Suggested Guiding Principles and Practices for the Sound Management of Hazardous Hospital Wastes
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1. Introduction

Hazardous hospital wastes are unique forms of solid and liquid waste generated in the diagnosis, treatment, prevention, or research, of human and animal disease. Each year large amounts of hazardous wastes are produced by hospitals, clinics, dispensaries, private medical and dental offices and research and veterinary facilities throughout the South-East Asia Region. These hazardous wastes, when ineffectively managed, may compromise the quality of patient care. Additionally, they present occupational health risks to those who generate, handle, package, store, transport, treat, and dispose of them. They also present environmental and public health risks through inappropriate treatment and/or disposal which may contribute to environmental pollution and the spread of infectious diseases to include AIDS, hepatitis, tuberculosis, cholera, diphtheria and many others. The concern is heightened by the existence of new and emerging pathogens as well as increasing drug resistance in re-emerging ones.

2. Background

Although the management of hazardous hospital wastes has become a serious concern in the South-East Asia Region, few governments in the Region have provided guidance to effectively manage the handling, treatment and disposal of these wastes. Typically few individuals on a hospital's management staff are familiar with the elements of proper
waste management. In many instances, waste handling is left to the poorly educated and lowest category of workers operating without any training, guidance and supervision.

Hospitals must realize that an effective program of hospital waste management is an integral part of a hospital's infection control program, and therefore critically linked to the quality of patient care and worker health and safety. Additionally, when properly implemented and enforced, effective waste management can have distinct economic benefits, such as cost savings linked to waste reduction and improved purchasing practices.

3. Purpose

The purpose of this document is to assist hospitals in establishing and implementing a sound programme for the effective management of hazardous hospital wastes. Such a program, when supported by a committed hospital management from the top down, will contribute to improved patient care, promote worker health and safety, and help to improve the overall economy and operation of the facility. It will also enhance the image of hospitals as professional health organizations totally committed, not only to quality patient care, but to public and environmental health as well.

4. Management Responsibility and Tasks

While a nation's central government bears overall responsibility for the regulation of hazardous hospital wastes, the main responsibility for their management lies with each individual hospital or other facility,
and with the local-government for ensuring public health and environmental regulatory compliance, as applicable.

Hospital Director's Responsibility: In order for a hospital to effectively manage a waste programme, it must have the enthusiastic support of the Hospital Director. At the Director's initiative, and through his/her assignment of management responsibilities to the administrative staff, a system of accountability and reporting can easily be established. In laying the foundation for a hazardous waste program, the Director must ensure that the staff complete the first four tasks listed below after which a final action plan can be implemented.

1. Define categories of hazardous hospital wastes
2. Assess current hazardous waste practices and responsibilities
3. Assess current hazardous waste costs
4. Develop an effective hazardous waste management policy and plan
5. Implement a hazardous waste management plan

Task 1: Define Categories Of Hazardous Hospital Wastes

Hospital wastes may be classified into two types:

1. General or non-hazardous wastes not contaminated with blood, body fluids, or other infectious agents or materials (also referred to as communal or municipal wastes) such as papers, fabrics, glass, food residues and containers; and
2. Hospital wastes considered hazardous due to actual or presumed biological and/or chemical contamination.
The basic categories of hazardous hospital wastes include: infectious, pathologic sharps, chemical, pharmaceutical, and radioactive wastes. Typically, the definitions of each category are provided by government guidelines or regulations. In general, these definitions are as follows:

**Infectious Wastes:** Infectious wastes include blood and blood products; items contaminated with blood, serum, or plasma; cultures and stocks of infectious agents from diagnostic and research laboratories and items contaminated with such agents; isolation was from highly infectious patients (to include food residues); discarded live and attenuated vaccines; and waste, bedding, and other contaminated materials infected with human pathogens.

**Pathological Wastes:** Pathological wastes include human tissues, organs, body parts, fetuses, and other similar wastes from surgeries, biopsies, autopsies; animal carcasses, organs, and issues infected with human pathogens.

**Sharps Wastes:** Sharps wastes include needles, syringes, scalpel blades, razors, infusion sets, contaminated broken glass, blood tubes, and other similar material.

