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Secretariat of the Pacific Regional Environment Programme

PacWastePlus
PACIFIC WASTE MANAGEMENT

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Waste Technology Management Options: HEALTHCARE WASTE

November 2020

Healthcare Waste

This publication provides details on some of the most appropriate waste management technologies identified for the PacWastePlus programme priority waste of Healthcare Waste with consideration to the inherent constraints of the Pacific island region.

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Our vision: A resilient Pacific environment sustaining our livelihoods and natural heritage in harmony with our cultures.

Content

There are thousands of waste technologies globally for reuse, recycling, segregation, handling, storage, treatment, volume reduction and disposal of the broad range of wastes addressed by the PacWastePlus programme. This publication provides details on some of the most appropriate waste management technologies identified for the PacWastePlus programme priority waste – Healthcare Waste - with consideration to the inherent constraints of the Pacific Island region.

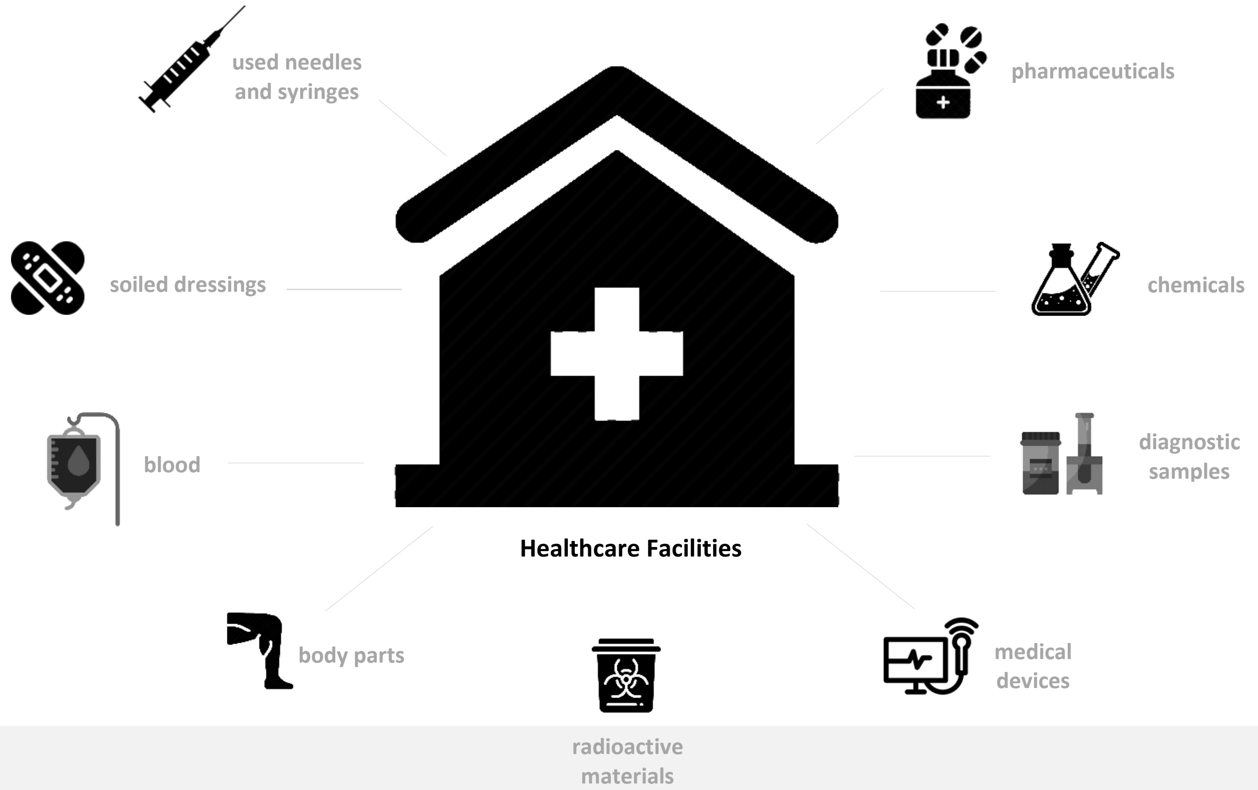
Ultimately, the determination of whether a technology is applicable to your situation and the waste problem you are seeking to manage will be project based.

