functions, and to facilitate the elimination of mercury in the urine.

The following should **NOT** be done in the event of a spill:

- **DO NOT** use a regular vacuum cleaner to pick up the mercury and mercury-contaminated items. The mercury will become airborne by way of the vacuum's exhaust and spread the contamination. Moreover, the vacuum cleaner will become contaminated and would have to be disposed as hazardous waste.
- **DO NOT** wash mercury-contaminated clothing, rugs or other fabrics in a washing machine. The washing machine and wastewater may become contaminated.
- **DO NOT** use a broom to sweep up the mercury. It can break the mercury into smaller beads, spreading them.
- **DO NOT** pour mercury down the drain. You may contaminate your plumbing, septic system, or your local sewage treatment plant.

Annexes

QA-FR-01 Form in case of incident/accident (Cf. annex 17 of the guide p.129)

Subject

The spillage of blood or other body liquids represent a risk of infection:

- by direct contact of the contaminated liquid with a mucosa (eyes, mouth, nose, etc), an open wound or cracked or scratched skin,
- by an injury or a cut with a cutting edge item.

So the intervention has to be done absolutely by taking appropriate precautions. Main pathogens that are transmitted by blood are the hepatitis B virus (HBV), the hepatitis C virus (HBC), and the human immunodeficiency virus (HIV). The following instructions were elaborated in order to pay attention to the protection from the exposure to blood or other biological liquids. They explain how to report and clean this type of spillage while taking necessary precautions.

Application domain

These instructions describe the steps to implement in case of blood or any other biological liquid spillage.

Responsibilities

The hospital staff and the healthcare and maintenance staff in particular, have to be prepared to interfere in case of spillage of blood or other biological liquid.

References

Procédure à suivre en cas de contamination par le sang, Université Laval; <http://www2.ulaval.ca/urgences/procedures/urgence911-/contamination-par-le-sang.html>; consulted in March 2014.

Instructions

1. Bring the spill kit. This one has to be directly accessible by the staff, and includes:

- disposable gloves
- disposable apron
- containers of IHCW
- Absorbent paper towels
- Disposable clothes
- Disinfectants
- Tools allowing the collection of sharp and cutting wastes (like tweezers).
- Protection glasses
- A broom and a brush.

PS: There are powders, available on the market, for the solidification of liquid waste, made from polyacrylate. They can also be included in the kit and can be used to solidify biological liquids in case of spillage.

2. Wear the appropriate personal protective (PPE) equipment:

- 2 pairs of gloves (vinyl or nitrile)
- An apron if there is a risk of clothes' contamination.
- A protective visor, if there is a risk of splatter.

3. Be equipped with the necessary cleaning material:

- absorbent material (paper towels...)
- efficient disinfectant or a bleach solution with 10% concentration (one unit of bleach water for 9 units of water).
- tweezers to remove broken glass pieces or sharps items.
- a yellow container for sharp waste or another puncture-resistant container, in order to place broken glass pieces or sharps items.
- 2 yellow plastic bags for IHCW .

4. Cover the spillage with an absorbent material (a paper towel, for instance), with precaution.

5. Inspect the location in order to see if there are splatters, and until where the spillage extends.

6. Surround the spillage in order to avoid its extension.

7. Report the spillage to the coordinator of the emergency room.

8. Pour the disinfectant, slowly and carefully (according to the recommended dilution), on the absorbent material that is covering the spillage in order to avoid any splatter.

9. Let the disinfectant act during the duration that is recommended by the manufacturer (a bleach solution with

a concentration of 10% has to remain in contact with the blood or the body liquid which is scattered, for a minimum of 20 minutes). In order to avoid risks of contamination by leaving the disinfectant act, remove gloves and wash hands with water and soap during at least 20 seconds. To remove the gloves, grasp one glove with the other, peeling off the first glove, sliding the fingers under the remaining glove at wrist, peeling off the second glove and discarding both gloves in the yellow hermetic plastic bag.

10. Remove the PPE and wash hands again or use a hydroalcoholic solution.

11. Wear again clean gloves and the PPE equipment.

12. In order to clean the spillage, start from the exterior and work towards the center. Pick-up hazardous items such as the broken glass, needles and syringes, etc. by using tweezers, or a brush with a dustpan. Put the hazardous items in a yellow container for cutting and sharp waste, or a waterproof container, puncture-resistant. Put the soiled absorbent material in a double yellow plastic bag for IHCW, while paying attention not to drip hazardous liquids or extend the contamination to other places.

