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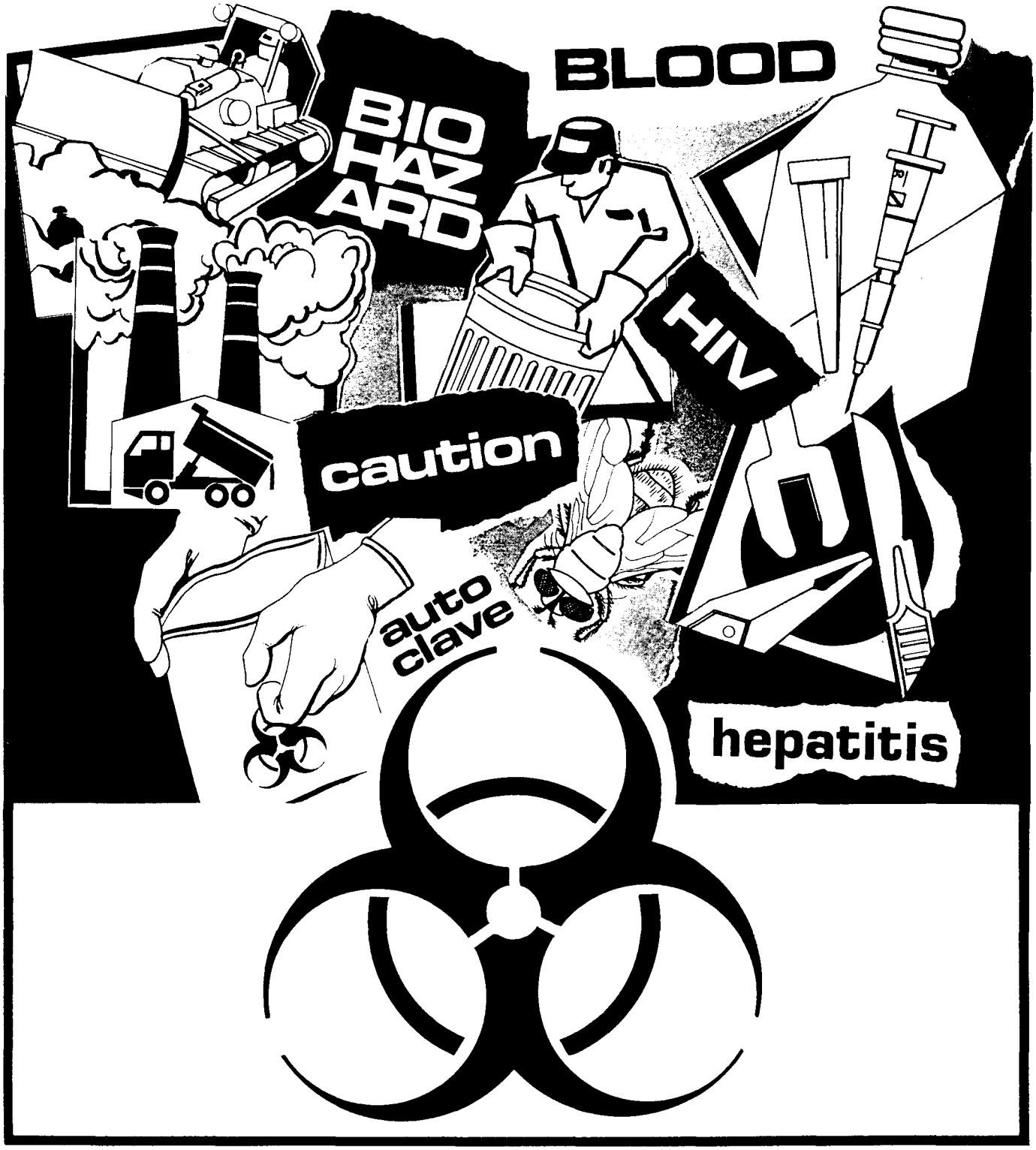
Model Guidelines for State Medical Waste Management



The Council of State Governments

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MEDICAL WASTE GUIDELINES

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CHARTS AND TABLES

FOREWORD

The public continues to view medical waste problems as a prime example of our deteriorating environment. Federal and state governments have passed and promulgated laws and regulations to help address these public concerns, but problems persist. Alternative public policy mechanisms, such as the guidelines in this document, are seen as one way to control sources of medical waste (such as self-administered health care) which are not easily addressed by law. They are also seen as a way to address medical waste concerns (such as source reduction) which were not originally dealt with in most of the early state medical waste laws.

This document presents a set of voluntary guidelines for the management of medical wastes. This approach — voluntary guidelines in lieu of statutory law — makes this an unusual document for our organization to produce, having published *Suggested State Legislation* — a compilation of state statutes — annually for over 50 years.

States and others wishing to study how non-regulatory guidelines might supplant or add to existing medical waste management law should find this study most useful.

Dan Sprague

Daniel M. Sprague
Executive Director

MODEL GUIDELINES FOR STATE MEDICAL WASTE MANAGEMENT

Background. Beach wash-ups of medical waste on the shores of five east coast states in the summer of 1988, children playing with vials of blood found in a dumpster and the illegal dumping of bags of medical waste brought forth a public outcry for more stringent management of medical wastes after they have left the site of generation. Since that time, almost every state has enacted regulations addressing some aspect of the medical waste management process. There are many areas, however, that have not been adequately addressed by most states, such as public education and facility operator training.

The Medical Waste Tracking Act of 1988 required the U.S. Environmental Protection Agency to identify alternative (i.e., non-regulatory) approaches to medical waste management. These *Guidelines* are in response to this requirement.

Introduction. The management of medical waste begins at the time or place at which an item ceases to be useful for its intended purpose and enters the waste stream. Medical waste is generated by large and small medical facilities, households and home healthcare and by illicit drug users. Operations that generate waste include research, medical, veterinary, anatomical pathological services and diagnostic, research and industrial operations.

The waste management process begins before wastes are produced with source reduction, reuse and recycling techniques. Management continues through segregation, packaging, transportation, treatment/destruction and disposal phases. Optimal management of medical wastes at every point in the process can insure minimal volume; protection of personnel, the public and the environment; the alleviation of public concern over the threat of infection or injury from these wastes; and efficient and cost effective programs for their disposal.

The Council of State Governments entered into a grant agreement with the U.S. Environmental Protection Agency's Office of Solid Waste in 1990-91 to develop guidelines for use by states and other entities that generate and/or manage medical waste. This publication is the result of that effort. The *Guidelines* are compiled on the basis of survey responses from state agencies and national associations (see Appendix B, page 32) that provided examples of existing guidelines and regulations, from independent research and from contributions and review by an advisory committee consisting of representatives of the regulated community, state regulatory agencies, public interest and academic institutions (see Appendix C, page 34).

Purpose. This document details the components of a medical waste management plan or program for consideration by the states and others who are primarily interested in the use of voluntary guidelines in lieu of mandatory statutes and/or regulations. The document also seeks to provide guidance for medical waste generators currently exempt from federal and state regulation, such as home users of medical products and areas such as personnel training.

Support. Funding for this effort was provided by the U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, project control number C-817784-01-0. This report is part of EPA's *Medical Waste Management in the United States: Final Report to Congress.* For further information about this report contact Michaelle Wilson, Chief (OS-332), Special Programs Section, Office of Solid Waste, U.S. Environmental Protection Agency, 401 M Street, S.W., Washington, D.C., 20460, (202/ 260-8551).

Authors. Research for this project was conducted by The Council of State Governments' Centers for Health and Environment, R. Steven Brown, Director. The primary author of this report is Karen Marshall, a Research Associate with the Center for Environment. Karen Armstrong-Cummings, John M. Johnson and Doris Ball assisted on this project. The cover and illustrations were produced by Elisa Pruden. The document was typeset by Connie LaVake.

What Is a Guideline? Documents entitled "Guidelines" vary widely in their intent. There are "how to" publications such as instructions for self-treating diabetics on the disposal of sharps, "Guides" to state regulations, or guidance as to what a hospital must do in order to meet certain provisions of its licensing requirements.

These guidelines are intended to serve as a ready-reference tool for all aspects of medical waste management. By virtue of its definition, guidelines are not mandatory and are therefore not enforceable through civil charges or fines. Part of their purpose is to reach sectors of the public that are not traditionally or practically governable by law.

A state can make these guidelines available to both the regulated and the non-regulated community for instruction in any aspect of waste handling that is not currently addressed by that state's statutes or regulations. For this reason, the document covers virtually all medical waste management issues. The *Guidelines* attempt to be specific enough to answer the practical day-to-day questions for the management of medical waste that, if carried out, will protect both the public and the environment from injury, the spread of infection and aesthetically offensive encounters with medical waste.

Scope of this Document. The *Guidelines* do not address areas such as incinerator standards that are already extensively regulated at the state and/or federal level. (Chapter 8 of the U.S. EPA's *Final Report to Congress* will cover the current status of state regulations of medical waste.) The Council is not expressing a preference for guidelines over a more formal regulatory program, but we do attempt to identify issue areas for which guidelines may prove adequate. States and industries can choose which of the guidelines to implement.

Terminology. Earlier statutes and regulations tend to refer to all medical waste by the term "infectious," even though the definition makes no reference to its capability for transmitting disease. Later terminology uses the word "medical," reserving "infectious" for waste known to be capable of transmitting disease. In this report, except for direct quotes, the term "medical waste" will be used throughout to refer to wastes that are potentially infectious or that pose a potential threat to the public health and safety.

A Note about Format. This document is laid out in a format that presents the actual guidelines always on the right-hand column of each page. Supporting text that provides explanation, rationale and state examples appears on the left-hand side of each page. This parallel format provides an uncluttered presentation of the actual guidelines while permitting easy reference to accompanying materials. All tables, charts, and illustrations are part of the supporting documentation.

Audience. This document is intended for use by federal agencies, the states, the private sector and other entities concerned with medical waste management. The views herein are not necessarily those of The Council of State Governments or the U.S. Environmental Protection Agency.

I. WASTE CHARACTERIZATION

In practice it is difficult to identify and segregate every article of medical waste from the solid waste stream. Therefore, most states list specific waste types in their definitions of medical waste rather than formulate a characteristic definition that would have to be applied on an item-by-item basis. In the same vein, these Guidelines list ten categories of waste for handling as medical waste. The rationale for selecting these categories is based on two characteristics that wastes must possess to come under the Guidelines: (1) the potential of the waste to transmit infection and (2) properties of toxicity and/or low level radioactivity.

Infectious Capability

The U.S. Environmental Protection Agency (EPA) defines *medical wastes* as any solid waste which is generated in the diagnosis, treatment (e.g., provision of medical services), or immunization of human beings or animals, in research pertaining thereto, or in the production or testing of biologicals (U.S. Environmental Protection Agency, March 24, 1989, pp.12373-12374). The EPA has restricted *infectious agent* to mean "any organism (such as a virus or a bacteria) that is capable of being communicated by invasion or multiplication in body tissues and capable of causing disease or adverse health impacts in humans" (American Veterinary Medical Association, 1989, p. 443). *Infectious waste* is waste that contains pathogens with sufficient virulence and quantity such that exposure to the wastes could result in infectious diseases.

However, currently there is no definitive, quantitative analysis that can be used to determine whether or not a waste is "infectious" (Minnesota, 1988, p. B.5). The characteristic of infectious *potential* is therefore based on principles of disease transmission.

The process of disease transmission can be conceptualized as a series of six links, with each link representing an essential step in the transfer of an infectious agent from one susceptible host to the next. If a break occurs in any of the links along the chain, the process of disease transmission is inhibited. The six links are as follows:

1. The presence of a sufficient quantity of an infectious agent.
2. The existence of a favorable environment ("reservoir") for survival of infectious agents.
3. A mode of escape for infectious agents.
4. An infectious mode of transmission.
5. An infectious route of entry.
6. A susceptible host.

The Agency for Toxic Substances and Disease Registry lists four main transmission modes of infection (U.S. Department of Health and Human Services, 1990, pp. 2.9-2.10):

1. "Direct transmission occurs when there is contact between an agent's source and a susceptible host. Direct transmission can occur through direct contact or droplet spray."
2. Airborne transmission occurs when "the etiologic agent is contained in or on relatively small particles that remain suspended in air for long periods of time. . . . Whatever the source, the aerosolized material must be produced and then propelled by an activity involving the release of comparatively high levels of energy."
3. "Vehicle-borne transmission occurs when an infectious agent is transported from its source to a susceptible host by contaminated materials or objects (indirect contact)."
4. Vector-borne transmission occurs "when a vector, most commonly an arthropod (insect), carries the agent on or in its body, or the agent develops in the vector."

"A determination of the probability of any given waste to preserve intact the chain of disease transmission provides a logical means for delineating relative infectivity. According to this method, the individual segments of the biomedical waste stream can be analyzed for their relative ability to provide a favorable environment for the growth and survival of infectious agents (link two) and to deliver sufficient quantities of those agents to a susceptible host via an infectious route of transmission (emphasis on link four).

Documentation Guidelines

The rationale behind the definition of what constitutes medical waste is based on two sets of criteria:

1. *The potential of the waste to transmit infection.* These wastes, by virtue of their characteristics, are capable of preserving the chain of disease transmission. Seven categories of wastes (numbers 1-7 on the following page) are universally handled as medical wastes, regardless of their source, because:

a. the infectious potential of a waste cannot necessarily be determined by its appearance;

b. the particular source of the item and/or its infectious nature may not be identifiable;

c. it is impractical and infeasible to test each item for its pathogen content (i.e., type and quantity).

2. *Wastes which possess a risk to public health or the environment for reasons other than infectious potential.* These wastes fall into three additional categories: wastes with low levels of radioactivity which are not under Nuclear Regulatory Commission regulations; and cytotoxics and wastes with trace amounts of toxic chemicals which do not fall into the hazardous waste category regulated by Subtitle C of the Resource Conservation and Recovery Act (RCRA). All bulk quantities of such wastes must be given primary consideration as Subtitle C wastes and are therefore not within the parameters of these Guidelines.

