The Federal Environmental Protection Authority

Technical Guidelines on the Environmentally Sound Management of Biomedical and Healthcare Wastes

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1.Introduction

Guidelines are preferably set based on country specific baseline information. However, under the prevailing Ethiopian conditions, the necessary information required for the preparation of the guidelines is inadequate, outdated and scanty. An alternative approach is to adopt or adapt the guidelines of international organizations. Accordingly, it has become imperative to adopt and use the Biomedical and Healthcare wastes of the United Nation Environment Program.

Therefore, the UNEP guidelines on Biomedical and Healthcare wastes adopted and introduced throughout the country. The guideline will be amended as more information on the state of Biomedical and Healthcare wastes is obtained.

1. The disposal of wastes originating from health-care establishments (public and private) can have an effect on human health and well-being, the environment (air, water, soil, animals, plants, landscape) and issues relating to public security and order.
2. Nevertheless, experience has proven that wastes originating from health-care establishments, when properly managed, generally pose no greater risks than that of properly treated municipal or industrial wastes. This also pertains to the disposal of biomedical and health-care wastes, in contrast to occasional public perception.
3. The guidelines provide information for the proper treatment of wastes from health-care establishments (public and private). The information provided takes due consideration of the waste management requirements of disposal and recovery measures as well as hygiene requirements. In addition to ecological aspects, the information and recommendations should be economically feasible and easy to undertake. It and also makes allowances for technical progress.
4. It has become apparent that the introduction of improved solutions for the segregation of waste within health-care facilities can result in reduced amounts of waste requiring special treatment and therefore in reduced waste treatment costs. In addition, new technologies have become available to treat and disinfect biomedical and health-care wastes so that they can be of with low risk by landfilling finally.

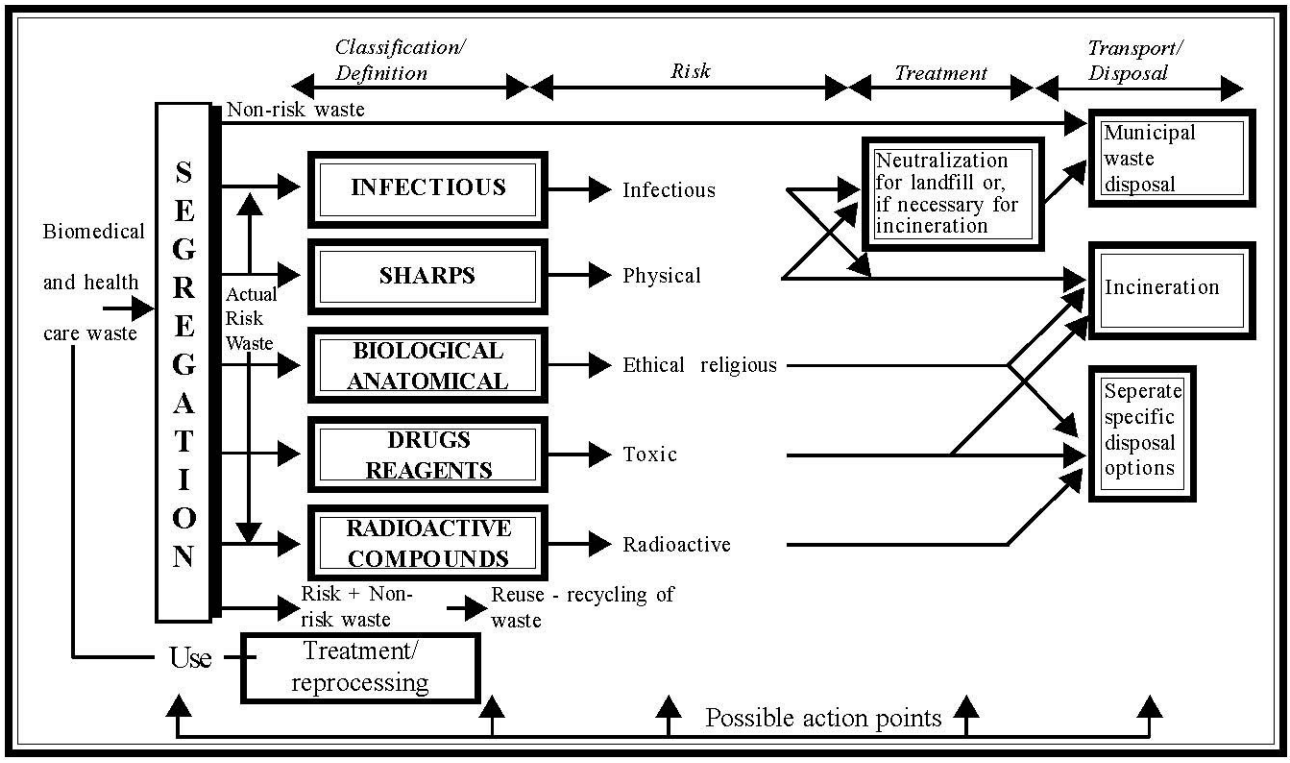
5. The safe management of biomedical and health-care waste is essential for community and environmental health. It is also important that the standards for the protection of the environment and human health are uniform across all health-care establishments, irrespective of technologies used for treatment and disposal. This in turn ensures a more viable and efficient industry. However, it should be noted that in many countries, the national authorities, in addition to industry, are an active participant in health-care, either providing services or paying for them. In addition, the lack of resources or of experience in developing standards may be significant factors affecting the capacity to treat biomedical and health-care wastes.
6. To manage biomedical and health-care waste effectively, the following should be taken into consideration:
   (a) Generation and minimization;
   (b) Separation and segregation of sources;
   (c) Identification and classification;
   (d) Handling and storage;
   (e) Packaging and labelling;
   (f) Transportation inside and outside health-care establishments;
   (g) Treatment;
   (h)Disposal of residues (including emissions);
   (i)Occupational health and safety; public and environmental health;
   (j)Stakeholder and community awareness and education;
   (k)Research into and development of improved technologies and environmentally friendly practices.
7. These guidelines attempt to address all of these issues and provide support for the achievement of improved environmental performance in managing biomedical and health-care waste. To be successful, waste management strategies should always take account of, and interact with, the process that generated the wastes in the first place.

2. Purpose and scope of the guidelines

8. Biomedical and health-care waste is a term for all waste generated in health-care establishments. Biomedical and health-care waste can briefly be described as waste from medical or other related practices. In reality, only a small proportion of this waste causes a higher risk of transmitting infectious diseases than normal household or municipal waste. These guidelines deal with all biomedical and health-care waste, with especial focus on the segregation and treatment of hazardous biomedical and health-care waste.

9. Concern regarding the safe management and disposal of biomedical and health-care waste has resulted from the perceived or real risk of potential transmission of infectious diseases through accidental injury or contact with infected body fluids. The disposal of sharps (needles, scalpels etc.) has attracted particular interest because of the small number of occupationally acquired hepatitis and HIV human immunodeficiency virus (HIV) infections suffered by health-care workers attributed to sharps injuries. The majority of sharps injuries, however, do not result in infection. It is therefore “good practice” in waste management to reduce the risk of injuries. Figure 1 describes some possible action points to establish “good practice” in waste management.

Figure 1 Biomedical and health-care waste strategy



3. General definition of biomedical and health-care waste

10. To get a better understanding of the waste management practice of health-care facilities, there is a need to have a common and internationally accepted definition for the waste generated in those facilities.

11. The general definitions below are set forth by these guidelines:

3.1 Health-care

12. Medical activities such as diagnosis, monitoring, treatment, prevention of disease or alleviation of handicap in humans or animals, including related research, performed under the supervision of a medical practitioner or veterinary surgeon or another person authorized by virtue of his or her professional qualifications.

3.2 Biomedical and health-care waste

13. The solid or liquid waste arising from health-care (including collected gaseous waste).

3.3 Hazardous health-care waste

14. This includes:

(a) Infectious health-care waste;

(b)Chemical, toxic or pharmaceutical waste, including cytotoxic drugs (antineoplastics)

(c) Sharps (e.g. needles, scalpels);

(d) Radioactive waste;

(e) Other hazardous waste.

3.4 Infectious health-care waste

15. All biomedical and health-care waste known or clinically assessed by a medical practitioner or veterinary surgeon to have the potential of transmitting infectious agents to humans or animals.

16. For the purpose of these guidelines, infectious health-care wastes are:

(a) Discarded materials or equipment contaminated with blood and its derivatives, other body fluids or excreta from infected patients with hazardous communicable diseases (specified in section 6.1, subsection B.5 below). Contaminated waste from patients known to have blood-borne infections under going haemodialysis (e.g. dialysis equipment such as tubing and filters, disposable sheets, linen, aprons, gloves or laboratory coats contaminated with blood);

(b) Laboratory waste (cultures and stocks with any viable biological agents artificially cultivated to significantly elevated numbers, including dishes and devices used to transfer, inoculate and mix cultures of infectious agents and infected animals from laboratories).

17. Wherever appropriate and applicable, waste from basic and fundamental biomedical and other research shall be managed according to the principles set forth for health-care waste.

3.5 Biological health-care waste

18. All body parts and other anatomical waste including blood and biological fluids and pathological waste that are recognizable by the public or the health-care staff and that demand, for ethical reasons, special disposal requirements.

3.6 Sharps

19. All biomedical and health-care waste with sharps or pointed parts able to cause an injury or an invasion of the skin barrier in the human body. Sharps from infected patients with hazardous communicable diseases (specified in section 6.1, subsection B.5 below), isolated wards or other pointed parts contaminated with the above-mentioned laboratory waste must be categorized as infectious waste.

4. Hazards of biomedical and health-care waste

4.1 Types of hazards

20. As mentioned in section 1, biomedical and health-care waste includes a large component of non-risk waste and a smaller proportion of risk waste. Non-risk waste is similar to municipal waste and does not create more health or other hazards than mismanaged municipal waste. If the risk waste is not properly segregated from other waste fractions (e.g. mixture of biological and pathological waste with sharps and body fluids), the whole mixture has to be handled as infectious waste. In this section, potential hazards related to exposure to biomedical and health-care waste will be addressed.
21. Exposure to hazardous or potentially hazardous biomedical and health-care waste can induce disease or injury. The hazardous nature of biomedical and health-care waste may be due to the following or a mixture of the following properties:

(a) It contains infectious agents, including contaminated sharps;

(b) It is cytotoxic or genotoxic;

(c) It contains toxic or hazardous chemicals or pharmaceuticals;

(d) It is radioactive;

(e) It contains sharps.

22. For the purposes of these guidelines, infectious substances are those substances known or reasonably expected to contain pathogens. Pathogens are defined as micro-organisms (including bacteria, viruses, rickettsia, parasites, fungi) or recombinant micro-organisms (hybrid or mutant) that are known or reasonably expected to cause infectious disease with a high risk for animals or humans. Note that not all pathogenic micro-organisms can be transmitted by waste as a pathway.

4.2 Persons at risk

23. All persons exposed to hazardous biomedical and health-care waste are potentially at risk of contamination through accidental exposure. This includes people within health-care establishments or any other source of biomedical and health-care waste, and people inside and outside these sources who either handle these wastes or are exposed to them, for example as a consequence of careless management. The main groups at risk are the following:

(a) Doctors, nurses, ambulance staff and hospital sweepers;

(b) Patients in health-care establishments or under home care;

(c) Workers in support services to health-care establishments, such as laundries, waste handling and transportation, waste disposal facilities including incinerators and other persons separating and recovering materials from waste;

(d) Inappropriate or inadvertent end-users such as scavengers and customers in secondary markets for reuse (i.e. households, local medical clinics, etc.).

24. Owing to the extension of drug abuse and of home care including home dialysis, the hazards associated with scattered small sources of biomedical and health-care waste should not be overlooked.