**Chemical Wastes:** Chemical wastes include solid, liquid, or gaseous chemicals such as solvents, reagents, film developer, ethylene oxide, and other chemicals that may be toxic, corrosive, flammable, explosive, or carcinogenic.

**Pharmaceutical Wastes:** Pharmaceutical wastes include outdated medications of all kinds, as well as residuals of drugs used in chemotherapy that may be cytotoxic, genotoxic, mutagenic, teratogenic, or carcinogenic.
Radioactive Wastes: Radioactive wastes include any solid, liquid, or pathological waste contaminated with radioactive isotopes of any kind.

These categories are a general guide and are not meant to be all inclusive and specific to all situations that may be encountered in a hospital. Therefore, as questionable situations arise, each hospital must decide if a particular device, material or substance should be regarded as hazardous waste based on available information and guidance from local and/or national health and environmental officials. It must be kept in mind that the definition of hazardous wastes is critical to a successful hospital management programme as it impacts upon the amount of wastes routinely generated and the necessary labour, materials, and other associated costs required to handle, transport, treat, and dispose of them.

Task 2: Assess Current Hazardous Waste Practices And Responsibilities

Hospital management must document current waste management practices and amounts of wastes generated. It must conduct a comprehensive audit to determine current personnel duties and responsibilities regarding hazardous hospital wastes and define handling and reporting practices. Each Department Head should conduct an audit of his/her department, or alternatively, and perhaps preferably, an independent consultant be brought in to conduct the facility audit. The audit should record and document detailed information about all personnel time spent in the performance of any hazardous waste function on a weekly or monthly basis, to include waste separation, storage locations, collection and transport schedules, amounts of wastes produced, and types and amounts of related
materials and supplies used, such as sharps and other infectious wastes containers, disinfectants and gloves.

**Task 3: Assess Current Hazardous Waste Costs**

Facility management must identify current costs associated with hazardous wastes. The hospital's director, other designated administrator or private consultant, responsible for economic aspects of the hospital, should conduct a detailed audit to include examination of purchasing practices, addressing the costs of those items that routinely become wastes whether they are disposable, reusable, or recyclable. Cost analysis must also include any and all materials associated with waste management, such as containers, labels, disinfectants, protective equipment (gowns, gloves, etc) and their frequency of use; personnel time related to all aspects of waste handling; and fuel and other costs associated with treatment, such as incineration and steam autoclaving.

**Task 4: Develop Effective Hazardous Waste Management Policy**

**Utilize Audit Results:** To achieve effective hazardous waste management, a hospital must develop a management policy based on its audits of practices and costs. A hazardous hospital waste management policy is an official statement of all practices and procedures to be routinely carried out in regard to hazardous wastes, from generation to treatment and ultimate disposal. Such practices and procedures will include information on waste minimization and the basic elements of waste management: separation, identification, handling, treatment, and disposal, based upon accepted technical guidelines.
Waste Management Policy and Plan: The management policy and plan should be in writing, be signed by the hospital director, and describe all levels of responsibility, from the highest administrative authority to the lowest staff member. It must contain a written Waste Management Plan containing detailed technical guidelines which is made available to all employees at their workstations throughout the hospital. The written policy and plan should describe the formation of a Hazardous Waste Management Committee headed by a Hazardous Waste Officer. The Committee is responsible for ensuring the implementation of the Hazardous Waste Management Plan that carries out the Hazardous Waste Management Policy.

Review Management Policy and Plan: Lastly, a medical waste management policy and plan should be reviewed and updated periodically, at least annually. The review should include reassessments of waste handling, treatment and disposal practices, as well as purchasing practices and costs in order to provide comparisons from year to year, identify and eliminate deficiencies, and promote effective waste minimization practices that can lead to a reduction of wastes generated, along with their associated costs.