"Links three and five relate primarily to the handling of those wastes determined to be infectious and therefore serve as the basis for the establishment of worker-safety programs which include barrier protection and containment procedures" (Minnesota, 1988, p. III.8).

The actual ability of a medical waste type to uphold links two and four of the chain of disease transmission thus provides the most logical basis for designating it as infectious waste.

Types of Medical Waste

Sharps: The American Blood Resources Association defines sharps as "objects or devices having acute rigid corners, edges, points or protuberances capable of cutting or piercing" (American Blood Resources Association, 1986, p. 1). Based on the principles of disease transmission, the potential for infection from contact with medical waste sharps is significantly greater than that related to contact with non-sharp waste. The greater potential is due to the fact that sharps can create a portal of entry whereas a portal must exist prior to contact with non-sharps for infection or disease to occur.

Cultures and stocks: These wastes from pathological and medical laboratories have an especially high potential for the transmission of infection. Laboratory safety practices have been established for four levels of protection provided to personnel, the environment and the community. The levels consist of combinations of laboratory practices and techniques, safety equipment, and laboratory facilities appropriate for the operations performed and the hazard posed by the infectious agents and for the laboratory function or activity (U.S. Department of Health and Human Services, 1988, p. 7). These biosafety levels are presented in the following table by ascending degree of protection.

Summary of Recommended Biosafety Levels for Infectious Agents

Biosafety	*Practices & Techniques*	*Safety Equipment*	*Facilities*
1	Standard microbiological practices	None: primary containment provided by adherence to standard laboratory practices during open bench operations.	Basic
2	Level 1 practices plus: Laboratory coats; decontamination of all infectious wastes; limited access; protective gloves and biohazard warning signs as indicated.	Partial containment equipment (i.e., Class I or II Biological Safety Cabinets used to conduct mechanical manipulative procedures that have high aerosol potential that may increase the risk of exposure to personnel.	Basic
3	Level 2 practices plus: special laboratory clothing; controlled access.	Partial containment equipment used for all manipulations of infectious material.	Containment
4	Level 3 practices plus: entrance through change room where street clothing is removed and laboratory clothing is put on; shower on exit; *all wastes are decontaminated on exit from the facility.*	Maximum containment equipment (i.e., Class III biological safety cabinet or partial containment equipment in combination with full-body, air-supplied, positive-pressure personnel suit) used for all procedures and activities.	Maximum Containment

(*Source:* U.S. Department of Health and Human Services, 1988, p. 10, emphasis added.)

Types of Medical Waste

The following categories of wastes should be segregated at the point of generation for management as medical wastes:

1. *Sharps* that have been used in animal or human patient care or treatment or in medical, research, or industrial laboratories. Includes hypodermic needles, syringes, scalpel blades, and blood specimen tubes; also pasteur pipettes and broken glass that have been exposed to infectious agents. For purposes of disposal, the Occupational Safety and Health Administration (OSHA) categorizes orthodontic wires as sharps.

2. *Cultures and stocks* of infectious agents and associated biologicals. Includes specimen cultures from medical and pathological laboratories; cultures and stocks of infectious agents from research and industrial laboratories; wastes from the production of biologicals; and discarded live and attenuated vaccines; culture dishes and devices used to transfer, inoculate, and mix cultures.

3. *Bulk human blood and blood products.* Liquid waste human blood, products of blood, items saturated and with the potential for dripping blood, serum, plasma, and other blood components.

4. *Pathological* wastes. Human tissues, organs, body parts and body fluids that are removed during surgery and post mortem procedures, with the exception of teeth, feces, excreta and corpses and body parts intended for interment or cremation.

5. *Isolation* wastes. Includes wastes contaminated with blood, excretions, exudates, or secretions from sources isolated to protect others from highly communicable infectious diseases which are identified as viruses assigned to Biosafety Level 4 by the Centers for Disease Control.

6. *Animal* waste. Contaminated animal carcasses, body parts, fluids and bedding of animals that have been afflicted with suspected zoonotic disease or purposely infected with agents infective to humans during research, in the production of biologicals, or in the in vivo testing of pharmaceuticals. (State agriculture departments and the U.S. Department of Agriculture

Unused sharps: There are several reasons for adopting a uniform policy for all sharps (Reinhardt and Gordon, 1991, p. 38):

- Although uncontaminated sharps are much less likely to cause disease than contaminated sharps, there remains the risk of physical injury (cuts, scrapes, and needle sticks).
- Risk of infection accompanies physical injury by sharps. Even a sterile sharp discarded into waste becomes nonsterile from being in the waste.
- No one likes to be stuck, and physical injury from sharps is unpleasant. It is also disturbing to the injured person because of the fear of AIDS it often evokes . . .
- A uniform sharps policy eliminates decisionmaking because no one has to decide whether or not a particular sharp is contaminated.
- Training and management are simpler, easier and more efficient when all sharps are handled in exactly the same way.
- Uniform sharps handling means universal use of sharps containers, a practice that offers protection for all handlers of sharps.
- A uniform sharps handling policy is consistent with public health concerns about drug abuse and the reuse of needles and syringes.

Low-Level Radioactive Waste: Radioactive waste from medical institutions is comprised of any waste containing or contaminated with radioactive isotopes (radionuclides). Low-level radioactive waste from institutions that use radionuclides for in vitro or laboratory testing or in amounts less than 200 uCi (and within specific radionuclide limits) are exempt from federal regulation and may be disposed of as solid waste according to Nuclear Regulatory Commission rules as set forth in 10 CFR 31.11 (Reinhardt and Gordon, 1991, p. 163). The Federal Low-Level Radioactive Waste Policy Act, amended in 1985, requires each state to be responsible for providing disposal capacity for its own low-level radioactive waste (Public Law 96-573.94).

Antineoplastics/cytotoxics: Cytotoxic chemicals are hazardous pharmaceuticals used in chemotherapy, and seven such compounds are on the RCRA "U" list of hazardous waste. Most can reasonably be expected to be mutagenic, teratogenic, and/or carcinogenic to man and animals (Reinhardt and Gordon, 1991, p. 142). Wastes resulting from the use of these materials (products of a process or operation) are not regulated Ibid.).

"Perhaps the wastes of most serious concern are unused portions of source containers (containers in which drugs are supplied), expired drugs, and surplus mixtures, which typically have larger quantities or higher concentrations of the drug. Chemically contaminated waste is also generated, including used needles and syringes, tubing and bottles used for intravenous administration, empty drug vials and ampoules, gloves, aprons and disposable benchtop coverings from biological safety cabinets. Needles, and perhaps some other items, may be considered both chemically contaminated waste and infectious waste" (Ibid.).

Antineoplastics generate three categories of wastes:

1. bulk contaminated materials, intravenous solutions or containers whose contents weigh more than 3 percent of the capacity of the container;
2. trace contaminated materials;
3. contaminated human excreta.

Cytotoxics "cannot be dispensed of in bulk quantities in medical waste incinerators without a RCRA hazardous waste incinerator permit. It is also true that these RCRA hazardous wastes could not be treated by most nonincineration treatment methods. Yet, given that these substances are usually encountered as 'trace' contaminants, rather than 'bulk wastes,' they are not managed as RCRA hazardous wastes, and can legally be disposed of with other medical wastes" (U.S. Congress, Office of Technology Assessment, 1990, p. 13).

Chemical wastes: Chemical waste is regulated as hazardous waste if it exhibits one of four characteristics: ignitability, corrosivity, reactivity or the ability to produce toxic leachate in a landfill. EPA defines the criteria for these characteristics in Subpart C of 40 CFR Part 261.

"EPA also regulates some chemical wastes that are discarded commercial chemical products listed in 40 CFR 261.33(e) as acute hazardous wastes (having hazardous waste numbers beginning with P) or in 40 CFR 261.33(f) as toxic wastes (numbered with U). . . . The rules also cover residue remaining in a non-empty container and debris regulations cover field situations and exposures to other animals.)

7. *Unused sharps.* Hypodermic needles, suture needles, syringes, scalpel blades. This category is included because of the risk of the item having been used without the handlers' knowledge and the added potential for illicit use if these items are disposed of as solid waste. In addition, unused sharps have the potential to cause physical injury from improper handling.

8. *Low-level radioactive* waste. From administering radiopharmaceuticals and performing nuclear medicine procedures and radio-immunology procedures. These wastes, such as radioactive sharps, are not under Nuclear Regulatory Commission regulations.

9. *Antineoplastic (cytotoxic, cytostatic)* drugs. Trace contaminated materials and contaminated human excreta that are not handled as RCRA hazardous wastes.

10. *Small volumes of chemical hazardous* waste. These are volumes that are exempt from Subtitle C of the Resource Conservation and Recovery Act. These wastes are products of a process or operation involving the use of hazardous chemicals.

resulting from the cleanup of a spill. . . . . Wastes resulting from the use of these materials (products of a process or operation) are not regulated, such as materials contaminated with a listed chemical generated in the course of a standard procedure" (Reinhardt and Gordon, 1991, p. 142).

Wastes with Multiple Characteristics: Frequently, medical wastes generated will fall into more than one of the ten categories in the Guidelines, such as radioactive sharps. A hierarchy for assigning priorities to the waste characteristics that present the greatest hazard can assist in waste management decisions.

Principles for the Management of Wastes with Multiple Characteristics (adapted from Reinhardt and Gordon, 1991, p. 178, 179):

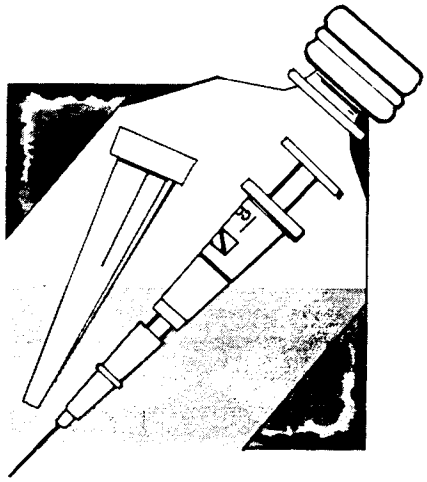
1. Give priority to the characteristic that presents the greatest risk.
   a. Ascertain which hazards are present in each waste.
   b. Assess the relative degree of risk present in each hazard.
   c. Assign priority to the hazard with the greatest risk.
   d. Develop a management scheme based on the relative degrees of risk.

2. Select treatment management procedures that are compatible with all the hazards present in the waste.

3. If possible, select a treatment technique that will provide suitable treatment for all the hazards.

4. If necessary, provide additional treatment for eliminating the remaining hazards.

Items That Are Not Medical Waste: According to the principles of infectious disease transmission, minimally soiled items in contact with infectious agents are probably not capable of infectious disease transmission because the potentially infectious materials will be contained or confined in the waste materials (U.S. Department of Health and Human Services, 1990, p. 3.3). If these items become saturated with blood, excretions, exudates or secretions containing a sufficient number of infectious agents, however, they would then be similar to material in the cultures and stocks, bulk human blood and blood products and animal waste categories and capable of infectious disease transmission, provided an appropriate portal of entry is present in a susceptible host (Ibid., p. 3.3- 3.4).

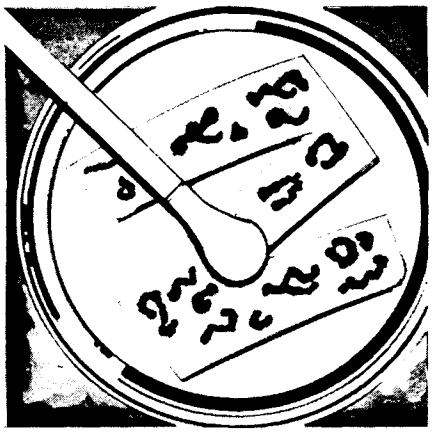


II. GENERATION

Documentation

Although hospitals have been the primary target of medical waste regulations, they are not the only generators of medical wastes. Small practices and non-facility sources such as illicit drug users have also been responsible for beach wash-ups and mismanagement of medical wastes.

These incidents have initiated stricter state and federal oversight of medical waste management. Medical facilities are the most easily identifiable sources for regulation, but not necessarily the worst offenders. Tighter control of medical facilities has seemed to alleviate some of the public concern over medical waste issues, but there are many other types of generators who need to improve their management methods.

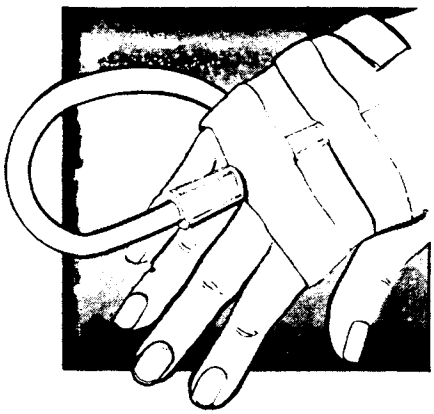


Types of Generators

There are many sources of medical waste with a wide variation in the amount of waste produced by each type of generator. The range of potential generators includes:

Hospitals:
- general medical and surgical
- psychiatric
- tuberculosis
- other specialty (obstetrics and gynecology, eye/ear/nose/throat, rehabilitation)

Intermediate care facilities:
- nursing homes
- in-patient care facilities for the developmentally disabled



Clinics:
- chronic dialysis
- free clinics
- community
- employee
- surgical
- urgent care
- abortion
- drug rehabilitation
- health maintenance organizations

Physician offices:
- general and family practice
- internal medicine
- pediatrics
- obstetrics and gynecology
- ophthalmology
- orthopedic surgery
- general surgery
- dermatology
- psychiatry
- otorhinolaryngology
- urological surgery
- cardiovascular disease
- neurology

Dental offices

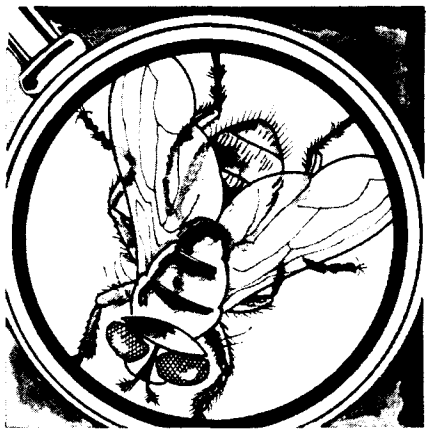
Laboratories:
- medical
- research
- industrial
- commercial diagnostic
- biologics manufacturing
- medicinal chemicals and botanical products
- pharmaceutical preparations

Funeral homes

Veterinarians

Agricultural

Blood Banks



Animal Care:
- shelters
- fur farms
- breeders
- experimentation units

Emergency medical services:
- ambulance services

Hospices

Household/Home Health Care:
- health care providers
- self care

Health units in:
- industry
- schools
- correctional facilities
- fire and rescue services

Medical and nursing schools

Illicit drug users

The U.S. EPA reports that the vast majority of regulated medical waste (about 77 percent) is generated by hospitals. However, hospitals comprise less than 2 percent of the total number of generators (U.S. EPA May 1990, pp. 1-3).