4.3 Hazards from infectious waste

25. Infectious waste may contain a great variety of pathogenic micro-organisms, but not all can be transmitted to humans and animals by contact with waste.
26. The pathogens contained in the waste may infect the human body through the following pathways: absorption through a crack or cut in the skin (injection), absorption through the mucous membranes, and rarely by inhalation and ingestion.
27. Concentrated cultures of pathogens and contaminated sharps (in particular syringe needles) are probably the waste items that create the most acute human health hazards.

4.4 Hazards from sharps

28. Sharps may not only cause cuts and punctures but also infect the wounds by agents which previously contaminated the sharps. Owing to this double risk of injury and disease transmission, sharps are considered problematic. The main diseases of concern are infections which may be transmitted by subcutaneous introduction of the agent - for example, viral blood infections.
29. Syringe needles are of particular concern because they constitute an important part of the sharps and are often contaminated with the blood of patients.

4.5 Hazards from chemical and pharmaceutical waste

30. Many chemicals and pharmaceuticals which are used in health-care establishments are hazardous chemicals (e.g. toxic, corrosive, flammable, reactive, explosive, shock-sensitive, cytotoxic or genotoxic). Fractions of these will be found in biomedical and health-care waste after their use or when they are no longer required.
31. They may have toxic effects, either through acute or chronic exposure, and injuries, including burns. Intoxications can result from absorption of the chemicals/pharmaceuticals through the skin or the mucous membranes and from inhalation or ingestion. Injuries can be provoked by contact of flammable, corrosive or reactive chemicals with the skin, the eyes or the mucous membrane of the lung

(e.g. formaldehyde and other volatile chemicals). The most common injuries are burns.

32. Mercury is another hazardous product common within hospitals owing to its prevalent use in literally hundreds of different devices. It is most concentrated in diagnostic devices such as thermometers, blood pressure gauges and, oesophageal dilators, Miller Abbott/Cantor tubes. It is also found in other sources such as fluorescent light tubes and batteries.

33. Disinfectants constitute a particularly important group of hazardous chemicals, as they are used in large quantities and are often corrosive. It should also be noted that reactive chemicals may form highly toxic secondary compounds. Chemical residues discharged into the sewage system may have toxic effects on the operation of biological sewage treatment plants or on the natural ecosystems of receiving waters. Pharmaceutical residues may have the same effects, as they may include antibiotics and other drugs, heavy metals such as mercury, phenols and derivatives and other disinfectants and antiseptics.

4.6 Hazards from cytotoxic waste

34. The severity of health hazards for health-care workers handling cytotoxic waste arises from the combined effect of the substance toxicity and of the magnitude of exposure that may occur during waste handling or disposal. Exposure to cytotoxic substances in health care may also occur during preparation for treatment. The main pathways of exposure are inhalation of dust or aerosols, skin absorption and ingestion of food accidentally in contact with cytotoxic (antineoplastic) drugs, chemicals or waste, or from contact with the secretions of chemotherapy patients.

4.7 Hazards from radioactive waste

35. Radioactive materials are unique in that they cause harm through both external radiation (by approaching them or handling them) and through their intake into the body. The degree of harm depends on the amount of radioactive material present or

taken into the body and on the type of material. Exposure to radiation from high-activity sources, such as those used in radiotherapy, can cause severe injuries, ranging from superficial burns to early fatalities. Radioactive waste arising from nuclear medicine is much lower in activity than the sources referred to above and is unlikely to cause such harm, but exposure to all levels of radiation is considered to be associated with some risk of carcinogenesis, however small.

36. There are well-established procedures for minimizing the hazards arising from work with radioactive materials, and these are normally implemented in hospitals and laboratories where such materials are used. Similarly, the arrangements for safe radioactive waste storage and disposal are well established. There should be a person or persons appointed in the organization with responsibility for ensuring that radiation protection is observed and that radioactive waste is properly and safely managed.

5. Field of application/source identification

37. These guidelines shall be applicable for the generation of biomedical and health-care wastes from health-care establishments. Health-care establishments shall specifically include the following:

(a) Large sources:

(i) University hospitals and clinics;

(ii) Maternity hospitals and clinics;

(iii) General hospitals.

(b) Medium sources:

(i) Medical centres;

(ii) Out-patient clinics

(iii) Mortuary/autopsy centres;

(iv) Farm and equine centres;

(v) Hospices;

(vi) Abortion clinics

(vii) Medical laboratories

(viii) Medical research facilities;

(ix) Animal hospitals;

(x) Blood banks and transfusion centres;

(xi) Emergency services.

(c) Small sources:

(i) General medical practitioners;

(ii) Convalescent homes;

(iii) Nursing and remedial homes;

(iv) Medical consulting rooms;

(v) Dental practitioners;

(vi) Animal boarding and hunt kennels;

(vii) Tattooists;

(viii) Acupuncturists;

(ix) Veterinary practitioners;

(x) Pharmacies;

(xi) Cosmetic piercers;

(xii) Zoos, safari parks, etc.

6. Waste identification and classification; waste groups

38.For the purpose of this guidelines the following biomedical and health-care waste classification is used:

A Health-care wastes with the same composition as household and municipal waste

A1 Normal household and municipal waste

B Biomedical and health-care waste requiring special attention

B1 Human anatomical waste (tissues, organs, body parts, blood and blood bags)

B2 Waste sharps (needles, syringes, scalpels, slides, ampoules, etc.)

B3 Pharmaceutical waste (e.g. expired medicines)

B4 Cytotoxic pharmaceutical wastes

B5 Blood and body fluid waste (materials contaminated with blood or other body fluids, soiled cotton from non-infected patients) Wastes which only require special measures to prevent the risk of infection during their management.

C Infectious wastes

For the purpose of these guidelines, infectious health-care wastes are:

(a) Discarded materials or equipment contaminated with blood and its derivatives, other body fluids or excreta from infected patients with hazardous communicable diseases(specified in section 6.1, subsection B.5 below). Contaminated waste from patients known to have blood- borne infections under going haemodialysis(e.g. dialysis equipment such as tubing and filters, disposable sheets, linen, aprons, gloves or laboratory coats contaminated with blood);

(b) Laboratory waste (cultures and stocks with any viable biological agents artificially cultivated to significantly elevated numbers, including dishes and devices used to transfer, inoculate and mix cultures of infectious agents and infected animals from laboratories).

D Other hazardous wastes.

Not exclusive to the medical health-care sector, e.g. solvents, chemicals, batteries, fixer solutions, etc.

E Radioactive waste from health care.

B1. Human anatomical waste

Description

Non-infectious human body parts, organs and tissues and blood bags.

Examples of such wastes

Tissue waste, removed organs, amputated body parts, placentas, etc.

Waste management guidance

It is primarily for ethical reasons that special requirements must be placed on the management of waste human body parts, organs and tissue. The waste must be collected in appropriate containers or bags as soon as possible and at the place where it is generated. The waste must be kept in tight receptacles (e.g. in the wooden coffins commonly used in pathology) and under cooled conditions when stored temporarily for a prolonged period of time, or else be handed over to a waste management facility within a reasonable period. Intermediate storage takes place at a location which is accessible only to trained personnel. Normally, the waste must always be incinerated completely, in an appropriate facility. Household waste incineration plants are, as a rule, not suitable for the incineration of amputated body parts, removed organs and placentas (cases of exceptions, such as separate storage and direct feeding, have to be clarified with the responsible authorities and the management of the incineration plant). In exceptional cases crematoria can be used for the incineration (disposal) of amputated body parts.

Exemptions and special provisions

Where only small quantities of these wastes are generated (e.g. in medical practices), they can be collected in appropriate containers (e.g. “hard box”) and managed jointly with municipal waste at a volume of up to 1 litre per waste bag. The management of animal waste body parts, organs and tissues is subject to the provisions of relevant special

legislation.

B2: Waste posing the risk of injury (sharps)

Description

Sharps are all objects and materials which are closely linked with health-care activities and pose a potential risk of injury and/or infection.

Examples of such wastes

Needles, drain tubes, syringes with the attached needle, butterfly needles, spikes, broken glassware, ampoules, pipettes, scalpel blades, lancets, vials without content, etc. Waste management guidance Wastes posing the risk of injury require measures to be taken to prevent injury and infection during the handling of these wastes within and outside of health-care establishments. These wastes have to be collected and managed separately from other waste. The collection containers must be puncture-resistant and leak tight. Storage of these wastes takes place at a location which is accessible only to trained personnel.

Note: Sharps from infected patients, isolated wards, infected patients undergoing haemodialysis or other pointed parts contaminated with laboratory waste must be categorized as infectious waste.

Exemptions and special provisions Syringes and needles should not be reused.

B3: Pharmaceutical waste

Description

Pharmaceutical wastes are pharmaceuticals, which have become unusable for the following reasons:

- Exceeded expiration date;
- Expiration date exceeded after the packaging or the ready-to-use preparation prepared by the user has been opened;
- Cannot be used for other reasons (e.g. call-back campaign).

Examples of such wastes

The term “pharmaceuticals” embraces a multitude of active ingredients and types of preparations. The spectrum ranges from teas through heavy-metal-containing disinfectants to highly specific medicines containing a large variety of different hazardous or non-hazardous substances. Waste management may therefore be based on a differentiated approach; for example, pharmaceutical waste could be divided into three classes and its management carried out in a class-specific manner as follows:

- Pharmaceutical wastes: Class 1

  Pharmaceuticals such as camomile tea and cough syrup which pose no hazard during collection, intermediate storage and waste management. Class 1 pharmaceutical wastes are not considered hazardous wastes. They are managed jointly with municipal waste.

- Pharmaceutical wastes: Class 2

  Pharmaceuticals which pose a potential hazard when used improperly by unauthorized persons. Class 2 pharmaceutical wastes are considered to be hazardous wastes. Their management takes place in an appropriate waste disposal facility.

- Pharmaceutical wastes: Class 3

  Heavy-metal-containing and unidentifiable pharmaceuticals, heavy-metal-containing disinfectants, which, owing to their composition, require special management. Class 3 pharmaceuticalwastes are considered to be hazardous wastes. Their management takes place in an appropriate waste disposal facility. However, owing to the fact that medicines are not normally labelled in accordance with their hazardous characteristics, the sorting of medicines into different classes, in particular classes 2 and 3, may often be too difficult in practice. Countries may therefore decide to consider all or a major part of medicines as hazardous waste or waste requiring special consideration.

Waste management guidance

Waste prevention: To reduce the generation of pharmaceutical waste, stocks of pharmaceuticals should be inspected periodically and checked for their durability (expiration date).

Recovery by specialized facilities: Possibilities for returning old pharmaceuticals to the producer or handing them over to a special collection system (e.g. pharmacies) for possible subsequent use could be explored. Such a return of pharmaceuticals in their original packaging prior to or within a reasonable period after the expiration date is possible if it is ensured that the producer or collector examines possibilities for subsequent use of the pharmaceuticals and that pharmaceuticals which are no longer usable are disposed of in an environmentally sound manner.
Pharmaceutical wastes which are considered to be hazardous wastes have to be collected separately in appropriate containers. Intermediate storage takes place at a location which is accessible only to trained personnel. This should be done in a manner to avoid misuse.

Exemptions and special provisions

Cytotoxic pharmaceutical waste: See Group B4: Cytotoxic pharmaceutical wastes.

B4: Cytotoxic pharmaceutical wastes

Description

Cytotoxic (antineoplastic) pharmaceutical wastes are wastes which can arise from use (administration to patients) and manufacture and preparation of pharmaceuticals with a cytotoxic (antineoplastic) effect. These chemical substances can be subdivided into six main groups: alkylated substances, antimetabolites, antibiotics, plant alkaloids, hormones and others. A potential health risk to persons who handle cytotoxic pharmaceuticals results above all from the mutagenic, carcinogenic and teratogenic properties of these substances. Consequently, these wastes pose a hazard, and the measures to be taken must also include those required by occupational health and safety provisions.
Examples of such wastes

Specific lists of pharmaceuticals which contain cytotoxic substances are available. Discernible liquid residues of cytotoxic concentrates, post-expiration-date cytotoxic pharmaceuticals and materials proven to be visibly contaminated by cytotoxic pharmaceuticals must be disposed of as cytotoxic pharmaceutical waste.