13. In case gloves are soiled, they have to be changed before carrying on work, by applying the methodology which was described in point 10.

14. Once the first cleaning is done, pour more disinfectant on the spillage zone. Wait the required time for the disinfectant to become effective. Clean a second time by starting as explained above, (in point 13).

15. Remove gloves, and wash hands with soap and water for at least 20 seconds.

16. Remove the protection equipment and wash hands once again.

17. Throw gloves, clothes and the contaminated equipment in a yellow IHCW bag.

18. Put the bag of IHCW in an IHCW bin.

Annexes:

QC-FR010-FAI100. Forms in case of incident/accident (Cf. annex 17 of the guide p.129)

Annex 17

Examples of forms to be filled in case of incident/accident

Go to the website of the environmental program of arcenciel to consult the annex:

<http://environnement-arcencielen.blogspot.com/>

Menu: waste management – section: manual of waste management

environnement Arc Formulaire en cas d'accident ou incident

Ref: QC-PRO10-FAI100
Date: 15/03/2013 / 11

SECTION 1: Identification de l'accident

Numéro de l'accident/incident: _____
Personne qui a subi l'accident/incident et fonction: _____
Personne qui a détecté l'accident/incident et fonction: _____
Service concerné: _____ Date: _____ Heure: _____
Endroit précis de l'accident/incident: _____ Date: _____ Signature: _____
Formulaire rempli par: _____
Formulaire approuvé par: _____

SECTION 2: Description de l'accident

Description objective et détaillée de l'accident/incident (sans analyse, ni jugement, ni occultation):

SECTION 3: Causes de l'accident et conséquences

Causes de l'accident:

- Absence d'application des mesures préventives
- Échec des mesures préventives
- Manque de communication
- Mauvaise maîtrise de la méthodologie de travail
- Erreur ou distancionnement dans la méthodologie de travail
- Autre: _____

Poster 1: Cytotoxic Waste

Pour votre sécurité, pour préserver la santé publique et l'environnement
Triez correctement les déchets cytotoxiques.

Les résidus des solutions ou suspensions de médicaments cytotoxiques, les médicaments cytotoxiques périmés, tout matériel contaminé par le processus de préparation des médicaments cytotoxiques et les excréments des patients traités par chimiothérapie

Contenu: Poudre d'urine, Reste de solutions, Seringue, Couche contaminée, Microcollecteurs ou boîtes pour les coupants / tranchants.

Poster 2: Infectious Waste

Pour votre sécurité, pour lutter contre les infections nosocomiales, pour préserver la santé publique et l'environnement,
Triez correctement les déchets d'activités de soins à risque infectieux (DASRI)

Contenu: Microcollecteurs ou boîtes pour les coupants / tranchants, Gants contaminés de sang, Sécrétions biologiques, Tube de sang, Boîte de Pils, Sac de Sang, Parasent.

Poster 3: Chemical Waste

Pour votre sécurité, pour préserver la santé publique et l'environnement
Triez correctement les déchets chimiques

Contenu: Déchets pharmaceutiques déconditionnés, Produits chimiques, Piles, Thermomètre à Mercure, Médicaments non utilisés.

Poster 4: Infectious Matter Warning

Les déchets d'activités de soins peuvent présenter un risque infectieux dû à la présence de microorganismes pathogènes.

Disposition: ces microorganismes peut survivre tout au long de la filière d'élimination de ces déchets et concerner les patients, les visiteurs, le personnel hospitalier, le personnel de collecte et de traitement des déchets, et le grand public.

ATTENTION MATIERE INFECTIEUSE
إحذرا مواد معدية

Le tri, le conditionnement et le traitement appropriés des déchets à risque infectieux permet la préservation de la santé et la sauvegarde de l'environnement.