Generator Quantities as Percents of Total Regulated Medical Waste and Generator Types as Percents of the Total Number of Sources

Generator Type	*Percent of Regulated Medical Waste Generated*	*Percent of Generators*
Hospitals	77.10	1.88
Long-term Health Care Facilities	6.36	3.36
Physicians' Offices	5.67	47.70
Clinics	3.59	4.11
Laboratories	3.31	1.14
Dentists' Offices	1.63	26.08
Veterinarians	.99	10.07
Funeral Homes	.84	5.41
Free-Standing Blood Banks	.52	.24

Calculated from U.S. Environmental Protection Agency, May 1990, Table 1-1, p. 1-5

Small Generators

Most states specify that only entities generating over a certain amount of medical waste per month are subject to state regulations. In their definitions of medical waste "generators" many states exempt small generators, e.g., sources who generate between less than 50 and 220 pounds (100 kilograms) per month.

The American Hospital Association recommends basing medical waste regulations on the properties of waste rather than the size of the entity that generates it (Bureau of National Affairs, *Infectious Waste: The Complete Resource Guide*, v.I 1988 at p. 13 in Stewart, et al., 1989, p. VI.28). Likewise, these Guidelines are directed to all generators of medical waste unless otherwise indicated.

Public Education

Increases in medical waste from residential sources is attributable to a number of changes in and outside of the health care delivery system. The Agency for Toxic Substances and Disease Registry reports that the number of injuries refuse workers sustain from sharps in residential solid waste is increasing. This trend appears to coincide with the increasing trend to in-home health care (U.S. Department of Health and Social Services, 1990, p. 6.3).

There are several trends that have increased the amount of medical waste emanating from unregulated sources:

1. Hospital patients are released on an out-patient basis sooner and more frequently. They are often prescribed with medical supplies for self-care at home.

2. The use of disposable items has increased the volume of medical waste entering the solid waste stream from private homes. The American Diabetes Association estimates that diabetic patients generated one billion used syringes in 1987, assuming that the syringes were not reused (U.S. Department of Health and Social Services, 1990, p. 6.2).

3. Many one-time use items are available over the counter for small livestock operations and other business or non-profit entities that do not come within the jurisdiction of regulated generators of medical waste.

4. Increases in the users of illicit intravenous drugs are another source of unregulated medical waste. The National Institute on Drug Abuse estimates that there are between 1.1 million and 1.3 million illicit IV drug users nationwide (U.S. Department of Health and Social Services, 1990, p. 3.22).

In its 1990 report to Congress on the public health implications of medical waste the Agency for Toxic Substances and Disease Registry recommended that "guidelines for in-home health care medical waste management should be developed by relevant government and private-sector organizations. As much as possible, these guidelines should also address the management of other sources of non-regulated medical waste. These guidelines may assist in alleviating the negative environmental impact of this waste stream" (U.S. Department of Health and Social Services, 1990, p.14).

The imposition and enforcement of state or federal regulations on individuals in their homes would be an impossible task. Likewise, local ordinances for trash separation and collection and use of sewage systems would encounter difficulties in enforcement. The Rockefeller Institute's Medical Waste Policy Committee recommends, instead, "a combination of local ordinances, patient education, and economic incentives:"

"The local ordinance would set forth specific duties such as separation and containment of sharps and disposal to avoid burdensome duties. A model ordinance could be developed to guide municipalities, just as model ordinances have been used to deal with the disposal of household toxic wastes (e.g. pesticides, paints).

" . . . patients at home must also be educated as to proper disposal of their medical wastes. . .education by the patient's physician or hospital staff at the time of discharge to home health care is likely to more focused and effective.

"Finally, economic incentives could be designed to further assure that patients comply with local ordinances and the guidances they have received from their physician and hospital. For example, a 'deposit-refund system for containerized wastes' could be instituted" (Stewart, et al., 1989, p. VI. 29-30).

"Perhaps most importantly, the public needs to understand the infectious waste management process and the fact that proper and safe management is possible. They need to feel confident that their health and environment are not threatened by infectious waste. The aesthetic and emotional concerns surrounding this issue are perhaps greater than any real hazard. Through a combination of public education and prudent management, this emotionally charged issue can be defused" (Cahail and Caquelin, 1989, p. 45).

The state of Washington is currently conducting a U.S. EPA-funded project to identify reasonable methods for home health care medical waste disposal. The study in concentrating on the handling of sharps.

Public Education

Education of the public, especially small generators such as home health care users of medical products, can greatly expedite the management of medical waste.

Educational efforts should:

1. Provide the public with an understanding of the medical waste management process and the fact that proper and safe management is possible;

2. Inform medical waste generators of safe and proper methods of disposal;

3. Inform persons who use syringes or similar items in the home (e.g. diabetics, etc.) as to ways in which they can reduce or eliminate hazards that may occur through improper disposal of these items.

4. Distribute pamphlets and administer on-site training programs designed to assist waste handlers in identifying potentially infectious waste as a limited subset of the composite medical waste stream;

5. Make employees within health care facilities aware of the potential hazards that exist and train them to handle them. They also need to know that just because something is thrown away, it does not suddenly disappear. Waste material can pose threats to both workers and the general public.

Minimization

The shift to the use of disposable products for health care and the implementation of universal precautions has significantly increased the quantity of medical waste generated. The growth in the use of disposables in health-care settings is attributable to a number of converging factors in recent decades. These include:

1. Increased concern over infection control;

2. Decreased available nursing staff (and a need to provide more expedient treatment and more convenient clinical practices);

3. Increased cost of health-care labor (and concern over the time needed to handle and sterilize reusable items); and

4. Consideration of disposables as part of the general solid waste stream of the health-care facility (with, in the past, resultant low cost for handling and disposal) (U.S. Congress, Office of Technology Assessment, 1990, p. 22).

"One widely held presumption is that the use of disposables is important from the perspective of infection control. . .

"Yet, infection control studies do not indicate a constant and consistent reduction in nosocomial infections where disposables replace reusable products" (Ibid., p. 22).

The quantity of wastes requiring special handling can be greatly reduced by an understanding and recognition of which wastes are medical wastes and must be segregated and which wastes can be managed as solid wastes. Separation of items that are returnable, reusable with or without cleaning, sanitizing or sterilization or are recyclable for purposes of reprocessing can further reduce the total volume of waste generated.

Reuse techniques involve cleaning and/or disinfection that does not significantly affect the waste's structural integrity and subsequent reuse. Recycling involves substantial reprocessing. "Before treatment" approaches to waste prevention and materials management can reduce the amount of material that enters the waste stream.

"Lessons from the management of other waste streams, notably hazardous waste and municipal solid waste, indicate that a sound control strategy for waste management follows the basic steps of characterizing the waste stream in light of different treatment alternatives, segregating some wastes to facilitate management based on these characteristics, and looking 'upstream' to discover any opportunities to reduce the volume and or toxicity of waste" (U.S. Congress, Office of Technology Assessment, 1990, p. 19).

Reuse:

"Reprocessing or reuse of single-use medical devices raises a number of technical, economic, ethical, and legal issues. The presence of residues from the reprocessing could affect the quality of a patient's care; the health care facility may be concerned about potential liability from reusing the device; devices that were not designed for multiple uses could fail when reused, and there may be inadequate or nonexistent quality control for the sterilization procedures used (U.S. Environmental Protection Agency, May 1990, p. 12.2).

". . .the practicality of reuse, given liability concerns and standard operating procedures for a particular health-care facility, may preclude reuse of particular medical items at an institutional level. Certain disposable items though are advantageous over reusable items for various reasons including controlling infection, saving labor costs for processing, and minimizing exposure to hazardous chemicals used in chemical sterilization processes. The use (and reuse) of disposables can be considered on an item by item basis, in light of how they will be used, including consideration of infection risks and other factors associated with those risks" (U.S. Congress, Office of Technology Assessment, 1990, p. 20).

Minimization

The minimization of medical waste can be accomplished through reuse, recycling and source reduction. Minimization techniques include:

- waste audits that emphasize characterization of the waste stream;
- development of a plan delineating necessary segregation techniques;
- education/training of the employees of the health-care facility;
- clearly marking and conveniently placing containers for segregation of wastes to encourage their use.

Source Reduction

The following source reduction or prevention techniques can reduce the toxicity or quantity of discarded products before the products are purchased, used, and discarded:

1. Manufacturers can consider waste issues in designs of current and planned medical and health-care products and their packaging.

2. Consumers of medical and health-care products (e.g., hospitals) can direct their purchasing decisions, product use, and the discarding of products toward waste reduction goals.

3. Improvements in materials management practices can eliminate overpurchasing items with a limited shelf life or storage or handling practices that cause materials to be less useful.

4. Toxics such as cadmium in medical products (pigments in red bags, in batteries and some plastics) or PVC plastics can be replaced with less toxic materials such as non-chlorinated plastics.

5. Materials can be used that are safer to burn, that reduce incinerator emissions or have higher heat recovery potential or are more biodegradable.

Laboratories can implement the following practices to minimize medical waste production (National Research Council, p.43):

6. Researchers can plan experiments and select reagents that minimize the production of mixed waste.

7. Experimental design may be modified such that the wastes are generated separately and in minimal volumes. Microscale techniques are now available for most experimental procedures.

8. When feasible, consider substituting less hazardous materials.

9. Make appropriate waste containers available at the work site to ensure

Source Reduction:

The two fundamental characteristics of wastes that are the focus of reduction efforts are:

1. Toxicity, i.e., eliminating or finding benign substitutes for substances that pose risks when they are discarded.

"The difficulties inherent in managing wastes with multiple hazards make it important to optimize waste management by minimizing the production of multihazardous wastes. Certain policies and activities will help to achieve this:

a. Do not mix waste streams.

b. Promote substitution policies.

c. Reduce the quantities of multihazardous wastes generated.

d. Identify sources of multihazardous wastes.

e. Store wastes for decay of radioactivity or until disposal options become available" (Reinhardt and Gordon, 1991, p. 180).

2. Quantity, i.e., changing the design or use of products to minimize the amount of waste generated when they are discarded.

Waste Management Plan

Small generators of medical waste may not require a written waste management plan. However, home self health care providers should be knowledgeable in the proper packaging and disposal of their medical wastes. Professional home health care providers and other small generators should be trained in the proper handling and transport of medical wastes generated in the course of their duties.

convenient and correct segregation and labeling of the waste.

Waste minimization techniques can be implemented in all departments of health care facilities. The identification and segregation of materials that are not medical waste for inclusion in the solid waste stream can reduce the special costs and handling associated with the transport and treatment of medical wastes. Additional segregation for reusable and recyclable items can further reduce the amount of waste destined for disposal. Selection of items for purchase that are reusable, recyclable or of low toxicity will expedite waste minimization efforts later in the waste handling process.

Waste Management Plan

The medical waste management plan is central to any medical waste management program. The plan should define all medical wastes handled by the facility, those responsible for their management, and procedures for handling them from the point of generation through disposal.

Each medical waste generator should prepare a written management and operations plan outlining policies and procedures for the safe and effective management of medical waste. The plan should be reviewed and updated as necessary. This plan should include the following elements:

- compliance with applicable regulations
- department and individual responsibilities; listing of infection control, environmental control and housekeeping personnel
- hours and days of operation at the facility and the number of conveyances delivering biomedical waste that are expected daily and that can be accommodated daily
- procedures for medical waste identification
- a description of the medical waste handled by the facility including type and volume
- waste minimization procedures
- segregation
- packaging
- storage
- transportation methods
- treatment methods
- treatment monitoring records
- disposal methods
- the transporters and disposal facilities that will be used
- contingency planning
- procedures for spill response
- a general inspection schedule for the facility
- staff training and safety
- record keeping for waste that has been treated on-site
- record keeping for waste transported off-site for treatment and/or disposal
- the generator's system for distinguishing between treated and untreated wastes

The policies and procedures portions of all waste management plans should be available for public inspection. The entire waste management plan should be available to public health and environmental officials, transporters and treatment and destruction facilities. Facilities should consider the advantages of making their entire waste management programs available to the public since public support and elimination of public fears is critical for conducting business.

Operation

Segregation: With minimal segregation, items such as patient care disposables and even leftover food could be treated the same as blood or sharps. Thus, the volume of waste that could be treated as medical waste is potentially much larger than if these items are separated at the point of generation.

