Public Disclosure Authorized

E & ER Group

E & ER Group
628 Second Street
Rodeo, CA 94572 USA

Phone 510-799-2551
Fax 510-799-2572

Audit of Biomedical Waste Management Practices

Grenada

E634
April 29, 2002

FIRST DRAFT-Do not quote

Public Disclosure Authorized

Prepared for:
Natural Resources Management Unit (NRMU)
Organization of Eastern Caribbean States (OECS)

April 29, 2002

FILE COPY

Table of Contents

Executive Summary i

Introduction iv

Objectives 1

Approach 1

Basic Information 2

Inventory of Major Health-Care Facilities 2

Assessment of Laws and Regulations 5

Assessment of Biomedical Waste Management Practices 6

- General Hospital, St. George's 6
- Princess Alice Hospital, St. Andrew's 12
- St. Augustine's Medical Services, St. George's 16
- Gouyave Health Centre, St. John's 18
- St. David's Health Centre, St. David's 24
- Grand Roy Medical Station, St. John's 27
- Princess Royale Hospital, Carriacou 29

Assessment of Biomedical Waste Treatment 30

Assessment of Waste Disposal 32

Recommendations 33

- Short-Term Recommendations 33
- Long-Term Recommendations 40
  - National Laws and Regulations 40
  - Institutional Policy, Administration, and Organization 41
  - Occupational Safety and Health 42
  - Waste Segregation and Classification 43
  - Waste Minimization 46
  - Labeling, Colour Coding, and Signage 46
  - Waste Collection 47
  - Handling and Transport Within the Facility 48
  - Transport Outside the Facility 48
  - Waste Treatment 48
  - Final Disposal 49
  - Summary of Biomedical Waste Management Procedures 49
  - Contingency Planning 50
  - Employee Training and Public Education 51

Appendix

Sources of Information A1
Sample Institutional Policy A2
Waste Minimization A3
Sample Poster A4

Executive Summary

This report presents the results of an audit of biomedical waste management practices in Grenada. The audit began with meetings with officials of the Ministry of Health and the Environment, followed by site visits to the main public and private hospitals, representative health centres, a medical station, Solid Waste Management Authority, two landfills, a pharmacy, and other related facilities between February 11 to 13, 2002. In the case of one hospital at another island, a phone interview was conducted. The assessment is based on information obtained during meetings and interviews, observations from site visits, photo-documentation, review of relevant documents, and follow-up data received after the visit.

Grenada is divided into seven health districts, six of which have a health centre. The centres are supplemented by 31 medical stations. There are three public hospitals—General Hospital (which is the main hospital), Princess Alice Hospital, and Princess Royale Hospital—two private hospitals, and eight private medical centres or clinics. An inventory of health-care facilities is provided, including a medical school, veterinary hospital, and public and private nursing homes.

The mainland of Grenada and Carriacou are divided into five solid waste collection zones. Domestic waste is deposited in engineered landfills. Waste pickers are not allowed to scavenge materials in the landfill. At the time of the visit, the Perseverance Landfill in the mainland was not in use due to a collapse in the cell structure. Solid waste was instead being brought to the old dumpsite until the landfill structure could be repaired.

The most relevant law is the Waste Management Act of 2001 which has come into force. The Act requires the development of a national waste management strategy to deal with all types of waste. Clinical wastes from health-care facilities are classified by the Act as hazardous waste. Except for these general requirements, there are no regulations dealing specifically with biomedical waste. Recommendations are made on various elements that could be addressed in future regulations.

Assessments of biomedical waste management practices are presented for seven representative facilities: General Hospital, Princess Alice Hospital, St. Augustine's (a private hospital), Gouyave Health Centre, St. David's Health Centre, Grand Roy Medical Station, and Princess Royale Hospital. Each facility is evaluated in terms of its written policies and procedures on biomedical waste management; colour coding and signage;

waste segregation, collection, and transport; waste treatment; waste disposal; employee training; and waste management organization.

Except for General Hospital, none of the facilities has policies or procedures for biomedical waste management. Written in 1993, the policies at General Hospital deal with some aspects of waste management, including sharps disposal. The policies regarding waste management are not comprehensive. In all the facilities visited, there is little or no formal training on biomedical waste management. Most of the information is disseminated informally by word of mouth.

There is no colour coding in any facility except for General Hospital where colour coding is used albeit inconsistently. All other facilities use black bags to collect biomedical waste and regular garbage.

In all facilities, sharps are segregated at the point of use and health-care providers are aware of the need to separate sharps. In general, rigid, puncture-resistant plastic containers of varying sizes are readily available and in use. Several facilities reported reusing sharps containers. The process of manually emptying out sharps containers poses a risk of needle-stick injuries to the workers. Worker protection should be provided. A few smaller facilities also use cardboard boxes for sharps collection. The boxes do not appear to be puncture-resistant.

Blood and body fluids are generally poured out into sinks that drained into the sanitary sewer. At the main hospital, the duct from the sluice room drains into an open channel; the staff could not confirm whether this channel connected to the hospital's sanitary sewer. Workers need to be provided protection from splashes of blood and body fluids.

Cultures and stocks are autoclaved on site at the main hospital. Pathological waste is interred on site, composted (e.g., placenta at St. Augustine's), or burned. There is little or no chemotherapeutic waste and low-level radioactive waste generated at this time. Spent chemical solvents used in the laboratory are generally poured down the drain. These chemical wastes should be treated as hazardous waste. Expired pharmaceuticals are generally dissolved, diluted, and flushed down drains (for small amounts of liquids and tablets including antibiotics), buried on site or at the landfill (for larger amounts), or in some cases, returned to the manufacturers.

Burning is the main form of waste treatment used in Grenada. The burning methods include: campfire-style open burning, open-pit burning, burning in a cement firebox, burning in drums, old cement block open-burn incinerators, a small in-house incinerator, burning in the local crematorium, and a new controlled medical waste incinerator (which was not in operation because of problems). Regular garbage, including plastics and cans, are burned with the biomedical waste. All of the open-burn methods

pose a fire hazard due to surrounding vegetation and other combustible materials around the burn area. Furthermore, they generally achieve insufficient levels of disinfection; release air pollutants such as toxic dioxins, furans, acid gases, particulates, and heavy metals; generate ash that may be hazardous; and result in unburned or partially burned residues that could include sharps.

It is recommended that the use of the incinerators be minimized or at least the following materials not be burned: halogenated plastics, waste containing heavy metals, pressurized containers, and organic solvents. Until appropriate biomedical waste treatment technologies are installed, the biomedical waste could be encapsulated and buried on site, or transported for safe burial at the landfills under a special arrangement with the Solid Waste Management Authority. Recommendations for new biomedical waste treatment technologies will be presented in another report.

Specific short-term recommendations are provided for each facility visited. General long-term recommendations are also presented dealing with the following: laws and regulations; institutional policy, administration, and organization; occupational safety and health; waste segregation and classification; waste minimization; labeling, colour coding, and signage; waste collection; handling and transport within the facility; transport outside the facility; waste treatment; final disposal; contingency planning; employee training; and public education. Feedback from stakeholders on the long-term recommendations will serve as the basis for the development of a national biomedical waste management plan.

INTRODUCTION

This project is a component of a larger World Bank-funded programme to address the problem of solid and ship-generated wastes with the goal of protecting the environment and enforcing the MARPOL 73/78 Convention. The programme involves six members of the Organization of Eastern Caribbean States (OECS) and is coordinated by the Natural Resources Management Unit of OECS.

This particular component of the project deals with the management of health-care waste in Grenada and has four specific tasks: (1) an audit of medical waste management practices, (2) review of existing medical waste treatment technologies, (3) development of a national biomedical waste management plan, and (4) a training programme/implementation and monitoring.

This report corresponds to the first of the aforementioned four tasks. It was prepared by Dr. Jorge Emmanuel of the E & ER Group based in Rodeo, California, USA. The author is grateful to Mr. Patrick Moore, Chief Environmental Health Officer, for his valuable assistance in arranging the site visits and interviews. He also thanks Mr. Ed Krisiunas for his help in the site visits. The author acknowledges the support of Permanent Secretary for Health, Ms. Eunice Sandy-David and all the personnel who provided information related to medical waste management in Grenada.

Comments on this report from the stakeholders should be sent to the address shown below.

Jorge Emmanuel, PhD, CHMM, PE, REP, DES
The E & ER Group
628 Second Street
Rodeo, CA 94572
USA
Ph. 510-799-2551
Fax 510-799-2572
E-mail: jemmanuel@mindspring.com

AUDIT OF BIOMEDICAL WASTE MANAGEMENT PRACTICES

Objectives

The objectives of this report are to review the current status of biomedical waste management in Grenada, and to present recommendations. The consultant's recommendations are based on:

a) The need to safeguard public health, enhance occupational safety of health-care workers, and protect the environment without compromising patient care

b) The need to conform to generally accepted international practices and standards related to the collection, transport, and disposal of potentially infectious waste

c) The desirability of regional harmonization, where appropriate, of practices and standards related to biomedical waste management.

