16 Minimal programmes for health-care waste management

This chapter summarizes the waste management practices recommended in this handbook and selects the options that are especially suitable for use by establishments that apply minimal programmes or in emergency situations. Typically, these situations include smaller rural health-care establishments or field hospitals, e.g. in refugee camps. The selected practices should ensure that health and safety requirements are met and an acceptable level of hazard protection is achieved. However, the recommendations should not be viewed as a substitute for the longer-term aim of establishing the more rigorous managerial procedures described elsewhere in this handbook.

Implementation of the recommendations should be incremental, i.e. achieved through gradual improvements, but it is of paramount importance that municipal authorities and managers of health-care establishments are made fully aware of the need for proper waste management procedures.

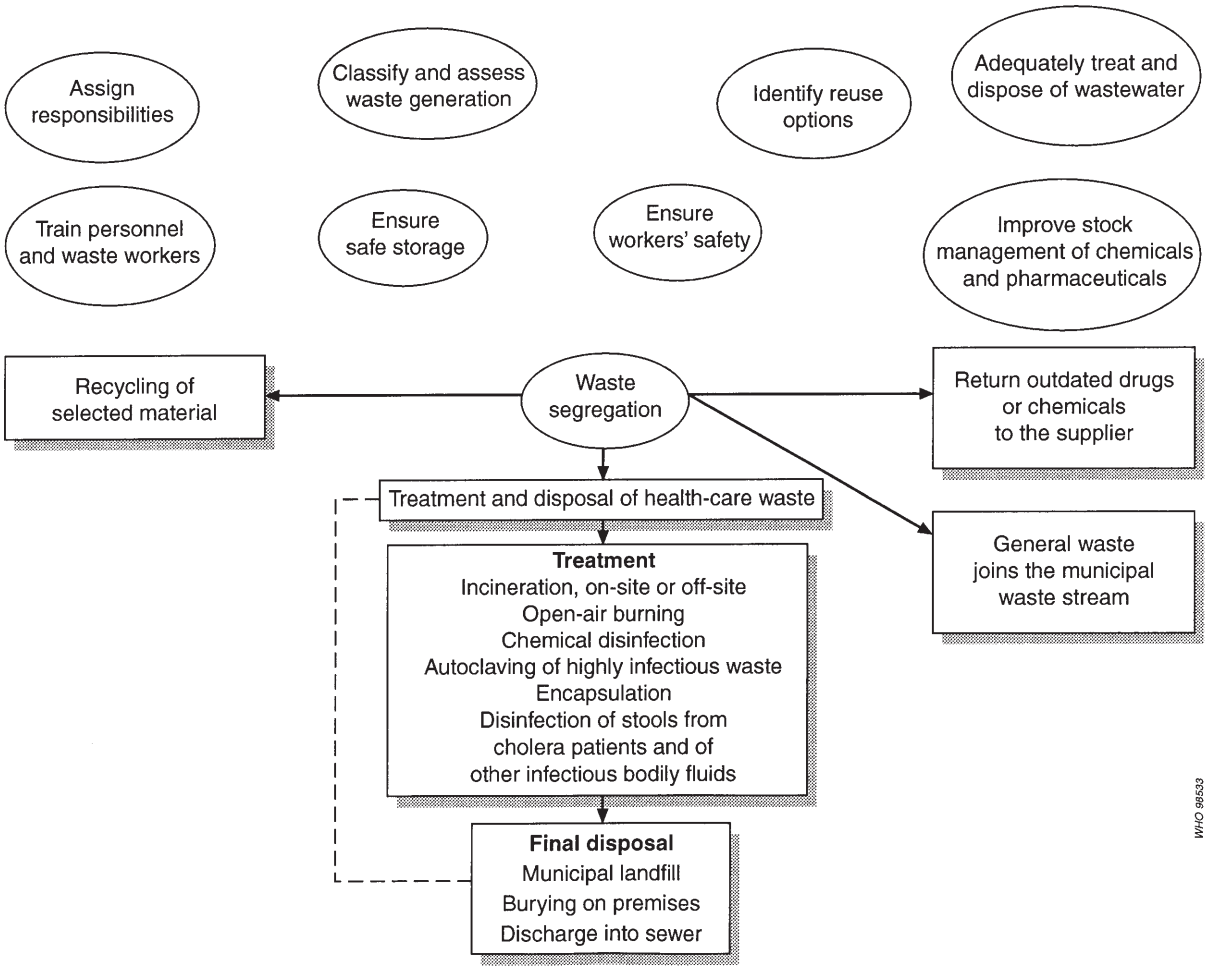
The first step would be the introduction of waste segregation: too often, health-care establishments treat hazardous health-care waste in the same manner as general waste. Separation of sharps may be a good starting point. Specific methods for the disposal of hazardous health-care wastes can then be introduced, followed by efforts to encourage waste minimization and the safe reuse of materials wherever possible.