If the waste containers are clearly labeled to designate medical from solid waste items, haulers and treatment and disposal facilities can easily identify the type of waste. If the waste is not clearly identified, waste handlers have little way of determining its infectious potential and must therefore treat all of the wastes as medical waste. Segregating medical waste that is not potentially infectious and handling it as ordinary solid waste can greatly reduce the volume and expense of medical waste treatment and disposal.

Containment: "Proper packaging of infectious waste breaks the disease transmission chain at the third link — by denying infectious agents a mode of escape from their growth reservoir. If the infectious organisms cannot escape from their reservoir, then they cannot gain access to a susceptible host and induce disease (Minnesota, 1988, p. IV.2).

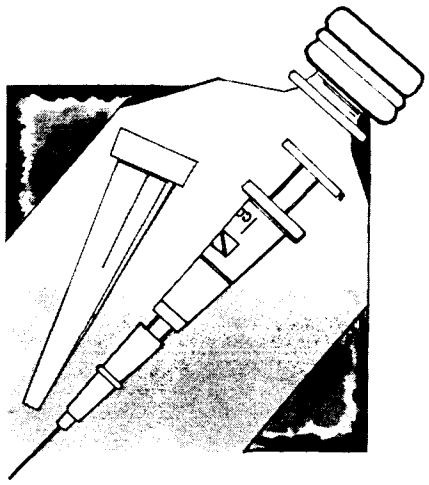
ASTM (American Society for Testing and Materials) has developed a dart test for assessing plastic bag thickness and/or durability for use as medical waste packaging. The test is the "Standard Methods of Test for Impact Resistance of Polyethylene Film by the Free Falling Dart Method, Standard of the American Society for Testing and Materials Designation D 1709-67, Method B."

Storage: Two types of facilities can increase the efficiency of medical waste trucking by combining medical wastes for transport to treatment facilities:

1. Transfer stations provide an intermediate point at which medical waste haulers can combine small loads of medical waste for further transport to treatment facilities. State storage and transportation requirements usually apply to these stations.

2. Collection stations provide a point to which small generators can bring their medical wastes for pickup by a transporter. These stations may not be as tightly regulated as transfer stations. The state of Texas regulates facilities in less populated areas that serve as collection points for generators who generate less than 50 pounds per month of waste and who transport their own waste.

The state of New Jersey is considering collection station regulations which include limiting the amount of medical waste that could be on-site at the station at a time and the length of time that it could reside there. The stations would register as non-commercial transporters. The state would allow storage of the wastes on trucks while at the collection station, unlike at transfer stations. Proper packaging and storage should apply to these stations and to the trucks that utilize them.



Operation

The clear designation and containment of medical waste at the point of generation for special handling and specific safety procedures for waste handlers to follow helps to ensure the protection of health care personnel and the public from exposure to infectious or unaesthetic materials. Proper management of generating sites expedites the transfer and treatment of medical wastes. The quality of handling is affected by the design of waste containers and storage areas. This section discusses the segregation, containment, labeling and storage of medical wastes.

Segregation

Segregation is the initial and crucial point in the waste handling process that determines the amount of waste and type of treatment to which it will be subjected in the ensuing waste management process.

1. Designate medical waste as soon as practical at the point/time of origin.
2. Separate medical waste from other solid waste (e.g., paper, garbage items).
3. Separate sharps.
4. Separate other medical wastes designated for on-site treatment from those intended for off-site treatment.
5. Separate wastes intended for recycling.
6. Segregate according to treatment method and packaging suitable for that method:
   a. liquid
   b. sharps
   c. non-sharp solid according to heat value, moisture content and biological and chemical composition
7. Provisions should be made for separating medical waste with multiple hazards (e.g., radioactive sharps) when additional or alternative treatment is required.

Handling

The following handling techniques can assure the safety and protection of personnel from injury and the integrity of waste containers:

1. Untreated medical wastes should only be compacted if the compaction takes place in a closed chamber which eliminates the possibility of exposure to infectious agents through aerosols.

2. Medical wastes should not be transferred through chutes or dumb waiters. Collection by gravity or pneumatic chute can also result in the forcing of contaminated air down the shaft and horizontally into other outlets located elsewhere in the building (e.g., nursing stations and other clinical areas).

3. Carts used to transfer wastes within the facility should be frequently disinfected. They should not be used for other materials (e.g., food service, patient baggage transfer) prior to decontamination.

Containment

The structures that are used for the containment of medical wastes during storage, transport, treatment and disposal can reduce the probability of the transmission of infection. In addition, proper containment of medical waste protects workers from physical injury, reduces the possibility of unaesthetic appearances, and greatly expedites the waste handling process.

1. Clearly marked, easily accessible containers for each type of waste will encourage optimal segregation.

2. The containers should be located in the immediate area of use.

3. These containers can include recyclables and reusables within the scope of hospital infection control policy and liability concerns, as well as medical and solid waste categories.

4. Too many containers can confuse and discourage health care personnel from attempting to properly designate the various wastes. Too few containers result in all wastes being designated for the costly and more involved process necessary for only certain types of waste.

5. Replace the containers routinely and don't allow them to become overfilled.

6. Seal all bags by lapping the gathered open end and binding with tape or closing device such that no liquid can leak.

7. If the outside of the bag is contaminated with body fluids, use a second outer bag. Use of double plastic bags for liquid waste is recommended.

8. If containers are to be reused for medical waste storage, handling or transport, thoroughly wash and decontaminate them by an approved method each time they are emptied, unless the surfaces of the containers had been protected by disposable liners, plastic bags or other means which are removed and disposed of with the waste. Include agitation (scrubbing) in the cleaning process to remove any visible solid residue, followed by disinfection.

9. Enclose and store incinerator ash in tightly lidded containers or sturdy plastic bags or contain it in such a way that waste transport workers will not be exposed to inhalable dust or spill when transferring the ash.

10. Select packaging materials that are appropriate for the type of waste and treatment process. Use packaging that maintains its integrity during storage and transport.

11. Don't use glass containers as primary containers for transportation of medical waste. Place glass containers into a rigid or semi-rigid, leakproof container and protect from breakage.

12. Use plastic bags that are impervious to moisture, puncture resistant, and distinctive in color or markings.

13. Reusable containers should be constructed of either heavy wall plastic or noncorrosive metal. Don't use these containers for any other purpose, unless they have been properly disinfected and have had medical waste symbols and labels removed.

14. Support heavy materials in double-walled corrugated fiberboard boxes or equivalent rigid containers.

15. Place liquid pourable wastes in leak-proof, rigid, puncture resistant, break resistant containers, capped or tightly stoppered bottles or flasks.

16. Place needles, syringes, breakable items and other sharps in a plastic vial or puncture-resistant box before they are placed into the bag. Needles should not be clipped or recapped by hand. Syringes should not be crushed.

17. OSHA Instructions specify the following recommendations for antineoplastic drug wastes (OSHA Instruction PUB 8-1.1, Office of Occupational Medicine, p. A-14, A-15):

a. Place antineoplastic drug wastes in sealable plastic or wire-tie bags of 4-mil-thick polyethylene or 2-mil-thick polypropylene, labeled with a cytotoxic hazard label and colored differently from other hospital trash bags. Use these bags for the routine accumulation and collection of used containers, syringes, discarded gloves, gowns, goggles, and any other disposable material.

b. Place needles, syringes and breakable items in a plastic vial or puncture proof box before they are placed into the bag. Don't clip or cap needles or crush syringes.

c. Keep the bag inside a covered waste container clearly labeled "cytotoxic waste only."

d. Locate at least one such receptacle in every area where the drugs are prepared or administered so that the waste need not be moved from one area to another. Seal the bag when it is filled and tape the carton.

Labeling

Each container to be transported off-site should be clearly marked as medical waste immediately after packaging. The label or tag should also identify the generator, transporter and date of shipment.

1. Label medical waste to be transported off-site immediately after packaging. The label should be securely attached to the outermost container and be clearly legible. The label may be a tag securely affixed to the package by string, wire, adhesive or other method that prevents loss or unintentional removal.

2. Use indelible ink to complete the information on the label. The label should be at least three inches by five inches in size. The lettering for "medical waste" should be no less than one inch in height. The wording should be readily visible from any lateral direction when the container is upright.

3. Include the following information:

a. The name, address, business telephone and state permit or identification number (if applicable) of the generator;

b. "Biomedical Waste" or "Medical Waste" in large print;

c. The name, address, business telephone and state permit or identification number (if applicable) of all transporters, treatment facilities, or other persons to whose control the medical waste is transferred. License number of transporters shall be provided if applicable;

d. The international biohazard symbol;

e. The date upon which the medical waste was packaged.

4. Label treated medical waste with the following information:

a. The name, address and business telephone number of the generator;

b. The date upon which the medical waste was treated;

c. Treatment method utilized;

d. Statement indicating that the waste has been treated and is no longer medical waste.

Storage (Prior to treatment)

Medical wastes may need to be stored on-site until a large enough quantity is accumulated to warrant treatment at the facility or until collection for transport to an off-site treatment facility is scheduled. Treatment system malfunction or staff shortages may also necessitate storage of waste. In addition, intermediate storage facilities may be necessary enroute to off-site facilities. Rural areas may find that the use of transfer or collection stations expedites proper management by small generators. All storage areas or units should be well secured to discourage access of drug users to needles and animals to organic matter (i.e., body parts) contained in the waste.

The following conditions apply to storage, transfer and collection stations:

1. Store medical waste in a specifically designated area located at or near the treatment site, or at the pickup point if it must be transported off site for treatment.

2. All areas used to store medical waste should be durable, easily cleanable, impermeable to liquids, and protected from vermin and other vectors.

3. Keep all storage areas clean and in good repair.

4. The manner of storage should maintain the integrity of the containers, prevent the leakage of waste from the container, provide protection from water, rain, and wind, and maintain the waste in a nonputrescent, odorless state.

5. Don't use carpets and floor coverings with seams in storage areas. The floor should be impervious to liquids with a perimeter curve. The floor should be sloped to drains connected to an approved sanitary disposal system.

6. Provide the room with exhaust ventilation.

7. For security reasons, limit access to the area to those persons specifically designated to manage medical waste.

8. Post such areas prominently with the universal biohazard symbol and with warning signs located adjacent to the exterior of entry doors, gates, or lids indicating use of the area for storage of medical waste and denying entry to unauthorized persons.

9. Treatment facilities should not store more than seven times the facility's total throughput capacity.

10. Maintain storage areas, including vehicles, at a temperature so as to control odors and to prevent conditions that will lead to putrefaction.

11. Duration:

a. Storage time should be minimized;

b. Time in transit shall be considered as time in storage;

c. Storage requirements begin once the container is no longer being filled.

12. OSHA specifies that antineoplastic wastes that are to be picked up by a commercial disposal firm must be held in a secure area in covered, labeled drums lined with 6.5-mil polyethelene liners.

13. Collection or transfer stations should submit the following information to the state division of solid waste management:

a. the name and address of the facility;

b. the name of the individual responsible for the operation of the facility;

c. the license number of the facility;

d. the area to be served by the facility.

Monitoring and Record Keeping

In *Illinois* generators of medical waste who treat such waste must keep and make available records: (1) of any required spore assay tests; (2) describing the approximate amount of waste treated; and (3) which demonstrate proper operation of treatment equipment. These requirements may be met through compliance with hospital licensing record keeping requirements, as long as the information is adequate to satisfy the three requirements above (McDowell, 1990, p.34).

Training

Although the intent of this document is for the management of medical waste, the safety and health of those who handle these wastes is certainly a related issue. Waste handlers are not as susceptible to injury or disease from medical wastes as are healthcare workers who routinely handle medical materials before and during medical procedures as well as after it enters the wastestream. But, the same safety precautions that are prescribed for medical personnel can be applied to anyone who handles medical wastes.

Of particular interest are the standards currently under development by OSHA to protect workers from occupational exposure to blood-borne diseases. Until the final regulations are in place, the requirements of OSHA Instruction CPL 2-2.44B on the inspection of healthcare facilities entitled Enforcement Procedures for Occupational Exposure to Hepatitis B Virus (HBV) and Human Immunodeficiency Virus (HIV) provide safeguards for healthcare workers who may be occupationally exposed to blood-borne pathogens. Occupational exposure is defined as "reasonably anticipated skin, eye, mucous membrane, or parenteral contact with blood or other potentially infectious materials that may result from the performance of an employee's duties" (American Dental Association, 1990, Infection Control-p. 9).

The instructions recommend training "high risk workers" (those who are at routinely increased exposure to body fluids from potentially infected patients) in the use of universal precautions. Universal precautions refers to a system of infectious disease control which assumes that every direct contact with body fluids is infectious and

Monitoring and Record Keeping

Generators of medical waste that is to be transported to a treatment facility should maintain records of the types of wastes being transported, the method of treatment, the designated treatment facility, and the transporter. Such records provide liability protection to the generator as well as documentation of good waste management practice.

Generators who treat waste on-site should keep available records on file at the generator location (1) of spore assay tests, (2) describing the approximate amount of waste treated; and (3) which demonstrate proper operation of treatment equipment.

Compliance with OSHA Instruction CPL 2-2.44B and other OSHA regulations may require records for each employee that contain the circumstances of any exposure incident, including date, location, nature of the incident and the name of the person who is the source of the medical waste. These medical records must be kept confidential except for disclosure or reporting required by OSHA or by law.

Training

Training of personnel who handle medical waste at the site of generation will help to ensure immediate and accurate identification and segregation of wastes and safe and effective handling procedures.

Training should include the following components:

1. Explanation of waste management plan.
2. Assignment of roles and responsibilities for implementation of the plan.
3. The epidemiology, modes of transmission and prevention of HIV and HBV.
4. Possible risks to the fetus from HIV, HBV and other infectious agents.
5. The location and proper use of personal protective equipment.
6. Proper work practices and "universal precautions."
7. The meaning of color codes, the biohazard symbol and precautions to follow in handling contaminated articles or medical waste.
8. Procedures to follow if a needlestick or other exposure incident occurs.
9. Waste minimization procedures.
10. Training should be implemented when management plans are first developed and instituted, when new employees are hired, and whenever management practices are changed.

