HOSPITAL WASTE MANAGEMENT

(Notes on the conference dictated
by Mr. Alvaro Cantanhede, CEPIS Advisor)
HOSPITAL WASTE MANAGEMENT

Definition
Classification - Identification
Segregation - Minimization
Packaging (at source)
Storage
Transferring - Transportation (Collection)
Treatment
Disposal
Contingency Plan
Emergency Plan
Implementing the Management Plan
Training and Supervising (Follow-Up)
Occupational hazards and health risks
Administrative and Economic Aspects
Legislation
DEFINITION OF MEDICAL WASTE

Medical waste is any waste generated at any medical facility. It may consist of pathological waste, infectious waste, hazardous waste and general wastes. These wastes are generated at hospitals, health care facilities and laboratories.
BASIC MEDICAL WASTE MANAGEMENT CONCEPTS

1. Medical waste should be managed through a pathway that includes generation, segregation, collection, storage, processing transport, treatment and disposal.

2. Where possible, hazardous waste should be treated prior to disposal to reduce or eliminated its hazard. (Because characteristics differ for each waste type, all wastes cannot be dealt with in the same way.

3. Hospital Waste Minimization or education is the most desirable goal of waste management it means material substitution, waste segregation, recycling, reuse, procedural changes, acquisition constraints, and treatments and processes that reduce a waste's amount or hazard.
OBJECTIVES OF MEDICAL WASTE MANAGEMENT

1. REDUCE RISKS AND LIABILITIES

   Decisions to reduce and manage risks should be documented in policies further detailed in employee procedures, and implemented through training.

2. CONTROL COSTS

   Waste disposal has grown to be a significant institutional support cost; waste management deserves a careful evaluation.
3. PLAN FOR THE FUTURE

Much is unknown about the future of waste regulation, available services, practices that generate wastes and treatment and disposal technologies. There is some safety in selecting treatment and disposal methods in wide use that have a proven record.

4. COMMUNICATE THE INSTITUTION’S COMMITMENT TO PROTECTING HUMAN HEALTH AND THE ENVIRONMENT

Low-profile risk communication nearly pays off.
<table>
<thead>
<tr>
<th>Generator Type</th>
<th>Number of Generators</th>
<th>RMW Generated All Facilities (Tons/Year)</th>
<th>RMW Generated Per Facility (lbs/month)</th>
<th>Reference Number</th>
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<tbody>
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<td>1. Hospitals</td>
<td>7,100</td>
<td>359,000</td>
<td>8,400</td>
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<td>2. Laboratories</td>
<td>4,300</td>
<td>15,400</td>
<td>600</td>
<td>4,5</td>
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<td>3. Clinics</td>
<td>15,500</td>
<td>16,700</td>
<td>180</td>
<td>6,5,7</td>
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<tr>
<td>4. Physicians' Offices</td>
<td>180,000</td>
<td>26,400</td>
<td>24</td>
<td>8,9,5,7</td>
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<tr>
<td>5. Dentists' Offices</td>
<td>98,400</td>
<td>7,600</td>
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<td>38,000</td>
<td>4,600</td>
<td>20</td>
<td>11,5,12</td>
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<tr>
<td>7. Long-Term Health Care Facilities</td>
<td>12,700</td>
<td>29,600</td>
<td>390</td>
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<tr>
<td>8. Free-Standing Blood Banks</td>
<td>900</td>
<td>2,400</td>
<td>440</td>
<td>13,14,7</td>
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<tr>
<td>9. Funeral Homes</td>
<td>20,400</td>
<td>3,900</td>
<td>32</td>
<td>15,5</td>
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<tr>
<td>10. Others</td>
<td>**</td>
<td>**</td>
<td>**</td>
<td>**</td>
</tr>
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<td><strong>Total</strong></td>
<td>377,300</td>
<td>465,600</td>
<td>**</td>
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</table>

* An explanation of how the quantity estimates were derived, and a description of assumptions made, are included in a memo to the docket for the EPA interim final rules published March 24, 1989."