Waste management guidance

The risks posed by cytotoxic pharmaceuticals are primarily of relevance for persons who come into contact with them during preparation and during or after their use. It has long been common practice in hospitals to see to it that the number of persons who come into contact with these products is small. Specific guidance on this is available. These wastes usually arise at central locations, i.e. in pharmacies and laboratories and they are also often found at places where the ready-to-use cytotoxic solutions are prepared. Intermediate storage of these wastes takes place under controlled and locked conditions. The precautions taken during the use of cytotoxic pharmaceuticals must also be applied on their journey outside the respective establishment, as releases of these products can have adverse environmental impacts. The management of these wastes, in covered and impermeable containers, must therefore be strictly controlled. Solid containers must be used for collection. The use of coded containers is recommended. For reasons of occupational safety, cytotoxic pharmaceutical wastes must be collected separately from pharmaceutical waste and disposed of in a hazardous waste incineration plant.

Exceptions and special provisions

None.

B5: Wastes with blood and body fluid

Description

These are wastes from health-care establishments not categorized as infectious wastes which are contaminated with human or animal blood, secretions and excretions. It is reasonable to assume that these wastes might be slightly contaminated with pathogens (in nearly the same way as household waste).

Examples of such wastes

Dressing material, swabs, syringes without the attached needle, infusion equipment without spikes, bandages, etc.

Waste management guidance

Special requirements must be imposed on the management of these wastes from the viewpoint of infection prevention inside the health-care establishments. Double bags or containers made of strong and leak-proof material are used for the collection of these wastes within health-care establishments.

Proper management of these wastes is by incineration in a household waste incineration plant but they can also be disposed of together with household waste on a controlled landfill site.

Exemptions and special provisions

This mixture of wastes should not be recycled.

C: Infectious wastes

Description

Special requirements regarding the collection and management of infectious wastes must be imposed whenever waste is known or, on the basis of medical experience, expected to be contaminated by causative agents of the diseases listed below and when this contamination gives cause for concern that the disease might spread. The list comprises diseases which make particular demands on infection prevention when the following factors are taken into account:

- The associated risk of infection (contagiousness, infection dose, epidemic potential);
- The viability of the pathogen (infection capacity/infectiousness);
- The route of transmission;
- The extent and nature of the potential contamination;
- The quantity of contaminated waste;

The severity and treatability of the disease that might be caused.

The wastes belonging to this group may occur in the context of diagnosis and treatment of patients suffering from the following diseases (relevant pathogen-containing excretions are given in brackets):

- Acquired immunodeficiency syndrome (AIDS)* (blood)
- Viral hepatitis* (blood, faeces)
- Creuzfeld-Jacob disease (CJD), transmissible spongiform encephalopathy (TSE)* (tissue, cerebrospinal fluid)
- Cholera# (faeces, vomit)
- Typhoid fever/paratyphoid fever# (faeces, urine, bile)
- Enteritis, dysentery, enterohaemorragic Escherichia coli (EHEC)-induced haemolytic uraemicsyndrome (HUS)# (faeces)

For the purpose of these guidelines, infectious health-care wastes are:

(a) Discarded materials or equipment contaminated with blood and its derivatives, other body fluids or excreta from infected patients with hazardous communicable diseases. Contaminated waste from patients known to have blood-borne infections undergoing haemodialysis (e.g. dialysis equipment such as tubing and filters, disposable sheets, linen, aprons, gloves or laboratory coats contaminated with blood).

(b) Laboratory waste (cultures and stocks with any viable biological agents artificially cultivated to significantly elevated numbers, including dishes and devices used to transfer, inoculate and mix cultures of infectious agents and infected animals from laboratories).

- Active tuberculosis (respiratory tract secretions, urine, faeces)
- Meningitis/encephalitis (respiratory tract secretions, cerebrospinal fluid)
- Brucellosis (blood)
- Diphtheria (respiratory tract secretions, secretions from infected wounds)
- Leprosy (secretion from nose/infected wounds)
- Anthrax (respiratory tract secretions, secretion from infected wounds)
- Plague (respiratory tract secretions, secretion from infected wounds)

- Poliomyelitis (respiratory tract secretions, faeces)
- Q fever (respiratory tract secretions, blood, dust)
- Glanders (respiratory tract secretions, secretion from infected wounds)
- Rabies (respiratory tract secretions)
- Tularaemia (pus)
- Virus-induced haemorrhagic fever, including hantavirus-induced renal (HFRS) and pulmonary (HPS) syndromes (blood, respiratory tract secretions, secretion from infected wounds, urine)

Waste of this kind is typically generated in the following places: isolation wards of hospitals; dialysis wards or centres caring for patients infected with hepatitis viruses (yellow dialysis); pathology departments; operating theatres; and medical practices and laboratories which mainly treat patients suffering from the diseases specified above. The relevant wastes are wastes contaminated with pathogen-containing blood, excretions or secretions (see list) or containers containing blood in liquid form.

Examples

The infections marked with (*) are usually transmitted through inoculation. Therefore, the wastes of relevance here are not taken to include dry contaminated waste from sporadic patients suffering from diseases in question (AIDS, viral hepatitis, CJD), such as contaminated swabs (e.g. from taking of blood samples), cotton plugs used in dental practices, etc. However, they do include blood-filled vessels and waste drenched with blood or secretions from surgeries performed on infected patients, used dialysis systems from yellow dialysis as well as wastes drenched with blood/secretions from medical practices and laboratories mainly treating patients who have contracted the diseases in question.

The infections marked with (#) are transmitted via faeces and oral ingestion of contaminated material. Relevant bodily discharges may be fed to the waste-water stream in observance of hygienic requirements. Management under conditions that would result from categorization as infectious waste must be considered only when the waste is heavily contaminated with excretions from diagnosed patients.

Infectious wastes in any case include the following:

(a) All microbiological cultures generated, for example, in institutes working in the fields of hygiene, microbiology and virology as well as in medical laboratories, medical practices and similar establishments and in which a multiplication of pathogens of any kind has occurred;
(b) Experimental animals as well as litter and animal faeces from animal test laboratories, if transmission of the above-mentioned diseases is to be expected.

Waste management guidance

Infectious wastes must be collected in tear-resistant and leakproof containers and transported to a central storage facility/delivery point in carefully sealed condition and without any transfer into other containers or sorting (containers marked with the "biohazard" symbol). They must be collected and transported in a way that precludes direct contact, and they may not be transferred into other containers at the central storage facility or during delivery. They must be stored in such a way that gas formation in the collection containers is avoided. To this end, efforts must be made to ensure that storage periods are as short as possible depending on climatic conditions (e.g. storage at temperatures below +15°C for not more than one week or at a temperature of 3°C to 8°C for a longer storage period).

Infectious waste must either be incinerated (approved incineration plant) or be disinfected prior to final disposal using a recognized method, preferably treatment with saturated live steam. Disinfected wastes may be disposed of in the same way as domestic waste. The disinfection plants must be operated under the operating parameters prescribed for waste disinfection, and this mode of operation must be documented. The use of a mobile disinfection plant to treat infectious waste is permissible only if the waste disposer furnishes proof that the plant has been checked by the competent authority or an approved institution for its functional and operational reliability on a regular basis.

Exceptions and special provisions

Body fluids and excreta of infected patients with hazardous communicable diseases can be discharged to the sewerage system if there is a strict separation between the waste and drinking water installations and the sewerage system is connected to a waste-water plant. In other cases, the body fluids and excreta have to be disinfected before being discharged to the sewerage system. Exceptionally if wastewater plant doesn't exist , infectious waste can be disposed of by using a special area in a controlled landfill if there is no risk of contamination of ground or drinking water and the infectious waste is directly covered with earth or other material.

E: Radioactive waste

Description

Material contaminated with a radioisotope which arises from the medical or research use of radionuclides. It is produced, for example, during nuclear medicine, radio immunoassay and bacteriological procedures, and may be in a solid, liquid or gaseous form.

Examples of such wastes

Radioactive waste includes solid, liquid and gaseous waste contaminated with radionuclides generated from in vitro analysis of body tissue and fluid, in vivo body organ imaging and tumour localization, and investigative and therapeutic procedures.

Waste management guidance

Where activity limits for immediate or simple disposal methods cannot be met (clearance levels), health-care establishments should segregate radioactive waste and store it during the required period to reduce the activity level. If the activity concentration is below these clearance levels, the material may be disposed of by normal methods. Since the half-life of most radioactive materials used in hospitals is in the range of hours or days, storage for a period of one or two months can be followed by disposal to the ordinary waste system with appropriate monitoring. Decayed non-infectious radioactive waste is placed inside

black plastic bags if they are intended for landfilling. Decayed but infectious radioactive wastes are placed in yellow plastic bags in preparation for disinfection. They should not be used as landfill prior to disinfection.

All radioactive waste designated for storage to allow decay should be kept in suitable containers which prevent dispersion of the content. A plastic bag in a large can or drum is an appropriate container. Containers used for the storage of radioactive waste should be clearly labelled to show the activity of the radionuclide on a given date and the period of storage required. These containers should be stored in a specifically marked area in a lead-shielded storage room for radioactive substances or for radioactive waste. The storage record should be endorsed specifically to indicate which items are "radioactive waste". Containers of radioactive waste should be marked "RADIOACTIVE WASTE" and should carry the radiation symbol.

High-level and usually long-half-life radionuclides used in health-care activities are used for therapeutic purposes, conditioned as sealed sources, in the format of pills, seeds, ribbons, tubes or needles. These sealed sources are recovered after use, washed, disinfected and stored under lead-shielding for reuse on other patients. These items may, however, become waste if their conditioning is damaged, if they have lost too much of their activity, or if they are no longer required. Spent radionuclide generators also become waste. In countries without a nuclear industry equipped to dispose of high-level radioactive waste, hospitals should package these items appropriately or place them inside the same boxes in which they were originally supplied, and send them back to their original supplier for reprocessing, eventual recycling or safe final disposal. In countries with the appropriate nuclear industry, hospitals may alternatively send non-recyclable high-level waste to the national radioactive waste disposal agency, which will take care of them. These items are usually valuable, and, in most cases, it is possible to reprocess them for recycling.

Exceptions and special provisions

Any health-care establishment using radioactive substances should hire a specialized radiation officer who, among other duties, will monitor the management and disposal of

radioactive waste and the storage of radioactive items.

7. Applicable state-of-the-art management, treatment and disposal technologies

39. It is generally recognized that waste management plans provide the best mechanism for improvement of environmental performance in waste management. A waste management plan can help generators to conserve resources and minimize waste through improved purchasing and reuse practices and through cost-effective, environmentally sound source separation, segregation, collection, transport, treatment and disposal of all waste streams generated within their facilities.
40. It is recommended that the plan be in the form of an environmental management system based on the ISO 14001 series of environmental management standards. This systems approach helps to ensure that auditable, verifiable documentation is available to demonstrate that operations are taking place as required. Such a system will also assist with the provision of quality data and information on which a state-of-the-environment report can be prepared. A prerequisite for developing or updating such a plan is adequate characterization and analysis of the existing waste stream and a detailed assessment of existing waste management practices. This process is commonly referred to as a waste audit.

7.1 Avoidance/prevention

41. The generation of hazardous wastes and other wastes within it is reduced to a minimum and that adequate disposal facilities for the environmentally sound management of hazardous wastes and other wastes are available.
42. For the various health-care establishments, waste management in observance of the waste avoidance and recovery obligation presupposes a system that is practice-oriented, clearly structured and manageable with clearly defined logistics. This can be achieved only if everyone who works in the health services sector gives increased thought to this issue and takes action to ensure that the volume and hazardousness of

wastes are minimized.