Contingency Planning

Medical waste generators should be prepared for unexpected situations such as accidental spills, loss of containment, exposure, equipment failure, and interruptions or delays in waste collection services that may require the use of alternative facilities. Procedures for handling these incidents should be formulated and disseminated to waste handlers.

Equipment and procedure for response to large spills of medical waste should include the following items. Small generators may handle only specific types and volumes of medical waste. They may select equipment that is adequate to handle these waste types and amounts.

1. Management of spills of medical waste.

All medical waste management facilities should keep a spill containment and cleanup kit within the vicinity of any area where medical wastes are managed, and the location of the kit shall provide for rapid and efficient cleanup of spills anywhere within the area. The kit should consist of at least the following items:

a. material designed to absorb spilled liquids. The amount of absorbent material should be that having a rated capacity of one gallon of liquid for every cubic foot of medical waste that is normally managed in the area for which the kit is provided or ten gallons, whichever is less. For vehicles transporting medical waste, the amount of absorbent material should be rated to absorb ten gallons.

b. one gallon of hospital grade disinfectant in a sprayer capable of dispersing its charge in a mist and in a stream at a distance sufficient to prevent contact of the worker with the spill or splashing from the sprayer. The disinfectant should be hospital

requires every employee exposed to direct contact with body fluids to be protected as though such body fluids were HBV or HIV infected. The precautions are intended to prevent health care workers from parenteral, mucous membrane, and nonintact skin exposures to blood-borne pathogens (U.S. Department of Labor, 1990, p.4).

Of particular importance to waste handlers, OSHA requires the implementation of specified housekeeping, waste handling and labeling procedures and provision of training programs for employees and maintenance of certain records.

As of 1990, 23 states and two territories have been approved to operate their own occupational safety and health plans. These plans must enforce standards for occupational exposure to blood- borne pathogens that are "at least as effective" as the federal standard (American Dental Association, 1990, Infection Control-p. 6).

grade and effective against mycobacteria.

c. enough red plastic bags to double enclose 150% of the maximum load accumulated or transported, that meet the ASTM 125 pound drop weight test and are accompanied by sealing tape or devices and labels or tags. These bags shall be large enough to over-pack any box or other container normally used for medical waste management by that facility.

d. two new sets of liquid impermeable and disposable overalls, gloves, boots, caps and protective breathing devices. Overalls, boots and caps shall be over-sized or fitted to medical waste workers and be made of materials impermeable to liquids. Boots may be of thick rubber and gloves shall be of heavy neoprene or equivalent. Boots, gloves and breathing devices may be reused if fully disinfected between uses. Tape for sealing wrists and ankles shall also be in the kit.

e. a first aid kit and boundary marking tape.

2. Containment and cleanup procedures:

a. Leave the area until the aerosol settles (no more than a few minutes delay).

b. The cleanup crew will don the cleanup outfits described above and secure the spill area.

c. Spray the broken containers of medical waste with disinfectant.

d. Place broken containers and spillage inside over pack bags in the kit, minimizing exposure.

e. Disinfect the area and take other cleanup steps deemed appropriate.

f. Clean and disinfect cleanup outfits before removing.

g. Remove cleanup outfits and place disposable items in cleanup bag.

h. Collect and handle all spill wastes as medical waste.

i. Take necessary steps to replenish containment and cleanup kit with items used.

3. Exceptions for small spills may be allowed.

4. Alternative arrangements for waste storage and treatment should be provided for in the event of equipment failure.

5. Exposure incidents.

OSHA defines occupational exposure as reasonably anticipated skin, eye, mucous membrane or parenteral contact with blood or other potentially infectious materials that may result from the performance of an employee's duties.

OSHA Instruction 2.44B on occupational exposure to bloodborne disease recommends the following procedures to insure compliance with OSHA inspections:

a. For any persons exposed to a medical waste spill who consents and so desires: collect a blood sample as soon as possible after the exposure incident for the determination of HIV antibody status.

b. Advise the exposed individual to report and seek medical evaluation of any acute illness accompanied by a fever that occurs within 12 weeks of the exposure incident.

c. Offer retesting for HIV antibody to individuals who are seronegative at 6 weeks, 3 months, and 6 months after the exposure incident.

d. Produce a follow-up report on whether any infection due to exposure actually occurred.

III. TRANSPORTATION

Medical waste that is not treated at the site of generation must be transported to a treatment or disposal facility. The remainder of waste (i.e., treatment residues or treated waste) that has been treated on-site, such as incinerator ash or autoclaved waste, must still be hauled to a permanent disposal facility. Proper management at this stage of the treatment process will ensure accountability for proper containment and handling of the material until its final destination.

In the selection of a waste hauler, the generator may want to obtain the following information: the size of the hauler's operation, state permits or operator's licenses, how long it has been in business, truck type, security measures and worker safety precautions or the details of the waste management plan, if the company indemnifies the generator (e.g., exempts from loss or damage) for its mishandling of the waste, and if the hauler will provide documentation needed for compliance with federal, state or local regulations.

Waste Management Plan

The transporter's waste management plan should contain policies and detailed procedures for the safe and effective management of medical waste and should provide for contingencies in emergency situations. The policies and procedures portions of the plan should be available to the public. The entire plan should be available to public health and environmental officials.

A commercial transporter in charge of a business that transports medical waste should prepare a management plan for the medical waste handled by the commercial transporter. The plan should describe the following items to the extent the information is applicable to the commercial transporter:

1. The type of medical waste that the commercial transporter handles;
2. The transportation procedures for the medical waste that will be followed;
3. The disposal facilities that will be used for the medical waste;
4. The steps that will be taken to minimize the exposure of employees to infectious agents throughout the process of transporting and disposing of medical waste;
5. The name of the individuals responsible for the transportation and management of the medical waste; and
6. The name(s) and phone numbers(s) of emergency coordinators and response procedure to control emergency situations.

Operation

All medical wastes to be transported should be properly segregated and identified. Vehicles should be operated by competent drivers in such a manner so as to ensure the safe containment and transport of materials to its destination.

Vehicles and compartments used to transport medical waste should be designed to facilitate the least stress to the structural integrity of medical waste containers. They should protect waste handlers and the public from accidental exposure to medical waste materials.

Small generators may transport sharps by U.S. Registered Mail, return receipt requested, to a disposal service. Sharps that have been encapsulated in a polymer matrix can be shipped via the United Parcel Service to a manufacturer of the process in Georgia. In addition, small generators may use their own vehicles to transport waste to the disposal facility. The small generator should have a written agreement stipulating that the disposal facility will accept the medical waste.

Transporters should practice the following procedures:

1. Avoid mechanical loading devices which may rupture packaged wastes.

Guidelines

2. Prominently identify vehicles transporting untreated medical waste on the two sides and the back of the cargo compartment with the following: the universal biohazard symbol, the words "medical waste," "biomedical waste," or "biohazard."
3. Limit access to vehicles, equipment, and service or parking areas used in the transportation of medical waste to those persons specifically designated to manage medical waste.
4. Guidelines of the storage section shall be applicable during transportation.
5. Medical waste should not be transported in the same vehicle with other waste unless the medical waste is separately contained in rigid containers or kept separate by barriers from other waste, or unless all of the waste is to be treated and disposed of as medical waste. Subsequent uses of vehicles should be compatible with the vehicle's prior use as a medical waste carrier. Backhauling by refrigerated vehicles is discouraged.
6. All transport vehicles and equipment used to transport medical waste must be thoroughly cleaned and disinfected weekly, before being used for any other purpose, and prior to any transfer of ownership. OSHA recommends that transporters with vehicles that are to be used for purposes other than hauling biomedical waste develop a quality control plan using biological challenges to evaluate the effectiveness of cleaning/disinfecting.
7. Recycled containers which are used repeatedly for transport and treatment of bagged waste should be disinfected after each use.
8. All vehicles transporting medical wastes should carry a spill containment and cleanup kit in the vehicle whenever medical wastes are conveyed. (See contingency planning for kit contents.)
9. Direct physical contact of the transport vehicle or equipment with

Monitoring and Record Keeping

West Virginia's draft proposed medical waste rules require all persons transporting medical waste to possess a valid license from the Public Service Commission. Applications for such license shall contain at a minimum the following:

1. Name of person or firm.
2. Business address and telephone number of person or firm, including headquarters and local office.
3. Make, model, and license number of each vehicle to be used to transport medical waste within the state.
4. Name, business address, and telephone number of each driver who will operate in the state.
5. Area (counties and cities) in the state in which the transporter will operate.
6. Any person or firm associated with the applicant firm or any other name under which that person or firm does business.
7. Any other person or firm using any of the same vehicles and operators.
8. The name and telephone number of a person who may be contacted in the event of an accident or release.
9. Detailed description of the methods to comply with spill management requirements.
10. Detailed description of the methods to be utilized to clean and disinfect the transport vehicles and equipment as required.
11. Verification that the applicant and all its employees involved in the transportation of medical waste are familiar with the provisions of this rule and agree to comply in full with said provisions.

The *Pennsylvania Interim Guidelines: Manifesting and Transporter Licensing for Infectious and Chemotherapeutic Waste* require that:

1. A transporter should not accept medical waste unless it is accompanied by a manifest which has been properly completed and signed by the generator.
2. A transporter should deliver the entire quantity of waste to the facility designated on the manifest or the next designated transporter listed on the manifest.
3. No owner or operator of a processing or disposal facility should accept medical or chemotherapeutic waste shipments received from off-site sources unless the shipment is accompanied by a manifest.
4. If there is a significant discrepancy in a manifest, the owner or operator should attempt to reconcile the discrepancy before the waste covered by the manifest is processed or disposed at the facility.

A discrepancy is a difference between the quantity or type of waste designated on the manifest, and the quantity or type of waste a facility actually receives.

A significant discrepancy occurs if any of the following apply:

a. Variations greater than 5% in weight.

b. Variations in piece count, such as number of boxes or bags, for batch waste.

c. Differences in waste type which can be discovered by inspection.

medical waste should be considered and managed as a spill.

Monitoring and Record Keeping

Monitoring of medical waste transportation helps to assure that wastes generated are properly assigned and hauled to a treatment or disposal facility. Accurate records assist in the identification of illegal hauling and disposal methods. Record keeping provides written documentation of the source of the medical waste, its type and amount, the intended treatment method, and the parties responsible for its ultimate proper disposal.

Training

Transporters of medical waste should provide training for the operators of vehicles that will transport medical waste. The training should include:

1. Familiarity with the contingency plans;
2. Instruction in personnel protection and safety that is appropriate to the risk that may be encountered in the transportation and handling of medical waste;
3. How to recognize waste that is unacceptable or that is packaged in such a fashion that it is not acceptable to the processing/disposal facility;
4. How to recognize a complete and correct bill of lading; and
5. How to use the recordkeeping system that is used by the owner/operator of the hauling company.

Contingency Planning

Contingency planning for medical waste transporters is the development of a plan of action in the event of an accidental spill, loss of containment, equipment failure or other unexpected circumstance.

Owners/operators of vehicles used in the transportation of biomedical waste should carry contingency plans for emergencies that address the following:

1. Plans for disinfection of the truck and any contaminated surface if a leaking container is discovered.
2. A notification list of individuals/agencies who are to be contacted in the event of a transportation accident. This list will include the local police

or sheriff, local highway patrol, local county health department, and solid waste division.

3. A plan for action that will be taken following a transportation accident. This plan should address the clean-up and decontamination of potentially contaminated surfaces; designation of back-up transportation for the medical waste; a description of the plans for the re-packaging and labeling of medical waste where containers are no longer intact.

4. Procedures that will be followed if a fire, theft or natural disaster occurs.

5. Procedures for the management of a leaking container or a container that has lost its integrity and procedures for the correct management of a container or truckload of waste that is not accepted by the processing/disposal facility, for whatever reason.

IV. TREATMENT, DESTRUCTION & DISPOSAL

The U.S. General Accounting Office reports that hospitals treat about 85 percent of their wastes on-site. The U.S. EPA estimates that approximately 70 percent of hospital medical waste is incinerated on-site and about 15 percent is steam-sterilized on-site in an autoclave. The other 15 percent is generally shipped off-site for autoclaving or incineration (U.S. General Accounting Office, 1990, p. 9).

There is not a uniform technical definition of effective treatment and the type or degree of treatment that is considered sufficient to render a waste incapable of transmitting infection.

Documentation

Three treatment methods for medical waste are sterilization, disinfection and decontamination/sanitization.

1. *Sterilization* is the destruction of all forms of microbial life, including viruses and fungal or bacterial endospores on inanimate surfaces;
2. *Disinfection* is the reduction of microbial life to levels at which infection is not likely, e.g., is free of bacterial or fungal endospores; and
3. *Decontamination/sanitization* is the reduction of microbial content on an inanimate surface to such an extent that an item is safe to handle (U.S. Department of Health and Human Ser-

Guidelines

Treatment is any method, technique or process designed to change the biological character or composition of waste to reduce or eliminate pathogens so that the waste no longer poses a hazard to persons who may be exposed to it. Sterilization may not be necessary in every situation. It is the removal or deactivation of pathogens that is important.