Approach

Information for this report was obtained from meetings with stakeholders and visits to various representative facilities conducted between February 11 to 13, 2002. Specific sources included:

a) Data gathered during meetings with government officials, health-care facility staff, solid waste management personnel, and other stakeholders (Note: due to difficulties in transportation, detailed information was also obtained through a phone interview in the case of one hospital)

b) Observations and photo-documentation of existing practices and technologies during site visits to two public hospitals, one private hospital, two health centres, a medical station, major pharmacy, crematorium, landfill, and the old dumpsite.

c) Review of relevant documents and publicly available reference materials

d) Responses to follow-up requests for additional information

e) Preliminary information provided by the Natural Resource Management Unit, Organization of Eastern Caribbean States.

Appendix A1 gives a list of the facilities visited, personnel who provided information, and documents and photos obtained.

Basic Information

Grenada is comprised of three islands: the mainland of Grenada, Carriacou, and Petite Martinique. It has a total land area of 344 sq km (133 sq mi) and a population of about 101,000 people (about 90,000 in the mainland, 10,000 in Carriacou, and 1,000 in Petite Martinique). The mainland is divided into six parishes: St. Patrick's, St. Andrew's, St. David's, St. George's, St. John's, and St. Mark's.

The Ministry of Health and the Environment, located at the Ministerial Complex (Botanical Gardens) in St. George's, is responsible, among others, for medical waste management and disposal. It is headed by the Minister of Health and the Environment Dr. Clarice Modeste-Curwen. The Permanent Secretary Ms. Eunice Sandy-David is the Ministry's administrative head. The Chief Medical Officer Dr. Bernard Gittens is the principal technical officer and supervisor of all district medical officers.

In the private sector, there is a Grenada Medical Association headed by Dr. Emma Henry-Thompson. There are an estimated 21 doctors who work exclusively in private individual or group practice, plus another 59 medical practitioners employed in the public sector most of whom are also in private practice. The total number of registered nurses is about 242.

For the purpose of solid waste collection, Grenada is divided into four collection zones in the mainland plus one zone in Carriacou. Municipal solid waste is disposed of in the Perseverance Landfill off the Western Main Road around the area of Halifax Harbor. Perseverance is a 7.2-hectare engineered landfill built on a gradient. It has a clay liner and is comprised of six cells, of which one (Cell 1) is developed. It has an area for weighing and a leachate drainage system including a leachate pond. Leachate and groundwater tests are conducted by the Caribbean Environmental Health Institute. Some separation of tires and batteries is done. The seven-day-per-week operation includes compacting and daily cover. Waste pickers are not allowed in the landfill to scavenge materials. Capacity is estimated at about 17.5 years.

Perseverance Landfill had been in operation for less than a year. Unfortunately, at the time of the site visit, a collapse of the structure between Cell 1 and Cell 2 due to heavy rains caused a temporary halt in the use of the landfill. Waste was being sent to an area in the old dumpsite a short distance away. Solid Waste Management Authority personnel expected the Perseverance Landfill to return to operation in three or four months. Solid waste in Carriacou is disposed of at the Dumfries Landfill, a 2.4-hectare engineered landfill.

Inventory of Major Health-care Facilities

Grenada is divided into seven health districts, of which six have a health centre as the primary care facility supplemented by 31 district medical stations. Generally, each health district has a district medical officer, family nurse practitioner, public

health nurse, district nurses, community health aides, dentist and dental auxiliary, pharmacist, environmental health officer, and mental health worker. The public (government-run) health-care facilities under the Ministry of Health include:

- three hospitals
- six health centres
- 31 medical stations
- a major dental clinic
- a psychiatric hospital
- a geriatric facility
- 16 pharmacy units at the hospital and community levels
- a rehabilitation centre

In addition, there are the following private health-care facilities (based on 2001 phone directory listings):

- two private hospitals
- one university hospital
- two veterinary hospital/teaching hospital
- eight other private facilities (medical centres, clinics, maternity unit)
- one public and about 10 private nursing homes
- five wholesale pharmacies
- about 16 retail pharmacies
- about 9 private dental clinics

By comparison, a 1998 Pan American Health Organization (PAHO) report estimated 18 private pharmacies and about 15 dentists with private practice. A 2001 PAHO report estimated five acute hospitals, 13 private nursing homes, two maternity units, and several medical offices in the private sector.

Table I below lists the hospitals, health centres, and medical stations in Grenada along with the number of beds or patients served by the district medical officer in 2001, where data were available.

Table I. Inventory of Health-Care Facilities

CATEGORY / LOCATION	FACILITY	NOTES
Public Hospitals		
St. George's	General Hospital	240-bed hospital
St. Andrew's	Princess Alice Hospital	60-bed hospital
Carriacou	Princess Royale Hospital	32-bed hospital
Private Hospitals		
St. George's	St. Augustine's Medical Services	18-bed hospital
St. George's	Marryshows Hospital and Health Clinic	
Teaching Hospital		
St. George's	St. George's University Med. School (private)	
Psychiatric Hospital		
St. George's	Mt. Gay Psychiatric Hospital	80-bed hospital
Veterinary Hospitals		
St. George's	GSPCA Hospital	
St. George's	SGU Veterinary Teaching Hospital	
Gov. Health Centres		
St. Patrick's	Sauteurs Health Centre	3,648 patients/yr
St. Andrew's	Grand Bras Health Centre	2,712 patients/yr
St. David's	St. David's Health Centre	2,134 patients/yr

St. George's	St. George's Health Centre	5,001 patients/yr
St. John's	Gouyave Health Centre	3,773 patients/yr
Carriacou	Hillsborough Health Centre	1,449 patients/yr
Gov. Medical Stations		
St. Patrick's	River Sallee	827 patients/yr
St. Patrick's	Mt. Rich	1,324 patients/yr
St. Patrick's	Tivoli	781 patients/yr
St. Patrick's	Union	1,117 patients/yr
St. Patrick's	Hermitage	629 patients/yr
St. Andrew's	Parraclete	545 patients/yr
St. Andrew's	Birch Grove	982 patients/yr
St. Andrew's	Mt. Carmel	1,031 patients/yr
St. Andrew's	Paradise	520 patients/yr
St. David's	Vincennes	872 patients/yr
St. David's	Crochu	947 patients/yr
St. David's	Westerhall	481 patients/yr
St. David's	Perdemontemps	1,755 patients/yr
St. George's	Grand Anse	748 patients/yr
St. George's	Calliste	
St. George's	Snug Corner	1,703 patients/yr
St. George's	Happy Hill	1,534 patients/yr
St. George's	Good Hope	1,651 patients/yr
St. George's	Woburn	1,088 patients/yr
St. George's	New Hampshire	1,200 patients/yr
St. George's	La Borie	1,532 patients/yr
St. George's	Morne Jaloux	1,381 patients/yr
St. George's	Mt. Moritz	593 patients/yr
St. George's	Airport (not a full clinic)	
St. John's	Grand Roy	897 patients/yr
St. John's	Florida	225 patients/yr
St. Mark's	Victoria	1,935 patients/yr
Carriacou	Mount Pleasant	741 patients/yr
Carriacou	Windward	1,117 patients/yr
Carriacou	Belle Vue South	563 patients/yr
Petite Martinique	Petite Martinique	1,045 patients/yr
Private Facilities		
St. George's	Old Trafford Medical Centre	
St. George's	Black Rock Medical Centre	
St. George's	Brooks-Smith-Lowe Institute	
St. Andrew's	Good Shepherd Clinic	
St. George's	Halifax Clinic	
St. George's	Salus Clinic	
St. George's	Traditional & Alternate Medical Clinic	
St. George's	Blakeford Maternity Unit	
Nursing Homes		
St. George's	Dorothy Hopkins Centre for the Disabled / Richmond Home	120-bed government facility
St. Andrew's	Cadrona Home	
St. George's	Chichester's Nursing Home	
St. George's	Grand Anse Gardens Home	
St. Patrick's	Hilario Fr. Cheshire Home	
St. John's	Hillview Home	
St. George's	Johnson's Home	
St. George's	Robertson's Convalescent Home	
St. George's	St. Cecilia Nursing Home	
St. Andrew's	St. Martin's Home	
Carriacou	Alexis Nursing Home	

Assessment of Laws and Regulations

The Ministry of Health and the Environment operates under several key legislation. Some of these statutes are: Hospital Act of 1953; Medical Officers Act of 1903; Medical Practitioners, Dentists and Veterinary Surgeons Registration Act of 1982; Midwives Act of 1954; Nurses Registration Act of 1980; Pharmacy Act of 1988; Public Health Act of 1925; Public Health (Immunization) Act of 1980; General Hospital Fee Rules (1988); Medical Products Act; Hospital Authority Act; Solid Waste Act of 1995; and Waste Management Act of 2001. Except for the last two, these laws regulate health-care providers in the public and private sectors.