43. The increasing relevance of the waste management problem demands an ecologically oriented reorganization. This should start with procurement, by giving preference to environmentally sounder products and replacing harmful or disposable products with reusable or alternative products, if these meet the relevant requirements in terms of hygiene and patient safety.

44. A noticeable reduction in waste volume can be achieved only if disposable products already in use are scrutinized as to their necessity. In principle, disposables such as disposable cutlery, disposable linen (including covering sheets), disposable instruments and equipment (scissors, scalpels, forceps) and disposable containers (kidney dishes, infusion bottles) should be replaced by reusable products and long-lived alternatives. For examples of specific reuse, waste reduction and waste recycling activities, see annex III?

7.1.1 Packaging

45. An issue closely related to the procurement of products is their packaging. It is possible to reduce the amount of waste generated noticeably if attention is paid in the selection of products to the associated amount of packaging. The latter should not exceed the minimum necessary to meet transportation, storage, hygiene and sterility requirements. Before orders are placed, the material input for the product and the packaging as well as the resulting input required for waste management should be taken into account.

46. The input required for the management of packaging waste can be reduced when:

(a) Preference is given to products involving small amounts of packaging;

(b) Preference is given to product packaging which can be refilled, reused or otherwise used as a supply or disposal receptacle within or outside the facility at which the product is used;

(c) Preference is given to demand-oriented package sizes;

(d) The manufacturer or supplier of the product is required, when placing the order, to take back the associated transport packaging and containers.

47. Where it cannot be avoided, packaging should be collected separately and fed to an appropriate recovery process. Appropriate recovery is common for cardboard, paper, glass and metals. Plastics can best be recovered if they are collected as type-specific fractions.

7.1.2 Kitchen and canteen waste

48. Kitchen and canteen waste can be utilized as feed substitute if it is disinfected in a manner that is appropriate for such use or if such use conforms with the conditions imposed by the authorities.

7.1.3 Laboratory waste and chemical residues

49. An effort should be made to establish which hazardous products and substances in the health-care industry can be avoided completely. Chemical residues can be reduced by adapting laboratory apparatus to the “state of the art” and performing laboratory tests and analyses if they meet medical needs. In the procurement of laboratory devices, attention should be paid to the aspect of relative chemical consumption.
50. The use of mercury contained in hospital diagnosis devices such as blood pressure gauges and thermometers has been targeted for elimination and future avoidance in many countries. Elemental mercury is toxic and such uses present hazards during use and at end-of-life. Mercury can neither be safely landfilled nor incinerated. Fortunately, safer alternatives now exist for each of these mercury-containing products. Thus the problem is best avoided in the first instance through procurement policies.
51. With regard to laboratory chemicals, a priority task is to find out whether the use of chlorinated hydrocarbons as solvents is unavoidable. The aim should be to replace such laboratory procedures. Laboratory chemicals and solvents should be collected and recovered, if the cost of recovery entailed is reasonable in comparison with that of other forms of waste management. The best possibilities for solvent recovery exist in pathology, histology and anatomy because relatively large amounts of fat and blood-contaminated solvents (xylene, toluene and others) arise in these sectors.

7.2 Segregation, collection, labeling and handling of biomedical and health-care waste

52. Segregation is the key to effective biomedical and health-care waste management. It ensures that the correct disposal routes are taken, personnel safety is maintained, environmental harm is minimized and recycling consumes the least resources. Biomedical and health-care waste should be segregated and collected in accordance with the specific treatment or disposal requirements.
53. Segregation should be carried out under the supervision of the waste producer and as close as possible to the point of generation. Segregation must therefore take place at source, that is, in the ward, at the bedside, in the theatre, in the laboratory, in the delivery room, etc., and must be carried out by the person generating the waste, for example the nurse, the doctor or the specialist, in order to secure the waste immediately and to avoid dangerous secondary sorting. It should be undertaken on the basis of the types of waste listed in the definition for biomedical and health-care waste.
54. Each health-care institution should prepare and follow a waste plan. Correct and efficient segregation will be achieved only through rigorous training and education of employees, supervisors and managers, and policies should take this into account.
55. The segregation must be applied from the point of generation throughout the entire waste stream to the point of final disposal, whether or not it is on-site. All storage and transportation methods must also follow this segregation system.
56. Segregated wastes of different categories need to be collected in identifiable containers. Every room, such as wards, laboratories and operating theatres, should have containers/bags for the types of wastes that are generated in that room. The waste segregation and identification instructions should be placed at each waste collection point to ensure proper procedure. Waste containers made of non-halogenated leakproof combustible materials should always be given preference. Plastic bags for storing the waste may be suspended inside a frame or placed inside a sturdy container. A lid should be provided to cover the opening of the bag. Sharps must always be collected in puncture-proof containers (not made of glass) to avoid

injuries to and infection of the workers handling them.

57. Clinical and sanitary personnel should ensure that the waste bags are removed and sealed when they are not more than three-quarters full. The preferred method of sealing involves a plastic sealing tag of the self-locking type; bags should never be closed by stapling. Each bag should be labelled with the point of generation (ward and hospital) and content.

58. A common system of labelling and coding of packaging should be developed for biomedical and health-care waste. A possible way of identifying biomedical and health-care waste categories is by sorting the waste into colour-coded bags or containers. As an example, a WHO-recommended colour coding is given in table 1. The use of internationally recognized symbols and signs is of very basic importance and is essential for the safety of handling and disposal of waste. It is recommended that the colour coding, the symbols and signs should be part of the waste management instructions and should be made known, e. g. by a poster on the wall at the waste collection points.

Table 1

WHO - recommended colour coding for biomedical and health-care waste as an example of a colour-coding system

TYPE OF WASTE	Colour of container and markings*	Type of container
Highly infectious waste	Yellow, marked "HIGHLY INFECTIOUS"	Strong, leak proof plastic bag, or container capable of being autoclaved
Other infectious waste, pathological	Yellow	Plastic bag or containers
Sharps	Yellow, marked "SHARPS"	Puncture-proof containers
Chemical and pharmaceutical waste	Brown	Plastic bag or container
Radioactive waste**		Lead box
General health-care waste	Black	Plastic bags

* Proposed colour coding and marking system; the use of other colour coding in a country is possible.

** Generated only in major hospitals.

59. Certain recommendations should be followed by the ancillary workers in charge of waste collection. They include:

(a) Waste should be collected daily from the wards, or as frequently as required, and transported to the central storage place;

(b) No bags should be removed without labelling indicating the point of generation (hospital and ward) and content;

(c) The workers should immediately replace the bags or containers with new ones of the same type.

60. Empty collection bags or containers should be readily available at the point of waste generation.

7.3 In-house transport and storage

61. It is important to ensure that waste does not accumulate at the point of generation. A routine for the collection of waste should be established in the waste management plan. Wastes should be moved through the facility in such a manner as to prevent unnecessary exposure to staff and others. Handling and transportation of waste containers should be minimized to reduce the likelihood of exposure to the waste. Specific routes should be planned through the facility to minimize the passage of loaded carts through patient care and other clean areas.

62. Carts used for moving biomedical and health-care waste through the health-care facility should be designed to prevent spills, and should be made of materials able to withstand exposure to common cleaning agents. They should have the following attributes:

(a) Easy loading and deloading;

(b) No sharp edges which could damage waste bags or containers during loading and deloading;

(c) Easy to clean.

63. All seals should be in place when movement of the bag has been completed. The carts should be cleaned regularly to prevent odour and as soon as possible if the waste material leaks or spills in the carts. The biohazard symbol should be clearly displayed on carts for the transport of infectious waste. These carts must be thoroughly cleaned

before any maintenance work is performed on them. The facility's infection control committee, biosafety officer or other appointed person should be consulted about the frequency of cleaning and the type of cleaning agent to be used.

64. After biomedical and health-care waste has been collected and moved from the point of generation, it must be held in storage areas to await disposal. These storage areas - either a separate area, room or building - should be dimensioned according to the quantities of waste generated and the frequency of collection. These areas must be totally enclosed and separate from supply rooms or food preparation areas. Recommendations for properties and equipment of the storage facilities are listed in box 1.

65. Storage areas must be identified as containing infectious waste, with the biohazard symbol clearly displayed. It is unacceptable for materials other than waste to be placed in the same storage area as infectious waste. Floors, walls and ceilings of storage areas must be thoroughly cleaned in accordance with the established procedures of the facility.

Box 1 Recommendations for storage facilities for biomedical and health-care waste in health-care establishments, e.g. hospitals

Properties and equipment
Impermeable hard-standing base with good drainage, easy to clean and disinfect and equipped with water supply;
Readily accessible to staff in charge of handling the waste;
Fitted with a lock, to prevent access by unauthorized persons;
Easily accessible to collection vehicles (carts);
. Inaccessible to animals, insects and birds;
. Good lighting and ventilation;
. Not situated in the proximity of fresh food stores or food preparation areas;
Situated close to the supply of cleaning equipment, protective clothing and waste bags or containers.

66. Unless a cooled storage room is available the proposed storage periods recommended by WHO between the generation and treatment of biomedical and health-care waste are the following:

Temperate climate: maximum 72 hours in winter maximum 48 hours in summer

Warm climate: maximum 48 hours during the cool seasond maximum 24 hours during the hot season

67. Anatomical waste should be stored at a temperature of 3° C to 8° C. All infectious waste must be refrigerated at a temperature of 3° C to 8° C if stored for more than a week. Health-care facilities should determine the maximum storage time of refrigerated or frozen biomedical and health-care waste based in the light of their storage capacity, rate of waste generation and any applicable local regulatory requirements.
68. Facilities refrigerating or freezing stored waste should use a lockable, closed storage facility or a lockable domestic-type freezer unit. Either type must be used only for storing anatomical and infectious waste, must display the biohazard symbol visibly and must be identified as containing infectious waste. Note that glass or plastic items containing infectious agents may fracture at lower temperatures.
69. The compacting of untreated infectious waste or waste with a high content of blood or other body fluids destined for off-site disposal (for which there is a risk of spilling) is not permitted. Cytotoxic waste should be stored in a specific place, separate from the storage room devoted to other biomedical and health-care waste.
70. Depending on the local legislation, radioactive waste should be stored in containers preventing dispersion, behind lead shielding. Waste designated for storage to allow decay should be labelled with the type of radionuclide, date and required storage details.

7.4 Special requirements for packaging and labelling for off-site transport

70. Risks may occur during the storage, handling, transportation and disposal of the

infectious waste. For this reason, biomedical and health-care waste generators are responsible for safe packaging, adequate labelling and authorization of the destination of the waste to be transported off-site. Hazardous biomedical and health-care waste should be packaged and labelled to comply with national regulations regarding the transport of hazardous wastes (dangerous goods), and with international agreements if they are shipped abroad for treatment. Where there are no such national regulations, the responsible authorities may refer to the "Recommendations on the Transport of Dangerous Goods" published by the United Nations, and specifically section 2.6.3 on infectious substances.

71. The control strategy for hazardous biomedical and health-care waste shall have the following components:
    (a) A consignment note should accompany the waste from production to final disposal; after the journey, the transporter should complete the part of the consignment note especially reserved for him and return it to the generator;
    (b) The transporting organization should be registered with, or known to, the waste regulation authority;
    (c) Handling and disposal facilities should hold a permit issued by a waste regulation authority, allowing the facilities to handle and dispose of hazardous biomedical and health-care waste.

72. The consignment note should be designed taking into account the waste control system in operation in the State concerned and also taking into account the forms issued in pursuance of the Basel Convention. [9] Anyone involved in biomedical and health-care waste generation, handling or disposal should be subject to a general "duty of care", i.e. ensure that documentation and transmission of waste comply with the national regulations.