Cultures and stocks are the medical wastes of greatest concern. These wastes are the result of microorganisms or specimen cultures produced in laboratories in which etiologic agents (human infectious disease

Comparison of Treatment Technologies

	Type of Treatment Technology		
Factor	*Steam Sterilization*	*Incineration*	*Hammermill/Chemical Treatment*
Operations			
Applicability	Most infectious wastes	Almost all infectious wastes	Most infectious wastes
Equipment operation	Easy	Complex	Moderately complex
Operator requirements	Trained	Highly skilled	Well trained
Need for waste separation	To eliminate non-treatable wastes	None	To eliminate non-treatables; for proper feeding
Need for load standardization	Yes	No	When feeding by type of waste
Effect of treatment	Appearance of waste unchanged	Waste burned	Waste shredded and ground
Volume reduction	30%	85-95%	Up to 85%
Occupational hazards	Low	Moderate	Moderate
Testing	Easy, inexpensive	Complex, expensive	Protocol under development
Potential side benefits	None	Energy recovery	Use of effluent in laundry
Onsite/off-site location	Both	Both	Both
Regulatory Requirements			
Medical waste tracking regulations	Applicable	Record-keeping	Not applicable
Applicable environmental regulations	Wastewater	Air emissions, ash disposal, wastewater	Wastewater
Releases to air	Low risk via vent	High risk via emissions	Low risk via vent
Releases to water	Low risk via drain	Low risk via scrubber water	Moderate risk via wastewater
Disposal of residue	To sanitary landfill; potential problem with red bags	Ash may be a hazardous waste; if so, to RCRA-permitted landfill	Effluent to sanitary sewer; residue to sanitary landfill
Permitting requirements	None	For siting, air emissions	None
Costs			
Capital	Low	High	Moderate
Labor	Low	High	Moderate
Operating	Low	High	Moderate
Maintenance	Low	High	Moderate
Downtime	Low	High	Moderate to high

(*Source:* Reinhardt and Gordon, 1991, pp. 67-68)

vices, 1990, p. 7.1).

Wastes that, although not potentially infectious or rendered non-infectious by treatment may still be aesthetically offensive or frightening. They therefore may require further treatment (e.g., grinding) to render them unrecognizable. These wastes do not represent a public health hazard, but for states in which one of the goals of medical waste management is to address the public's fear of these wastes, alteration of its physical appearance may be warranted.

Waste Suitability

Not only the category of medical waste but its physical composition and packaging influences the selection of the optimal treatment, destruction and disposal method. For example, higher levels of polyvinyl chloride (PVC) plastics in medical wastes may be contributing to higher concentrations of hydrogen chloride (HCl) in emissions, on average, from medical waste incinerators compared with municipal solid waste incinerators (U.S. Congress Office of Technology Assessment, 1990, p. 21).

Cultures and stocks — biosafety level four laboratory standards

"Liquid effluents from laboratory sinks, biological safety cabinets, floors, and autoclave chambers are decontaminated by heat treatment before being released from the maximum containment facility. Liquid wastes from shower rooms and toilets may be decontaminated with chemical disinfectants or by heat in the liquid waste decontamination system. The procedure used for heat decontamination of liquid wastes is evaluated mechanically and biologically by using a recording thermometer and an indicator microorganism with a defined heat susceptibility pattern. If liquid wastes from the shower rooms are decontaminated with chemical disinfectants, the chemical used is of demonstrated efficacy against the target or indicator microorganisms . . .

"The exhaust air from the facility is filtered through HEPA (high efficiency particulate air) filters and discharged to the outside so that it is dispensed away from occupied buildings and air intakes. Within the facility, the filters are located as near the laboratories as practicable in order to reduce the

causing agents) must be grown in high concentrations. These wastes should be sterilized or incinerated. Some treated medical wastes, although non-infectious, may still be aesthetically offensive. For this reason, treatment may include processes, such as grinding, that cause waste to become less recognizable. This additional treatment step considerably increases the cost and complexity of the waste handling process, but states may find it worthwhile if it helps to alleviate the public's fear of medical wastes.

Treatment does not always precede disposal, as is the case of the discharge of liquid wastes by a generator to a sewer for treatment at a sanitary sewage facility. Incinerator emissions are also a form of disposal (to the air) that occurs simultaneously with the treatment and destruction of waste.

Waste Suitability

The ten categories of medical wastes and the treatment, destruction, and disposal methods that are suitable for each are listed below, given they comply with all applicable regulations.

1. *Sharps*

Sharps are the waste category of greatest concern because of their ability to puncture the skin, thereby creating a portal of entry for the transmission of disease. The treatment goal should therefore be to prevent human exposure and injury. Sharps are generated by both commercial facilities such as hospitals and dentist offices and by households such as self-care by diabetics and outpatients. Treatment options for the two types of generators are as follows.

a. Commercial generators:

i. placement in a puncture-resistant, leak-proof container, chemical disinfection, and disposal in a sanitary landfill;

ii. placement in a puncture-resistant container, steam sterilization, and disposal in a sanitary landfill;

iii. placement in a puncture-resistant, leak-proof container, incineration, and disposal in a sanitary landfill; or

iv. encapsulation in a matrix which will solidify and deposition in a landfill. The encapsulation process uses a phenolic solution to disinfect sharps and an oxidizing agent to encapsulate them in a polymer matrix that is a solid block-like material.

b. Household generators:

Package sharps waste in such a manner that it will greatly reduce the likelihood that anyone who handles the waste would be exposed to needles. This should involve placing syringes needles in a puncture resistant, tightly lidded container prior to disposal. The common two liter PET plastic soda bottle is recommended because of its ability to withstand the compactions associated with the waste stream. The container should then be sealed and appropriately labeled (e.g. "WARNING: Sharps" or "WARNING: Syringes"). Because plastic bottles are recyclable, it is also advisable to put "Do Not Recycle" on the label.

2. *Cultures and Stocks*

Cultures and stocks of microbiological agents are artificially grown in laboratories to what could be an extremely high dose for an exposed individual, much greater than would be normally found in nature. For this reason, the treatment goal for cultures and stocks should be complete destruction prior to disposal into the general waste stream. Treatment and disposal methods are as follows.

a. steam sterilization followed by disposal in a sanitary landfill;

b. incineration followed by disposal in a sanitary landfill;

c. thermal inactivation followed by disposal in sanitary landfill; or

d. chemical disinfection followed by disposal in a sanitary landfill.

3. *Bulk human blood and blood products*

Although blood-contaminated items can be visually frightening, the real risk of disease tramsmission would be no greater than that posed by commonly found items in the waste stream such as feminine hygiene products or disposable diapers (e.g., human contact must be made). But, when blood enters the waste

length of potentially contaminated air ducts. The filter chambers are designed to allow in situ decontamination before filters are removed and to facilitate certification testing after they are replaced. Coarse filters and HEPA filters are provided to treat air supplied to the facility in order to increase the lifetime of the exhaust HEPA filters and to protect the supply air system should air pressure become unbalanced in the laboratory" (U.S. Department of Health and Human Services, 1988, p. 26-27).

Radioactive, cytotoxic and chemical wastes:

The Agency for Toxic Substances and Disease Registry finds that "materials such as antineoplastic agents, toxic chemicals, radioisotopes, and chemicals volatilized by steam should not be autoclaved, to prevent possible contact during autoclave opening and venting and secondary contamination during subsequent process cycles. Chemical decontamination is usually the method of choice for these substances" (U.S. Department of Health and Human Services, 1990, p. 7.2).

The Oklahoma State Department of Health has issued the following instructions for disposal of antineoplastic agents and related wastes that are not regulated as hazardous waste at permitted biomedical waste incinerators:

"Each waste container, as packaged for transportation and incineration, may contain only one container of an antineoplastic agent that has been prepared but not administered, or one container of an antineoplastic agent that was partially administered or one container of an antineoplastic agent that has not been diluted (prepared for administration) that is being discarded because it is out-of-date or has been contaminated.

"The waste container may be filled with other infectious waste or chemical waste, including disposable materials which have come in contact with antineoplastic agents during preparation, handling and administration of such agents. Such waste includes, but it not limited to masks, gloves, gowns, empty IV tubing bags and vials, and other contaminated materials."

stream as a liquid, it has the potential to spray to the mucous membranes of anyone in the spray path when compacted in the waste stream. The following methods are recommended for bulk blood and blood products.

a. discharge to a sanitary sewer system;

b. discharge to an approved on-site septic system;

c. incineration followed by disposal of the residue in a sanitary landfill.

4. *Pathological wastes*

Although of no greater risk of disease transmission than other components of the waste stream, pathological wastes possess the potential to shock or offend aesthetically. These wastes should therefore be rendered unrecognizable before disposal by the following methods.

a. incineration followed by disposal of the residue in a sanitary landfill;

b. steam sterilization and grinding followed by disposal in a sanitary landfill; the American Dental Association recommends that, if included, extracted teeth containing metal restorations should not be autoclaved prior to disposal because of the possible release of potentially harmful vapors, such as mercury vapor.

c. thermal inactivation and grinding followed by disposal in a sanitary landfill;

d. chemical disinfection and grinding followed by disposal in a sanitary landfill.

5. *Isolation wastes*

Because of their potential to contain CDC level 4 pathogens, the treatment goal for isolation wastes is sterilization. Treatment methods are as follows.

a. incineration followed by disposal of the residue in a sanitary landfill;

b. steam sterilization followed by disposal in a sanitary landfill;

6. *Animal waste*

These are wastes that have been exposed to zoonotic disease and therefore require sterilization. Treatment and disposal methods are as follows.

a. carcasses, body parts, fluids and bedding — steam sterilization and grinding of carcasses and body parts followed by disposal in a sanitary landfill;

b. carcasses, body parts, fluids and bedding — useful to decontaminate the surface of a carcass before transporting to an incinerator; incineration followed by disposal of the residue in a sanitary landfill;

c. fluids — thermal inactivation followed by disposal in a sanitary landfill or discharging into a sanitary sewer system;

d. fluids — chemical disinfection followed by disposal in a sanitary landfill or discharging into a sanitary sewer system.

7. *Unused sharps*

a. placement in a puncture-resistant, leak-proof, hard-to-open container, chemical disinfection, and disposal in a sanitary landfill;

b. placement in a hard-to-open, puncture-resistant container, steam sterilization, and disposal in a sanitary landfill;

c. placement in a puncture-resistant, leak-proof container, incineration, and disposal in a sanitary landfill; or

d. encapsulation in a matrix which will solidify (see *Sharps*: a.iv.) and deposition in a landfill.

8. *Low-level radioactive waste (not under Nuclear Regulatory Commission regulation)*

a. chemical decontamination; should NOT be steam sterilized.

9. *Antineoplastic drugs (trace amounts not handled as RCRA hazardous wastes)*

a. chemical decontamination; should NOT be steam sterilized.

10. *Small volumes of chemical hazardous waste (exempt from Subtitle C of RCRA)*

a. chemical decontamination; should NOT be steam sterilized.

Waste Management Plan (General)

Each facility should have a written medical waste management and operations plan which includes the following:

1. A description of the biomedical waste handled by the facility including type and volume of waste;

Treatment Technologies

Incineration

"Incineration of medical wastes remains a prevalent treatment method in the United States. The advantages of incinerating medical wastes, are those associated with the incineration of any type of waste: significant volume reduction (by about 90 percent), assured destruction, sterilization, weight reduction, and the ability to manage most types of wastes with little processing before treatment. The disadvantages include potential pollution risks associated with incineration processes and increased costs associated with controlling pollution emissions" (U.S. Congress Office of Technology Assessment, 1990, p. 41).

Maine Biomedical Waste Management Rules specify the following general design standards for medical waste incinerators:

1. The types, amounts (by weight and/or volume), and characteristics of all medical waste expected to be processed shall be determined by survey.
2. Facility design capacity shall consider such items as waste quantity and characteristics, variations in waste generation, equipment downtime, and availability of alternate storage, processing, or disposal capability.
3. Facility systems and subsystems shall be designed to assure standby capability in the event of breakdown.
4. Audible signals shall be provided to alert operating personnel of critical operating unit malfunctions.

Additional recommendations for all types of incinerator systems from the states of *Maine* and *Washington* include the following.

5. Grated beds should not be used for the incineration of liquid wastes.
6. Incinerator design should include measures to minimize infiltration air. This would reduce the consumption of auxiliary fuel, increase residence time, and increase exposure of combustion gases to high temperatures.
7. Stack design and location should be of sufficient height and located to assure that stack emissions do not enter nearby building ventilation systems or windows. Stacks should be designed according to EPA- defined "good engineering practices."

For new or modified sources, stack design should comply with the intentions of the proposed state air toxics regulations upon promulgation.

2. A detailed narrative explaining how the facility will operate, including, but not limited to, design capacity, equipment specifications, on site storage, and flow diagram schematics for all parts of the facility;
3. Total capacity and life expectancy of the facility, including calculations used to derive these data;
4. Hours and days of operation at the facility and the number of conveyances delivering biomedical wastes that are expected daily and that can be accommodated daily;
5. A general inspection schedule for the facility;
6. A description of security procedures and equipment;
7. Training procedures for personnel who handle biomedical waste;
8. Emergency spill containment and cleanup procedures and equipment;
9. The name, address, and telephone number of the person(s) responsible for biomedical waste management for the facility.

Operation (General)

Operational requirements for treatment facilities include restricted access, waste identification, safe handling to avoid puncturing containers, and adhering to charging rates that are within incinerator or autoclave design.

Operating standards include methods and operational requirements for waste treatment, design requirements, quality control guidelines, reporting requirements, and procedures for preventing and cleaning up medical waste spills.

Monitoring and Record Keeping (General)

Monitoring is essential in development of standard operating procedures for each treatment technique to verify that the treatment process is effective. Monitoring also permits refinement of the operating procedures so that excess processing can be avoided while savings are realized in expenditures of time, energy, and/or materials. Subsequent periodic monitoring serves to demonstrate that treatment is adequate to render the waste non-infectious, thereby confirming that proper procedures were used and that the equipment was functioning properly.

Medical waste disposal facilities should maintain records of:

1. Policies and procedures for handling medical waste;
2. Special training received by persons involved with medical waste management;
3. Spills of medical waste and containment methods employed;
4. Members of the facility's infection control committee;
5. Operating information (e.g., hours of operation, equipment maintenance and replacement, inspections);
6. Monitoring results;
7. Medical waste received from off-site:
   a. waste type and volume;
   b. generator name and address;
   c. transporter;
   d. treatment and disposal method.