The Solid Waste Act of 1995 and the Grenada Solid Waste Management Authority Act of 1995 established an autonomous statutory body, the Solid Waste Management Authority, to manage a system of collection and disposal of solid waste (garbage). Four private contractors carry out the hauling of solid waste. Although the removal and disposal functions have been privatized, the Ministry of Health and the Environment maintains its regulatory role of monitoring and oversight.

The Waste Management Act of 2001 (Act No. 16 of 2001), which has come into force, provides for the management of waste according to best practices. The Act requires the development of a national waste inventory and a national waste management strategy. Under the strategy, an implementation programme must be created which includes establishment of standards, requirements, and procedures for management of all types of waste. The law specifically requires that the strategy "identify methods by which ... biomedical waste ... and other specified classes of waste are to be managed." [Part II, Section 5 (3)(b)]

The Waste Management Act establishes penalties for storage and disposal of waste in a manner likely to cause pollution of the environment or harm to human health. The minister is given the responsibility for making regulations.

Among the components of wastes classified as Hazardous Waste in Schedule 1, Part A of the statute, are:

- Y1 Clinical wastes from medical care in hospitals, medical centres and clinics
- Y2 Wastes from the production and preparation of pharmaceutical products
- Y3 Waste pharmaceuticals, drugs and medicines

Under Schedule 1, Part B of the statute, Hazardous Waste characteristics include:

- H6.2 Infectious substances: substances or wastes containing viable micro organisms or their toxins which are known or suspected to cause diseases in animals or humans

Under the statutory definitions, biomedical waste is defined as including "any waste containing human or animal fluids, flesh, bones, or other body parts except hair." [*Note: For the purpose of this report, the term "biomedical waste" will have a broader meaning and will be used to refer to any waste from a health-care facility that poses a hazard including waste that is capable of producing infectious disease.*]

Except for the above-mentioned statutory definitions, there are no classifications provided for the various components of health-care wastes. As reported by environmental health officers, there are no regulations dealing specifically with the management of wastes from health-care facilities. This issue will be addressed further in the recommendations and the draft national biomedical waste management plan.

Assessment of Biomedical Waste Management Practices

Below are assessments of biomedical waste management practices for each of the following six representative health-care facilities inspected during one or more site visits:

1. General Hospital, Fort George's Pointe, St. George's
2. Princess Alice Hospital, Mirabeau, St. Andrew's
3. St. Augustine Medical Services (private hospital), Grand Anse, St. George's
4. Gouyave Health Centre, Gouyave, St. John's
5. St. David's Health Centre, Petit Esperance, St. David's
6. Grand Roy Medical Station, Gouyave, St. John's

A brief assessment is also made of Princess Royale Hospital in Belair, Carriacou, based solely on an in-depth telephone interview with the hospital administrator. Problems with inter-island transportation at the time of the visit made it difficult to travel to Carriacou by sea or air.

General Hospital, St. George's

General Hospital on Fort George's Pointe is the main acute care hospital in Grenada. It has 240 beds with a bed occupancy rate of about 60%. The hospital is staffed by about 30 physicians, 144 nurses, 84 nursing auxiliaries, 47 administrative personnel, and 146 other workers (PAHO, 1998). The hospital provides a wide range of services including general surgery, laboratory, and emergency services. It houses a female medical ward, two female surgical wards, a male medical ward, a male surgical ward, a pediatric/infant ward, maternity ward, a 9-bed ophthalmology ward, intensive care unit, private wards, physiotherapy department, and a 20-bed psychiatric unit which was recently moved.

A new four-story facility being constructed within the current hospital grounds will increase the number of beds to 270. (Note: this figure apparently includes about 20 rest beds for auxiliary personnel). The new facility was about 75% complete at the time of the visit.

The hospital generates sharps waste, tissues and anatomical parts from two surgical theatres, placenta waste from maternity, blood and body fluids, laboratory waste, and other common wastes such as soiled dressings, bandages, gauze, swabs, etc. No chemotherapeutic waste is produced. As with all health-care facilities, general garbage is also produced.

General Hospital was visited on two separate occasions. Departmental supervisor Nurse Lyneve Bailey acted as guide during the first site visit; Deputy Director Franklin Gittens hosted the second visit.

1. Policies and Procedures

The hospital has written policies in the form of an in-house infection control manual developed in November 25, 1993. Examples of key policies pertaining to waste were:

- Policy No. 003 Soiled linen
- Policy No. 005 Universal precautions
- Policy No. 006 Disposal of sharps
- Policy No. 009 Personnel protection

On sharps management (Policy No. 006), the policy requires puncture-resistant containers, no recapping of needles, no bending or breaking of needles, no disposal of needles with regular garbage, and the prompt disposal of all used sharps.

With sharps posing the major hazard among health-care waste components, the existence of a sharps disposal policy at General Hospital is important. However, no similar policies were found for dealing with other waste components such as cultures and stocks, blood and body fluids, and pathological waste. Furthermore, there were no general policies on waste minimization, segregation, collection, handling, transport, treatment, and disposal.

2. Colour Coding and Signage

Colour coding is inconsistently used at the hospital. In some places, as shown in Figure 1, a container with a red bag is placed beside a container with a black bag to segregate potentially infectious waste from regular garbage. (In this case, however, packaging that is probably not infectious was thrown in the red bag. A cursory examination of the contents of some bags indicated poor segregation practices even when red and black bags were available.)

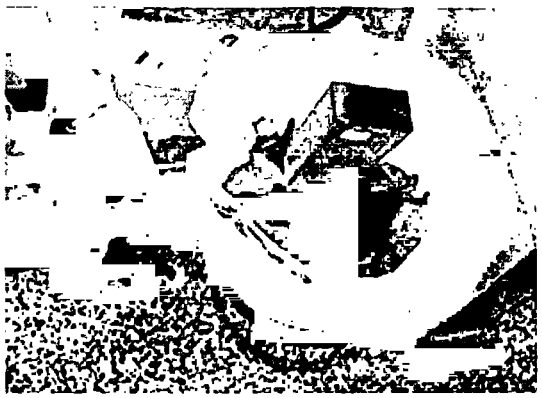


Figure 1. Red and Black Bags Used at General Hospital

In general, black bags were used for garbage. Black bags were also used to collect soiled linen (Figure 2). In at least one area, however, red bags are used for regular garbage, as shown in Figure 3.

Figure 2. Black Bags Used for Soiled Linen

Figure 3. Red Bags Used for Regular Garbage

The hospital laboratory seems to have an adequate supply of red bags as well as red autoclavable bags. Red bags were purportedly donated by a hospital in Gainesville, Florida. Hospital personnel noted that donated red bags were often of poor quality.

Clearly, despite the availability of red bags, a colour coding system is not used in some parts of the hospital or is used inconsistently in others. Colour coding and signage are important aspects of waste segregation for effective waste management, protection of public health, and occupational safety. They are the generally accepted standards for handling health-care waste. No signage related to health-care waste management was found in the facility. The lack of colour coding and signage is an issue that needs to be addressed in the future.

3. Waste Segregation, Collection, and Transport

Sharps are collected in red-coloured, puncture-resistant, plastic containers. They range in size from 2 litres to large 40 litre plastic containers. Figure 4 shows two sizes of sharps containers near a bin for regular garbage.

Figure 4. Sharps Containers in General Hospital
(left-below sink; right-on shelf)

The handling, collection, and disposal of contaminated sharps waste pose one of the greatest occupational hazards facing health care workers worldwide because of the frequency of needle-stick injuries and the potential transmission of bloodborne pathogens. For this reason, the generally accepted performance criteria for sharps containers include: puncture resistance, rigidity, durability, leak resistance on the sides and bottom, ability to be closed, and functionality under all normal conditions during their use. The sharps containers that were seen in General Hospital meet the standard criteria.

When full, the sharps containers are picked up by orderlies and emptied into a box or placed in a large bag for incineration. Several large boxes full of sharps were found in the alley outside the laboratory awaiting transport for disposal.

Cultures and stocks are autoclaved on-site in the laboratory prior to disposal. This procedure is ideal for the management of cultures and stocks.

Blood and body fluids are poured out in the sluice room. Blood samples and unused units of blood from the blood bank are autoclaved. Because of the shortage of laboratory supplies, collection tubes and bottles are emptied out in the sluice room, soaked overnight in a disinfectant solution (sodium hypochlorite) as shown in Figure 5, then washed, dried in a hot air oven, and reused.