7.4.1 Packaging requirements

73. In general, the waste should be packaged in resistant and sealed bags or containers to prevent spilling during handling and transportation. The bags or containers should be resistant to their content (puncture proof for sharps, resistance to aggressive

chemicals) and to normal conditions of handling and transportation such as vibration and changes in temperature, humidity or pressure (resulting from altitude, for example)

In general packaging should include the following essential elements:

(a) An inner packaging comprising:

(i) Watertight primary receptacle of metal or plastics with leakproof seal (e.g. a heat seal, a skirted stopper or a metal crimp seal);

(ii) A watertight secondary packaging;

(iii) Absorbent material in sufficient quantity to absorb the entire contents placed between the primary receptacle and the secondary packaging; if several primary receptacles are placed in a single secondary packaging, they shall be individually wrapped so as to prevent contact between them;

(b) An outer packaging of adequate strength for its capacity, mass and intended use, and with a minimum external dimension of 100 mm.

7.4.2 Labeling

74. All waste bags or containers should be identified by labels containing basic information on producer and content. This information may be directly written on the bag or container or by pre-printed labels. The following major information should appear on the label:

- the type of waste;
- the total quantity of waste covered by the description (by mass or volume);
- the packaging should be appropriately marked with the month and the year of manufacture; and
- the body authorizing

7.5 Recycling/recovery

75. Recovery and recycling constitute one step in a systematic priority approach for environmentally sound waste management. Waste segregation at source is the basic

requirement for cost-effective normal recycling operations on the non-hazardous component of biomedical and health-care waste. Some examples for the recycling of non-hazardous waste components are given in annex II.

76. Opportunities for chemical waste recycling can be described as follows:

(a) Unused or waste chemicals in quantity can often be returned to the supplier for reprocessing;

(b) Larger health-care facilities should establish internal reuse of chemicals;

(c) Certain material such as mercury from broken thermometers, unused batteries containing mercury, cadmium, nickel and lead-acid and halogenated or non-halogenated solvents should be given to specialized recyclers.

7.6 Disposal operation/technologies, accreditation and environmental impacts

77. Biomedical and health-care waste should, if required, be inactivated or rendered safe before final disposal or discharge. The decision to treat biomedical and health-care waste and the choice of treatment method should be determined in accordance with the following considerations:

(a) The type and nature of the waste material;

(b) The hazard and viability of the organisms in the waste;

(c) The efficiency of the treatment method;

(d) The operating conditions of the treatment method.

Table2 Examples of waste treatment methods related to the type of waste

Type of waste **Treatment**	**Gas**	**Liquid**	**Solid**

Thermal	Possible	Recommended	Recommended
Chemical	Appropriate	Appropriate	a/
Irradiation	b/	b/	b/
Incineration	Appropriate	c/	Recommended
Filtration	Recommended	Possible	Not applicable

a/ Not possible for mixed wastes.

b/ Only for small amounts of wast

c/ Recommended if the calorific value is high enough to reach a sufficiently high temperature.

78. The treatment method should be amenable to validation and independent of any packaging, and should be monitored. Monitoring can involve sampling and analysis or testing of the effluent for hazardous organisms or the use of suitable physical engineering or other process controls to demonstrate effective operation within the prescribed operating criteria.

79. Treatment of the waste should be validated with regard to the inactivation of the organisms and of any residual contamination of the packaging or containers. The process should not significantly increase the risk of exposure of laboratory staff or other waste handlers to the hazard itself or to other risks from the concomitant hazardous agents, equipment and substances which are employed in the treatment. Outlines of the main advantages and drawbacks of the treatment and disposal options addressed in these guidelines are shown in table 3.

7.6.1 Methods of treatment or disposal

80. The validated chemical and physical methods for the treatment or inactivation of waste include: steam sterilization, chemical disinfection/sterilization, dry heat

sterilization and other methods.

81. The relative effectiveness of these and other treatment methods depends on a number of factors including the volume, concentration, type and hazard caused by the organisms and the physiological state, the diffusion resistance of the material to be disinfected and the operating parameters and conditions of the treatment method. In general, steam sterilization should preferably be used in the treatment of infectious waste. Thermal methods are generally easier to validate and monitor than chemical treatment and are less damaging to the environment.

82. Methods other than steam sterilization should be selected only if this is impracticable or inappropriate. For example, effluent from veterinary research, contaminated laboratory equipment, fixtures and furniture which cannot readily be removed may be effectively treated using a gaseous fumigant such as formaldehyde. These methods of treatment can be used alone or in combination, depending on the risk assessment requirements and/or discharge consent standards, to enable the waste to be inactivated and safely discharged.

Table 3: Summary of the main advantages and drawbacks of treatment and disposal options

Treatment/disposal methods	Advantages	Drawbacks
Pyrolytic incineration/two-stage incineration with efficient gas cleaning	Very high disinfection efficiency; adequate for all infectious waste and most pharmaceutical and chemical waste.	Incineration temperature above 800°C, destruction of cytotoxics; relatively high costs of investment and ope-ration. Care has to be taken on the management of the incineration residues (e.g. bottom ashes, fly ashes) because they can ex-hibit hazard characteristics.
Single chamber incineration with dust reduction	Good disinfection efficiency; Drastic reduction of the weight and volume of waste; the residues may be disposed of in a landfill; no need for highly qualified operators; relatively low investment and operation costs.	Generation of significant emissions of atmospheric pollutants and periodic slag and soot removal; with temperature below 800°C, inefficient in destruction of thermally resistant chemicals and drugs such as cytotoxics.
Drum or brick incinerator	Reduction of the weight and volume of the waste; the residues may be disposed of in a landfill; no need for highly qualified operators; very low investment and operating costs.	Only 99 per cent destruction of microorganisms; no complete destruction of many chemicals and pharmaceuticals; massive emission of black smoke, fly ash and toxic flue gas. Exception only for disposal of infectious waste under certain circumstances outside urban areas (e.g., no other treatment method available during an emergency situation like acute outbreak of communicable) diseases).

Table 3 cont…

Treatment/disposal methods	Advantages	Drawbacks
Chemical disinfection	Efficient disinfection under good operating conditions with special waste; costly if the chemical disinfectants are expensive.	Requirement of highly qualified technicians for operation of the process; use of hazardous substances which require comprehensive safety measures; inadequate for pharmaceutical, chemical and most types of infectious waste (mixed solid waste).
Autoclave wet-thermal treatment	Environmentally sound; relatively low investment and operation costs. Good for infec- tious and microbiological wastes.	Shredders are subjected to many breakdowns and bad functioning; operation requires qualified technicians; inadequate for pharmaceutical and chemical waste or waste which is not easily penetrable by steam; without shredding or other methods of destruction although inad equate for anatomic waste.
Microwave irradiation	Good disinfection efficiency under appropriate operational conditions; environmentally sound.	High investment and operation costs; potential operation and maintenance problems; only for wet infectious waste or for infectious waste with a high water con tent.
Encapsulation(e.g. with concrete or gypsum)	Simple and safe; low costs.	Only for sharps.
Special engineered landfill	Safe if access is restricted and where natural infiltration is limited.	Safe if access to site is limited and there is no risk of water contamination.

7.6.1.1 Steam sterilization

83. Steam sterilizing or autoclaving is the exposure of waste to saturated steam under pressure in a pressure vessel or autoclave. Autoclaves should meet the requirements of internationally agreed standards. Autoclavable waste containers should be of a design and material, which allows steam to penetrate the load. They should have

sufficient stability and resistance to the maximum operating temperature and pressure.

84. In addition to any devices such as gauges or indicators which measure and record the basic operating criteria (e. g. temperature, vacuum, pressure), a biological or chemical indicator should be placed in the waste load for validation to indicate that the necessary sterilization conditions have been achieved. The operational parameters, e. g. time, pressure and temperature, should be maintained and checked during the sterilization cycle.
85. While the temperature and time depend upon the total volume of the material to be treated, the number and type of organisms and their resistance against steam, it is necessary first to remove all the air from the autoclave, the waste and the waste containers to ensure that the required sterilization temperature will be maintained. In the case of closed containers included in waste material, the validation (with biological indicators) should take place within the material being sterilized. Sterilization should commence only when the air has been removed from the autoclave and the operating temperature has been reached.
86. The potential of complete air removal is affected by factors such as the type of waste, the amount of waste, the packaging, the water content of the waste and the form and material of the container. The whole treatment process, including loading, the load, the suitability of the packaging or the container, air removal and filtration of the removing gas and liquid effluent discharge should be validated.
87. A record should be retained of all monitoring, maintenance and performance tests carried out on the autoclave together with a logbook or similar record of all routine disposals including the temperature charts and details of the load. When appropriate, air removed from the autoclave should be discharged into the environment after passing through a microbiologically validated filter.
88. Details of sterilization procedures, including the operational parameters and conditions, should be written down as a standard operating procedure document or operating manual which is to be used by all waste handlers. The document should be kept under review. A suitable biological indicator for steam sterilization is the spores of Bacillus stearothermophilus. Autoclaving may not change the visible appearance

of the waste and it may be necessary to distinguish treated from untreated waste by careful removal or obliteration of biohazard warning labels from treated containers or by labeling such containers as “autoclaved” or “sterilized”.

89. Alternatively, chemical indicators may be added to the load to indicate that the load has been autoclaved. Aesthetic concerns may require that the autoclaved waste is further treated to render it acceptable for final disposal, e.g. if the waste contains human or animal material or tissue. Autoclaving may not remove or reduce the non-biological hazards arising from the presence of chemical or physical agents or other materials in the waste.

7.6.1.2 Dry heat sterilization

90. Dry heat sterilization is the exposure of the waste to heat at a temperature and for a time sufficient to ensure sterilization of the entire waste load. The sterilization process should be monitored by the addition of a suitable indicator or measuring device to the waste load, and where appropriate by monitoring the organism(s) present in the waste. The sterilizing unit or equipment should incorporate a suitable thermal cut-out device which is independent of the device used for indicating or monitoring.

7.6.1.3 Chemical disinfections/sterilization

91. This method involves the exposure of waste to chemical agents which possess antimicrobial activity. General disinfectants may not inactivate organisms such as spores, some fungi and viruses and should not be used as the principal treatment methods unless thermal procedures are inappropriate because of the nature of waste or contaminated material. Thermal sterilization should be given preference over chemical disinfections for reasons of efficiency and environmental considerations.
92. The choice of an appropriate chemical agent and conditions of use should be determined by the risk assessment, taking into account the identity of the organism(s) to be treated, the nature of the waste and the presence of organic, protein

or particulate matter, and the nature of the surfaces, items or equipment which will be exposed to the chemical disinfectant.

93. Chemical agents should be used at the manufacturers' recommended concentrations and exposure times according to the requirements and conditions of use. The chemical agent selected should be compatible with other substances or material that may be present in the waste load so that its efficiency is not reduced, and also to ensure that toxic or hazardous products are not thereby formed or released. The efficiency of any chemical agent against a particular organism or type of organism may be confirmed by reference and adherence to manufacturers' data and instructions. Ethylene oxide, formaldehyde (alone or with low-temperature steam) and certain other agents may be used as gaseous fumigants, particularly for equipment and items that should be treated in situ. This method can also be used for the disinfection of body fluids and excreta before being released to the sewer system if no thermal treatment is available.

7.6.1.4 Other treatment/disposal methods

94. The options available for the treatment/disposal of waste and waste effluent which cannot be recycled or reused are incineration and landfill.

95 Other waste treatment methods are available but are not yet validated for general use and have only limited application. These include irradiation (e. g. with microwave, gamma and ultraviolet radiation) and other treatment methods (e. g. encapsulation and filtration). If such methods are used, validation and monitoring procedures should be performed.

96 The selection of an appropriate option should be based on a number of considerations, including:

(a) The nature of the waste and its intrinsic hazard;
(b) Whether the waste has been inactivated by a reliable and validated method;
(c) The aesthetic acceptability of the discharged waste;
(d) The potential deleterious effect of the discharged waste on the environment;

(e) The ease and reliability of the disposal method;

(f) The disposal and other costs;

(g) The general occupational hazards and risks to waste producers, handlers and operators;

(h) The overall impact of the disposal or discharge plant or equipment on the local and general environment.