16.1 Basic principles

The total absence of management measures to prevent exposure to hazardous health-care waste results in the maximum health risk to the general public, patients, health-care personnel, and waste workers. It is therefore emphasized that even very limited waste management measures can dramatically reduce this risk.

Effective confinement of waste and safe handling measures provide significant health protection. For example, burning hazardous health-care waste in open trenches or small furnaces is better than uncontrolled dumping; reducing the amount of hazardous waste by segregation is better than accumulating large quantities; good stock management of chemicals and pharmaceuticals not only reduces waste quantities but also saves purchase costs; proper identification of waste packages warns health-care personnel and waste handlers about their contents. All these measures to reduce risk are relatively simple and cheap and should be considered by any health-care establishment. The principle of "doing something is better than doing nothing" is important and underlies any effort to initiate a system for the management of health-care waste.

Fig. 16.1 Basic steps in health-care waste management in minimal programmes



The basic elements of minimal programmes of health-care waste management are represented schematically in Fig. 16.1. At the local level, the following basic actions should be taken:

- assessment (quantitative and qualitative) of waste production;
- evaluation of local treatment and disposal options;
- segregation of health-care waste from general (or municipal) waste;
- establishment of internal rules for waste handling (storage, colour coding, collection frequency, etc.);
- assignment of responsibilities within the health-care establishment;
- choice of suitable—or better—treatment and disposal options.

16.2 Health-care waste segregation

16.2.1 The waste categories

Three categories of health-care waste are recognized:

- General (non-risk) waste, including uncontaminated waste similar to domestic waste; may represent about 80% of the total waste production from health-care establishments.
- Hazardous health-care waste.
- Highly hazardous health-care waste.

Hazardous health-care waste includes:

- "Usual" infectious waste, excluding sharps but including anatomical or pathological waste, and waste contaminated with human blood or other body fluids, excreta, and vomit. This category typically makes up about 75% of the hazardous health-care waste, or around 15% of the total waste, produced by health-care establishments.
- Chemical and pharmaceutical residues, e.g. cans, bottles, or boxes containing such residues, and small quantities of outdated products.
- Non-recyclable and discarded pressurized containers, which are hazardous only if burned as they may explode. Many undamaged containers may be refilled.

Highly hazardous health-care waste, which should be given special attention, includes:

- Sharps, especially hypodermic needles.
- Highly infectious non-sharp waste, including microbial cultures, carcasses of inoculated laboratory animals, highly infectious physiological fluids, pathological and anatomical waste.
- Stools from cholera patients or body fluids of patients with other highly infectious diseases.
- Bulk quantities of outdated hazardous chemicals, such as strong disinfectants, or significant quantities of waste containing mercury.
- Genotoxic waste, e.g. radioactive or cytotoxic waste, typically used in cancer chemotherapy but not in district hospitals. If minimal waste management programmes are being applied, genotoxic substances should not be used in general hospitals, but may be used in the oncological departments of university hospitals.