"This generator type includes health units in industry, schools, correctional facilities, fire and rescue services, and others. EPA is currently investigating the number of generators in this category (see text for further discussion).
<table>
<thead>
<tr>
<th>Country</th>
<th>Number of Beds</th>
<th>Total Waste (Tons/day)</th>
<th>Hazardous Waste (Tons/day)</th>
</tr>
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<tbody>
<tr>
<td>Anguilla</td>
<td>24</td>
<td>26</td>
<td>5</td>
</tr>
<tr>
<td>Argentina</td>
<td>150,000</td>
<td>164,250</td>
<td>32,850</td>
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<td>Barbados</td>
<td>2,111</td>
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<td>Bolivia</td>
<td>8,749</td>
<td>9,580</td>
<td>1,916</td>
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<tr>
<td>Brazil</td>
<td>501,660</td>
<td>549,318</td>
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<td>Colombia</td>
<td>45,761</td>
<td>50,108</td>
<td>10,022</td>
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<td>Cuba</td>
<td>50,293</td>
<td>55,071</td>
<td>11,014</td>
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<td>Chile</td>
<td>42,969</td>
<td>57,051</td>
<td>9,410</td>
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<tr>
<td>Dominica</td>
<td>322</td>
<td>353</td>
<td>71</td>
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<tr>
<td>Ecuador</td>
<td>16,429</td>
<td>17,986</td>
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<td>Guyana</td>
<td>2,204</td>
<td>2,413</td>
<td>483</td>
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<td>Guatemala</td>
<td>13,667</td>
<td>14,965</td>
<td>2,993</td>
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<td>Jamaica</td>
<td>5,745</td>
<td>6,291</td>
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<td>Mexico</td>
<td>60,099</td>
<td>65,808</td>
<td>13,162</td>
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<td>Nicaragua</td>
<td>4,904</td>
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<td>1,074</td>
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<td>Peru</td>
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<td>Saint Lucia</td>
<td>399</td>
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<td>87</td>
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<td>Trinidad and Tobago</td>
<td>4,281</td>
<td>4,688</td>
<td>938</td>
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<tr>
<td>Uruguay</td>
<td>14,133</td>
<td>15,476</td>
<td>3,095</td>
</tr>
<tr>
<td>Venezuela</td>
<td>47,200</td>
<td>51,684</td>
<td>10,337</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1,007,063</strong></td>
<td><strong>1,102,734</strong></td>
<td><strong>220,547</strong></td>
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<tr>
<td>Country</td>
<td>Year Study</td>
<td>Solid Waste Generation (kg/bed/day)</td>
<td>Min.</td>
</tr>
<tr>
<td>----------------</td>
<td>------------</td>
<td>------------------------------------</td>
<td>------</td>
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<tr>
<td>Netherlands</td>
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<tr>
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<tr>
<td>U.S.A.</td>
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<td>Argentina</td>
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<td>Argentina</td>
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<td>Brazil</td>
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<td>Chile</td>
<td>1973</td>
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<tr>
<td>Paraguay</td>
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<tr>
<td>Peru</td>
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<tr>
<td>Venezuela</td>
<td>1976</td>
<td></td>
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### Hospital Waste Generation

<table>
<thead>
<tr>
<th>Country</th>
<th>Hospital Beds (1)</th>
<th>Waste Generation, 1991 (2) (ton/day)</th>
<th>Waste Generation, 2000 (3) (ton/day)</th>
</tr>
</thead>
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<tr>
<td></td>
<td>Country, 1987</td>
<td>Total(,) Municipal, Special</td>
<td>Total(,) Municipal, Special</td>
</tr>
<tr>
<td></td>
<td>Capital, 1991</td>
<td></td>
<td></td>
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<td>Costa Rica</td>
<td>7,173</td>
<td>12.4; 6.2; 2.1</td>
<td>14.9; 7.4; 2.5</td>
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<td>El Salvador</td>
<td>7,394</td>
<td>9.4; 4.7; 1.6</td>
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<td>13,667</td>
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<td>Honduras</td>
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<td>4,904</td>
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<td>Panama</td>
<td>7,181</td>
<td>10.4; 5.2; 1.7</td>
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<td>Total (or mean)</td>
<td>45,660</td>
<td>59.2; 29.6; 9.9</td>
<td>71.0; 35.5; 11.8</td>
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</table>

(1) Source for 1987, official figures by PAHO and in 1991, a Rapid Assessment was conducted by PAHO.
(2) Estimated on the basis of 3.0, 1.5 and 0.5 kg/bed/day, for total, municipal and special waste unit generation.
(3) Same as (2) with a yearly increment of 2% (20% in 9 years).
Quantitative Classification of Health Care Wastes, related with the Production Area

Source: Hospital Wastes, Machado Jr. M.C., Sobral G.M. d O., CETESB, 1978
WASTE CLASSIFICATION

GENERAL WASTE: domestic type, packing materials, stores, work, shop, etc.

PATHOLOGICAL WASTE: tissues, organs, body parts, human fetuses, animals carcasses, blood and body fluids;

RADIOACTIVE WASTE: solid, liquid and gaseous waste contaminants with radio nuclides (in vitro analysis, in vivo body organ imaging and therapeutic procedure;

CHEMICAL WASTE: discarded solid, liquid and gaseous hazardous or non-hazardous chemical (toxic, corrosive, etc)
INFECTIOUS WASTE: cultures and stocks of infectious agents from labs. Work, surgery and autopsies wastes, from infected patients, hemodialysis, etc.

SHARPS: needles, syringes, scalpels, saws, blades, broken glasses, etc can cause cut or puncture; broken

PHARMACEUTICAL WASTE: outdated, spilled and contaminated pharmaceutical drugs, etc

PRESSURIZED WASTE: containers containing gases and/or aerosols that can explode in the incinerator
SIMPLIFIED CLASSIFICATION OF HOSPITAL WASTES FOR DEVELOPING COUNTRIES

- Non-hazardous hospital wastes (general wastes)
- Sharps
- Infectious waste (other than infected sharps)
- Chemical and pharmaceutical wastes
- Other hazardous hospital/medical wastes
Table 1. Categories of waste produced by various types of health care service

<table>
<thead>
<tr>
<th>Source</th>
<th>General</th>
<th>Pathological</th>
<th>Radio-active</th>
<th>Chemical</th>
<th>Infectious</th>
<th>Sharps</th>
<th>Pharmaceutical</th>
<th>Pressurized containers</th>
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</tr>
</tbody>
</table>

* Blood and body fluids.
* Tissue and bone.
HOSPITAL WASTE CLASSIFICATION
Type of management (Hueber, 1990)

TYPE A: COMMON WASTES

From administrative areas, general cleaning, food preparation, and storage. Example: paper, plastic, foodstuff, glass, ash and garbage.