Figure 5. Containers Soaked in Disinfectant Prior to Reuse

A dressing trolley is usually wheeled into the patient wards. Each ward has two containers: a pail (Figure 6) for soiled dressings and bandages, and a step-on bin for general garbage. Black bags are used to line the bins.

Figure 6. Pail for Soiled Dressings Used in the Wards

In the operating theatres, kick buckets with different bags are used. Some buckets are used for gauze and swabs, others for linen. Orderlies bring out the waste, which is divided into two waste streams—biomedical waste and regular garbage. In the set-up room, dry wrappers are collected and disposed as regular trash.

As mentioned, regular garbage is collected in containers lined with black plastic bags. Covered containers were generally found in the wards. In one area, however, an uncovered garbage bin containing food waste was found in an open corridor with three cats nearby (Figure 7). This situation could lead to an unsanitary condition.

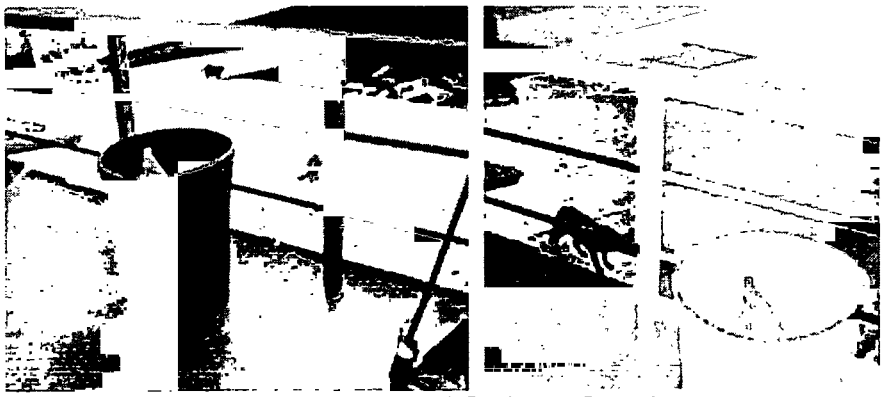


Figure 7. Uncovered Garbage Container

4. Waste Treatment

Until recently, clinical wastes including soiled dressings, placenta, tissues and other pathological waste, were burned in an old incinerator on the hospital grounds. Incinerator ash was then collected and sent to the solid waste dumpsite. Hospital personnel noted that sharps waste did not burn well, perhaps indicative of an old incinerator design and/or a poorly maintained incinerator incapable of achieving high temperatures. Environmental health officers mentioned that the incinerator was often out of service.

However, with the new construction, the old incinerator had been dismantled to make way for a new incinerator being planned near the new building and adjacent to the energy block where the chillers and electricals are housed (Figure 8). In the interim, pathological waste including large tissues are being transported to the LaQua Brothers crematorium for burning.

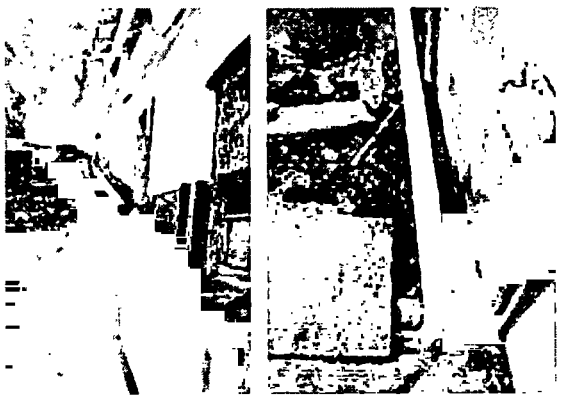
Figure 8. Planned Location for New Treatment Technology

At present, the hospital does not have a management system for the disposal of hazardous waste. Solvents and other hazardous wastes are apparently discharged into the sewer system or disposed of with regular solid waste.

5. Waste Disposal

As noted above, blood collection tubes are disinfected in hypochlorite solution, dried in a hot air oven, and reused. The spent disinfectant is poured into a sink

that drains directly to an outside drain running parallel to the building and emptying out into an open drain (Figure 9). The outside storm drain is along a vehicle parking area in the courtyard of the hospital grounds. Hospital and ministry personnel were not able to confirm whether the effluent goes through the hospital's sanitary sewer or is simply discharged without treatment. Chemical waste such as formaldehyde is discarded down the drain.



Figures 9. Duct From Sluice Room (left) and Open Drain (right)

In general, the burnt sharps, ash, and other waste residues from the incinerator are brought to the landfill or dumpsite. Landfill workers complained that syringes are often found in the waste.

6. Employee Training

According to the former infection control coordinator, training should be conducted every quarter. Since the infection control committee is not as active as in the past, training programmes may not be fully implemented. Discussions with staff members indicated that some personnel, such as the laboratory staff, had a good understanding of the issues associated with biomedical waste handling and disposal.

7. Waste Management Organization

The hospital has an infection control committee. At the time of the site visit, the infection control coordinator was on sick leave. The committee had apparently been active in the past but key members have since left.

Princess Alice Hospital, St. Andrew's

Princess Alice Hospital (PAH) is located in Mirabeau northeast of St. George's on the eastern side of Grenada a short distance from Grenville. Ms. Stephanie Sandy, charge nurse the day of the site visit, accompanied the consultant. There are approximately 60 beds evenly divided between the male and female wards. A pediatric ward is also present with 6-8 beds. The operating theatre, laboratory, and radiology units are not operational at this time. PAH is primarily a triage facility with more extensive procedures and surgeries being performed at General Hospital in St. George's.

1. Policies and Procedures

No specific policy exists at Princess Alice Hospital for the management of biomedical waste.

2. Colour Coding and Signage

No red bags were observed being used in the hospital, only black bags. With respect to signage, a poster was found on breaking the chain of infection (Figure 10).

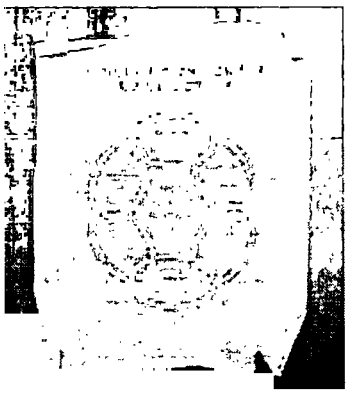


Figure 10. Poster on the Chain of Infection

3. Waste Segregation, Collection, and Transport

PAH utilizes a slightly different method of biomedical waste management as compared to the experience with other health-care facilities. Sharps bins include plastic containers, cardboard boxes, or plastic bags. They are available for use and located throughout the facility (Figure 11). However, only black bags were in use at the hospital. These black bags (Figure 12) are removed on a regular basis by groundskeepers and are carried to the rear of PAH for disposal via incineration. The sharps containers are then returned to service. With the exception of placentas, all other waste is collected in black bags.

Figure 11. Sharps Bins in Male Ward (left) and A and E (right)

Figure 12. Black Bags

4. Waste Treatment

In the past, blacks bags and sharps containers were carried to the rear of PAH where a relatively new incinerator (Evans Tabo Universal Minimaster, Leeds, UK), constructed in 2000, was used to burn the waste (Figure 13). The incinerator used oil as auxiliary fuel. Placentas would also be incinerated.

Figure 13. New Incinerator (Not in Operation)

Before the new incinerator was installed, the hospital used a simple cement firebox with a protective roof, as shown in Figure 14. The old firebox incinerator is in disrepair and surrounded by weeds.

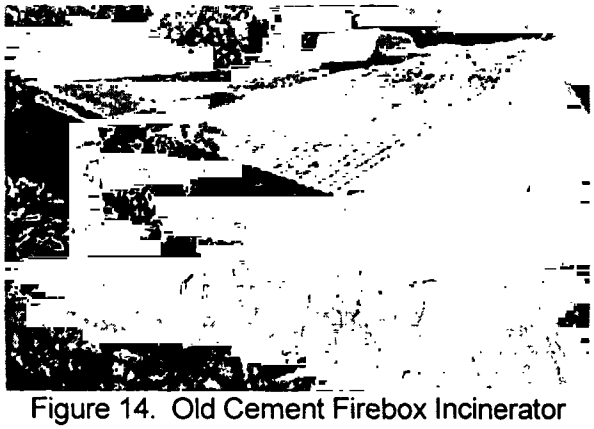


Figure 14. Old Cement Firebox Incinerator

During the site visit, the new Minimaster incinerator was not operational. The staff explained that this was because of problems related to burning glass bottles and cans along with the biomedical waste. Until the unit is repaired, all waste is being burned in a "campfire" adjacent to the existing incinerator (Figure 15). Significant amounts of unburned or partially burned residues could be seen with the campfire-style open burning method (Figure 16). This method of treatment is discussed further later in this report.