Annex 18

Posters

Go to the website of the environmental program of arcenciel to consult the annex:

<http://environnement-arcencielen.blogspot.com/>

Menu: waste management – section: manual of waste management



References

- A multi-criteria assessment of scenarios on thermal processing of infectious hospital wastes: A case study for Central Macedonia. Karagiannidis A., Papageorgiou A., Perkoulidis G. Sanida, G., and Samaras P. 2010. *Waste Manag*; 30(2):251-62. doi: 10.1016/j.wasman.2009.08.015. Epub 2009 Oct 27.
- Alternatives for the treatment and disposal of healthcare wastes in developing countries; Diaz, L.F., L.L. Eggerth, and G.M. Savage. 2005. *Waste Manag*; 25(6):626-37 USA.
- Assessing generated quantities of infectious medical wastes: a case study for a health region administration in Central Macedonia, Greece. Sanida, G., Karagiannidis, A., Mavidou, F., Vartzopoulos, D., Moussiopoulos, N., Chatzopoulos, S. 2010. *Waste Manag*. 30, 532–538.
- Assessment of health-care waste treatment alternatives using fuzzy multi-criteria decision making approaches. Dursun, M., E. Ertugrul Karsak, and M.A. Karadayi. 2011. *Resources, Conservation and Recycling*, Vol. 57, 98-107.
- Assessment of occupational and environmental safety associated with medical waste disposal in developing countries: a qualitative approach. Patwary, M.A., O'Hare, W.T., Sarker, M.H., 2011a. *Saf. Sci.* 49, 1200–1207.
- Characteristics of medical waste in Taiwan. Kuo H., Shu S., Wu C., and Lai J. 1999. *Water, Air and Soil Pollution* 114, 413–421.
- Convention de Bâle sur le transfert et l'élimination des déchets dangereux; Synthèses de la législation européenne; http://europa.eu/legislation_summaries/environment/waste_management/l11022_fr.htm; consulté le 3 juin 2013
- Countries, Lebanon. World Health Organization (WHO). Beirut, 2013. <http://www.who.int/countries/lbn/en/> (consulté le 1er mai 2013).

Déchets chimiques hospitaliers, de la réglementation à la pratique. Philippe Parvy. France, 2005.

Déchets d'activité de soins à risques, comment les éliminer? Ministère de la Santé et des Sports, direction générale de la santé, France, 2009.

Déchets infectieux, élimination des DASRI et assimilés, prévention et réglementation, Institut National de Recherche et de Sécurité, 4eme édition, France, 2013.

Décret 13389 du Ministère de l'Environnement relatif à la gestion des Déchets d'Activités de Soins, Liban, 2004.

Demonstrating and Promoting Best Techniques & Practices for Reducing Health-Care Waste to Avoid Environmental Releases of Dioxins and Mercury, Issue 3, September 2011.

Determination of hospital waste composition and disposal methods: a case study. Altin, S., Altin A., Elevil B., and Cerit O. 2003. Polish

Journal of Environmental Studies 12 (2), 251–255.

Elements of a Model Facility Policy on Healthcare Waste Management, UNDP GEF Global Healthcare Waste Project, 2009.

Élimination des déchets d'activités de soins à risques ; Direction départementale des Affaires sanitaires et sociales (DDASS) et Direction Régionale des Affaires sanitaires et sociales (DRASS) de Lorraine, France, 2007.

Elimination des déchets médicaux ; Office fédéral de l'environnement, des forêts et du paysage OFEFP, Berne, 2004

Emissions investigation for a novel medical waste incinerator. Xie, R., W.J. Li, J. Li, B.L. Wu, and J.Q. Yi. 2008. J Hazard Mater. 2009 Jul 15;166(1):365-71. doi: 10.1016/j.jhazmat.2008.11.029. Epub 2008 Nov 18.

Environment and sustainability; Health Technical Memorandum, 07-01: Safe

management of healthcare waste, department of health Department of Health/Finance and Investment Directorate/Estates and Facilities Division, United Kingdom, 2006

Gérer les accidents d'exposition au sang ou à un liquide biologique (AES), Université de Genève, 2012.

Gestion des déchets d'activités de soins en Europe, État des lieux de la réglementation et des recommandations ; Rudologia, Pôle français de compétences déchets, France, 2008.

Gestion des déchets hospitaliers, corporation d'hébergement Québec, 2011.

Gestion des déchets solides d'activités de soins dans les centres de santé primaires, Guide d'aide à la décision. Organisation Mondiale de la Santé (OMS), Genève, 2005.

Guidance on Microbiological Challenge Testing of Healthcare Waste Treatment autoclaves UNDP GEF Global Healthcare

Waste Project, 2010.

Guide for Eliminating Mercury from Health Care Establishments; Health Care Without Harm, 2011.