7.6.1.5 Incineration

97. Incineration can be used as one important method for the treatment and decontamination of biomedical and health-care waste. Oxidation at high temperature converts the organic compounds into their gaseous oxides, mainly carbon dioxide and water. Inorganic components are mineralized and converted into ash, unless they pass into the flue gas.

98. Depending on the type of incinerator, the following objectives can be achieved:

(a) Destruction of pathogens;

(b) Reduction of the hazard and pollution potentials as far as possible;

(c) Reduction of volume and quantity;

(d) Conversion of remaining residues into a form which is utilizable or suitable for landfill;

(e) Use of the released heat.

99. For reasons of emission control and operational safety and reliability, it is desirable to incinerate the biomedical and health-care waste from as many hospitals as possible in one central unit. In specific cases, even smaller separate incinerators may be justified. With a view to minimizing the environmental impact of incineration plants, emissions in the air, water and soil shall be reduced by the use of effective and advanced incineration and emission control techniques under technically and economically viable conditions, taking into account the location of the plant.

100. Incineration leads to a significant reduction of the volume and quantity of the treated waste. Waste which has not been previously treated to inactivate it or to render it

safe should be incinerated in a plant suitably designed and operated for the destruction of biomedical and health-care waste or other hazardous waste. If biomedical and health-care waste can be incinerated only in inadequate conditions (low temperature, inadequate emission control system), waste fractions like cytotoxic drugs, chemicals, halogenated materials or waste with a high content of heavy metals (batteries, broken mercury thermometers, etc.) should not be consigned to such an incinerator.

7.6.1.6 Landfill

101. To date, there is no adequate risk assessment of the use of landfills for untreated biomedical and health-care waste which may contain infectious organisms and hazardous chemicals. Best practice would require that any landfill used for biomedical and health-care wastes be engineered and secured (specially engineered landfill).
102. There are ongoing health and safety issues (and hence legal implications) associated with disposal of untreated biomedical and health-care wastes. With the availability of suitable landfill sites being reduced, the physical problem of disposing of large volumes of waste must be considered.
103. Disposing of infectious wastes into a landfill greatly increases the risks to human health and the environment of exposure to infection from this source. If the waste is disturbed by any means, or not properly covered, further risks will arise. It is therefore not good practice to dispose of infectious waste directly into a landfill. To guard against these risks, where landfill is the only available option, infectious wastes should be treated in order to destroy/remove their infectivity, preferably at the site of generation of the waste. This can be done by using known effective techniques such as autoclaving, microwave treatment, dry heat sterilization or chemical disinfection.
104. The following is a description of the features of a “specially engineered landfill” which are necessary for the safe and environmentally acceptable disposal of biomedical and health-care wastes:

(a) Impermeable clay and/or synthetic liner to minimize groundwater pollution;
(b) Collection, treatment and environmentally acceptable disposal of leachate;
(c) Monitoring systems for groundwater surrounding the site to check integrity of leachate contamination protection;
(d) Daily and final covers to restrict the potential for disease vectors, reduce odours and reduce water infiltration;
(e) Monitoring for gas migration in the unsaturated zone surrounding the site, together with control measures if necessary.

105. It is generally accepted that untreated biomedical and infectious health-care waste disposal into landfills is not "best practice". Where health-care wastes are disposed of at a specially engineered landfill site, the following should apply:

(a) Biomedical and infectious health-care wastes should be deposited at the lowest edge of the working face of the landfill or in an excavation;
(b) An operator or representative should supervise immediate cover with solid waste or cover soil to a depth of at least 1 metre;
(c) Any compacting should be only on the cover material;
0 (d) Biomedical and health-care disposal areas should be at least 3 metres from the proposed
1 edge of the landfill;
(e) No access of unauthorized persons to the site of the landfill;
(f) Any biomedical and health-care waste should be at least 2 metres below the final surface of the landfill i.e. not in the final lift.

106. The following biomedical and hazardous health-care wastes are generally considered unsuitable for disposal at a landfill site:

(a) Identifiable body tissue;
(b) Cytotoxic wastes;
(c) Pharmaceutical, laboratory or domestic chemicals;
(d) Radioactive wastes;
(i) Infectious wastes.

107. Landfill is recognized as the terminal site for all wastes including ash from incineration and residues from other processes. Some residues of the treatment process residues may contain chemicals that could interact with other materials in a landfill. Consideration needs to be given to the stability and nature of such process residues and any potential impacts prior to disposal into a landfill. Some of the treatment processes may also contribute excess water to the landfill. Resultant leachate considerations require that engineered landfills should be used to ensure maximum environmental protection.

108. The application of treatment and disposal methods to biomedical and hazardous health-care waste categories is shown in table 4. It provides a broad overview of suitable treatment and disposal methods for the different health-care waste categories.

Table 4 Overview of disposal and treatment methods suitable for hazardous health-care waste categories

Method Waste types	**Pyrolytic incineration/two-stage incineration (with after burning zone, e.g. rotary kiln)**	**Single-chamber incineration or municipal waste incineration**	**Chemical disinfection**	**Autoclavewet-thermal treatment**	**Microwave irradiation**	**Encapsulation (e.g. with concrete, gypsum, etc. only minimal programmes)**	**Specially engineered landfill**
Infectious waste	**Yes**	Yes (special requirements, like direct	Small quantities	**Yes**	Yes (wet waste)	No	Yes b/
Anatomic	**Yes**	Yes b/	No	c/	c/	No	Yes b/
Sharps	**Yes**	Yes b/	Yes	Yes	No	Yes	Yes b/
Pharmaceutical waste	Small quantities or **(at high temperature >850 °C)**	Yes b/	No	No	No	Yes	Small quantities
Cytotoxic waste	**At high temperature >850 °C**	No	No	No	No	No	In exceptional cases if special requirements
Chemical waste	Small quantities	c/	No	No	No	No	In exceptional cases if special requirements are met
Radioactive waste d/	Low-level infectious waste	Low-level infectious waste	No	No	No	No	No

b/ Not the preferred method.

c/ Uncertainty still prevails as to the unsuitability of the disposal operation. There could be cases where the disposal option could be of safeguards are in place. d/ Only if the clearance levels set by IAEA are met. Note: Entries in bold indicate preferred methods.

7.7 Responsibility (including emergency response and contingency plan)

7.7.1 Assignment of responsibilities

109. The proper management of biomedical and health-care waste is largely dependent on good administration and organization. These should be supported by adequate legislation and financing as well as active participation of trained and informed staff.

110. The head of the hospital /clinic should establish a waste management team to develop a waste management plan. The head of the establishment should formally appoint the members of the waste management team in writing, informing each of them of their duties and responsibilities as outlined below.

111. In institutions where no direct patient care service is available, such as medical research institutions, the head of the establishment should use his discretion to appoint members of the waste management team. Depending on the availability of relevant staff, the post of waste management officer may be assigned to the hospital engineer, the hospital manager, or any other appropriate staff member, at the discretion of the head of the hospital.

7.7.1.1 Duties of the head of the hospital

112 The head of the health-care establishment is responsible for the following tasks:

(a) Formation of a waste management team to formulate a written waste management plan for the hospital; within this plan, the duties and responsibilities of all members of staff, both clinical and non-clinical, shall be clearly defined in respect of the handing of health-care waste. A clear line of accountability shall be indicated in both the clinical and non-clinical management structures;

(b) Designation of the waste management officer (WMO) to supervise and coordinate the waste management plan; such an appointment shall not relieve him of his overall responsibilities in ensuring that biomedical and health-care

and other waste are disposed of in accordance with the national guidelines;

(c) Keeping the management plan up to date;

(d) Allocation of sufficient financial and manpower resources to ensure efficient operation of the plan for example, he has to ensure that adequate manpower is assigned to the WMO to ensure efficient operation of the waste management plan;

(e) Ensuring that monitoring procedures are incorporated to assess the efficiency and effectiveness of the disposal system and to effect the continuous improvement and updating of the system where appropriate;

(f) Appointing a successor immediately in the event of personnel leaving key positions in the waste management team, or assigning temporary responsibility until a successor is appointed;

(g) Ensuring adequate training for key staff members; he shall designate staff responsible for coordinating and implementing training courses;

(h) Ensuring adequate emergency response planning.

7.7.1.2 Duties of the waste management officer (WMO)

113. The WMO is responsible for the day-to-day operation and monitoring of the waste management system. He shall have direct access to all members of hospital staff to facilitate his control function. The WMO will be directly responsible to the head of the hospital. He shall liaise with the infection control officer, the pharmaceutical officer and the radiation protection officer to familiarize himself with the correct procedures for handling and disposing of pathological, pharmaceutical, chemical and radiological wastes.

114. Concerning waste collection, the WMO should undertake the following tasks:

(a) Controlling internal collection of waste containers and their transport to the central waste storage facility of the hospital, on a day-to-day basis;

(b) Ensuring the supply of items required for waste collection and handling; he should liaise with the supplies department to ensure that an appropriate and acceptable range of health-care waste bags and containers, protective

clothing and collection trolleys are available at all times;

(c) Ensuring that hospital attendants and ancillary staff immediately replace used bags and con tainers with the correct new bag or container as appropriate;

(d) Directly supervising hospital attendants and ancillary workers assigned to collect and trans port health-care waste.

115. Concerning waste storage, the WMO should:

(a) Ensure the correct use of the central storage facility for health-care waste at the health-care establishment, which shall be fenced with a lock on the entrance; hospital attendants and ancillary staff should always have immediate access to the storage area;

(b) Prevent unsupervised dumping of waste containers on the hospital grounds, even for short periods of time.

116. To supervise evacuation or disposal of the waste, the WMO should:

(a) Coordinate and monitor all waste disposal operations;

(b) Monitor methods of transportation of wastes on-site and off-site and ensure that wastes collected from the hospital are transported by an appropriate vehicle to the designated incinerator;

(c) Ensure that waste is not stored on the hospital grounds for periods longer than specified in the guidelines and that the required frequency of collection is maintained; he should therefore liaise with the transport organization, which may be the local authority or a private contractor.

117. For staff training and information, the WMO should:

(a) Liaise with the matron and the hospital supervisor to ensure that the nursing staff and medical assistants are familiar with their responsibilities for segregation and storage of waste and of the limited responsibilities of hospital attendants and ancillary staff in the handling and trans port of sealed waste bags and containers;

(b) Liaise with departmental heads to ensure that all doctors and other qualified clinical staff are aware of their responsibilities regarding segregation and storage of waste and of the limited responsibilities of hospital attendants and

ancillary staff in the handling and transport of sealed bags and containers;

(c) Ensure that hospital attendants and ancillary staff are not involved in waste segregation and that they handle only waste bags and containers sealed in the correct manner.

118.For incident management and control, the WMO should:

(a) Ensure that emergency procedures are available and in place at all times and that personnel are aware of the appropriate action to be taken;

(b) Investigate or review incidents reported during the handling of health-care waste.

7.7.2 Emergency response

119. For health-care establishments, spills of infectious or other hazardous material or waste are probably the most common emergencies related to hazardous material. Basically, the same response procedures are applied, regardless of whether the spills are from material or waste. The response to emergencies should ensure the following:

(a) The waste management plan should be respected;

(b) Contaminated areas should be cleared and, if necessary, disinfected;

(c) The exposure of workers should be limited as much as possible during the operation;

(d) The impact on the environment should be limited to the extent possible.

120. The staff should be well prepared for emergency response, and the required equipment should be easily available at all points in time and within reasonable distance to ensure that an adequate response can be made safely and routinely. The procedures for the different types of emergencies should be written down. For dangerous spills, clean-up should be carried out by designated, specifically trained personnel.