16.2.2 Segregation and packaging

Careful segregation and separate collection of hospital waste may be somewhat onerous for hospital personnel but it is the key to safe, sound management of health-care waste. Segregation can substantially reduce the quantity of health-care waste that requires specialized treatment. To make separate collection possible, hospital personnel at all levels, especially nurses, support staff, and cleaners, should be trained to sort the waste they produce.

In any area that produces hazardous waste—hospital wards, treatment rooms, operating theatres, laboratories, etc.—three bins plus a separate sharps container will be needed. Recommendations for the segregation of waste are given in Table 16.1. The following important points should be noted:

- If hazardous and highly hazardous wastes are to be disposed of in the same way, they should not be collected separately.
- In a health-care establishment using genotoxic products, the safety procedures applicable to radioactive or genotoxic products should be enforced.
- If sharps are to be encapsulated, it is convenient to collect them directly in the metallic drums or barrels used for encapsulation, which limits the hazards associated with handling.
- For hazardous waste and highly hazardous waste the use of double packaging, e.g. a plastic bag inside a holder or container is recommended for ease of cleaning.

Table 16.1 *Segregation of health-care waste*

Waste		Receptacle		
Category	Description	Type	Colour and markings	Characteristics
Hazardous	Non-sharp infectious waste; some pharmaceutical and chemical residues	Container, or plastic bag in a holder	Yellow	Leak-proof
Highly hazardous	Highly infectious non-sharp waste	Container, or plastic bag in a holder	Yellow, marked HIGHLY INFECTIOUS	Leak-proof, suitable for autoclaving
Sharps	Sharps	Sealable box or drum or cardboard box	Yellow, marked SHARPS	Puncture-proof, leak-proof
General	Similar to municipal waste, not contaminated by hazardous substances	Plastic bag or container	Black	No special requirements

- Stools of cholera patients should be collected in buckets because of the need for disinfection. Discharge to sewers or to the environment may contribute to the spread of the disease.

Selection of appropriate packaging is difficult in establishments that cannot afford disposable plastic bags or containers. In such circumstances, hazardous waste may also be collected in paper bags, inside a container that will not be removed. Plastic or metal containers for hazardous waste should be disinfected, for example with sodium hypochlorite (bleach), before reuse. The bags should be sealed or containers firmly closed before they are filled to three-quarters of their capacity. The equipment should be simple, robust and locally available.

16.2.3 Safe handling and storage

Hospital cleaning personnel should be informed about the potential risks posed by waste handling. They should be trained in safe handling procedures and should wear protective aprons and gloves.

The waste should be collected daily. General waste may be stored in convenient places that facilitate collection by the municipal service, but hazardous health-care waste should be stored in a closed room. Waste should not be stored close to patients or where food is prepared. Infectious waste should be disposed of within the following periods:

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

warm climate: maximum 48 hours during the cool season
maximum 24 hours during the hot season

Before containers of hazardous health-care waste are loaded on to a truck for transport off site, they should be sealed. Waste bags and containers should also be labelled with the address of the producer and the waste category. For safety reasons, however, it is strongly recommended that establishments applying minimal waste management programmes in

areas without adequate treatment facilities should dispose of hazardous health-care waste within their own premises.

16.3 Minimization and safe recycling of health-care waste

16.3.1 Chemicals and pharmaceuticals

Careful and comprehensive management of stores will substantially reduce the quantities of chemical and/or pharmaceutical waste produced by health-care establishments. Ideally, the waste in these categories should be limited to residues of chemical or pharmaceutical products in their original packaging (bottles, boxes, cans, etc.). Waste minimization will also give rise to financial savings.

Proper management of chemical or pharmaceutical stores will be supervised by the Chief Pharmacist of the health-care establishment and should include the practices listed in Box 16.1.