Task 5: Implement Hazardous Waste Management Plan

Hazardous Waste Management Committee. The Hazardous Waste Management Committee implements and maintains the Hazardous Waste Management Policy and Plan. In addition to the Hospital Director, members of the Committee will usually include all Medical Department Heads, the Hospital Supervisor, the Infection Control Officer, the Head of Housekeeping/Environmental Services, the Pharmaceutical Officer, the Radiation Officer, the Hospital Engineer, and others as appointed by the Director.
Figure 1- Suggested Hazardous Waste Management Committee

HOSPITAL DIRECTOR

WASTE MANAGEMENT OFFICER

Hazardous Waste Management Committee

Medical Department Heads
Hospital Supervisor
Infection Control Officer
Pharmaceutical Officer
Radiation Officer
Hospital Engineer

Head of Housekeeping/Environmental Services

A member of the Committee is appointed to serve as the Waste Management Officer (WMO), or alternatively, an individual is hired to serve in that capacity full time. The WMO, who is both a member and chair of the Committee, reports directly to the Hospital Director and is responsible for the day-to-day operations of the Waste Management Plan, to include coordination with Department Heads, problem-solving, development of training programs, incident investigations, review of waste activity reports, conducting monthly meetings of the Waste Management Committee, and interacting with local public health and environmental officials.

The Waste Management Committee makes recommendations directly to the Hospital Director. Recommendations may be made regarding policy changes, purchasing practices, training, personnel matters, pending regulations, or any other matter related to hazardous waste management. All
waste records, reports, recommendations, policy changes, and any other matters directly or indirectly involved with hazardous wastes are documented in writing and retained in a permanent file for examination as necessary by local health and environmental officials and/or the Ministry of Health.

5. Elements of the Hazardous Wastes Management Plan

Hazardous hospital wastes must be managed through a pathway composed of ten elements, each of which must be addressed in terms of personnel and material costs, as well as occupational health and safety risks. The ten elements include: waste minimization/separation, identification, handling, treatment, disposal, security, record-keeping, training, health and safety, and emergency planning.

5.1 Waste Minimization/Separation

Waste minimization is a process that strives to reduce the amount of wastes categorized as hazardous. A reduction in hazardous wastes is a reduction in waste handling and a reduction in costs. The effective separation of hazardous hospital wastes from non-hazardous wastes is the key element in promoting waste minimization. Separation is most effective when done prior to a procedure that generates the hazardous waste. For example, after use, a syringe becomes hazardous waste, but its original package does not. When separated from the syringe before use, the packaging can be placed into a non-hazardous waste container, avoiding potential contamination and subsequent classification as hazardous waste.
It is important that containers used for the separation of hazardous wastes be leak-proof and kept in a secured area. It is imperative that needles are not recapped, but placed along with other sharps in a puncture-proof container that, when full, undergoes appropriate treatment and/or disposal. Proper waste separation also reduces occupational health and safety risks by eliminating subsequent sorting and repackaging.

5.2 Waste Identification

The use of colour-coding and labeling of hazardous waste containers provides for effective waste separation, in addition to identifying its source of generation and persons responsible. If a hospital does not have an adopted color code, then that of WHO is recommended: yellow for infectious waste, red for sharps and highly infectious wastes, brown for chemical and pharmaceutical wastes, and black for noninfectious/non-hazardous waste. Infectious, pathological, and sharps wastes should also be marked with the international biohazard symbol. They should also be labeled with the date, department's name and name of responsible person. Likewise, leak-proof chemical and pharmaceutical waste containers must be labeled to identify the chemical or medication, its department of origin and date, and show the name of the Department Head or other person of responsibility.

5.3 Waste Handling

Waste handling within the hospital includes collection, transport, measurement, and storage. Detailed procedures are contained in the hospitals Hazardous Wastes Management Plan. Typically, the waste is collected from each department on a regular schedule by an individual with a cart dedicated to waste collection. The waste handler wears a protective gown and gloves, and follows a decontamination procedure for the waste
cart after each collection. After the waste is transported through the hospital (using a specifically designated route) to the storage area, its weight is measured and recorded. The waste is then placed in a secured storage area to await on-site treatment or transport off-site for treatment. The Hazardous Wastes Management Plan should contain limitations on the length of time the waste can be stored unrefrigerated.

5.4 Waste Treatment

Treatment may be defined as a process that changes the character of hazardous wastes to render them less hazardous or non-hazardous. Treatment may or may not reduce waste volume and render it unrecognizable. While treatment is always limited by what is technically and economically feasible and achievable, it is important to remember the basic philosophy that doing something in regard to treatment, no matter how limited, is better than doing nothing.