This publication also includes some consideration factors to assist with your decision-making.

What is Healthcare Waste?

Healthcare waste is defined as waste generated from diagnosis, treatment, and immunisation of humans.

Waste generated by healthcare facilities include:



Current Practises

Health care waste management in Pacific Island Countries and Timor-Leste currently includes landfilling, open burning, placenta pits and high temperature thermal treatment. There is a wide-ranging need to improve health care waste management processes, however donor investment mostly has been directed towards the purchase and installation of high-temperature incinerators either at hospitals or more recently, at waste management facilities.

Current practices impose health risks to areas where scavenging at waste disposal sites occur and /or at health facilities where manual sorting of wastes is undertaken. It is believed that very few of the regions key hospitals and health clinics met all the minimum standards for proper management of hazardous healthcare waste.

It is useful to categorise the overall health-care waste stream into the following categories:

Solid waste

Waste typically disposed of in a household or business setting
e.g. food, recyclable plastics, paper, etc.

Solid waste requires no specialised waste management and can be managed through normal waste services.

Infectious waste

Waste suspected to contain pathogens and pose a risk of disease transmission
e.g. waste contaminated with blood and other body fluids; laboratory cultures and microbiological stocks; waste including excreta and other materials that have been in contact with patients infected with infectious diseases.

Both Infections wastes and hazardous wastes can be managed through many of the technologies discussed in this publication.

Hazardous waste

Several waste types are classified as hazardous:

- **Sharps** - Used or unused sharps
  e.g. hypodermic, intravenous, or other needles; auto-disable syringes; syringes with attached needles; infusion sets; scalpels; pipettes; knives; blades; broken glass).
- **Pathological waste** - Human tissue, organs, or fluids; body parts:
  foetus; blood products
- **Pharmaceutical waste** - Pharmaceuticals that are expired or no longer needed; items contaminated by or containing pharmaceuticals. Cytotoxic (toxic to living cells) waste containing substances with genotoxic (damages the genetic information within a cell causing mutations) properties.
  e.g. waste containing cytostatic drugs (often used in cancer therapy), genotoxic chemicals
- **Chemical waste** - Waste containing chemical substances
  e.g. laboratory reagents; film developer; disinfectants that are expired or no longer needed; solvents; waste with high heavy metal content, e.g. batteries; broken thermometers and blood pressure gauges).

Low-level radioactive waste – Waste containing radioactive substances:

e.g. unused liquids from radiotherapy or laboratory research; contaminated glassware, packages, or absorbent paper; urine and excreta from patients treated or tested with radionuclides; sealed sources).

Radioactive wastes require specialist treatment, and you should contact your Ministry/Department of Health or Environment to determine the correct disposal techniques suitable to the regulations of your country.

Technology Options

HIGH TEMPERATURE THERMAL PROCESSES

Thermal processes rely on heat to destroy pathogens (disease-causing micro-organisms). High temperature thermal e.g. (incineration, pyrolysis, gasification) is the most used disposal approach for large volumes of clinical waste.

Incineration involves combustion of medical waste at high temperatures thereby reducing the combustible fraction to an inert disinfected ash containing sterile non-combustible matter. Incineration can process all healthcare waste however it creates airborne emissions. Anyone utilising this technology should understand local emission regulations to ensure the technology will comply with local and national requirements. Air emissions can be impacted by waste feedstock containing pollutants such as high mercury or cadmium content i.e., broken thermometers, used batteries, etc., or halogenated plastics.

Gasification uses sub stoichiometric (less oxygen than needed for full incineration) air, water or steam, [unlike incineration where excess or stoichiometric air is used] to create a synthetic gas which is then cleaned and used as a fuel in many processes. It is more generally used on other waste streams rather than healthcare waste due to its sensitivity to feeds that are non-homogeneous.

Pyrolysis uses the application of heat in the absence of air and is more suited to the production of a biochar (charcoal from biomass) which is why it is generally used more as a 'pyrolysis phase' in an overall incineration process when considered for healthcare waste.