Figure 15. Campfire-Style Open Burning

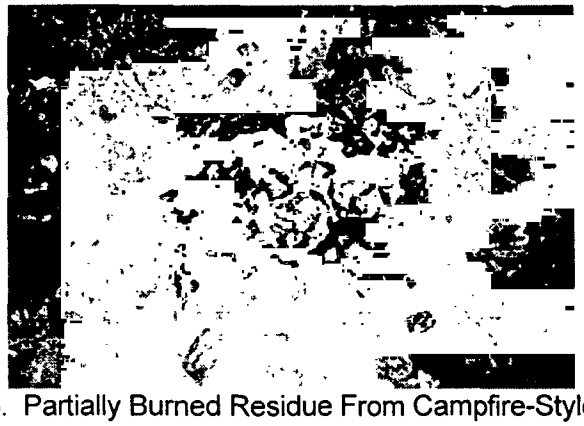


Figure 16. Partially Burned Residue From Campfire-Style Burning

5. Waste Disposal

Ash from burning either in the incinerator or campfire is discarded in the area adjacent to both existing burn areas.

6. Employee Training

It is clear issues of sharps disposal have been conveyed to staff. It does not appear there is any "formal" biomedical waste management training at PAH.

8. Waste Management Organization

There is no management committee or group dealing specifically with biomedical waste management at PAH.

St. Augustine's Medical Services, St. George's

St. Augustine's Medical Services is a modern, private hospital in Grand Anse, St. George's. Three-and-a-half years old, the facility offers an in-patient centre for medical and maternity services; major and minor surgery; an outpatient department with x-ray, ultrasound, laboratory, and emergency services; and a pharmaceutical dispensary. The hospital has 18 beds with an occupancy of about 4-5 beds per day. Managing Director Dr. L.N. Amechi and Nurse Angela Naraine hosted the site visit. Dr. Amechi commented on the hospital's desire to implement environmentally friendly best practices for the management of their wastes.

The hospital generates sharps waste, tissues and anatomical parts, placenta waste, blood and body fluids, laboratory waste, and other common wastes such as soiled dressings, bandages, gauze, swabs, etc. No chemotherapeutic, radiological, nor isolation wastes are produced. General garbage is also produced. Laboratory specimens and cultures are sent to General Hospital.

1. Policies and Procedures

The hospital has no written policy documents on waste management.

2. Colour Coding and Signage

Except for sharps which are collected in red-coloured sharps containers, colour coding is not used in the hospital. All other waste is collected in black plastic bags. The lack of colour coding and signage is an issue that needs to be addressed in the future. No signage on waste management was found.

3. Waste Segregation, Collection, and Transport

Sharps are collected at the point of use in puncture-resistant, plastic sharps containers ranging in size from 1.4 litres (1.4 qt) to 7.6 litres (8 qt). The large sharps containers (B-D Guardian brand) are used mainly in the operating theatre, laboratory, and emergency room (Figure 17). The small sharps containers (B-D Guardian and Sharps-a-Gator brands) are used in other parts of the facility (Figure 18). Hospital staff estimated that about 20 large containers are filled every three months and about four small containers every week. Staff indicated that needles are removed before disposal.

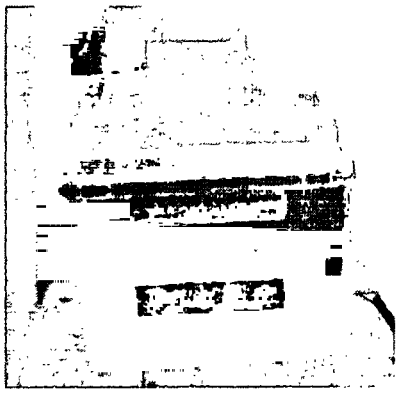


Figure 17. Large Sharps Containers at St. Augustine's

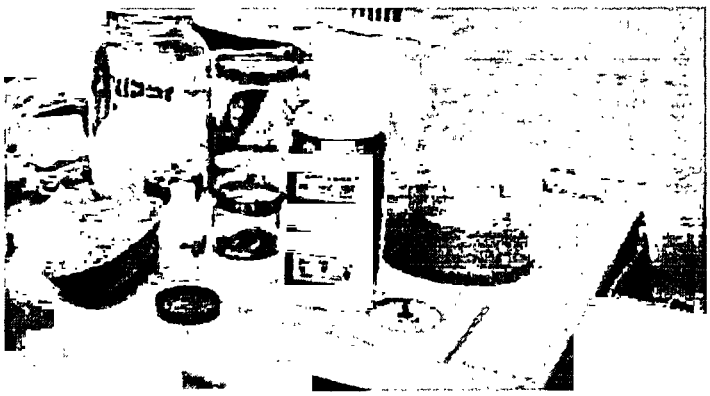


Figure 18. Small Sharps Containers at St. Augustine's

Cultures are sent to General Hospital. Specimen containers are placed in sealed plastic containers (i.e., regular containers taken from household products) and transported to General Hospital in private vehicles. This practice provides added safety during transport.

Soiled dressings, bandages, gauze, etc. are collected in small separate black bags (Figure 19). Linens are collected and reused.

Figure 19. Sample Black Bag

4. Waste Treatment

Sharps are sealed and burned in a drum incinerator and the residues are buried. Blood and body fluids are suctioned and drained in the sink. Glass containers are washed and disinfected then reused. Anatomical parts from amputations are sent to the LaQua Brothers crematorium.

Placenta waste is composted and used as fertilizer. This environmentally friendly method has been used in some developing countries successfully.

Other wastes such as dressings are burned twice a week in a small in-house incinerator called a "Bunnie 2" (Figure 20). The small incinerator, a rectangular structure measuring 12.5" wide x 24" high x 11" deep, is installed inside a room. It has a waste feed door above an ash removal door. The combustion area is approximately 11" x 10" x 11". The exhaust duct goes out of the room to the roof outside with the stack opening a few feet above the roof line. No technical documents were found on the Bunnie 2 incinerator. This method of treatment is discussed further later in this report.

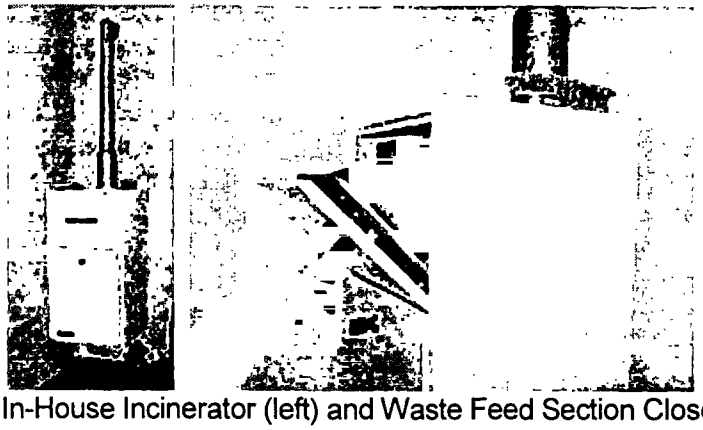


Figure 20. In-House Incinerator (left) and Waste Feed Section Close-Up (right)

5. Waste Disposal

Blood and body fluids are drained in the sink and go through two septic tanks which feed into a soakaway (absorption) pit.

Ashes from waste burned in a drum incinerator or the small in-house incinerator are buried. As mentioned, composted placenta waste is used as fertilizer.

6. Employee Training

There is no specific training on biomedical waste management.

7. Waste Management Organization

There is no management committee dealing specifically with biomedical waste management at St. Augustine's.

<u>Gouyave Health Centre, St. John's</u>

Gouyave Health Centre is located in St. John's Parish about 12 km north of St. George's by road. It provides ante-natal, post-natal, family planning, child care, dental, and maternity/delivery services. The health centre has a general medical/health clinic, chronic disease clinic, pharmacy, mental health services (once a month), as well as a phlebotomy station for taking samples sent to General Hospital and blood glucose monitoring for diabetics. As with all the health centres, the facility is the major primary care unit and, in effect, a triage area for the region.

The range of waste generated includes sharps, blood and body fluids, placenta, small tissues, as well as soiled dressings and gauze. Cultures are sent to General Hospital. No chemotherapy agents are used at the health centre.

The Gouyave Health Centre operates 24 hours a day, 7 days a week. It is staffed by three district nurses, a family health practitioner, public health nurse, two community health aides, two caretakers, a groundskeeper, and a pharmacist shared with Grand Roy Medical Station. As many as 40 patients a day may be served in the doctor's clinic which is open three times a week, and another 30 patients a day may come in for dressings and other basic health services. About 15 patients come once a week for family planning assistance. Dental extractions are done two days a week, while dental hygiene for children is provided during the other three days a week. Data from the ministry show that 3,773 patients were served by the district medical officer at the Gouyave Health Centre in 2001. Family nurse practitioner Joan Lewis hosted the site visit.