It should be understood that there is no ideal or perfect waste treatment method, and all technologies have both advantages and disadvantages. Hospitals that elect to have on-site treatment should select a treatment method based on treatment effectiveness; investment, maintenance, and service costs; hazardousness of post-treatment residues, and environmental pollution. Alternatively, hospitals may elect to take a cooperative approach by co-sharing ownership and operation of an off-site treatment technology, which could also provide for the waste treatment needs of other healthcare facilities.

(1) Chemical wastes. Treatment requires physical reduction and destruction of the materials, usually through high temperature incineration. Pressurized containers, as well as wastes loaded with heavy metals such as cadmium and mercury, should never be incinerated. Preferably, these wastes are sent to a designated hazardous waste landfill. Alternatively, wastes may possibly
be returned to the manufacturer, sent to a government approved recycling or recovery center. Processing used x-ray film developer solution to recover the silver, helps to reduce chemical waste, is cost-effective, and is recommended.

(2) **Pharmaceutical wastes.** Unused or expired medications should be returned to the manufacturer for disposal. Alternatively, they may be sent to a government approved hazardous waste incinerator. They should not be burned in a hospital waste incinerator, buried, or disposed of in a landfill.

(3) **Radioactive wastes.** Radioactive isotopes are collected, packaged, inventoried, and securely stored as required by the appropriate nuclear regulatory authority, for time periods suitable for complete radioactive decay. In the case of mixed radioactive and infectious wastes, the radioactive component is addressed first, followed by suitable treatment for the infectious component.

(4) **Infectious wastes, sharp, and pathological wastes.** Treatment will vary depending upon the waste, technologies available, public health and environmental regulations, and costs. Pathological wastes must be treated either by burying or incineration. Hospitals can choose to treat highly infectious and sharps wastes by steam autoclaving or incineration.

Steam autoclaving can be instituted immediately in most hospitals by dedicating an autoclave unit for waste treatment. Physical requirements for the effective steam autoclave treatment of wastes normally vary from those required for sterilizing medical supplies. Typically, this involves minimum time and temperature requirements, with consideration of moisture content. Research findings have shown that to effectively inactivate all vegetative microorganisms and most bacterial spores, small amounts of waste on the order of 5-8 kg require a 60-minute cycle at a minimum of 121° C, 15 psi (latm), with allowance for steam penetration to the waste material.
All infectious wastes, sharps, and pathological wastes can be incinerated in a one or two-chambered incinerator with required emission controls. Chemical and pharmaceutical wastes may be treated in a high-temperature incinerator if approved by the government for that purpose. It must be realized, however, that while incineration effectively reduces waste volume and eliminates infectiousness, the production of toxic air emissions and the hazardousness of the ash residue are major concerns. Additionally, construction of a new incinerator requires substantial investment, demands continual and costly maintenance and repairs, may not meet future regulatory requirements, and usually faces public opposition.

Commercial alternative technologies may be used if approved by national and local authorities. These include steam autoclave, microwave, and mechanical/chemical disinfection. Steam autoclaving uses moist heat under pressure, and treated wastes may be shredded following treatment. Microwave disinfection employs pretreatment grinding and shredding of the wastes, followed by moist heat treatment provided by a series of microwave units. Mechanical/Chemical disinfection simultaneously grinds and shreds the wastes while mixing them with a chemical disinfectant such as chlorine dioxide. While alternative technologies are not suitable for treating pathological, chemical, or pharmaceutical wastes, they are advantageous in that they can treat the majority of hazardous hospital wastes, require a much smaller investment compared to incineration, and have been shown to be very effective and environmentally friendly. Additionally, as mentioned, many of these systems employ a destructive grinding/shredding pre-treatment phase that reduces the volume of the waste and renders it unrecognizable. The table below presents the advantages and disadvantages of various medical waste treatment technologies.
### Table 1 – Medical Waste Treatment Technologies