Their nature and management technics are the same as for domestic wastes.
HOSPITAL WASTE CLASSIFICATION
Type of management (Hueber, 1990)

TYPE B: HIGH INFECTIOUS WASTES

Patient general services, medical services, emergency, etc. Example: Cotton, gauzes, bandages, syringes, serum bottles, catheters, disposable sheets, towels, diapers, etc.

They require special management in and outside the hospital.
HOSPITAL WASTE CLASSIFICATION

Type of management (Hueber, 1990)

TYPE C: PATHOLOGICAL AND INFECTIOUS WASTES

Patients with AIDS, hepatitis, tuberculosis, diarrheas, typhus, etc. Wastes from microbiological laboratories, surgery materials, childbirth, haemodialysis, and obstetrician units. Animal excreta used in tests and experiments. Blood-soaked materials, excreta and/or secretions from isolation areas.

These wastes require special management at their source point, treatment and final disposal to ensure the elimination of their hazardous characteristics and reduction of pollution and infection risks.
HOSPITAL WASTE CLASSIFICATION
Type of management (Hueber, 1990)

TYPE D: HUMAN ORGANIC WASTES

Wastes originated in operating theaters, delivery morgue, necrosis, and pathology departments. Examples: amputations, decayed tissues, fetus, placenta, etc.
HOSPITAL WASTE CLASSIFICATION
Type of management (Hueber, 1990)

TYPE E: HAZARDOUS WASTES

Those that require, legally or because of its physico-chemical characteristics, a special handling. Included are: radioactive and material, chemical wastes, aerosol containers, wastes from chemotherapy, wastes from radiology and nuclear medicine, and others.

Wastes included in type A and B, once they are out of the hospital, they can be disposed of and transported together with the domestic wastes.

Wastes included under C and E, require special handling and treatment to ensure the elimination of its noxious properties and the risk they involve.

Wastes included in type D also require special handling, according to its nature.

All premises with at least one of the areas above mentioned, are considered as a source of hazardous wastes.
SEGREGATION OF INFECTIOUS WASTE

Segregation of infectious waste at the point of origin.

Segregation of infectious waste with multiple hazards as necessary for management and treatment.

Use of distinctive, clearly marked containers or plastic bags for infectious waste.

Use of the universal biological hazard symbol on infectious waste containers, as appropriate.
SEGREGATION OF MEDICAL WASTES

1) The segregation of medical wastes is to be done at the source point of generation. Here, staff handling the material can readily identify the hazards of each.

2) Medical waste is to be segregated into pathological/infectious, hazardous and solid wastes. (non-infections)

3) Responsibility for waste segregation should never be conferred on anyone who is untrained in the medical field, unless explicit instructions are given for specific wastes.

The segregation of waste at the point generation reduces the amount of subsequent exposure staff receive in handling the waste. It also serves to curtail the spread of pathogens by concentrating the infectious waste.
WHY WASTE MINIMIZATION

- the need to preserve total landfill capacity

- the desire to reduce environmental impacts

- the reduction in occupational and environmental

- less waste results in less handling, smaller chance of exposure, lower incinerator emissions, and reduced possibility of a release

- waste minimization is an essential component of all institutional waste management plan as a commitment to managing institutional risks
WASTE MINIMIZATION METHODS

Reducing the amount of materials used

  Purchasing constraints
  Substitution to reusable supplies
  Substitution to less wasteful or less hazardous supplies
  Other procedural changes

Reducing the amount of waste generated

  Source separation
  Waste segregation
  Other procedural changes

Recycling and reuse

  Steam sterilization
  Gas sterilization
  Other decontamination methods (chemical or radiation)

Volume reduction techniques

  Incineration (also reduces weight)
  Steam sterilization (minimal)
  Compaction
  Shredding, milling, crushing

Energy recovery techniques

  Incineration with boiler
PACKAGING OF INFECTIONOUS WASTE

Selection of packaging materials that are appropriate for the type of waste:

- plastic bags for many types of solid or semi-solid infectious waste.
- puncture-resistant containers for sharps.
- bottles, flasks, or tanks for liquids.

Use of packaging that maintains its integrity during storage and transport.

Use of plastic bags that are impervious, tear resistant, and distinctive in colour or marking.

Closing the top of each bag by folding or tying as appropriate for the treatment or transport.

Placement of liquid wastes in capped or tightly stoppered bottles or flasks.