1. Policies and Procedures

The health centre has no written policy nor any written procedures on waste management.

2. Colour Coding and Signage

Colour coding is not used at the health centre. The consultant found red containers being used for regular garbage beside a red container used for sharps (Figure 21).

Figure 21. Red Garbage Containers (foreground and back)
Near a Red Sharps Container (partially hidden by cabinet)

Both red and white containers are used for sharps waste. Figure 22 shows two white or translucent sharps containers under the dressing table beside the pail used for soiled dressings. No signage regarding waste management was found.

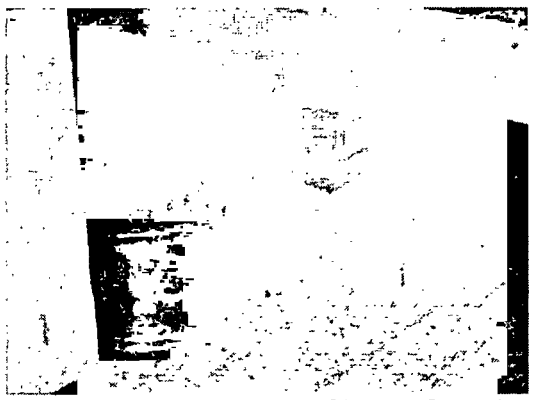


Figure 22. White-Coloured Sharps Containers

3. Waste Segregation, Collection, and Transport

Sharps (specifically, needles and syringes) are collected in puncture-resistant sharps containers such as the 6.6 litre (6.9 oz) B-D sharps container shown in Figure 23. The consultant noted that sharps containers were readily accessible and could be found in the dental clinic (Figure 24), family planning, district medical officer's clinic, ante-natal room, phlebotomy station (Figure 25), maternity, dressing room, and records office. Broken vials are placed in larger tubes and disposed with other sharps. Nurses reported carrying sharps containers with them whenever they would conduct immunizations in the field.

Figure 23. 6.6-Litre Sharps Container at Gouyave

Figure 24. Sharps Container in the Dental Clinic

Figure 25. Sharps Containers in the Phlebotomy Station

Approximately one container would be filled per week. In the past, sharps containers were collected by the Ministry of Health in district vehicles and taken to General Hospital for incineration. The health centre staff reported that sharps containers have not been collected in some time so they have been incinerating them on site.

Cultures and pap smears are brought to the General Hospital laboratory through an ambulance or by private vehicles carried by centre staff.

Small tissues, such as skin tags, removed at the centre are collected along with swabs and soiled dressing for incineration. Placenta waste is generated at the rate of about 2-3 times per month. Placenta is collected in white covered pails (Figure 26) and buried on the centre grounds in a sloping area pictured in Figure 27. This is an acceptable practice but the burial should be deep enough to prevent animals from digging up the waste.

Figure 26. Pails Used For Placenta

Figure 27. Burial Area for Placenta Waste

Dressings are discarded in a metal pail 10" high with a 12" opening (Figure 28). Bloody gauze and other waste in the dental clinic are collected in a white bin lined with a black bag (Figure 29).

Figure 28. Metal Pail for Dressings

Figure 29. Container for Blood Gauze and Other Waste in Dental Clinic

The health centre's caretaker is responsible for transporting the wastes to the incinerator.

4. Waste Treatment

Waste is burned in a small "incinerator" – a small concrete block enclosure that has, on the upper part, a large opening on one side for burning and a small opening at the bottom part for ash (Figure 30). The incinerator is right beside an older unused incinerator. The groundskeeper ignites the waste in the incinerator's larger opening using kerosene. Burning is done about three times a week. Upon closer scrutiny, the consultant found that regular garbage—such as paper, cans, cardboard, etc.—is also burned in the incinerator (Figure 31).

Figure 30. Incinerator (right) At Gouyave

Figure 31. Unburned Garbage in the Incinerator

The small incinerator was built beside an unused older incinerator of the same type of construction. Partially burned sharps could be found on the ground around the incinerator (Figure 32). The appearance of the partially burned residues indicates very poor combustion which is characteristic of these types of open burners. This method of treatment is discussed further later in this report.

Figure 32. Partially Burned Residues on the Ground Around Incinerator

5. Waste Disposal

Ash residues are apparently disposed of in the grounds surrounding the health centre.

6. Employee Training

There is no formal training on biomedical waste management. However, it is apparent that information on sharps collection has been conveyed to staff since sharps containers are readily found and used properly.

7. Waste Management Organization

There is no management committee or group dealing specifically with biomedical waste management.

St. David's Health Centre, St. David's

St. David's Health Centre is located on the eastern side of the mainland in St. David's Parish. The facility serves as a health centre and triage area for the region in conjunction with General Hospital where more extensive procedures are performed. There are approximately three examination rooms and one dental examination room. The delivery room is not functional at this time. According to staff, the health centre sees about 60-80 patients per day. Data from the ministry show that 2,134 patients were seen by the district medical officer at St. David's in 2001. District health nurse Ms. Rachel Samuel accompanied the consultant on the tour.

1. Policies and Procedures

No specific policy exists on the management of biomedical waste.

2. Colour Coding and Signage

No colour coding is used. All waste is collected in black bags.

3. Waste Segregation, Collection, and Transport

Sharps bins (plastic containers as well as cardboard boxes) are available for use throughout the facility. Cardboard box sharps containers are shown in Figure 33. They are collected by staff (health aides or district nurses). The dental examination room primarily generates sharps which is collected in a 2-gallon plastic sharps container (Figure 34). The sharps container takes several weeks to a few months to fill. Another container, a white pail, is used to collect other dental waste in the dental clinic (Figure 35).

Figure 33. Cardboard Boxes Used for Sharps

Figure 34. Plastic Container for Sharps Waste in the Dental Clinic

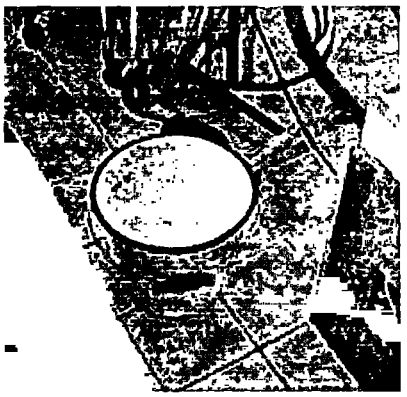


Figure 35. White Pail for Other Dental Waste

Approximately four years ago, sharps containers were collected and transported to General Hospital for treatment and disposal. Today, sharps containers and boxes are brought by the staff to the rear of the facility where they are burned.

All waste is collected in black bags. Figure 36 shows a bin for domestic waste. Municipal solid waste is removed by the Solid Waste Management Authority.

Figure 36. Bin For Regular Garbage

4. Waste Treatment

Biomedical waste, often mixed with regular garbage, is burned at the rear of the facility in an old cement incinerator (Figure 37). This method of treatment is discussed further later in this report.

Figure 37. Incinerator at St. David's: Ash Collection (left) and Stack (right)

5. Waste Disposal

After material is burned, ash is collected and disposed of along with solid waste. Some material may be dispersed by wind to the surrounding area during windy days.

6. Employee Training

It is clear that issues of sharps disposal have been conveyed to staff as sharp bins or collection containers are located throughout the facility. Information on disposal practices is by word of mouth.

7. Waste Management Organization

There is no management committee or group dealing specifically with biomedical waste management.

Grand Roy Medical Station, St. John's

Grand Roy Medical Station is one of three medical stations linked to Gouyave Health Centre; the other two are Victoria and Florida Medical Stations. Grand Roy is 5 km by road south of Gouyave Health Centre. The medical station provides a limited range of services. Data from the ministry indicate that 897 patients were seen at Grand Roy Medical Station in 2001. Sharps are apparently the major infectious waste stream of concern. Nurse L. Joseph accompanied the consultant on a brief tour.

1. Policies and Procedures

The medical station has no written policy on waste management.

2. Colour Coding and Signage

Colour coding is not used.

3. Waste Segregation, Collection, and Transport

Sharps are collected either in red plastic sharps containers (Figure 38) or in cardboard boxes (Figure 39). The boxes are used for needles, syringes, and empty ampoules, and bottles. Figure 38 also shows a blue container for soiled dressings and other waste.