Advantages

- Potential to produce energy – is dependent on technology.
- Complete destruction of pathogens including animal and plant pathogens
- Volume reduction – Can reduce volume by 90% dependent on composition of input and technology type.
- Air emissions – As stated above air emissions can be controlled but at a cost.

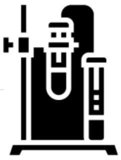
Disadvantages

- Capital and operating costs – Generally considered high cost hence the need to be able to use energy, by-products or compensate for high alternate disposal costs to be viable in many cases.
- Technical complexity – Technology has advanced and is now highly complex in modern incineration technologies used in Europe. Less complex technology is available however dependent on waste input there is a trade off with atmospheric emissions as much of the cost is in the air emission clean up technology. This also results in a need for higher operator skills and training requirements.
- Air emissions – As stated above air emissions can be controlled but at a cost.
- Ash disposal – Ash if produced by the technology may not have a recyclable outlet and may have to be disposed of to landfill dependent upon the facilities.

STEAM AND DRY BASED LOW-HEAT THERMAL

Steam disinfection, a standard process in hospitals, is done in autoclaves and retorts. Dry heat processes heat the waste by microwave, forced convection, circulating heated air around the waste, or using radiant heaters.

An **Autoclave** is a machine that provides:



- a physical method of sterilization by killing bacteria, viruses, and even spores present in the material using steam under pressure.
- sterilizes the materials by heating to a particular temperature for a specific period.
- more recent designs have incorporated vacuuming, continuous feeding, shredding, mixing, fragmenting, drying, chemical treatment and/or compaction, to modify the basic autoclave system.

The types of waste commonly treated in this way are:

cultures and stocks

materials contaminated with blood

soft wastes (gauze, bandages, drapes, gowns, bedding, etc.) from patient care.

limited amounts of fluids, isolation, and surgery wastes

laboratory wastes (excluding chemical waste)

trace contaminated chemotherapy waste - facilities should check with their local and national

sharps

human anatomical wastes (ethical, legal, cultural, and other considerations may preclude their treatment)

Volatile and semi-volatile organic compounds, bulk chemotherapeutic wastes, mercury, other hazardous chemical wastes, and radiological wastes should *not* be treated via microwave or in an autoclave or retort.

Huge and bulky bedding material, large animal carcasses, sealed heat-resistant containers, and other waste loads that impede the transfer of heat should be avoided as well.

Advantages

- Steam treatment is a proven technology with a long and successful track record.
- The technology is easily understood and readily accepted by hospital staff and communities.
- It is approved or accepted as a medical waste treatment technology in most countries.
- The time-temperature parameters needed to achieve high levels of disinfection are well established.
- Autoclaves are available in a wide range of sizes, capable of treating from a few kilograms to several tonnes per hour.
- Because many people have microwave ovens, it is easy for hospital staff and communities to understand and accept that technology.
- If proper precautions are taken to exclude hazardous materials, the emissions from autoclaves and retorts are minimal.
- Capital costs are relatively low.
- Many autoclave manufacturers offer features and options such as programmable computer control, tracks and lifts for carts, permanent recording of treatment parameters, autoclavable carts and cart washers, and shredders.

Disadvantages

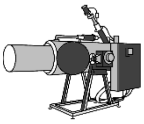
- The technology does not render waste unrecognisable and does not reduce the volume of treated waste unless a shredder or grinder is added.
- Any large, hard metal object in the waste can damage any shredder or grinder.
- Offensive odours can be generated but are minimised by proper air handling equipment.
- If hazardous chemicals such as formaldehyde, phenol, cytotoxic agents, or mercury are in the waste, these toxic contaminants are released into the air, wastewater, or remain in the waste to contaminate the landfill.
- If the technology does not include a way of drying the waste, the resulting treated waste will be heavier than when it was first put in because of condensed steam.
- Barriers to direct steam exposure or heat transfer (such as inefficient air evacuation; excessive waste mass; bulky waste materials with low thermal conductivity; or waste loads with multiple bags, air pockets, sealed heat resistant containers, etc.) may compromise the effectiveness of the system to decontaminate waste.

Chemical technologies use disinfecting agents in a process that integrates internal shredding or mixing to ensure sufficient exposure to the chemical.