<table>
<thead>
<tr>
<th>Parameters Influencing Incineration</th>
<th>Advantages of Incineration</th>
<th>Disadvantages of Incineration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turbulence and mixing</td>
<td>Reduction of waste volume,</td>
<td>Public opposition</td>
</tr>
<tr>
<td>Moisture content of waste</td>
<td>weight</td>
<td>High investment, operation cost</td>
</tr>
<tr>
<td>Filling of combustion chamber</td>
<td>Ability to make waste</td>
<td>Formation of dioxins and furans</td>
</tr>
<tr>
<td>Temperature and residence time</td>
<td>unrecognizable</td>
<td>High maintenance, testing, and repair costs</td>
</tr>
<tr>
<td>Maintenance and repair</td>
<td>Acceptability for all waste types</td>
<td>Vulnerability to future restrictive emissions laws</td>
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<td></td>
<td>Heat recovery potential</td>
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<tr>
<th>Parameters Influencing Steam Autoclave Disinfection</th>
<th>Advantages of Steam Autoclave Disinfection</th>
<th>Disadvantages of Steam Autoclave Disinfection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature and pressure</td>
<td>Low investment cost</td>
<td>Inability to change waste appearance</td>
</tr>
<tr>
<td>Steam penetration</td>
<td>Low operating costs</td>
<td>Inability to change waste volume</td>
</tr>
<tr>
<td>Size of waste load</td>
<td>Ease of biological testing</td>
<td>Lack of suitability for some waste types</td>
</tr>
<tr>
<td>Length of treatment cycle</td>
<td>Creation of residue that is less hazardous than for incineration</td>
<td>Production of uncharacterized air emissions</td>
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<tr>
<td>Chamber air removal</td>
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<table>
<thead>
<tr>
<th>Parameters Influencing Microwave Disinfection</th>
<th>Advantages of Microwave Disinfection</th>
<th>Disadvantages of Microwave Disinfection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waste characteristics</td>
<td>Ability to make waste unrecognizable</td>
<td>High investment cost</td>
</tr>
<tr>
<td>Moisture content of waste</td>
<td>Significant volume reduction</td>
<td>Increased waste weight</td>
</tr>
<tr>
<td>Microwave source strength</td>
<td>Absence of liquid discharges</td>
<td>Lack of suitability for some waste types</td>
</tr>
<tr>
<td>Duration of microwave exposure</td>
<td></td>
<td>Potential to expose workers to contaminated shredder</td>
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<tr>
<td>Extent of waste mixture</td>
<td></td>
<td>Production of uncharacterized air emissions</td>
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<tr>
<th>Parameters Influencing Mechanical/Chemical Disinfection</th>
<th>Advantages of Mechanical/Chemical Disinfection</th>
<th>Disadvantages of Mechanical/Chemical Disinfection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemical Concentration, temperature, pH</td>
<td>Significant waste volume reduction</td>
<td>High investment cost</td>
</tr>
<tr>
<td>Contact time with chemical</td>
<td>Ability to make waste unrecognisable</td>
<td>Lack of suitability for some waste types</td>
</tr>
<tr>
<td>Waste and chemical mixing</td>
<td>Rapid processing</td>
<td>Production of uncharacterised air emissions</td>
</tr>
<tr>
<td>Recirculation versus flow-through</td>
<td>Waste deodorization</td>
<td>Need for chemical storage and use</td>
</tr>
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Encapsulation and controlled burying are additional options. Encapsulation is most often used for sharps and involves filling high-density plastic containers three-fourths full with waste and then filling them up with cement mortar or sand or other suitable material. The encapsulated waste may then be sealed and stored at an approved site, depending on local regulations. Alternatively, metallic drums may also be used with cement mortar as the filling material, followed by deposition in a landfill, if permitted.

Lastly, if other options are not available, safe burying inside the hospital premises may be elected. In this event, the following measures must be adhered to: (1) access to the disposal site should be restricted, (2) the landfill hole should be lined with clay to prevent environmental pollution, (3) the site should be managed as a sanitary landfill, with each layer of waste covered with a layer of earth, and (4) large quantities of chemical waste should not be buried.

5.5 Waste Disposal

Disposal is the final placement of treated or acceptable untreated wastes and/or their residuals. Small quantities of liquid wastes, to include blood and chemicals, may be neutralized and discarded into the sanitary sewer with the approval of local authorities. Large quantities of solvents, film developer, and other chemicals, should never be discarded in the sanitary sewer but should be incinerated in a government approved hazardous waste incinerator, or recovered or recycled if possible. The latter usually entails an arrangement with a contractor for pick up, processing, and/or disposal.
Normally, treated solid wastes are deposited in a sanitary landfill. Often there is a designated area where such wastes, even though treated, are to be placed. Pathological wastes, if not incinerated, should be buried in a secure, controlled area to prevent animal scavenging.