No compaction of infectious waste or packaged infectious waste before treatment.
HOSPITAL WASTE CONTAINERS
GENERAL SPECIFICATIONS

- Rigid, Semi-rigid, Non-Rigid (bags);
- One-way (single use), moisture proof, non transparent;
- Appropriate color coding and emblem coded tags;
- Sealable to prevent leakage or egress of microorganisms;
- Safe to transport—strong enough to resist internal or external mechanical damage;
- Filling to a level to allow an easily and tightly closing;
- Fly proof, leak proof and protected against scavengers (rodents, dogs, cats, people)
- Puncture and tamper proof containers (sharps)
- Other – e.g. radioactive wastes (appropriate container pending decay); autoclave bags must allow steam to penetrate and sterilize, etc.
RISCO BIOLÓGICO

Figura 2
STORAGE OF INFECTIOUS WASTE

Minimize storage time.

Proper packaging that ensures containment of infectious waste and the exclusion of rodents and vermin.

Limited access to storage area.

Posting of universal biological hazard symbol on storage area door, waste containers, freezers, or refrigerators.
External Storage of Hospital Wastes
TRANSPORT OF INFECTIOUS WASTE

Avoidance of mechanical loading devices which may rupture packaged wastes.

Frequent disinfection of carts used to transfer wastes within the facility.

Placement of all infectious waste into rigid or semi-rigid containers before transport off-site.

Transport of infectious waste in closed leak-proof trucks or dumpsters.
Fig. 3.I - Contenedor com Rodízios
Fonte: COMLURB/BNDES
Transport External (Collection)

1) A vehicle use for the transport of contaminated waste should be fitted with a fully enclosed body lined internally with stainless steel or aluminium to provide a smooth impervious finish; all corners and angles shall be covered to prevent lodgements of waste matter.

The floor of the body to be continuous with the sides to a height of at least 50 millimetres. The vehicle body to be so constructed as to prevent the spillage or discharge of any matter therefrom and shall be fitted with a locking door or indoors. The body to be provided with a ventilating system.
II. Every contaminated waste vehicle should display in a prominent position on both sides and rear of the vehicle a sign painted in on a background the letters at least 80 mm high.

III. Every vehicle used in connection with the transport of contaminated waste to be cleaned and disinfected at a suitable site at the end of each day's usage; and all wastes from the cleansing process disposed of in a suitable manner.

IV. A contaminated waste vehicle should not be used for any other purpose.

V. Equipment and disinfector shall be carried on the vehicle at all times to be used to cleanse and disinfect any matter or thing which has been contaminated by any spillage of contaminated waste during loading, transport or unloading.
TREATMENT OF INFECTIOUS WASTE

Treatment could be considered any method, technique or process designed to change the biological character or composition of waste.

- establishing standard operating procedures for each process used for treating infectious waste.

- monitoring of all treatment processes to assure efficient and effective treatment.

- use of biological indicators to monitor treatment (other indicators may be used provided that their effectiveness has been successfully demonstrated).
# Recommended Methods for Treatment and Disposal of Hospital Waste

<table>
<thead>
<tr>
<th>Types of Wastes</th>
<th>Incineration</th>
<th>Steam Sterilization (Auto-claving)</th>
<th>Chemical Disinfection</th>
<th>Thermal Inactivation</th>
<th>Recycling</th>
<th>Sanitary Landfill</th>
<th>Burial Cemetery</th>
<th>Storage Pending Decaying</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. General</td>
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<td>2. Pathological</td>
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<td>3. Radioactive</td>
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<td>4. Infectious</td>
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<tr>
<td>5. Sharp</td>
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<tr>
<td>6. Chemical</td>
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<td>7. Pharmaceutical</td>
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<td>8. Pressurized Container</td>
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</tbody>
</table>
TREATMENT METHODS

1. INCINERATION

Incineration is a process in which wastes are burned under controlled conditions to oxidize the carbon and hydrogen present in the waste. Incineration can be used to treat many types of waste: materials which are not incinerable remain as residue, along with unburned combustibles (ashes).

2. ADVANTAGES

- It destroys any material containing organic carbon, including pathogens.

- It reduces the volume and mass of material that must be disposed of in landfills by 80 to 95 percent.

- The heat can be recovered to generate steam and/or electricity.

3. DISADVANTAGES

- Air emissions containing several pollutants.

- Operation and maintenance are complex.

- Capital, maintenance and operational costs.
3. GAS STERILIZATION

In gas sterilization processes, waste is exposed to a gas. The wastes are placed in an air tight chamber; air is evacuated and a sterilizing agent such as ethylene oxide or formaldehyde, is introduced, penetrating the waste and killing infectious agents.

ADVANTAGES

- It can be used to treat reusable items that cannot be subjected to heat and moisture.

DISADVANTAGES

- Potential worker exposure to the disinfectant gas (probable human carcinogens).

- It does not reduce waste volume or waste weight; nor does it affect waste recognizability.

- The toxic gases are vented to the atmosphere after use.

- Treated material contains residues of the gases that are released over time.
4. CHEMICAL DESINFECTION

The processes involve contacting medical wastes with a liquid chemical desinfectant. The materials enter a bath where they are mixed with the desinfectant. The resulting liquids, including any remaining desinfecting agents, are released to the sewer system while the solid residues are drained of, the desinfectant is disposed of in a landfill.

ADVANTAGES

- The treatment can be done at the source of generation

DISADVANTAGES

- The chemicals (desinfectants) may present a moderate risk to operators and maintenance personnel.