Figure 38. Red Plastic Sharps Container

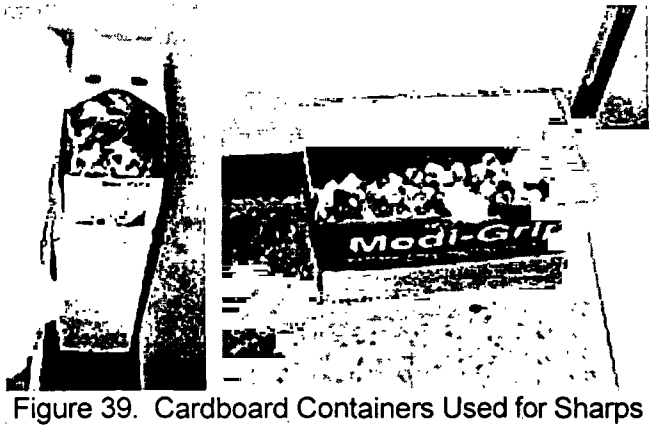


Figure 39. Cardboard Containers Used for Sharps

4. Waste Treatment

The waste is burned once a week in a small open-burn incinerator of similar design as that found in Gouyave Health Centre (Figure x33-34). As is done in Gouyave, regular garbage is also burned in the open burner. This method of treatment is discussed further later in this report.

Figure 40. Incinerator at Grand Roy

5. Waste Disposal

Ash residues are apparently disposed of in the facility grounds.

6. Employee Training

There is no formal training on biomedical waste management.

7. Waste Management Organization

There is no management committee or group dealing specifically with biomedical waste management.

Princess Royale Hospital, Carriacou

Note: The information below on Princess Royale Hospital was obtained through an in-depth interview with the administrator, Ms. Ester Henry-Fleary. A site visit was not possible due to difficulties in arranging transportation to the island.

Princess Royale Hospital in Belair, Carriacou, is a 32-bed institution with an average occupancy of about 8 beds per day. It is situated on a hill in the middle of the island. The hospital provides maternity, pediatric, and 24-hour emergency services. The facility has male and female wards, and a small hematology unit for complete blood count (CBC) tests only. There are two private rooms that can be used as isolation rooms but there have been no cases requiring isolation. Medical instruments are sterilized using an autoclave. The hospital does not have a laboratory nor x-ray services. No surgery is conducted. In the future, the hospital may be upgraded to provide x-ray, laboratory, and other services.

1. Policies and Procedures

The hospital has no written policy on waste management.

2. Colour Coding and Signage

Colour coding is not used.

3. Waste Segregation, Collection, and Transport

Sharps are collected in disposable sharps containers, described as red boxes donated from the U.S. The containers have a round opening at the top. When the containers are full, they are emptied and reused. Placenta is placed in plastic bags and burned. Soiled dressings are collected in flip-top bins lined with garbage bags. They are collected daily and put in a large closed bin for storage until the end of the week when they are burned.

4. Waste Treatment

An incinerator was installed about nine or ten years ago but it has been out of service for two years. The British company that supplied parts for it went out of business so broken parts have not been replaced. Since then, waste is burned in an open pit. The burn pit is at the edge of the hospital grounds to keep smoke away from the facility. This method of treatment is discussed further in the next section.

5. Waste Disposal

Regular sewage from toilets and other drains, as well as effluent from the sluice room, go through a septic tank and soakaway. Ash residues are apparently left in the open pit. Since the pit is on a hill, there is some concern for adverse environmental impacts of runoff due to rains.

6. Employee Training

There is no formal training on biomedical waste management.

7. Waste Management Organization

There is no management committee or group dealing specifically with biomedical waste management.

Assessment of Biomedical Waste Treatment

Burning has been the main method for biomedical waste treatment in Grenada. The types of burning systems found in the country are as follows:

- Campfire-style open burning
- Open-pit burning
- Cement firebox with a roof
- Drum incinerator
- Cement block open burners
- In-house "Bunnie 2" incinerator
- Use of the crematorium
- Controlled incinerator

The campfire-style open burning used in Princess Alice Hospital simply employs a ring of rocks to enclose the waste as it is burned on open ground. This method poses an immediate risk of spreading fire especially during dry weather. The large amounts of partially burned residues show that very poor combustion conditions exist resulting in inadequate levels of disinfection. Moreover, open burning releases many air pollutants such as particulates and carbon monoxide. If chlorinated plastics are burned, highly toxic organic compounds such as chlorinated dioxins and furans are formed as well as hydrogen chloride, a toxic gas. Toxic metals may also be released if the waste includes mercury, lead, and other heavy metals.

Open-pit burning is used in Princess Royale Hospital in Carriacou. Like campfire-style burning, open pit burning also poses some fire hazard, does not adequately destroy pathogens, and releases many pollutants.

The old cement firebox previously used in Princess Alice Hospital may not adequately destroy pathogens and releases pollutants into the air. The cement enclosure would be a step better than the campfire since it may reduce the fire

hazard compared to campfire and open-pit burning. But is essential that the surrounding area is cleared completely of vegetation and other combustible material. The same could be said about drum incinerators such as one reportedly used by St. Augustine's.

The cement block open-burn incinerators seem to be in common use. They were found in Gouyave, Grand Roy, and St. David's. According to one source, these incinerators were built in the last 10 years. The upper burn section is simply a cement firebox with one side open. Waste is placed into the burn section through the large opening. As with all forms of open burning, there is a risk of spreading fire. The incinerators in Gouyave and Grand Roy, for example, are surrounded by low-lying vegetation which may catch fire especially during unusually dry, hot days. Furthermore, open burners do not achieve high enough temperatures to ensure a high level of disinfection. They also emit many air pollutants to the surrounding area. Whenever chlorinated plastics are burned, those pollutants include highly toxic organic compounds as well as hydrogen chloride. Toxic metals may also be released if the waste includes mercury, lead, and other heavy metals. The conditions of poor combustion are shown by the large amounts of partially burned residues including sharps found on the ground around the incinerators.

It is difficult to assess the Bunnie 2 incinerator at St. Augustine's because of the lack of technical documentation. The system seems to use electrical heaters and controls. If so, higher combustion temperatures may be achieved compared to all the incinerators described so far. Since it is a single-chamber design, however, one would expect the release of air pollutants possibly including toxic organic compounds, acid gases, and metals.

General Hospital and other facilities such as St. Augustine's take their pathological waste to the LaQua Brothers crematorium. A crematorium is specifically designed to burn pathological waste. Assuming it is a relatively modern design, the crematorium would likely reach high temperatures to achieve high levels of disinfection. However, crematoriums are not designed to handle plastics (especially chlorinated plastics), metals, and other material found in health-care waste. The crematorium would likely not have air pollution control devices to remove dioxins and furans, other chlorinated hydrocarbons, particulate matter, hydrogen chloride, mercury, cadmium, lead, and other toxic pollutants. The use of the crematorium is supposedly a temporary measure until a treatment technology is in place at the new hospital.

The new incinerator at Princess Alice Hospital, an Evans Tabo Universal Minimaster (Leeds, UK) seems to be a dual-chamber, controlled air incinerator although this was not established since technical documentation was not available. The incinerator has a controller on the left side and two oil burners—either two burners for the primary chamber or a burner and an afterburner. This indicates that the incinerator is designed to reach high temperatures using electronic controls. Except for a possible afterburner, there are no other obvious air pollution control devices in the incinerator. Thus, while this incinerator may achieve higher levels of disinfection than the other burning methods discussed, pollutant releases will likely not meet U.S. EPA or European Union emission

limits. At the time of the site visit, the incinerator was inoperable because of problems with the incinerator.

State-of-the-art incinerators generally involve a rotary kiln or dual-chamber design with auxiliary burners and controllers to carefully control and maintain high temperatures. The incinerator chambers must operate at about 1,500-3,000 °F (800-1,600 °C). In the 1960's, many of the new hospital incinerators then were dual-chamber controlled-air designs: medical waste burned in a primary chamber operating typically at 1,400 °F (760 °C) with controlled amounts of air, followed by a secondary chamber operating usually between 1,800-2,200 °F (980-1,200 °C). Controllers, auxiliary burners in both chambers, and an air injection system were used to maintain high temperatures. The new controlled incinerator in Princess Alice Hospital belongs to an older generation of incinerators.

Biomedical waste incinerators are a known source of highly toxic dioxins and furans, particulate matter (fly ash), hydrogen chloride, hydrogen fluoride, sulfur dioxide, nitrogen oxides, carbon monoxide, lead, mercury, cadmium, arsenic, and other air pollutants, as well as hazardous ash. Air pollution control devices, such as scrubbers and baghouse filters, lessen but do not eliminate these air pollutants. Dioxins and furans are considered among the most toxic substances because of the extremely low doses at which they can affect humans and animals. Particulate matter not only contribute to air pollution but can be dangerous in themselves because of trace amounts of toxic chemicals that adsorb on the surface of particulates which can then be inhaled into the lungs. Gases such as hydrogen chloride and sulfur dioxide contribute to air pollution, form acid rain, and can damage plants directly or through their acidity. Heavy metals such as lead and mercury are toxic when taken into the body; they are released with the fly ash and deposited on soil or surface water thereby contaminating the environment.