16.3.2 Pressurized containers

Aerosol cans are not generally recyclable and may be disposed of to landfills together with general waste. Many undamaged pressurized gas containers, however, may be easily recycled, and should be returned to their original supplier for refilling. Pressurized containers must never be incinerated as they may explode, causing injury to workers and/or damage to equipment.

16.3.3 Mercury

Metallic mercury is a valuable product. In case of a spill, e.g. from a broken thermometer, all droplets of mercury should be recovered with a spoon for later sale or reuse.

16.3.4 Recyclable sharps

Hospitals with very limited resources should use recyclable sharps, such as glass syringes with needles, and scalpels. Only items that are designed for reuse, i.e. that withstand the sterilization process, should be recycled

Box 16.1 Management of chemicals and pharmaceuticals for waste minimization

- Frequent ordering of relatively small quantities rather than large amounts at one time; this applies particularly to unstable products.
- Use of the oldest batch of a product before newer batches.
- Use of *all* the contents of each box or bottle.
- Prevention of product wastage, e.g. in wards and during cleaning procedures.
- Checking the expiry date of any product at the time of delivery.

in this way. Before reuse, scalpels, syringes, needles, and other sharps must be thoroughly cleaned and sterilized; disinfection alone is inadequate. Any failure in the sterilization process may result in the transmission of severe infections. Sterilization may be by chemical means, by flame exposure, or by autoclaving. Smaller district hospitals that lack autoclave facilities may consider sending items to the closest general hospital for sterilization.

16.4 Treatment and disposal of hazardous health-care waste

For health-care establishments with few resources and applying minimal waste management programmes, affordable treatment and disposal methods for hazardous and highly hazardous waste may be classified into three categories:

- thermal processes
- chemical processes
- containment processes.

16.4.1 Thermal processes

Static-grate single-chamber incineration
Waste may be burned in a simple furnace, with a static grate and natural air flow. De-ashing, loading, and unloading operations are carried out manually. The low heating value of properly segregated health-care waste is high enough for combustion, but addition of a small quantity of kerosene may be needed to start the fire and blowing of air may also help in establishing optimal combustion. The burning efficiency may reach 90–95%, i.e. 5–10% of the material may remain unburnt in the ashes and slags. The operating temperature will be around 300 °C, which will kill most microorganisms but will be insufficient to destroy thermally resistant chemicals or pharmaceuticals.

Advantages
- Good disinfection efficiency.
- Drastic reduction of waste; the weight and volume of residual ashes and slags are about 20% those of the original waste. The residues may then be landfilled.
- No requirement for highly qualified operators.
- Relatively low investment and operation costs.

Drawbacks
- Generation of significant emissions containing atmospheric pollutants, including flue gases and fly ash; may produce odours (which can be limited by not incinerating halogenated plastics).
- Periodic removal of slag and soot necessary.
- Inefficiency in destruction of thermally resistant chemicals and drugs (e.g. cytotoxics).

Drum or brick incinerators
Where a single-chamber incinerator is not affordable or available, simple confined burning may be applied. A steel drum or walls of bricks or concrete can be erected over a screen or fine grate and covered with a second screen to prevent dispersion of ashes or light material. The waste is placed inside and burned with the help of manual ventilation and addition of kerosene if necessary. Constant supervision is essential to

prevent any spread of the fire to the surrounding area. The combustion efficiency may reach 80–90% and kill 99% of microorganisms. The temperature of the fire will not exceed 200 °C, and this process should be used only in emergency situations or when other treatment methods cannot be implemented.

Advantages
- Drastic reduction of weight and volume of the waste.
- Very low investment and operating costs.

Drawbacks
- Relatively poor destruction efficiency.
- No destruction of many chemicals and pharmaceuticals.
- Massive emission of black smoke, particulates, and toxic flue gases.

Open-air burning

Open-air burning of infectious waste (excluding pathological waste) should be carried out only as a last resort, in rural dispensaries, isolated health posts, or emergency situations. If possible, the burning should take place in the pit of final disposal (i.e. where the residues will be buried), and the process should be supervised by the person responsible for waste management in the health-care facility. It should be performed downwind of, and as far as possible from, the facility or other communities. The area within which the burning is carried out should be fenced to prevent unauthorized persons and animals from entering.