Hazardous medical waste generation rates of different categories of health-care facilities. Komilis, D., A. Fouki, and D. Papadopoulos. 2012. Waste Manag; 2012 Jul;32(7):1434-41. doi: 10.1016/j.wasman.2012.02.015. Epub 2012 Mar 22.

HCWH. Non-Incineration Medical Waste Treatment Technologies. August 2001. Washington, DC.

Health and Safety Perspective on Medical Waste Management in a Developing Country: A Case Study of Dhaka City. Patwary, M.A., O'Hare, W.T., Street, G., Elahi, K.M., Hossain, S.S., Sarker, M.H., 2009b. Gemini International Limited, pp. 282–290. ISBN:

978-0-9562303-2-4.

Healthcare Waste Management, World Health Organization (WHO), Geneva, 2011. <http://www.who.int/mediacentre/factsheets/fs253/en/> (consulté le 1er septembre 2012).

Healthcare waste management: current practices in selected healthcare facilities, Botswana. Mbongwe B., Mmerekhi B., and Magashula A. 2008. *Waste Management* 28 (1), 226–233.

Hospital waste management and toxicity evaluation: a case study. Tsakona M., Anagnostopoulou E., and Gidarakos E. 2007. *Waste Management* 27 (7), 912–920.

Improvement and modification of the routing system for the health-care waste collection and transportation in Istanbul; Alagoz A.Z., and Kocasoy G. 2007. *Waste Manag.* 2008; 28(8):1461-71. Epub 2007 Oct 18.

Incineration of different types of medical wastes: emission factors for gaseous emissions; Alvim-Ferraz M.C.M., and Afonso S.A.V. 2003. *Atmospheric Environment* DOI:10.1016/S1352-2310(03)00572-7 pp.5415-5422.

Instructions pour nettoyer un déversement mineur de mercure; Centre de collaboration nationale et de Santé Environnementale, (CCNSE), Canada, 2007.

Intervention en cas de déversement; Université d'Ottawa, <http://www.uottawa.ca/services/sesst/Deversements.html>, consulté le 28 juin 2013.

Key issues study on the operation management of medical waste incineration disposal facilities. Chen, Y., L. Liu, Q. Feng, and G. Chen. 2012. *Procedia Environmental Sciences*, Volume 16, issue (2012), p. 208-

213. DOI: 10.1016/j.proenv.2012.10.029.

La gestion des déchets dans les établissements de santé Panorama réglementaire & propositions pratiques de mise en œuvre ; MEAH (Mission Nationale d'Expertise et d'Audit hospitalier), France, 2008 .

Le tri des déchets dans les établissements de santé ; Comité de coordination de lutte contre les infections nosocomiales, (CCLin Sud-Ouest), France, 2009.

Les déchets d'activités de soins ; Agence Régionale de Santé, Direction de la Santé Publique, Département Santé Environnement, Pôle Environnement Extérieur, France, 2010.

Les filières sécurisées de traitement des DASRI (Déchets d'Activités de Soins à Risques Infectieux); Fédération nationale des activités de dépollution et de l'environnement (FNADE), 2009 .

Maîtrise du risque infectieux en Établissement d'Hébergement pour Personnes Âgées Dépendantes (EHPAD) ; Fiches Techniques / Pratiques CCLIN Sud-Ouest (- Fiche n° VII.1, France, 2011 .

Manuel de gestion des déchets médicaux; Comité international de la Croix-Rouge, Genève, Suisse, 2011.

Medical waste management in Korea. Jang, Y.C., Lee, C., Yoon, O.S., Kim, H. 2006. J. Environ. Manag. 80, 107–115.

Medical waste production at hospitals and associated factors. Cheng Y.W, F.C Sung, Y. Yang, Y.H. Lo, Y.T. Chung, K.C. Li. 2009. Waste Manag. Vol. 29, 440-444.

Mercury spill decontamination incident at the Rockefeller University; Santoro A.; Journal of Chemical Health & Safety, January/February 2006.

Ministère de l'Environnement, arrêté 11-1 du concernant les rapports réguliers relatifs au traitement des déchets médicaux dangereux et infectieux, Liban, 2011.

Ministère de l'Environnement, arrêté 52-1 du concernant les critères et taux permettant de réduire la pollution de l'air de l'eau et du sol, Liban, 1996.