Treatment Technologies

Incineration

Incineration converts combustible materials into noncombustible residue or ash, exhaust gases, and heat. Incineration of medical waste should be conducted under sufficient burning conditions (e.g., temperature, residence time, and feed quantity) to reduce all combustible material to a form such that no portion of the combustible material is visible in its uncombusted state and to control emissions of hazardous constituents during incineration.

An on-site incineration facility should include the following factors.

- There should be access to equipment for service and replacement.
- Shelter for equipment is needed to protect it from the elements.
- Incineration equipment and support elements, such as scrubbers or bag houses, bulk storage chemicals, and flue stacks are fairly massive and should be placed at a grade.
- Traffic flow for trucks and cars should not interfere with the movement of waste containers.
- Due to the uneven waste stream collection and flow to the incinerator, a staging area of sufficient capacity is needed to hold waste during heavy

8. Automated, continuously operated feed systems are desirable because they minimize fluctuations in temperature and maintain a steady rate of operation, thus tending to emit lower levels of pollutants.

Incinerator Operation: "The successful use of incineration as a method for treating infectious waste ultimately depends on the proper operation of the incinerator and air-pollution control devices. Good operating technique affects the reliability of equipment, reduces down-time, prolongs the life of equipment, increases combustion efficiency, helps ensure complete ash burnout, increases worker safety, and assists compliance with air pollution control regulations" (Turnberg, 1989, Attachment 7, p. 52).

The following aspects of incinerator operation and maintenance contribute to complete destruction of medical wastes.

1. *Waste Feed Rate and Characterization:* Avoid overloading and adjust for waste composition.

a. The following variations in waste composition affect operation:

- moisture content and heating value affects combustion temperature;
- high plastic content can cause temperature surges that can damage the incinerator;
- combustion products of waste with chlorine content is corrosive to the incinerator and may damage the refractory (chamber lining) and the stack.

b. Controlled-air type: capacity of the secondary chamber determines the waste charging or feed capacity of the incinerator.

c. Waste should not be loaded into the incinerator until it has been preheated and pollution control devices are fully operational.

d. Wastes containing solvents should be avoided.

e. Overloading of waste, or the burning of high heating value wastes in an incinerator designed to burn at lower temperatures can lead to overheating of thermocouples and crack the refractory.

2. *Temperature and Residence Time:* Medical waste incinerators should be capable of maintaining a minimum temperature in the primary chamber sufficient to destroy infectious agents and produce a residue essentially free of odors and unstable organic matter.

collection periods. This waste should be incinerated later the same day.

- Due to extensive heat radiation from equipment, most incineration enclosures are not insulated but are very well ventilated.

Training for Incinerators: A trained incinerator operator should be present at the facility in which an incinerator is located whenever waste is being burned. The facility-employed operator will control the operation of the incinerator performance testing.

An incinerator operator should be trained to deal with the complexity of medical waste composition and potential hazards, incinerator equipment, air pollution control devices, monitoring information, and applicable regulations.

The American Society of Mechanical Engineers is establishing a U.S. EPA-sponsored certification and training program for operators of medical waste incineration equipment. The proposed program will include the following:

- basic principles of combustion
- incinerator equipment characteristics
- medical waste characteristics
- products of waste combustion
- air pollutants
- air pollution control devices
- automatic control systems
- emission monitoring equipment
- industrial hygiene
- typical problems
- scheduled maintenance
- incinerator operations
- state and other applicable regulations.

In addition, an incinerator operator training program should provide an understanding of the following elements:

- proper waste handling procedures
- environmental and health concerns related to improper incineration
- worker safety procedures
- record keeping procedures
- accident response.

Incinerator Operation: The handling of the ash produced by incineration warrants special precautions.

1. Incinerator ash residue:

a. Removal should occur in such a way that there will be no fugitive emissions to the air during loading or transport. The ash should be wetted prior to handling to prevent dust emissions.

b. All personnel handling ash should wear or use dust masks, gloves, and protective clothing as a safety precaution.

2. Bottom ash:

a. handle in a manner consistent with asbestos management standards (40 CFR Part 61) and dispose of in a solid waste disposal facility.

3. Fly ash:

a. would need to be handled as a toxic waste or extremely hazardous waste based on sampling results.

Incinerator Monitoring: Monitoring of incinerator performance and residues will help to detect equipment malfunction and ensure the complete destruction of medical wastes.

Monitoring should include the following elements:

1. Monitors should provide continuous information on combustion temperature and waste, fuel, and air feed rates.

2. Continuous recording parameters include temperature, key operating parameters of air pollution control equipment, waste charging rates, and carbon monoxide and particulate emission monitors.

3. Stacks should be equipped with continuous emission monitors which measure opacity.

4. Ash: Visual inspection should not reveal commonly combustible materials such as paper, cardboard, and cloth which have not been completely burned.

5. Annual inspection.

6. Records should be kept of the weight and general composition of waste charged to the incinerator.

Steam Sterilization

Steam sterilization is a treatment method for medical waste that utilizes saturated steam within a pressure vessel (known as a steam sterilizer, autoclave, or retort) at time lengths and temperatures sufficient to kill infectious agents within the waste.

a. Operating temperatures should be attained before loading the waste.

b. The amount of air and fuel should be adjusted to maintain operating temperature at the necessary level.

c. Adjustments should be made as the composition of the waste changes.

Incinerator Maintenance: "Scheduled preventive maintenance, regular cleaning, and visual inspection of equipment is recommended to avoid excessive emissions and costly breakdowns" (Turnberg, 1989, Attachment 7, p. 45). Worn refractories should be replaced, ash deposits on walls and ducting should be removed, air inlets should be cleaned and replaced, and worn mechanical parts should be replaced. (See table below)

Incinerator Monitoring: Wisconsin guidelines recommend that incinerator operators continually record combustion temperatures and amounts of waste incinerated. In Pennsylvania incinerators must report quarterly on the microbiological analysis of ash,

Operation for Steam Sterilization: Standard, written, operating procedures should be adopted for each steam sterilizer including time, temperature, pressure, type of waste, type of container(s), closure on container(s), pattern of loading, waste content, and maximum load quantity.

Operation should include the following procedures:

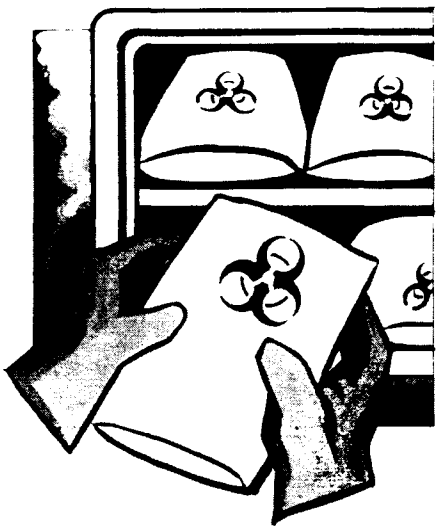
1. The entire waste load should be exposed to the necessary temperature for a defined period of time.

Typical Maintenance Inspection
Lubrication and Cleaning Schedule for a Biomedical Waste Incinerator

Frequency	*Incinerator Component*	*Procedure*
Hourly	Ash removal conveyor	Inspect & clean as required
	Water quench pit	Inspect water level and fill as required
Daily	Opacity monitor	Check operation of the opacity monitor & check exhaust for visible emissions
	Oxygen monitor	Check operation of oxygen monitor
	Thermacouples	Check operation of thermocouples
	Underfire air ports	Inspect & clean as required
	Limit switches	Inspect for freedom of operation & potential obstructing debris
	Door seals	Inspect for wear, closeness of fit & air leakage
	Ash pit/internal dropout sump	Clean after each shift on batch units w/o continuous ash conveyor system
Weekly	Heat recovery boiler tubes	Inspect & clean as required. Clean weekly for 6 weeks to determine optimum cleaning schedule
	Blower intakes	Inspect for accumulation of lint, debris; Clean as required
	Burner flame rods (gas-fired units	Inspect & clean as required
	UV scanner flame sensors	Inspect & clean as required
	Swing latches and hinges	Lubricate
	Hopper door support pins	Lubricate
	Ram feeder carriage wheels	Lubricate
	Heat-recovery induced-draft	Inspect & clean fan housing as required. Check for corrosion. Check V-belt drives and chains for wear
	Hydraulic systems	Check hydraulic fluid level & add the proper replacement fluid as required. Investigate sources of fuel leakage
Biweekly	Ash removal conveyor bearings	Lubricate
	Fuel trains & burners	Inspect & clean as required. Investigate sources of fuel leakage
	Control panels	Inspect & clean as required. Keep panel securely closed & free of dirt to prevent electrical malfunction
	External surface of incinerator & stack	Inspect external "hot" surfaces. White spots or discoloration may indicate loss of refractory
Monthly	Refactory	Inspect & repair minor wear areas with plastic refractory material
	Internal ram faces	Inspect for wear. These stainless steel faces may wear out and may require replacement in 1 to 5 years depending on service
	Upper/secondary combustion chamber	Inspect & vacuum any particulate matter that has accumulated on the chamber floor. Lubricate
	Large combustion air blowers & heat recovery induced draft fans (fans whose bearings are not sealed)	Lubricate
	Hydraulic cylinder clevis & trunnion attachments to all moving components	Inspect & adjust as required
	Burner pilots	Inspect & paint with high temperature as required
	Hot external surfaces	Inspect & paint with equipment as required
Semi-annually	Ambient external surfaces	Inspect & brush clean as reuired. Lubricate chamber
	Chains	Lubricate

Source: U.S. EPA. *Operation and Maintenance of Hospital Medical Waste Incinerators.* EPA 450/3-89-002, Work Assignment 16, March 1989 in Turnberg, 1989, Attachment 7, pp. 46-48.

and annually on ash's chemical analysis. Monitoring data shall be maintained for a period of three years.



Chemical Disinfection

"Chemical agents such as chlorine have been used as disinfectants for medical products for some time, although the applications to large volumes of infectious wastes generated in hospitals and laboratories is more recent" (U.S. Congress, Office of Technology Assessment, 1990, p. 33). Currently there aren't any disinfectants registered with the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) for use with medical waste. FIFRA registers by use. Most are surface disinfectants.

For infection control purposes, disinfectants are chemical germicides that are approved for use as hospital disinfectants and are tuberculocidal when used at recommended dilutions. (See table on following page.)

2. The degree of steam penetration is the critical factor. Air must be completely displaced from the treatment chamber for steam penetration to occur.

3. Residual air in the autoclave chamber prevents effective sterilization. It may be due to use of impervious plastic bags, use of deep upright containers, or improper loading.

4. Loads should be small enough to attain and maintain sterilizing temperatures.

5. Bags should be opened and bottle caps and stoppers should be loosened immediately before placement in the sterilizer to facilitate steam penetration. Adding water to containers is recommended to assure steam contact with waste.

Maintenance: Maintenance should include the following.

1. Sterilizers should be routinely inspected and serviced.

2. Monitoring will indicate that the equipment is functioning properly.

Monitoring and Record Keeping for Steam Sterilization: Routine performance checks and record keeping will ensure that autoclaves will be maintained in optimal working condition and that wastes are being thoroughly sterilized.

Monitoring should include the following:

1. A recording thermometer should be used to ensure that a sufficiently high temperature is maintained for an adequate period of time during the cycle.

2. A chemical indicator strip/tape that changes color when a certain temperature is reached can be used to verify that a specific temperature has been achieved. It may be necessary to use more than one strip over the waste package at different locations to ensure that inner content of the package has been adequately autoclaved. However, it does not show the length of time waste has been exposed to steam at that temperature.

3. Bacillus stearothermophilus is recommended as the biological indicator. Steam sterilization units should be evaluated under full loading for effectiveness with spores of Bacillus stearothermophilus placed at the center of a load processed under standard operating conditions no less than once per every 40 hours of operation. Because of the risk of unnecessary exposure to the worker who must retrieve the monitor, testing should be done in a simulated waste load and not with an actual load of medical waste.

4. A log should be kept at each steam sterilization unit that is complete for the preceding three year period. The log shall record the date, time, and operator of each usage; the type and approximate amount of waste treated; the post-sterilization reading of the temperature sensitive tape; the dates and results of calibration; and the results of effective testing.

Training for Steam Sterilization: Operator training should include the following components:

1. Knowledge of standard autoclave principles and recognition of proper operation;

2. Knowledge of waste stream characteristics;

3. Minimization of aerosols;

4. Prevention of waste spillage;

5. Wearing protective attire to prevent burns;

6. Quality assurance testing and frequency of testing.

Chemical Disinfection with Grinding or Incapsulation

This treatment process grinds the wastes in a hammermill in the presence of a chemical disinfectant. Factors that should be considered in selection of chemical disinfection as a treatment method are the types of microorganisms likely to be present in the waste, the degree of contamination, the amount of proteinaceous material present, and the type of disinfectant.

Operation for Chemical Disinfection: Several factors influence the effectiveness of chemical disinfection. The type of disinfectant used, its quantity and concentration, contact time with the waste, and the temperature at which it and the wastes are treated determine the completeness of the disinfection process.

Thermal Inactivation

The batch units "consist of a vessel of sufficient size to contain the liquid generated during a specific operating period (e.g., 24 hours). The system may include a second vessel that provides continuous collection of waste without interruption of activities that generate the waste.

"The waste may be pre-heated by heat exchangers, or heat may be applied by a steam jacket that envelopes the vessel. Heating is continued until a pre-determined temperature (usually measured by a thermocouple) is achieved and maintained for a designated period of time." The contents of the vessel/tank are normally discharged to the sewer. Local, state or federal temperature restrictions on sewer discharges may necessitate a second heat exchanger to remove excess heat from the effluent (U.S. Environmental Protection Agency, 1986, p. 4.11-12).