7.7.2.1 Response to injuries

121. A response programme should be established for immediate reaction to injuries or exposure to a hazardous substance. All staff handling biomedical and health-care waste should be trained in dealing with injuries. Such a programme should include the following elements:

(a) Immediate first aid measures, such as cleansing of wounds and skin and splashing of eyes;

(b) Immediate reporting to a responsible designated person;

(c) Retention, if possible, of the item and details of its source for identification of possible infection;

(d) Additional medical care from an accident, emergency or occupational health department as soon as possible;

(e) Medical surveillance;

(f) Blood or other tests if indicated;

(g) Recording of the incident;

(h) Investigation, determination and implementation of remedial action.

7.7.2.2 Dealing with spills

122. Spills usually require only clean-up of the contaminated area. In spills of infectious agents, it is important to determine the type of infectious agent, as some may require immediate evacuation of the area, whereas others require fewer precautions. The more hazardous spills usually occur in laboratories rather than in health-care departments.

123. Spill-cleaning procedures should specify safe handling operations and appropriate protective clothing. An example of such a procedure is provided in box 2. Appropriate equipment for collecting the waste and placing it in new containers, and for disinfection, should be provided. Table 6 provides an example of the required items.

Box 2 Example of general procedure for spill-cleaning

(a) Evacuate the contaminated area;
(b) Eye and skin decontamination (disinfection) of exposed personnel should take place immediately;
(c) Inform the designated person (usually the waste management officer);
(d) Determine the nature of the spill;
(e) Evacuate all the people not involved in cleaning up if agent is particularly hazardous;
(f) Provide first aid and medical care to injured persons (see response to injuries);
(g) Secure the area to prevent additional exposure of persons;
(h) Provide adequate clothing to personnel involved in cleaning up;
(i) Limit the spread of the spill;
(j) Neutralize or disinfect the spill or contaminated material if indicated;
(k) Collect the spill and the contaminated material; Sharps should never be picked up by hand, but with tools, e.g. pans or brushes. Spilled material and contaminated items used for cleaning should be placed into the appropriate bags or containers;
(l) Decontaminate or disinfect the area, and absorb; (m)Rinse the area, and absorb;
(n) Decontaminate or disinfect the used tools;
(o) Take off protective clothing and decontaminate or disinfect it if necessary;
(p) Seek medical care if exposure to hazardous material has occurred during the operation.

Table 5 Example of a list of items for spillage-cleaning

Action	Tools or items
Approaching the spillage	Protective equipment
Containing the spillage Neutralizing or disinfecting the spillage (if necessary)	Absorbent material (e.g. absorbent paper, towels, gauze pads) For infectious material: disinfectant a/
	For acids: sodium or calcium carbonate or other base
	For cytotoxic material: special chemical degradation substances
	For bases: citric acid powder or other acid
Collecting the spillage	For liquids: absorbent paper, gauze pads, wood shavings, calcium bentonite, diatomaceous earth
	For solids: forceps, broom, dust pan or shovel
Containment for disposal	Mercury: mercury sponge or vacuum pump
	Plastic bag (red, yellow or brown, as appropriate), sharps container
Decontamination or disinfection of the area	For infectious material: disinfectants a/
	For hazardous chemicals: suitable solvent or water

Source: WHO.

a/ Such as bleaching powder, which is a mixture of calcium hydroxide, calcium chloride and sodium hypochlorite, used in the powder form or in solution of varying dilutions (1:1 to 1:100), depending on the nature of the spilled material.

7.7.2.3 Reporting accidents and incidents

124. All waste management staff should be trained in emergency response and made aware of the correct procedure for prompt reporting of accidents and incidents. Accidents or incidents, including near-misses, spillages, damaged containers, inappropriate segregation or any incidents involving sharps should be reported by the WMO if waste is involved, or otherwise to another designated person. The report should include:
    (a) The nature of the accident or incident;
    (b) Where and when it occurred;
    (c) Which staff were directly involved;
    (d) Other relevant circumstances.
125. The incident should be investigated by the responsible officer (WMO in cases of waste) to establish its causes and if possible action taken to prevent recurrence. Records should be kept.

8. Waste management auditing

126. The purpose of a waste audit is to help a hospital to determine which initiatives will be most beneficial. It does this by developing a detailed picture of the current status of waste generation and disposal for the hospital. It then identifies potential areas for improvement and develops action plans for each area. The ultimate impact of environmental action is judged in terms of a positive impact on the environment and cost savings for the institution.
127. There are three major steps involved in the waste audit. They include information gathering, waste stream analysis and the development of action plans. First, a waste audit must collect information on the following:
    (a) The total volume of each type of waste generated by the entire hospital;
    (b) The volume of each type of waste generated by each specific area in the hospital;
    (c) The current costs associated with the disposal of each type of waste;
    (d) The waste management initiatives currently in place. Typically, these include reuse, reduction, recycling and recovery programmes.

128. Much of the information can be found in purchase records and requisitions, estimates made by the facility, and a search of the literature, and from interviews with staff concerning their experience in handling waste in the facility.

129. The next step in the waste audit is to proceed with the sorting and weighing of the components of the waste stream or to conduct a waste stream analysis. This second task will be referred to as the comprehensive study of general waste. This task is usually accomplished by personnel from the housekeeping staff over a period of two weeks. For safety reasons, no types of waste that could threaten the staff in any way are sorted - that is, biomedical waste, sharps, chemicals and so on are weighed only.

130. The third stage of a waste audit is to develop action plans for reuse, reduction, recycling and recovery initiatives. This involves analysing the data collected and, in the first part of the audit, identifying potential areas of opportunity. Each of these areas is then investigated to identify potential benefits associated with realistic initiatives.

131. For each area where benefits can be achieved, an action plan is developed to implement the initiative. The plan identifies where existing systems and work habits can be modified and where new systems could be introduced to achieve the desired results. While the action plan covers the entire hospital, the recommendations for action may focus on specific areas within the hospital where the most benefit can be gained.

132. Hospital managers or personnel making decisions need specific information about which types of waste are being generated, the volumes of these wastes and the locations of their generation. This information allows initiatives to be targeted to the specific hospital locations and/or types of waste for which the most significant benefits can be obtained. For example, waste recycling is most effective when the segregation of recyclables from non-recyclables occurs at the point where the waste is generated. By the time waste has reached the disposal hopper or compactor, it is too late to consider waste reduction, reuse or recycling options. Knowing the specific locations where most of the recyclable waste is generated permits assessment of the recycling opportunity and the development of appropriate plans.

9. Capacity-building

133. The objectives of a comprehensive capacity-building strategy could include the following:

(a) To provide a basic legal, technical and logistical framework;

(b) To introduce options for the sound management of biomedical and health-care wastes;

(c) To develop a logical framework for the completion of national biomedical and health-care waste profiles and the preparation of national health-care waste plans.

134. The elements of a comprehensive capacity-building programme are:

(a) Establishment of a committee for the environmentally sound management of bio medical and health-care wastes; Completion of national (local) health-care waste profiles;

(b) Development of a national (local) health-care waste management programme, including a technical and financial plan;

(c) Preparation of national regulations on the environmentally sound management of biomedical and health-care wastes;

(d) Undertaking of training programmes for health-care personnel, waste disposers, enforcement institutions, etc., including development of decision-supportive tools for policy makers and waste handlers.

9.1 Education and training of personnel of health-care establishments

135. A biomedical and health-care waste management policy is not effective unless it is applied daily by all involved staff in a consistent and accurate way. Training employees in implementing the policy is a critical step for a successful biomedical and health-care waste management programme. The overall aim of the training is to develop in the participants awareness of health, safety and environmental protection

issues relating to biomedical and health-care waste and how these can affect them in their daily work. It should highlight the responsibilities and role of the employees in the overall management programme. Health and safety at the workplace and environmental awareness are the responsibility of everyone.

136. All hospital personnel, including senior medical doctors, should be educated with a view to convincing them of the importance of the comprehensive health-care waste management policy of the hospital and of its value for the health and safety of everyone. This is the best way to obtain their collaboration in the implementation of this policy.

137. Training activities should be designed for and targeted at four main categories of personnel: managers and regulatory staff, e.g. safety advisers; medical doctors; nurses and assistant nurses; and hospital cleaners, waste handlers and drivers.

138. Medical doctors may be educated through high-level workshops chaired by the head of the hospital, while general hospital staff may be educated through formal seminars. The training of waste managers and/or regulators does not usually take place in the hospitals but in public health schools or university departments of hospital engineering.

139. Education programmes should include: information on each aspect of the health-care waste policy and its justification; informing each hospital staff member of his or her responsibilities and role in implementing this policy; and technical instructions on the application of the practices relevant to the target group.

140. As the best way of learning is probably through practice, hands-on training in small groups should be considered where relevant. Testing the participants at the end of the course, by simple true/false or multiple-choice questions, often provides an incentive for learning and gives the course organizers an idea of the actual knowledge acquired by the participants. The more detailed course contents are presented below.

141. The instructors should have experience in teaching and training, be familiar with the hazards and practices of biomedical and health-care waste management and, ideally, have experience in waste handling.

142. Periodic repetition of courses will refresh the acquired knowledge, provide

orientation for new employees and for existing employees with new responsibilities, and provide continuous updating on policy changes. Follow-up training will provide data about the retention of information and the need for refresher courses.

9.1.1 Responsibility for training

143. The head of the health-care establishment should appoint a responsible person such as the infection control officer, the doctor for hygiene or the WMO for all training related to segregation, collection, storage and disposal of health-care waste. He should ensure that staff at all levels are aware of the hospital waste management plan and policy and of their responsibilities and obligations within the framework of this plan and policy. A record of all training sessions should be kept. The content of the training programmes should be periodically reviewed and updated where necessary. For smaller sources of biomedical and health-care waste, a central training function could be established at the regional health authority.

9.1.2 The training package

144. A training package could be developed by the national government agency responsible for the disposal of biomedical and health-care wastes.

145. The training package on biomedical and health-care waste should be suitable for various types of health-care establishment, including government hospitals, teaching hospitals, dental hospitals, polyclinics, health centres, health-care research institutions, clinical laboratories and other establishments where health-care wastes are generated. Such a training package would also be useful for educational establishments and the sectors providing services for biomedical and health-care waste disposal. The package should contain numerous illustrations, such as drawings, figures, photographs, slides or overhead transparencies.

9.1.3 Selection of participants

146. The ideal number of participants for a training course is 20 to 30 because larger groups may render discussions and exercises difficult. Training courses should be

organized and targeted for all personnel categories. The discussions may, however, be easier if the group is composed of personnel from various disciplines (e.g. supervisors, medical and nursing staff, laboratory staff, engineers, ancillary staff) or if the group is laced with one or two medical assistants and nurses.

147. It may be beneficial to include senior administration staff and heads of department in certain training groups to demonstrate their commitment to the policy to other staff members and to show that the policy is the responsibility of all personnel of health-care establishments. Line managers may find it worthwhile to run the training sessions themselves, with their own personnel attending.

9.1.4 Training recommendations

9.1.4.1 Training recommendations for personnel providing health-care

148. As mentioned above, the content of the training course should provide an overview of the waste management policy and its inherent rationale and provide information on relevant practices for the targeted group. For example, personnel providing health-care will mainly be informed that with respect to waste segregation practices:

(a) Care should be taken while removing needles from syringes during operations which require this;

(b) In no event should the staff correct segregation mistakes by removing items from a bag or container once disposed of, or by placing a bag into a bag of another colour;

(c) Hazardous and general waste should not be mixed. However, where this has occurred, the mixture should be treated as health-care risk waste;

(d) Nursing and clinical staff should ensure that adequate numbers of bag holders and health-care waste containers are provided for the collection and on-site storage of medical waste in the wards, clinics, operating theatres and other sources of waste generation. These on-site receptacles should be located close to the source of waste generation.