- The ability of the process to render the waste less infectious has not been thoroughly evaluated.
5. THERMAL INACTIVATION

It involves heating a waste to temperatures which destroy infectious agents. Generally this method is used only for large volumes of liquid wastes. The wastes are held in a chamber for a specified period of time, under a pre-determined temperature and then released.

ADVANTAGES

- It can be used for liquids, which are not effectively treated by either steam or gas sterilization.

DISADVANTAGES

- Extensive time and energy requirements.

- It does not alter the physical form or quantity of waste that must be disposed of after treatment.
6. IRRADIATION

The process involves the use of U.V. or ionizing radiation from a source to destroy infectious agents.

ADVANTAGES

- Little energy input (no heat is required).

- It is suitable for use on materials which cannot be thermally treated.

DISADVANTAGES

- Technology is complex and requires highly trained operating and support personnel.

- Disposal of the decayed source is a significant problem.

- Human exposure to U.V. radiation can cause adverse health effects.
7. OTHER TREATMENTS

7.1 MICROWAVE TREATMENT

The microwaves heat the waste to 200°F and volative materials and wastes are driven off during the process the wastes are first ground and shredded and finally sprayed with wastes.

7.2 GRINDING AND SHREDDING

Grinding and shredding are used to convert wastes into a more homogeneous form and/or smaller particles that can be easily handled (prior to chemical desinfection; needle-clipping devices).

7.3 COMPACTION

Compaction techniques are used to reduce waste volume; they can also affect waste recognizability. It is not a technique designed to render a medical waste non-infectious or less infectious.
STEAM STERILIZATION (Autoclaving)

The waste is placed in a sealed chamber and exposed to steam at the required temperature and pressure for a specified time. (12 minutes in contact with saturated steam at 121°C).

ADVANTAGES

- Equipment is simple to operate.
- Proven technology used for many years in the health care.
- It is capable of decontaminating most medical wastes.
- It reduces volume and render some plastics non-recognizable.

DISADVANTAGES

- It does not reduce the mass of material to be disposed of.
- It can produce extremely offensive odors which can be released into the ambient (eventually toxic emissions).
- It does not affect the reconizability of most non-plastic wastes.
- Potential safety hazard due to the hot surfaces in the autoclaving.
<table>
<thead>
<tr>
<th>Equipment</th>
<th>Capacity Range</th>
<th>Temperature °C/Time</th>
<th>Costs US$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incinerators</td>
<td>500 to 8,000 LBS/HR</td>
<td>900 to 1,400</td>
<td>340,000 to 6,000,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- &gt; 500/ton</td>
</tr>
<tr>
<td>Microwaves</td>
<td>220 to 900 LBS/HR</td>
<td>150 (steam)</td>
<td>400,000 to 700,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>95 to 100</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>30 min</td>
<td>120 to 160/ton</td>
</tr>
<tr>
<td>Autoclaving</td>
<td>300 LBS/HR</td>
<td>120 to 160</td>
<td>600,000</td>
</tr>
<tr>
<td>Plasma conversion</td>
<td>20 to 25 ton/day</td>
<td>4,000 (torch)</td>
<td>100,000/ton</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(d/ton/const)</td>
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<td></td>
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<td></td>
<td>2500 (flame reach the wastes)</td>
</tr>
</tbody>
</table>
Small incinerator made from an oil drum
(Source R A Reed, WEDC, Loughborough University, UK)
Figure 2. Typical liquid injection combustion chamber.
Figure 4. Typical fixed hearth combustion chamber.
ABB Sanitec Microwave Disinfection System

The Proven Solution For The Treatment Of Infectious Medical Waste.
### Emitted substance

<table>
<thead>
<tr>
<th></th>
<th>Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Daily average values</strong></td>
<td></td>
</tr>
<tr>
<td>Particulates</td>
<td>10</td>
</tr>
<tr>
<td>Organic compounds (as total organic carbon)</td>
<td>10</td>
</tr>
<tr>
<td>Hydrogen chloride (HCl)</td>
<td>10</td>
</tr>
<tr>
<td>Hydrogen fluoride (HF)</td>
<td>1</td>
</tr>
<tr>
<td>Sulphur dioxide (SO₂)</td>
<td>50</td>
</tr>
<tr>
<td>Carbon monoxide (CO)</td>
<td>50</td>
</tr>
</tbody>
</table>

| **Half-hourly average values** |       |
| Particulates                  | 30    |
| Organic compounds (as total organic carbon) | 20    |
| Hydrogen chloride (HCl)       | 60    |
| Hydrogen fluoride (HF)        | 4     |
| Sulphur dioxide (SO₂)         | 200   |

| Average values with sample period of 0.5-8 hours | A | B |
| Cadmium + thallium and their compounds (expressed as metal) combined total | 0.05 | 0.1 |
| Mercury and its compounds (expressed as metal) | 0.05 | 0.1 |
| Antimony + arsenic + chromium + cobalt + copper lead + manganese + nickel + tin + vanadium & compounds (expressed as metal) combined total | 0.5 | 1 |

| Average values with sample period of 6-8 hours |       |
| Dioxins and furans (as toxic equivalent)      | 0.1 ng/m³ |

**NOTES:**
(i) Emission limits are complied with if, over the year, none of the emission limits in column A are exceeded, or if 97% of the average emission values recorded do not exceed the limits in column B. (ii) 1 = limits for new plants, 2 = limits for existing plants.