5.6 Security

Throughout South-East Asia, as in many other parts of the world, maintaining the security of hazardous hospital wastes from generation through ultimate disposal is a significant challenge. Scavenging on hospital grounds, sometimes at the point of waste generation must be recognized as a threat to hospital infection control and patient care, as well as to public and environmental health. Hospitals must make and enforce rules, as well as provide employee training and other security measures necessary to curtail and prevent such activity. Where possible, the treatment or pre-treatment of wastes at the time of generation, such as placing needles and syringes in a heat destruction unit, can be helpful. Limiting public access to hospital areas where waste is separated, collected, transported, and stored prior to treatment and disposal, should be a priority within a hospital's Hazardous Waste Management Plan.

5.7 Recordkeeping

Effective hazardous hospital waste management requires accurate recordkeeping of all aspects of the program to document compliance, assess expenditures and evaluate minimization efforts. The written waste management policy should identify those staff responsible for
recordkeeping, important information that should be recorded include among others: (1) amounts and types of wastes generated by each department and for the entire hospital, (2) direct costs for supplies and materials used for collection, transport, storage, treatment, disposal, decontamination, cleaning and training, (3) all labor costs associated with waste management, (4) costs for prevention and treatment of waste related injuries and illnesses such as immunizations, post-exposure prophylaxis, etc., (5) repairs and associated costs for incinerator or other technology and (6) types and costs of contractor services.

5.8 Training

A hazardous hospital wastes management policy is not effective if it is not integrated into the daily work activities of all personnel. The training of employees to implement the Hazardous Wastes Management Plan is critical to success. Training must be provided when the management policy and plan is first implemented, when new employees begin work, when existing employees are assigned new work responsibilities, and whenever policy changes are made by the administration. Training should focus on the written Hazardous Wastes Management Plan and all aspects of hazardous waste management as discussed throughout this guide. It should also specifically highlight each employee's responsibilities and where they fit into the entire management policy and plan. It is important that Department Heads and/or others with direct employee supervisory responsibilities receive the proper training and materials necessary to enable them to serve as trainers. Resource materials and information necessary to the design and presentation of a quality training program are usually available from a variety of sources, to include Ministries of Health and
Environment, the World Health Organization, and healthcare waste management consultants.

5.9 Health and Safety

An effective hazardous hospital waste management policy should include provision for continual assessment of worker compliance with required safe practices and procedures. An appropriate health and safety program should include: proper training, issuing of personal protective equipment (such as gowns and gloves), and medical surveillance (with immunization and post-exposure prophylaxis).

The health and safety training must ensure that workers know and understand the potential risks associated with hazardous hospital waste, the value of immunization for hepatitis B virus (HBV), and the importance of using the personal protective equipment issued to them. Specifically, such training should emphasize: (1) the epidemiology and prevention of bloodborne pathogen (HBV and HIV) transmission, (2) the meaning of color codes, labels and related precautions, (3) the proper use of protective equipment, (4) correct waste handling procedures, (5) routine personal hygiene, and (6) procedures to follow if needlestick or other injury or unexplained illness occurs.

5.10 Emergency Planning

Hospital management should be prepared for unexpected hazardous waste situations such as accidental spills, equipment failures, delays or interruptions in waste collection, transport, or treatment services, or any other incident that requires rapid action and decision making. As much as possible, such emergencies should be addressed in the written hospital waste management plan. For example, the step-by-step emergency
cleanup procedure of an infectious waste spill, to include a notification system, disinfectants to be used, and documentation of actions taken, should be part of the waste management policy as well as employees' training.

6. Conclusion

By implementing a hazardous hospital waste management policy and plan that includes components outlined in this document, hospitals and research facilities are taking steps toward securing a healthy and safe environment for their patients, employees and communities.

It is recognized that the management of hazardous hospital waste is not only a technical problem, but is intimately influenced by cultural, social, and economic circumstances. At the local level, hospitals are encouraged to work together to address the economic, public health, and environmental impact concerns of hospital waste management. The formation of a local or regional committee, where each hospital is represented and members can share ideas and experiences, and work together to address common problems and formulate uniform and perhaps cooperative solutions that are technically and economically feasible, is strongly encouraged.