Confined burning, e.g. in a drum incinerator, should always be preferred, as the risk to personnel of contact with the waste or with partly burned residues is lower. The advantages and drawbacks of open-air burning are the same as for drum or brick incinerators, but there is the additional disadvantage that burning may be incomplete and non-uniform.

16.4.2 Wet thermal disinfection

Wet thermal disinfection is based on exposure of shredded infectious waste to high-temperature, high-pressure steam. Shredded waste is introduced into a reacting tank, vacuum conditions are established, and steam is introduced. Precise operating procedures have to be followed by qualified technicians for efficient disinfection. Wet thermal disinfection should be considered only by health-care establishments with sufficient technical and financial resources and where incineration in single-chamber or drum/brick incinerators is unacceptable, for example because of air pollution problems.

Advantages
- Environmentally sound.
- Reduction in waste volume.
- Relatively low investment and operation costs.

Drawbacks
- Shredders subject to breakdown and poor functioning (and are thus the weak point of the process).
- Qualified operators essential.
- Inadequate for anatomical, pharmaceutical, and chemical waste, and waste that is not easily penetrated by steam.

Autoclaving
Autoclaving is an efficient wet thermal disinfection process. Typically, autoclaves are used in hospitals for the sterilization of recyclable items, and these units allow for the treatment of only limited quantities of waste. They are therefore generally used only for highly infectious waste, such as microbial cultures and sharps. Even a general hospital with very limited resources should be equipped with an autoclave, but a district hospital may well not have one. The advantages and drawbacks of the autoclave are similar to those of wet thermal processes.

Advantages
- Efficient.
- Environmentally sound.
- Relatively low investment and operation costs.

Drawbacks
- Qualified operators essential.
- Inadequate for anatomical, pharmaceutical, and chemical waste, and waste that is not easily penetrated by steam.
- The hospital autoclave used for sterilization has capacity for treatment of only limited quantity of waste.

16.4.3 Chemical disinfection

Chemical disinfection is an efficient process, but costly if the prices of disinfectants are high. For safe operation it requires trained technicians provided with adequate protective equipment and is therefore not recommended for treating all infectious health-care waste. However, the process can be useful in specific cases, such as disinfection of recyclable sharps or disinfection of stools from cholera patients.

Chemical sterilization of recyclable sharps
Chemical sterilization of scalpels, syringes with needles, and other recyclable sharps may be considered as an alternative or complementary method to thermal sterilization. After thorough cleaning and drying, the sharps are placed in a tank and exposed to a strong disinfecting gas or liquid, such as ethylene oxide, formaldehyde, or glutaraldehyde.

Advantage
- Highly efficient (may be more efficient than thermal sterilization).

Drawbacks
- Trained operators essential.
- Costly if the chemical disinfectants are expensive.
- Uses hazardous substances that necessitate safety measures.

Chemical disinfection of stools from cholera patients
Vibrio cholerae, the causative agent of cholera, is not very resistant and its elimination does not require the use of very strong chemical disinfectants. Buckets containing stools of patients with acute diarrhoea may be disinfected through addition of chlorine oxide powder or dehydrated lime oxide (CaO). Other liquid or powder disinfectants may also be used. In case of a cholera epidemic, hospital sewage must also be treated and disinfected. Where there is sufficient space, sewage may be treated through lagooning, followed by effluent disinfection with sodium hypochlorite. In cholera epidemics in emergency situations these disinfection

measures should also be applied in field hospitals to prevent the spread of the disease.

Advantages
- Efficient disinfection.
- No need for highly trained operators.

Drawback
- Not significant compared with the benefits.