**Proposed emission limits (mg/m³) as of June 1993**

_Source: EC_
DISPOSAL METHODS

1. On site (large hospital with available areas)

2. Pits for on-site disposal of sharps and/or small quantities of waste (in small health centers)

3. Municipal landfills (open dumps)

4. Sanitary landfills (w/o special cells)

5. Secure landfills
DISPOSAL METHODS
HAZARDS AND FACTORS TO BE CONSIDERED FOR LAND DIPSOSAL

- Materials that are designated for disposal in a land fill or dump may, not ever reach that place, or may be removed after being placed there.

- Infection may be spread by flies, rats or cockroaches that come into contact with infected tissues, dressings, bedding, etc.

- The possibility of chemical pollution of water resources if chemical or drugs are deposited in significant quantities.

- The open burning of solid waste causes unpleasant odors and smoke.

- The difficulty of control and supervising.
Pit for on-site disposal of sharps

Use of a pit for disposal of small quantities of waste
(Source R A Reed, WEDC, Loughborough University, UK)
DISPOSAL METHODS

Disposal of wastewater

Hospital sewage discharges directly into a water body

Hospital sewage discharges to urban sewer network

Hospital sewage has its own sewage treatment plant and treated effluent is discharged into a river, lagoon, etc.

OBSERVATIONS

- Waste including cyto-toxic drugs must never be discharged into sewers.

- Use of hospital sewage (even after treatment) for irrigation of sensitive crops should be avoided.

- Use of separate collection system for infectious patients and isolation wards.
MEDICAL WASTE DISPOSAL FACILITY
PROJECT IMPLEMENTATION REQUIREMENTS

1. PROJECT PLANNING SERVICES
   * SITE ANALYSIS AND SELECTION ASSISTANCE
   * WASTE ANALYSIS
   * RESIDUE DISPOSAL OPTIONS
   * FINANCING OPTIONS
   * COST ANALYSIS

2. PERMITTING
   * STATE REGULATORY PROCESS
   * LOCAL APPROVALS

3. ENGINEERING AND SITE DESIGN
   * SYSTEMS ENGINEERING
   * BALANCE OF PLANT

4. CONSTRUCTION
   * PROJECT MANAGEMENT
   * SYSTEM FABRICATION
   * INSTALLATION
   * SYSTEM START-UP AND TESTING

5. OPERATION
   * TRAINING
   * MANAGEMENT
   * MAINTENANCE AND REPAIR
   * REGULATORY AGENCY REPORTING
   * PERFORMANCE GUARANTEES
HOSPITAL CONTINGENCY PLAN

SOURCE: USEPA

1. Minimize quantity of residues at the point source.
2. Separate residues into compatible groups using systematic methods.
3. Substitute for less hazardous chemicals if possible.
4. Recycle wastes when practical.
5. Avoid disposal of non-biodegradable residues into the sewerage.
6. Train employees how to deal with hazardous wastes in case of accidents.
7. Sterilize hazardous wastes through vapour, incineration or microwaves to avoid dispersion to streets and highways.
8. Manage all hazardous wastes and set annual reduction goals.
9. Review annually the contingency plan to evaluate its effectiveness.
EMERGENCY PLAN FOR HOSPITALS

- Personal security
- Isolate the accident area
- Notify the authority
- Position/Commander {Report/Action Plan
- Identify (the product)
- Action - Action Plan
- Protection (Protection Equipment)
- Control
- Implementation Plan
- Decontamination
- Hazardous Hospital Wastes
- Waste Disposal
- Documentation of the event
IMPLEMENTING THE MANAGEMENT PLAN
The Human Element is More Important than the Technology

POLICIES

Any institution or company that generates infectious or medical wastes should have a formal policy that defines the objectives for managing the risks of the wastes.
IMPLEMENTING THE MANAGEMENT PLAN
The Human Element is More Important than the Technology

PROCEDURES AND TRAINING

Written procedures (manuals) and written documentation are needed to explain how the policy objectives should be accomplished.

Effective training of employees utilizes a variety of written, graphic and interactive training methods.
IMPLEMENTING THE MANAGEMENT PLAN
The Human Element is More Important than the Technology

ASSIGNING RESPONSIBILITIES

The procedures need to specify responsibilities and duties by position. Administrative support, coordination of assignments and communication are essential.
IMPLEMENTATION OF A MEDICAL WASTE MANAGEMENT PLAN

- A written PLAN is tangible evidence of a serious commitment to safely manage infectious and hazardous waste.

- The PLAN should outline the current procedures as well as proposals for improving waste management.

- The PLAN should mainly focus on infectious wastes - the most problematic area.

- The PLAN should be prepared by the person or committee responsible for waste management oversight.

- The PLAN must identify functional responsibilities for all procedures.

- The PLAN has to be approved by the organization's administrator(s) responsible for planning, when it is completed.

- The PLAN should be updated regularly.
TRAINING AND SUPERVISION

- All health care establishments should have written policies on waste handling procedures.