The Minnesota Pollution Control Agency has approved electro-thermal-

The liquids resulting from chemical disinfection, including any remaining disinfecting agents, are released to the sewer system. If the chemical disinfectant is recyclable with some processing of used/spent disinfectant liquid then the effort should be made. Solid residues are drained of the disinfectant and disposed of in a landfill.

The following disinfectants are recommended for use in chemical disinfection:

- Chlorine compound solutions, specifically hypochlorite and chlorinated isocyanurates, at a strength of fifteen percent (volume/volume);
- Chemicals registered with the U.S. Environmental Protection Agency as virucidal, bactericidal, fungicidal, parasiticidal, and sporicidal;
- Chlorine bleach should not be used in the presence of Iodine-125 due to potential release of radioiodine. Formalin or a phenolic disinfectant should be substituted.

Thermal Inactivation

Thermal inactivation is a treatment method that utilizes heat transfer to provide conditions that reduce the presence of infectious agents in waste. Thermal inactivation units for the treatment of liquid wastes are batch-type units or continuous treatment processes. The batch-type unit is a vessel in which the waste may be pre-heated by heat exchangers or by a steam jacket that envelopes the vessel. The continuous process consists of a small feed tank and a steam-based heat exchanger. Liquid waste is fed into the feed tank, across the heat exchanger and then recirculated through the tank. Thermal inactivation of solid waste is accomplished by the application of dry heat in an oven which is usually operated by electricity.

Operation for Thermal Inactivation: Thermal inactivation operations should include the following.

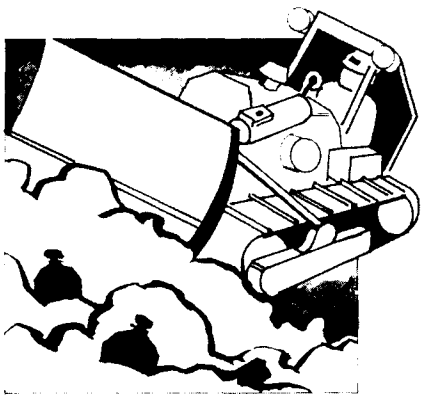
Comparison of Selected Chemical Disinfectants

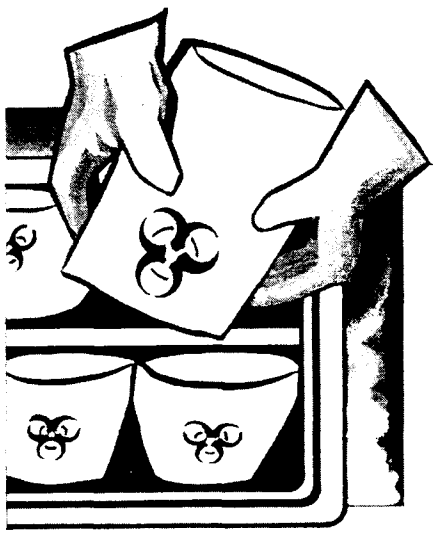
	Chlorine Compounds	*Iodophor*	*Alcohols (a)*	*Formaldehyde*	*Glutaraldehyde*
Inactivates					
Vegetative bacteria	yes	yes	yes	yes	yes
Lipoviruses	yes	yes	yes	yes	yes
Nonlipid viruses	yes	yes	(b)	yes	yes
Bacterial spores	yes	yes	no	yes	yes
Treatment requirements					
Use dilution	500 ppmc (c)	25-1600 ppmc	70-85%	0.2-8.0%	2%
Contact time, min.					
Lipovirus	10	10	10	10	10
Broad spectrum	30	30	not effective	30	30
Important characteristics					
Effective shelf life is greater than 1 week	no	yes	yes	yes	yes
Corrosive	yes	yes	no	no	no
Flammable	no	no	yes	no	no
Explosion potential	none	none	none	none	none
Inactivated by inorganic matter	yes	yes	no	no	no
Skin irritant	yes	yes	no	yes	yes
Eye irritant	yes	yes	yes	yes	yes
Respiratorirritant	yes	no	no	no	no
Toxic	yes	yes	yes	yes	yes
Applicability					
Waste liquids	yes	no	no	no	no
Equipment surface decontamination	yes	yes	yes	yes	yes

(a) Ethyl and isopropyl alcohols.
(b) Results are variable, depending on the virus.
(c) Concentration of available halogen.

Source: Reinhardt and Gordon, 1991, p. 117

deactivation technology for the decontamination of medical waste: "This process involves pre-shredding the waste, initially heating it with an electric source, and then maintaining a temperature of 194 degrees F within the waste for at least two hours while in a large, enclosed chamber (Minnesota Pollution Control Agency, p. 2). This process is currently being used in Alaska.





1. Mixing may be appropriate to maximize homogeneity of the waste and temperature during the loading and heat application steps of the treatment cycle.

2. Temperature and Residence Time:

a. Requirements can be selected on the basis of the resistance of either the pathogen present in the waste or of a pathogen that is more resistant than those being treated.

b. Shorter contact time in a continuous treatment process may require a higher temperature than in a batch-type system.

c. Circulation of the air is necessary to ensure that all waste reaches the required temperature.

Monitoring for Thermal Inactivation: The only continuous monitoring currently available is temperature. Pathogen destruction monitoring involves periodically spiking the waste with a known quantity of heat-resistant bacteria and testing viability after treatment. However, retrieval of the monitor may result in unnecessary worker exposure. Therefore, testing should be done in a simulated waste load.

Irradiation

Irradiation exposes wastes to ultraviolet or ionizing radiation from a source such as cobalt 60 in an enclosed, shielded chamber. Irradiation is suitable for use on materials which cannot be thermally treated. The advantages of this treatment method are its small electricity needs, no steam requirement, and the lack of residual heat in treated waste. Disadvantages are the large capital outlay, the necessity of highly skilled personnel, the disposal of the decayed radiation source, and the need for a large operating space. Another disadvantage in ultraviolet radiation is that the method is only effective if the ultraviolet radiation reaches the waste material. There is very little penetration into the waste unless the waste is transparent to ultraviolet radiation. Areas shadowed from the ultraviolet radiation will not be effectively treated.

Operation for Irradiation: Irradiation operation procedures should include the following:

1. Microorganisms must have direct exposure to the UV rays for a sufficient length of time.

2. Relative humidity can affect treatment effectiveness of ultraviolet radiation.

3. Minimum exposure rate has not yet been determined.

Grinding and Shredding (Destruction Method)

This method is used to convert treated and some untreated medical wastes into a more homogeneous form that can be easily handled. The wastes are physically broken into smaller particles. Grinding and shredding makes waste unrecognizable, facilitates treatment (e.g., autoclaving, disinfection), and minimizes storage, transport and handling costs.

Operation for Grinding and Shredding: The equipment should maintain a negative pressure to ensure that no materials escape from the device. HEPA (high efficiency particulate air) filtration of exhaust is recommended to minimize aerosolization.

The quantity of metal and glass present, the size of the waste, and the presence of fibrous, rubber, or soft plastic materials adversely affect the process. Metal and glass can wear down the grinding edges of the equipment. Fibrous, rubber or soft plastic materials may become caught on the hammermills and cause the equipment to malfunction.

Monitoring for Grinding and Shredding: Observation of the shredded waste's size distribution verifies that the equipment is functioning properly.

Compaction (Destruction Method)

Compaction is used in the waste handling process to reduce waste volume. It can also affect recognizability. It does not decrease the disease transmission capability of medical waste.

A hydraulic ram is generally used to compress the waste against a rigid surface. The disadvantages of this method are the potential for aerosolization, the high probability of leakage, and poor incineration characteristics. Compaction can destroy

Alternative Treatment Technologies

Chemical decontamination:

"Recently, a chemical decontamination system with the potential for more widespread application has been developed. The system processes infectious waste using an electrocatalytic system. The system purportedly will destroy any known living organism by the oxidizing solution's temperature, acidity, and chemical activity. The system requires no pressure vessels and only normal amounts of electric power" (U.S. Department of Health and Human Services, 1990, p. 7.3).

Microwave:

Unlike thermal treatment which heats wastes externally, microwave heating occurs inside the waste material. The Minnesota Pollution Control Agency has given microwave technology approval for decontamination of medical waste: "This process involves preshredding the waste, injecting it with steam, and heating it for 25 minutes at 203 degrees F under a series of microwave units. The material is rotated on an auger to ensure that uniform heating and decontamination occur. The treated waste may then be landfilled or incinerated" (Minnesota Pollution Control Ageny, p. 2). Minnesota reports that the process is currently being used in California, North Carolina and some European countries.

The following types of wastes are suitable for treatment by microwaving: refuse containing blood, secretions, bandages, napkins, single-use hypodermic needles and cannulas. This method is not suitable for body parts, organ refuse, or other waste that requires special treatment such as animal cadavers, outdated medications, chemicals and radioactive waste (Stewart et. al., 1989, p. III.17).

Macrowave:

One new treatment method is the use of macrowaving. Macrowaves are low frequency radio waves which treat waste by electro- thermal deactivation. Heat produced by the waves kills disease-causing pathogens throughout the waste. The advantages of this treatment technique are that it generates no air or water discharge and the materials treated are recyclable. A macrowaving facility currently in operation does not accept pathological, chemical or hazardous waste ("Stericycle Substitutes Radio Waves for Irradiation in Treatment Process" in National Solid Wastes Management Association, January 7, 1991, p. 3).

Approval:

New York state specifies the following for the approval of alternative regulated medical waste treatment systems:

"a. Any method or technique for treatment or disposal of regulated medical waste for which approval by the Commissioner is sought must not pose a threat to public health. Approval shall be based on detailed information, obtained in conformance with generally recognized scientific principles, submitted by the applicant for a method or technique which will render the waste non-infectious, safer for transport, amenable for storage, or reduced in volume.

b. The method or technique shall conform to principles generally recognized within the scientific community and will:

i. decontaminate the waste, or change the character of the waste so as to make it safer or more amenable for transport, or reduced in volume; and

ii. not create a threat to health or safety; and

iii. not violate applicable environmental laws or regulations" (Title 10 Health: Chapter II - Part 70 Regulated Medical Waste, Subpart 70-2).

Landfill

"A landfill does not provide an environment that is conducive to the survival of human pathogens" (Minnesota, 1988, p. IV.7). High temperature (100-120 degrees F. or greater), oxygen depletion, pH, moisture, and microbial conditions reduce the number of viable infectious organisms.

It is also unlikely that pathogens will reach the groundwater beneath a properly sited landfill. "As a leachate percolates through the soil, its pathogenic organism concentration in the leachate is reduced by 'soil filtration,' a process somewhat analogous to the attenuation of sewage in a septic system. "The infectious organisms cling to the edges of soil particles and, without the nutrients, quantity of oxygen the integrity of containers, resulting in possible exposure of waste handlers to the waste materials.

The 1986 EPA Guidelines discourage the use of compaction in the handling of medical waste. The 1989 Medical Waste Tracking Act does not recognize compaction as an acceptable destruction technique. This method is therefore not recommended for untreated wastes.

Alternative Treatment Technologies

The following information should be requested from a manufacturer of an alternative medical waste treatment method to determine whether the treatment method is suitable for use by a generator or treatment facility operator:

- name of firm
- address
- contact person
- phone number
- indication as to whether the method is intended for treatment of microbiologics, sharps or both
- a brief description of the method
- statement as to how this method deactivates, kills, disinfects or sterilizes microbiologically contaminated waste, and attachment of microbiology laboratory results indicating level of treatment (e.g., disinfection or sterilization)
- how this method renders sharps unrecognizable, unusable, and incapable of causing puncture injury
- chemical substances or radiologic methods used
- important operational parameters
- if the method results in the production or release of hazardous substances

Landfill

Medical waste that has been treated as described in previous sections and packaged such that it is clearly evident that the waste has been effectively treated is no longer subject to management as medical waste and may be collected, transported and disposed of as municipal solid waste. Therefore, once medical waste has been treated, it may be disposed at a sanitary landfill as regular municipal waste.

and other conditions necessary to their survival, eventually die off" (Ibid., pp. IV.8-9). ". . . bacteria in the aerated zone above the water table rarely move downward through homogeneous soil more than five feet. If bacteria do enter the saturated zone, they will travel in a fairly narrow band a few feet wide and normally will completely disappear after travel of about 100 feet downstream from the point of entry in unconsolidated formation. Therefore, if solid wastes are deposited in a properly constructed sanitary landfill, there should be little chance of contamination of groundwater with pathogenic micro-organisms" (DeRoos, R. 1972. Environmental Considerations in the Ultimate Disposal Choice for Hospital Waste (unpublished) in Minnesota, 1988, IV-9.).

Documentation

Sewer

"Certain types of infectious waste water are routinely sterilized by heat before they are discharged into the sanitary sewer system or into a receiving stream such as a river. Examples of these wastes include some wastewaters from research and industrial laboratories and from pharmaceutical production. For these wastewaters, the treatment of choice is often thermal inactivation/sterilization" (Reinhardt and Gordon, 1991, p. 111).

State and local wastewater quality regulations usually impose limits on a variety of constituents and parameters including chemicals, pH, organic material (biochemical oxygen demand or BOD), and total suspended solids (Reinhardt and Gordon, p. 121).

Guidelines

Sewer

Liquid medical waste can be disposed of into a health department approved on-site septic system or a sanitary sewer system for treatment at the wastewater treatment plant if the system is not a combined sanitary/storm sewer system. Untreated medical wastes should not be placed into a combined sanitary/storm sewer system. Medical waste disposed of to the sanitary sewer system must meet state and local regulations on wastewater quality.

The grinding and sewering of medical waste solids causes two concerns: the potential for the generation of an infectious aerosol and the clogging of sewer lines with a rope-like material that can form as a result of increased organic matter loading into the system. Sewers are suitable for the disposal of liquid wastes only.

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