16.4.4 Containment processes

Landfilling in municipal disposal sites
Waste may be landfilled in municipal disposal sites if it cannot be treated before disposal. However, health-care waste should not be deposited or scattered on the surface of open dumps. If landfilling is planned, the following minimal requirements should be met:

- measures established by a municipal authority for the rational and organized deposit of municipal wastes that could be used to dispose of health-care wastes;
- if possible, engineering work instigated by the municipal authority to prepare the disposal site to retain wastes more effectively;
- rapid burial of the health-care waste, so that human or animal contact is as limited as possible.

In addition, it is recommended that health-care waste is deposited in one of the following two ways:

- in a shallow hollow excavated in the mature municipal waste, in the layer below the base of the working face, where it is immediately covered by a 2-m layer of fresh municipal waste; scavenging in this part of the site must be prevented.
- in a deeper pit (1–2 m) excavated in mature municipal waste (at least 3 months since being landfilled) which is then backfilled with the mature waste that was dug out; again, scavenging in this part of the site must be prevented.

Alternatively, a specially constructed small burial pit could be prepared to receive health-care waste only. The pit can be 2 m deep and filled to a depth of 1 m. Each load of waste should be covered with a soil layer 10–15 cm deep. (Lime may be placed over the waste if coverage with soil is not possible.) In case of a disease outbreak involving especially virulent pathogens (such as the Ebola virus), both lime and soil cover may be added. Access to this area should be restricted and closely supervised by the responsible staff to prevent scavenging. An example of dedicated pit design is shown in Fig. 8.12 (page 109).

Before health-care wastes are sent for land disposal, it is prudent to inspect the proposed landfill site to ensure that there is satisfactory control of waste deposition.

Advantages
- Low costs.
- Relatively safe if access is restricted and the site is selected according to the above conditions.

- Effective biodegradation of the biological components of health-care waste if landfill operations are properly carried out.

Drawbacks
- Access restrictions may not always be guaranteed.
- It may be difficult to assess whether the conditions for safe landfill are being met.

Safe burying inside premises
In certain health-care establishments in remote locations, temporary refugee camps, and areas experiencing exceptional hardship, safe burial of wastes on hospital premises may be the only rational option available at times. The design and operation of the burial pit is as described above and illustrated in Fig. 8.12 (page 109). To limit risks to health and of environmental pollution, some basic rules should be applied:

- Access to the disposal site should be restricted to authorized personnel only.
- The burial boundary should be lined with a material of low permeability (e.g. clay), if available.
- Only hazardous health-care waste should be buried.
- Large quantities (over 1 kg) of chemical wastes should not be buried at the same time; burial should be spread over several days.
- The burial site should be managed in the same way as a landfill, with each layer of waste being covered with a layer of earth to prevent development of odours and infestation by rodents and insects.

The safety of waste burial relies critically on operational practices. Safe on-site burial is practicable for only relatively limited periods of time, e.g. 1–2 years, and for relatively small quantities of waste, say up to 5–10 tonnes in total. Where these limits are exceeded, a longer-term solution, involving treatment of the waste or disposal at a municipal solid waste landfill, will need to be found.

Advantages
- Less hazardous than letting waste accumulate and remain accessible.
- Low costs.

Drawbacks
- Risks of pollution in permeable soils if the waste becomes saturated with water.
- It may be difficult to prevent scavenging at all times.

Encapsulation
Encapsulation is recommended as the easiest technology for the safe disposal of sharps. Sharps are collected in puncture-proof and leak-proof containers, such as high-density polyethylene boxes, metallic drums, or barrels. When a container is three-quarters full, a material such as cement mortar, bituminous sand, plastic foam, or clay is poured in until the container is completely filled. After this material has dried, the container is sealed and may be landfilled, stored, or buried inside the hospital premises. It is also possible to encapsulate chemical or pharmaceutical residues together with sharps.

Advantages
- Simple and safe.
- Low costs.
- Also applicable to chemicals and pharmaceuticals.