149. Upon completion of the training course, the members of staff should be aware of their responsibilities.

9.1.4.2 Training recommendations for waste-handling staff

150. Relevant training chapters may constitute a basis for the training course. Topics covered may include the waste management policy, health hazards, on-site transportation, storage, safety practices and emergency response. The attention of members of staff who routinely handle biomedical and health-care waste may decrease with time, which will increase the risk of injury. Periodic training is therefore recommended.

9.1.4.3 Training of health-care waste management operators

151. The minimal training requirements for waste management operators should include the following:

(a) Information on the risks associated with the handling of biomedical and health-care waste;

(b) Training on the procedures for dealing with spillages and accidents;

(c) Instructions on the use of protective clothing.

152. The training needs will depend on the type of operations the staff perform. Depending on the duties, training on specific areas (e.g. operation of incinerators, waste transportation) will be required.

9.1.4.4 Training for members of staff who transport waste

153. The health-care establishment may either transport the waste itself or contract an authorized waste transporter. Drivers and waste handlers should be specifically trained and be aware of the nature and risks of the waste being transported. In particular, transport staff should be trained in the following issues, and be able to carry out the procedures and respect the instructions without any help from others:

(a) Correct procedures for handling, loading and unloading waste bags and containers;

(b) Procedures for dealing with spillages or accidents; for these procedures, written instructions should be available in the vehicle;

(c) Protective clothing and footwear should be worn at all times.

154. The vehicles dedicated to waste collection should at all times carry a supply of plastic bags, protective clothing, cleaning tools and disinfectants to clean and disinfect any spillage which may occur during loading, transport or unloading. Documentation and recording of health-care waste, e.g. by using a consignment note system, are necessary because they make it possible to trace the waste from the point of collection to the final disposal facility. The head of the health-care establishment should liaise with the transport contractor to ensure that the waste collection crew is well trained. Untrained personnel should never be allowed to handle biomedical and hazardous health-care waste.

9.1.4.5 Training of incinerator operators

155. Operation of incinerators requires qualified incinerator operators. It should be remembered that the availability of such operators in certain regions should be verified before purchasing high-technology incinerators. If qualified operators are not available, health-care establishments should either resort to alternative health-care waste disinfection technologies or contract the incineration out through a regional facility.

156. Incinerator operators should have received at least secondary technical education. They should be specifically trained in the following subjects:

(a) Overall functioning of the incineration facility, including heat recovery and flue-gas cleaning technologies, if they exist;
(b) Health, safety and environmental implications of their operations;
(c) Technical procedures for the operation of the plant;
(d) Emergency response, e.g. in case of equipment failures, alarms;
(e) Maintenance of the plant;
(f) Surveillance of ash quality and emissions according to the specifications.

9.1.4.6 Training of operators of specially engineered landfill sites

157. The training of landfill operators is important for limiting subsequent risks presented by buried biomedical and health-care waste, both in relation to preventing scavenging and to protecting the quality of water. Operators should be trained in the following areas:

(a) Health risks related to biomedical and hazardous health-care waste;

(b) Hazards related to sorting of this type of waste, which should in no event be practised by the landfill operators or other people;

(c) Handling of biomedical and health-care waste by drivers or site operators, which should be limited to a minimum;

(d) Use of protective equipment and personal hygiene;

(e) Application of safe procedures to dispose the wastes into a landfill;

(f) Procedures for emergency response.

Annex I: Glossary/terminology

Activity	Disintegration of an amount of a radionuclide in a particular energy state at a given time per time interval at a given moment.
Air pollution	The presence of a material or substance in the air which may be harmful to either the natural or human environment, which includes any material present in sufficient concentrations for a sufficient time, and under certain circumstances, to interfere significantly with the comfort, health or welfare of persons or with the full use and enjoyment of property.
Air quality standards	The level of pollutants that cannot by law be exceeded during a specified time in a defined area.
	Solid or liquid waste arising from health-care (medical) activities such as diagnosis, monitoring, treatment, prevention of disease or alleviation of handicap in humans or animals, including related research, performed under the supervision of a medical practitioner or veterinary surgeon or another person authorized by virtue of his professional qualifications.
Bottom ash	The non-airborne combustion residue from burning fuel and other materials in an incinerator. The material falls to the bottom of the incinerator and is removed mechanically.
Capacity	The quantity of solid waste that can be processed in a given time under certain specified conditions, usually expressed in terms of mass per 24 hours.
Chemical waste	Wastes generated from the use of chemicals in medical, veterinary and laboratory procedures, during sterilization processes and research.
Collection	The act of removing accumulated containerized solid waste from the generating source. Private collection of solid and liquid waste by individuals or companies from residential, commercial, health facility or industrial premises; the arrangements for the service are made directly between the owner or occupier of the premises and the collector.
Cytotoxic waste	Material which is visibly contaminated with a cytotoxic drug during the preparation, transport or administration of cytotoxic therapy.

Decontamination	The process of reducing or eliminating the presence of harmful substances such as infectious agents so as to reduce the likelihood of disease transmission from those substances.
Disinfection	Process of reducing the viability of micro-organisms by various physical and chemical methods.
Emergency	A situation created by an accidental release or spill of hazardous chemicals or infectious material which poses a threat to the safety of workers, residents, the environment or property.
Exposure	The amount of radiation or pollutant present in a particular environment (i.e. human, natural) which represents a potential health threat to the living organisms in that environment.
Fly ash	The finely divided particles of ash entrained in the flue gases arising from combustion. The particles of ash may contain incompletely burned material. The particles are frequently glassy spheres but may also be crystalline or even fibrous in structure.
Health-care waste	See biomedical and health-care waste.
Human tissue	The tissue, organs, limbs, blood, and other body fluids that are removed during surgery and autopsy.
Incineration	The controlled burning of solid, liquid or gaseous combustible wastes to produce gases and residues containing little or no combustible material.
Irradiation	Exposure to radiation of wavelengths shorter than those of visible light (gamma, x-ray or ultraviolet) for medical purposes, the destruction of bacteria in milk or other foodstuffs or initiation of polymerization of monomers or vulcanization of rubber.
Liquid wastes	Any waste material that is determined to contain “free liquids” - liquids which readily separate from the solid portion of waste under ambient temperature and pressure.
Monitoring	Periodic or continuous surveillance or testing to determine the level of compliance with statutory requirements and/or pollutant levels in various media or in humans, animals and other living things.
Off-site facility	A clinical and related waste treatment, storage or disposal facility that is located away from the generating site.

On-site facility	A clinical and related waste treatment, storage or disposal facility that is located on the generating site.
Pharmaceutical waste	Wastes from the production, preparation and use of pharmaceutical products.
Pyrolysis	The decomposition of organic material by heat in the absence of or with a limited supply of oxygen.
Radioactive waste	Material contaminated with a radioisotope which arises from the medical or research useof radionuclides. It is produced, for example, during nuclear medicine, radio immunoassay and bacteriological procedures, and may be in a solid, liquid or gaseous form.
Residual wastes	Those materials (solid or liquid) which still require disposal after the completion of a treatment or resource recovery activity, e.g., slag and liquid effluents following a pyrolysis operation and the discards from front-end separation systems.
Sanitation	The control of all the factors in the physical environment that exercise or can exercise a deleterious effect on human physical development, health, and survival.
Sharps	All objects and materials which are closely linked with health-care activities and pose a potential risk of injury and/or infection.
Sterilization	A process used to reach a state free of viable micro-organisms. Note that in a sterilization process, the nature of microbiological death or reduction is described by an experimental function. Therefore, the number of micro-organisms that survive a sterilization process can be expressed in terms of probability. While the probability may be reduced to a very low number, it can never be reduced to zero.
Waste minimization	The application of activities such as waste reduction, reuse and recycling to minimize the amount of waste that requires disposal.
Waste segregation	The process of keeping source-separated wastes apart during handling, accumulation (interim storage), storage and transport to assist resource recovery and to ensure that appropriate designated treatment and/or disposal methods are utilized. Waste segregation should be practised by both generators and waste-handling companies for efficient waste management.

Annex II: Examples of specific waste reduction, reuse and recycling activities

Purchasing practices

- Purchase recycled content material where appropriate (e.g. office paper, envelopes, toilet tissue, paper towels) and look for environmental labels. Work with purchasing committees to determine which products may be suitable
- Work with suppliers to have oversized packaging materials returned or recycled
- Use building construction products with recycled content materials (e.g. drywall, asphalt)
- Use environmentally responsible vehicles and maintenance products (e.g. propane as fuels, re-refined oils, retreated tyres, recycled antifreeze).

Reduction

- Use two-sided photocopying
  Use electronic mail (i.e. personal computers or phone messages)
  Buy in bulk (e.g. food and drink containers in the cafeteria and soaps and detergents in house keeping)
- Avoid products with excess packaging and work with suppliers to reduce it
- Reroute publications such as magazines, newspapers and journals
- Circulate memos or documents
- Use bulletin boards for posting announcements
- Single-space texts
- Use two-way envelopes for billing
- Make sure staff understand how to use equipment to reduce wastage
- Use the reduction feature on your copier to fit more than one paper per page
- Use permanent tape dispensers, not disposable ones
- Use refillable pens instead of disposable ones
- Purchase durable equipment, furnishings and supplies
- Install energy-efficient appliances (e.g. lighting)
- Use water-saving devices
- Turn off lights and office equipment when not in use
- Use incinerators that meet the new discharge guidelines and have an energy recovery system

- Use computer fax software to send facsimiles without making hard copies
- Use non-solvent liquid scintillation cocktails in laboratories
- Use less hazardous radioactive materials where appropriate
- Develop microtesting procedures to reduce chemical usage
- Make sure biomedical waste is properly segregated from general waste to reduce disposal costs and increase materials for recycling
- Explore opportunities to reduce formalin usage in sample analysis by replacing with cold, physiological saline solutions where appropriate
- Replace formalin solutions with commercially available, less toxic cleaning solutions in dialysis machines.

Recycling

- Newspapers and telephone books can be given to farmers or charitable organizations as bedding

- Give used towels and rags to rag recyclers · Use plain-paper fax machines; the paper is recyclable and the messages will not fade

- Recycle juice bottles or baby formula; juice and food material containers; newspapers; and plastic containers (e.g. polyethylene containers or other types where appropriate)

- Recycle cardboard with a commercial recycler or through your supplier · Recycle pallets with a commercial recycler or through your supplier · Include pick-up of containers as part of the supplier's role in your contracts

- Work with suppliers to help them design workable packages that are recyclable

- Pool local businesses that recycle material and contract for the services of the same recycler t o reduce pick-up costs

- When purchasing products, ensure that all packages can be returned to the supplier or recycled at your facility

- Use a distribution network to recycle materials back to a central location for better marketing of material

・ Explore waste-recycling options for food waste either as human food, as animal feed either directly or through a commercial processor - or as composting or for vermiculture, and use compost at your facility in landscaping

・ Contract a shredding company that recycles your shredded paper

・ Involve ambulatory patients in waste minimization programmes (e.g. psychiatric and geriatric patients in composting projects)

・ For large waste generators, explore processing equipment such as balers or compactors for recyclable materials

・ Locate markets for recyclable materials which are generated in sufficient quantities, such as office paper, cardboard, plastics, solvents (xylenes, toluenes, CFCs), oils (vegetable and hydraulic) and construction and demolition materials such as drywalls, asphalt, concrete, wood Install silver recovery units for photo processing waste waters

・ Evaluate opportunities for anaesthetic gas recycling.

Reuse

・ Donate used publications to doctors' surgeries, nursing homes or the local library.

・ Reuse worn cloth nappies and towels as rags.

・ Reuse scrap paper for notepads and draft copies.

・ Reuse old envelopes by applying labels (with non-solvent glues) on top of old addresses.

・ Use reusable nappies, incontinence pads and underpads where appropriate.

・ Use reusable urine trays.

・ Use reusable drapes and gowns where appropriate.