Until recently, chlorine-based technologies (sodium hypochlorite and chloride dioxide) were the most used, however some controversy exists regarding possible long-term environmental effects, especially of hypochlorite and its by-products in wastewater.

Safety and occupational exposures should be monitored when using any chemical technology.

Non-chlorine technologies are quite varied in the way they operate, and the chemical agents employed. Some use peroxyacetic acid, ozone gas, lime-based dry powder, metal catalysts, or biodegradable proprietary disinfectants.



Alkaline hydrolysis technology (a process for the disposal of human and pet remains using lye and heat) is being marketed as an alternative to the traditional options of burial or cremation.

The types of waste commonly treated in chemical-based technologies are generally the same as in steamed based technologies [see above] - and the same as in steam technologies, volatile and semi-volatile organic compounds, chemotherapeutic wastes, mercury, other hazardous chemical wastes, and radiological wastes should not generally be treated in chemical treatment units.

Advantages

- Highly efficient disinfection under good operating conditions
- Some chemical disinfectants are relatively inexpensive

Disadvantages

- Requires highly qualified technicians for operation of the process
- Uses hazardous substances that require comprehensive safety measures.
- Inadequate for pharmaceutical, chemical, and some types of infectious waste.

ELECTRON BEAM TECHNOLOGY: USE OF IONIZING RADIATION

Electron beam technology bombards medical waste with ionising radiation, causing damage to the cells of micro-organisms. Electron beam technology does not have residual radiation after the beam is turned off.

Shields and safety interlocks are necessary to prevent worker exposure to the ionising radiation.

Volatile and semi-volatile organic compounds, chemotherapeutic wastes, mercury, other hazardous chemical wastes, and radiological wastes should not be treated in this way.

Advantages

- Good disinfection efficiency under appropriate operation conditions

Disadvantages

- Relatively high investment and operating costs.
- Potential operation and maintenance problems.

BIOLOGICAL TECHNOLOGY: USE OF ENZYMES (PLACENTIA PITS)

Biological processes typically use natural enzymes to decompose organic waste.

Placenta pits allow pathological waste to degrade naturally. Around 90% of such waste is liquid, which will soak away into the ground. The rest will degrade though a complex and variable mixture of biological and chemical anaerobic processes. As the waste decomposes, pathogens will be destroyed as well, though some, including eggs, are more resilient than others.

These were designed to dispose of placentas and similar pathological waste. They cannot be used for solid wastes.

Wastes should not be treated with chemical disinfectants like chlorine because these chemicals destroy the microorganisms that are important for biological decomposition.

Advantages

- Low costs
- Relatively safe if access to site is restricted and where natural infiltration is limited

Disadvantages

- Safe only if access to site is limited and certain precautions are taken

High temperature thermal

Economic considerations
Fuel and maintenance expenses are high

Environmental considerations
Acceptable with proper maintenance

Social considerations
Easily understandable technology; Concerns about emissions

Operational considerations
Acceptable with proper maintenance

Electric or Fuel energy source (autoclave/retort)

Economic considerations
Tied into grid, costs minimal

Environmental considerations
Acceptable, standard usage in hospitals

Social considerations
Easily understandable technology and accepted

Operational considerations
Requires waste separation/shredding

Electromagnetic Radiation energy source (microwave

Economic considerations
Capital costs relatively high

Environmental considerations
Acceptable

Social considerations
Many people have microwave ovens, so it is easy for hospital staff and communities to understand and accept the technology

Operational considerations
Requires waste separation/shredding

Chemical Technology

Economic considerations

Capital and operational costs low

Environmental considerations

Acceptable with proper handling and safety measures

Social considerations

Easily understandable technology and accepted

Operational considerations

Requires waste separation; Requires special PPE and training for operator

Electron Beam Technology

Economic considerations

Capital costs relatively high

Environmental considerations

Source of ionizing radiation can be an issue

Social considerations

Societal concerns around ionizing source materials

Operational considerations

Requires waste separation; Requires special PPE and training for operator

Biological Technology

Economic considerations

Capital and operational costs low

Environmental considerations

Acceptable

Social considerations

Easily understandable technology and accepted

Operational considerations

Requires waste separation, limited HC waste can be disposed of with this technology

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