Drawback
- Not recommended for non-sharp infectious waste.

16.5 Management of hazardous health-care waste by waste categories

16.5.1 Infectious waste and sharps

Most treatment methods outlined in section 16.4 above are suitable for infectious waste and sharps, except that:

- in the wet thermal process, shredding of sharps is problematic;
- encapsulation is not suitable for infectious waste.

Incineration in single-chamber incinerators should be the method of choice in establishments that apply minimal waste management programmes. Highly infectious waste, such as cultures and stocks of infectious agents from laboratory work, should be sterilized by wet thermal treatment (e.g. autoclaving) at the earliest stage, i.e. inside the health-care establishment, and soon after production, if possible. For other infectious health-care waste, disinfection to reduce microbial concentration is sufficient.

Sharps should also be incinerated whenever possible and can be incinerated together with other infectious waste. Encapsulation is also suitable for disposing of sharps.

Blood should be disinfected before discharge to the sewer (unless there is an adequate wastewater treatment plant) or may be incinerated.

After incineration or other disinfection process, residues may be landfilled.

16.5.2 Pharmaceutical waste

Sound management of pharmaceutical products, with a view to waste minimization (see section 16.2), is of prime importance. Small quantities of chemical or pharmaceutical waste can be disposed of easily and relatively cheaply, but large amounts may require special, more costly treatment, such as high-temperature incineration. Comprehensive management of pharmaceutical stores should be supervised by the Chief Pharmacist of the health-care establishment.

Small quantities of pharmaceutical waste are usually collected in yellow containers together with infectious waste and therefore follow the same disposal pathway, being either incinerated or safely buried. It should be noted, however, that temperatures reached in a single-chamber furnace may be insufficient to disintegrate thermally resistant pharmaceuticals. Small quantities of pharmaceutical waste, such as outdated drugs (except cytotoxics and antibiotics), may also be discharged to the sewer but should not be discharged into natural waters (rivers, lakes, etc.).

Significant quantities of pharmaceutical waste may be disposed of by the following methods:

- Incineration (if an incinerator able to reach a combustion temperature of 800 °C is available); the incineration residues may be landfilled.
- Discharge to the sewer. Water-soluble, relatively mild pharmaceutical mixtures, such as vitamin solutions, cough syrups, intravenous solutions, eye drops, etc., may be diluted with large amounts of water and then discharged to sewers (where sewerage systems exist). This process should *not* be used for antibiotics.
- Encapsulation. When incineration is not feasible and water dispersion is not recommended, pharmaceutical waste should be encapsulated.
- Return to the original supplier if possible.

Note: Cytotoxic drug residues and other cytotoxic waste should *never* be mixed with other pharmaceutical waste, but should be processed separately according to the procedure described in this handbook (section 9.3).

16.5.3 Chemical waste

As for pharmaceutical waste, improved management of chemical waste starts with waste minimization efforts. The proper management of chemical stores will be supervised by the Chief Pharmacist of the health-care establishment (see section 16.3).

The hospital's Infection Control Officer, Chief Hygienist, or Chief Pharmacist should be designated to supervise the use of chemicals throughout the health-care establishment. The main users of chemical disinfectants, which are among the most hazardous chemicals used in the establishment, are likely to be the Infection Control Officer/Chief Hygienist and his or her staff.

Small quantities of chemical waste will include residues of chemicals in their packaging, outdated or decomposed chemicals, or chemicals that are no longer required. These are generally collected in yellow containers, together with infectious waste, and follow the same disposal pathway (either incineration or safe burying).

Large quantities of chemical waste should *not* be collected in yellow plastic bags or containers. There is no safe and cheap method for their disposal; the treatment options are the following:

- Incineration under subcontract by a public or private agency equipped for the safe disposal of hazardous chemical waste. The thermal reactivity of the waste should be checked; certain solvents will burn and can therefore be incinerated in simple incineration units, although it must be remembered that those containing halogens could cause air pollution.
- Return to the original supplier (if the supplier has facilities for safe disposal). In this case, appropriate provisions should be included in the original purchase contract for chemicals.
- Exportation to a country with the expertise and facilities to dispose safely of hazardous chemical waste. Shipment of chemical waste should comply with international agreements, such as the Basel Convention and the United Nations *Recommendations on the transport of dangerous goods*.