Ministère de l'Environnement, arrêté 8-1 concernant les critères liés aux polluants de l'air et les effluents générés par les institutions classées et les stations de traitement des eaux usées, Liban, janvier 2001.

Non-Incineration Medical Waste Treatment Technologies; Health Care Without Harm (HCWH); August 2001. Washington, DC.

Plan de la politique des sciences, de la

technologie et de l'innovation (STIP) au Liban, UNESCO, Division des politiques scientifiques et du développement durable, 2008.

Procédure à suivre pour déclarer et nettoyer un déversement de sang ou des liquides corporels; Université d'Ottawa, 2008.

Procédure concernant les fuites et les déversements de produits à risques, Université polytechnique de Montréal, http://www.polymtl.ca/sg/docs_officiels/1312fuit.htm, consulté le 28 juin 2013.

Procédure en cas de contamination par le sang; Université de Laval, <http://www2.ulaval.ca/urgences/procedures/urgence-911/contamination-par-le-sang.html>, consulté le 28 juin 2013.

Recueil National des Statistiques Sanitaires au Liban (RNSSL). Liban. 2012. Institut de gestion de la santé et de la protection sociale,

Université Saint Joseph (USJ), Organisation Mondiale de la Santé(OMS), Ministère de la santé publique.

Référentiel d'accréditation des hôpitaux libanais, Liban, 2009.

Replacement of mercury thermometers and sphygmomanometers in health care, Technical guidance, World Health Organization (WHO), Geneva, 2011.

Safe health-care waste management: Policy paper; World Health Organization (WHO); Geneva, 2013. http://www.who.int/water_sanitation_health/medicalwaste/hcwmpolicy/en/ (consulté le 1er mai 2013).
Safe Management of Waste from Health-Care

Activities. Geneva: World Health Organization; Pruss A., Giroult E., and Rushbrook P. World Health Organization (WHO), 1999.

Safe management of wastes from health-care activities; Second edition. World Health Organization (WHO), 2013.

Second Supplement to the Fourth Edition of the International Pharmacopoeia, World Health Organization (WHO). Geneva, 2011. Solid Waste Management. United Nations Environment Program (UNEP), Japan, and Cal Recovery, Inc. USA. 2005. UNITED NATIONS PUBLICATION, ISBN: 92-807-2676-5.

Ten ways to Reduce Regulated Medical Wastes (RMW), Going Green: A Resource Kit for Pollution Prevention in Health Care; Health



Care Without Harm, 2002.

The Office of Environmental Health and Radiation Safety (EHRS), University of Pennsylvania, Philadelphia, 2011. http://www.ehrs.upenn.edu/programs/bio/selectagents/sa_destruct.html#prions (consulté le 20 novembre 2012) .

Treatment and disposal alternatives for health-care waste in developing countries—a case study in Istanbul, Turkey; Alagoz A.Z., and Kocasoy G.; 2007. *Waste Manage Res* 2007;25:83–9.

United Nations Environment Program (UNEP), 2002. Technical guidelines on the Environmentally Sound Management of Biomedical and Healthcare Waste. Basel Convention, United Nations Environment

Programme.

United Nations Environment Program (UNEP), Japan, and CalRecovery, Inc. USA. 2005. *Solid Waste Management*. UNITED NATIONS PUBLICATION, ISBN: 92-807-2676-5.

Waste Management Practices: Municipal, Hazardous and Industrial. Pichtel, J. 2005. Boca Raton: Taylor & Francis, c2005.

Waste Minimization, Segregation and Recycling in Hospitals, Going Green: A Resource Kit for Pollution, Prevention in Health Care; Health Care Without Harm, 2001.

arcenciel.org

Training on HCRW management
Consultancy in HCRW management
Collection of IHCW
Treatment of IHCW

arcenciel
Environment program
Jisr el Bacha, Sin el Fil, Beirut
Tel: 961-1-495561
environnement@arcenciel.org

Useful contacts

Public Institutions

Ministry of Environment
Lazarieh center, Beirut
Tel: 961-1-976555
webmaster@moe.gov.lb

Ministry of Public Health
Museum road, Beirut
Tel: 961-1-615775
info@moph.gov.lb

Lebanese Council for Development
and Reconstruction
Tallet Al Serail, Riad El Solh, Beirut
Tel: 961-1-980096
infocenter@cdr.gov.lb

engage in development