- The people responsible for implementing these policies should be clearly identified.

- The waste handling procedures should be made known and readily to all personnel concerned, not only those at the senior level.

- Basic training in waste handling procedures should be given to all new personnel in service. Training for all personnel should form part of a training programme. (Programme must take into consideration personnel who may not be fluent in the language of the country or who may be only semi-literate).

The basic content of training programmes should include information on:

- The hazards of health care waste.

- The methods of preventing the transmission of nosocomial infections related to waste handling.

- The safety procedures for dealing with chemical, pharmaceutical and radioactive waste and sharps.

- Proper waste segregation, handling, packaging, transport and disposal.
TRAINING AND SUPERVISION

• Action and notification to supervisors in case of accident.

These programmes should be periodically reviewed and updated as necessary.

• Good supervision is essential for the maintenance of efficient and safe waste handling operations.

• The selection and training of supervisory personnel plays a fundamental role in in-house waste management.

• Information on health care waste management policy and methods should also be given to support staff, maintenance personnel and personnel from external organizations, such as transport firms, who may be involved in handling the waste.
OCCUPATIONAL HAZARDS AND HEALTH RISKS

I) FUNDAMENTAL

Identification of health and environmental hazards associated with mismanagement of hospital wastes;

Avoidance of public alarm by exaggerating risks or looking for non existent problem

II) PEOPLE EXPOSED TO HEALTH HAZARDS RELATED TO HOSPITAL WASTES

Patients and personnel (in general)

Personnel in supporting services: laundries, incinerators, waste disposal sites, collection, etc;

Patients and personnel in home care or primary care (e.g. homedialysis)
III) PATIENTS AT SPECIAL RISK FROM INFECTIONS

Immune-suppressed patients (patients with AIDS)

With bleeding or clotting disorders

On dialysis

Drug abusers or addicts
MINIMIZATION OF OCCUPATIONAL HEALTH RISKS RELATED WITH WASTES IN HOSPITALS

- DEVELOPMENT OF OCCUPATIONAL HEALTH PROGRAMS

- Safe or less hazardous substitutes for chemical agents;
- Closed storage for volatile agents (reducing exposure to which are a health hazard);
- Use of proper venting and exhausting in accordance with principles of occupational hygiene;
- Use of color-and emblem-coded tags and containers where the pre-sorting and segregation of waste is needed;
- Monitoring measures and spot surveys in problem areas or highrisk situations;
- Epidemiological analysis to determine groups of personnel at excessive risk of particular types of health problem;
The following principal requirements could be identified:

- a staff member should be designated as the waste management officer;

- all wastes categories should be properly identified;

- waste should be properly segregated and disposed safely and hygienically;

- health care establishments or their controlling organization should bear all the necessary costs associated with waste management programmes;

- on-site disposal plants such as incinerators, should be subjected to the same authorizing procedures as the other waste disposal facilities in the area;

- contractual relationships should exist between the waste producer, transporter, disposer and any other party involved in the waste management.
ADMINISTRATIVE AND ECONOMIC ASPECTS

Cost effectiveness is an essential factor in any health care waste management plan. It comprises the most economic combination of:

- initial capital investment;
- amortization over the effective life of the plant and equipment;
- operating labour and material costs;
- maintenance and repair costs;
- energy equipments;
- contractual costs;
- overhead costs

To minimize costs, the feasibility of cooperation between local health care establishments should be considered.
BELIZE CITY HOSPITAL
WHO LIVES IN THE HOSPITAL?

SICK PEOPLE AS WELL AS BACTERIAS
DOCTORS AND NURSES
HOSPITAL CLEANING IS IMPORTANT?

PATIENTS SHOULD HAVE A PLACE FREE OF BACTERIAS IN THE SAME WAY AS THAT OUTSIDE THE HOSPITAL.
WHY IS CLEANING IN THE HOSPITALS DIFFERENT?

HOSPITAL INFECTION CAN BE THE CONSEQUENCE OF EXPOSURE TO A CONTAMINATED ENVIRONMENT (DUST, FURNITURE AND EQUIPMENT)
HOW DOES A HOSPITAL INFECTION OCCUR?

BACTERIAS LIVING IN THE HOSPITAL ENVIRONMENT ATTACK PATIENTS
DO WE CLEAN ALL THE HOSPITAL AREAS IN THE SAME WAY?

THERE ARE DIFFERENT AREAS IN ANY HOSPITAL

- CRITICAL AREAS
- SEMI-CRITICAL
- NON CRITICAL

DEPENDING ON EACH AREA, CLEANING IS DONE DIFFERENTLY
CLASSIFICATION OF AREAS

* CRITICAL AREAS
  - SURGICAL CENTER
  - ISOLATION WARD
  - LABORATORIES
  - DIALYSIS UNIT
  - BURN UNIT
  - NURSERY
  - AUTOPSY ROOM
  - INTENSIVE CARE UNIT
  - STERILIZATION CENTER