All three options are costly and may be unpracticable, which makes it particularly crucial that chemical waste is minimized. The following recommendations should also be observed:

- Hazardous chemical wastes of different nature should never be mixed.
- Hazardous chemical waste should not be disposed of in sewer systems.
- Large amounts of chemical waste should not be buried as they may contaminate groundwater.
- Large amounts of chemical disinfectants should not be encapsulated as they are corrosive and sometimes flammable.

16.5.4 Cytotoxic waste

Cytotoxic drugs are highly hazardous to the health of the individual and to the environment. Recommendations on cytotoxic safety may be found in section 12.3. Disposal options, described in section 9.3, are the following:

- Return to the original supplier.
- Incineration at high temperatures, e.g. in rotary kilns or high-performance double-chamber pyrolytic incinerators (if available).
- Chemical degradation.

The following recommendations should also be observed:

- Residues from cytotoxic drugs or other cytotoxic waste should never be mixed with other pharmaceutical waste.
- Cytotoxic waste should never be discharged into natural water bodies or landfilled.

In countries where the above disposal procedures are not feasible, use of cytotoxic and radioactive products should be restricted to university research and teaching hospitals.

16.5.5 Radioactive waste

For safety reasons, medical use of radioactive isotopes should be restricted to university hospitals, and any hospital that uses radioactive products should appoint a qualified Radiation Officer. The rules for safe management of radioactive waste outlined in section 9.7 of this handbook should be enforced.

16.5.6 Pressurized containers

Undamaged pressurized containers should be returned to the supplier for refilling, and adequate provision for this should be included in the original purchase contracts. If return is not possible, containers may be buried safely. Any residual pressure should be released before disposal. Aerosol containers cannot usually be refilled and should be buried. Pressurized containers should never be burned or incinerated because of the severe risk of explosion.

16.5.7 Used batteries and thermometers

Batteries, thermometers, and various items of measuring equipment may have a high metal content, including toxic heavy metals such as mercury or cadmium. Disposal options are as follows:

- Recycling by specialized cottage industries. This is the best disposal solution when available.
- Exportation to a country with the expertise and facilities to dispose safely of hazardous chemical waste. Conditions of shipment should comply with the Basel Convention.
- Encapsulation. If neither of the two options above is feasible, encapsulated waste may be disposed of in an impermeable landfill (if available) or other landfill.

This type of waste should not be incinerated because of the toxic metallic vapours emitted, nor should it be buried without encapsulation as this may cause pollution of groundwater.

However, if the quantities of wastes with high heavy-metal content are minimal (similar to the quantities in municipal waste) and there are no opportunities for reuse of heavy metals within the country, they may also join the municipal waste stream.

16.6 Workers' training and safety at work

In health-care establishments and regions that operate minimal management programmes, the health and safety practices described in Chapter 12 and the training outlined in Chapter 15 should be implemented. This is of particular importance, since minimal programmes of waste management are likely to result in greater risks of exposure for workers than the more comprehensive managerial methods described in this handbook.

For personnel who handle wastes, including hospital cleaners and technicians, training in safety measures should cover the following issues:

- packing, handling, and storing of hazardous health-care waste;
- the need to wear protective gloves and aprons when handling waste containers;
- operation of on-site treatment and disposal methods, such as single-chamber furnace operations, encapsulation, and safe burying.

Technicians in charge of chemical disinfection should be trained to implement appropriate safety precautions and emergency measures and be informed about chemical hazards. Nurses and cleaning personnel should be made aware of the occupational risks linked to handling of sharps.

References and suggested further reading

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