* SEMI-CRITICAL AREAS
  - WARDS
  - PHARMACY
  - LAUNDRY ROOM
  - CONSULTING ROOMS
  - KITCHEN
  - ELEVATORS

* NON CRITICAL
  - OFFICES
  - ADMINISTRATION
  - DRESSING ROOMS
  - STOCK ROOM
HOW TO CLEAN A HOSPITAL

1. PLACE ALL THE MATERIAL ON THE CART
2. COLLECT THE GARBAGE
3. WASH THE RECIPIENT
4. WET THE LOCATION AND APPLY SOAP
5. PASS THE MACHINE OR A CLOTH WITH ROD
6. REMOVE THE DIRTY LIQUID WITH CLOTH AND ROD
7. RINSE AND DRY THE FLOOR
1. PLACE ALL THE SEALED BAGS ON THE CART OF THE HOSPITAL FLOOR
2. THE CART SHOULD BE ALWAYS CLOSED
3. PLACE THE CART NEAR THE ELEVATOR AT THE ESTABLISHED HOURS
4. PASS THE BAGS FROM THE CART OF EACH FLOOR TO THE ELEVATOR'S CART
5. DISINFECT THE EACH FLOOR CART
COLLECTING AND SEALING THE GARBAGE

1. COLLECT ALL THE GARBAGE OF THE FLOOR
2. SEAL THE PLASTIC BAGS WHEN THEY ARE FULL AT 2/3 OF THEIR CAPACITY
3. WASH AND DRY THE RECIPIENTS
4. PLACE ANOTHER PLASTIC BAG IN THE RECIPIENTS
INDIVIDUAL PROTECTION EQUIPMENT

WHAT SHOULD BE USED DURING THE CLEANING AND DISINFECTING?

BOOTS  GLOVES  APRONS

WHAT SHOULD BE USED DURING THE COLLECTION AND TRANSPORTATION OF GARBAGE?

CAP  MASK
WHAT TO DO WITH THE CLEANING MATERIAL AFTER USING IT?

IN THE CRITICAL AND SEMI-CRITICAL AREAS

1. WASH
2. DISINFECT
3. DRY
4. STORE
MATERIAL FOR CLEANING

MOP

DUST CLOTH

BUCKET

DUST BIN

POLISHER

LADDER
TECHNIQUE FOR DISINFECTION OF EQUIPMENT AND FLOOR

1. PREPARE TWO BUCKETS (BLUE AND RED) WITH DISINFECTANT SOLUTION

2. WET CLOTH IN THE SOLUTION OF THE BLUE BUCKET

3. WRING TO REMOVE EXCESS LIQUID

4. PASS ON THE LOCATION TO BE CLEANED

5. WET THE CLOTH IN THE SOLUTION OF THE RED BUCKET AND WRING TO REMOVE EXCESS LIQUID

6. PLACE INTO THE BLUE BUCKET

7. LET DRY WITHOUT RINSING
THE TWO-BUCKET TECHNIQUE

BLUE BUCKET

WET THE CLOTH AND REMOVE EXCESS LIQUID

PASS OVER OBJECTS

RED BUCKET

WASH AND REMOVE EXCESS LIQUID FROM THE CLOTH

* THE TWO BUCKETS CONTAIN A SOLUTION OF PHENOL CONCENTRATION AT 3%
WHERE, WHEN AND HOW DO WE USE DESINFECTANTS

* WHERE?

CRITICAL AREAS

. FLOOR
. EQUIPMENT

SEMI-CRITICAL AREAS

. EQUIPMENT

* WHEN?

EVERYDAY AND AFTER CONTAMINATION

* HOW?

THE TWO-BUCKET TECHNIQUE
WHEN TO WASH YOUR HANDS?

- AFTER CLEANING WORK
- WHEN HANDS ARE DIRTY
- BEFORE AND AFTER USING THE TOILETTE
- AFTER COUGHING, SNEEZING OR CLEANING THE NOSE
- AT THE END OF A WORKING DAY
DO NOT FORGET:

DON'T TOUCH OBJECTS OR PEOPLE

DO NOT USE DRY CLOTHES NOR BROOMS IN CRITICAL OR SEMI-CRITICAL AREAS

FIRST CLEAN HALF OF THE CORRIDOR AND AFTERWARDS THE OTHER

TO CLEAN WALLS? RAISE ASIDE YOUR ARM

FOR CLEANING, BEGIN FROM THE BACK OF THE ROOM THROUGH THE DOOR
Management of Waste Personnel allocation

LEON S., Guillermo; SANDOVAL Q., Carlos et al. Metodología para la evaluación y diagnóstico de las condiciones sanitarias de las unidades de servicios de atención de salud. CEPIS/OPS/OMS. Marzo 1992

MOORE, Alan Charles. Mission report - Disposal of medical and toxic wastes in health facilities (Guam 1 April to 3 May 1991). WHO


HPE/PAHO/WHO. Project - Management of hospital solid wastes and control of the effects on health and the environment in Central America and Panama. September 1991

GREEN, Alex E.S. Medical waste incineration and pollution prevention. Van Nostrand Reinhold. New York

U.S. ENVIRONMENTAL PROTECTION AGENCY. Executive summary - Guidance on the management of infectious waste. 1986

DEPARTMENT OF ENVIRONMENTAL HEALTH SERVICES. A guideline for medical waste management - Handbook. County of San Bernardino. California, USA