Single-chamber incinerators, which only operate at about 550 to 750 °F (about 300-400 °C), emit black smoke and volatile organic compounds in addition to the pollutants listed above. Unfortunately, the temperatures at which single-chamber incinerators operate fall within the temperature range in which highly toxic dioxins and furans are formed, i.e., 480-840 °F (250-450 °C). If proper operating conditions are not met, as in the case of the open-burn methods, incinerators could also release pathogens through discharge air and residues.

Research has shown that destruction of test spores take place when the waste is exposed to a minimum of 1,400 °F (760 °C) in a primary chamber and 1,600 °F (870 °C) in a secondary chamber with a 1.2 second residence time. Some regulatory authorities require a minimum temperature of 1,800 °F (980 °C) in the secondary chamber and a minimum 2-second residence time as a safety factor to ensure total destruction of all pathogens. Most likely, none of the technologies described above can meet this standard.

Assessment of Waste Disposal

As already noted, the engineered Perseverance landfill in the mainland was not in use during the time of the site visit because of the collapse of a portion of the

landfill. Once the landfill is back in operation, it will be an important component of a cradle-to-grave biomedical waste management system.

During visits to the landfill, the old dumpsite, and the offices of the Solid Waste Management Authority (SWMA), workers repeatedly informed the consultant of finding sharps in the waste on regular occasions. Some suggested that the sharps, mainly needles and syringes, might come from private physicians' offices as sharps are discarded with their domestic waste. At the old dumpsite, one worker reported finding needles in the waste only a few days before. Waste pickers are not allowed in the landfill thereby reducing the problem of needle-stick injuries. However, it is essential that the landfill workers also be protected from needle-stick injuries.

Some SWMA staff stated that they could accept treated biomedical waste if they are informed ahead of time. Waste, such as ashes or sharps, should be packaged well so as to minimize handling and exposure to workers. If necessary, biomedical waste could be buried in specially designated area.

Disposal of Expired Pharmaceuticals

With regards to expired or condemned pharmaceuticals, Chief Pharmacist Mr. Benedict Newton explained that in the local dispensaries, liquids are generally diluted and flushed down the drain while tablets are dissolved, diluted, and also flushed down the drain. Antibiotics are emptied down the sink. For large volumes especially from pharmaceutical warehouses, an arrangement is made with the landfill for quick burial and compaction. Some facilities have been able to return expired drugs to manufacturers for substitution or replenishment.

An official of a major private pharmaceutical firm explained that expired drugs are either buried on site or at the Perseverance landfill. Liquid medicines such as cough syrup and tonics are emptied in a hole on the ground and excess mud is added. This usually involves a maximum of about 200 ml of liquid at any given time. Tablets are removed from the containers and placed in plastic bags. Landfill staff is notified; they then designate where the bags would be buried. An amount equivalent to half a regular trash bag is disposed of every three to four months.

Recommendations

Notes on Recommendations

Short-term recommendations are provided for immediate implementation to address imminent hazards and to protect health and the environment, and enhance worker safety. They may include some temporary measures as part of a transition to the full implementation of best practices and a national biomedical waste management system.

SHORT-TERM RECOMMENDATIONS:

General Hospital:

- Sharps containers should not be overfilled. When about 3/4th full, they should be removed and replaced with empty containers.

- Ideally, sharps containers should not be emptied out unless the sharps waste has already been treated (such as in an autoclave designed for infectious waste treatment) and only if a safe method is used (such as automated systems that empty containers with minimum handling). Until such a management system is in place, it is essential that workers be provided with added protection, including face-shields, puncture-resistant gloves and aprons to be worn whenever sharps containers are being emptied. Sharps containers should be washed thoroughly and disinfected prior to reuse.

- Personnel who are involved in emptying out bottles or vials of blood or body fluids should be provided with face-shields, gloves, and aprons to protect them from splashes of blood or body fluids.

- The hospital should check to determine if the duct from the sluice room in the laboratory drains into the hospital's sanitary sewer. If so, then the open section where the duct ends and the effluent drains into the sewer should be closed to prevent exposure of the public to the wastewater. If the effluent flows into an open storm drain and is discharged without treatment, then the duct should be re-routed and connected to the hospital's sanitary sewer system.

- Until the installation of a treatment technology, the hospital should minimize, and as much as possible eliminate, waste with high metal content (e.g., mercury thermometers, batteries), halogenated plastics (e.g., plastics made of polyvinyl chloride or PVC), organic solvents (e.g., formaldehyde, xylenes), and pressurized containers (e.g., aerosol cans) in the waste that is sent to the LaQua Brothers crematorium for burning.

  As a temporary alternative in the absence of a treatment technology, the hospital could bury its biomedical waste in the engineered landfill under a special arrangement with the Solid Waste Management Authority. The waste should be placed in appropriate packaging to prevent breakage during transport and disposal. Whenever waste from the hospital is brought to the landfill, the landfill operators should be informed ahead of time. The landfill operators should designate a special area where the waste can be buried immediately with minimal handling by landfill workers.

- The storage of biomedical waste boxes in alleys and hallways creates a hindrance to the means of egress and could pose a hazard during an emergency. The waste boxes should be moved to another storage site where there is less access to the waste by the public and where movement of people is not impeded. Moreover, the removal of waste should be done on a more frequent basis.

- Toxic solvents such as formaldehyde should not be poured into drains. They should be stored and treated as hazardous waste in accordance to current or future hazardous waste management regulations.

- Due to shortages in supplies, tubes are reused. The laboratory should consider decreasing the amount of chemical disinfectants discharged into the sewer. One method could be the use of the autoclave, instead of the overnight soaking in hypochlorite solution, to disinfect the tubes while adding additional rinsing steps to remove dried blood.

- Since red bags are available in the facility, the hospital should promote the consistent use of colour coding in order to clearly distinguish between infectious waste (red bags or red containers) and regular garbage (black bags). More education should be provided to ensure that hospital staff knows what items should and should not be placed in red bags.

- Regular garbage containers in open corridors should be fitted with covers to prevent odors, spillage, and scavenging by animals.

- The infection control committee should be revived and strengthened. Among its immediate tasks is the coordination of in-service training on existing policies dealing with infectious waste, in particular, sharps management and segregation. The committee should also ensure that the existing policies on waste management are consistently implemented.

Princess Alice Hospital:

- Ideally, sharps containers should not be emptied out unless the sharps waste has already been treated (such as in an autoclave designed for sharps waste treatment) and only if a safe method is used (such as automated systems that empty containers with minimum handling). Until such a management system is in place, it is essential that workers be provided with added protection, including face-shields, puncture-resistant gloves and aprons to be worn whenever sharps containers are being emptied. Sharps containers should be washed thoroughly and disinfected prior to reuse.

- Cardboard boxes and plastic bags should be used for sharps only if sharps waste is first collected in rigid, puncture-resistant, plastic containers. These hard containers can then be sealed and placed in cardboard boxes or plastic bags for temporary storage. Every effort should be made to prevent needle-stick injuries to the groundskeepers and others transporting the boxes or bags.

- The campfire-style of burning waste should be discontinued because of the potential fire hazard and environmental problems. If the cement firebox is used instead, it is essential that the surrounding area first be cleared of any vegetation and other combustible materials. Furthermore, the firebox itself should be cleaned and returned to working order. Waste with high metal content (e.g., thermometers, batteries), halogenated plastics (e.g., plastics made of polyvinyl chloride), organic solvents, and pressurized containers should not be burned in the firebox.

Until a centralized treatment system is put in place or a new treatment technology is installed on site, a better alternative would be to arrange for the disposal of biomedical waste in a restricted section of the landfill. The waste should be placed in appropriate packaging (puncture-resistant containers for sharps; leak-proof containers for liquid/semi-liquid waste) to prevent breakage during transport and disposal. Whenever biomedical waste from the hospital is brought to the landfill, the landfill operators should be informed ahead of time. The landfill operators should designate a special area where the waste can be buried immediately with minimal handling by landfill workers.

- A committee should be created to deal with biomedical waste management. The task of the committee in the immediate term should be the implementation of an educational programme to ensure proper segregation, collection (including sharps management), transport, and treatment of biomedical waste. The programme should be monitored with feedback from the staff. Additional information could be disseminated through a hospital newsletter or bulletin.

St. Augustine's Medical Services:

- Needle clippers should be avoided since they may result in needle-stick injuries to the workers cutting off the needles. Since the sharps waste is apparently buried on site, it eliminates the problem of needle-stick injuries to waste pickers scavenging in uncontrolled dumpsites; thus, needle cutting is unnecessary. If needles need to be removed for any reason, newer electronic needle destruction technologies should be considered.

  If sharps waste is buried on site, the burial area should be clearly delineated and marked with signs to prevent accidentally digging up the waste in the future. A better alternative would be to encapsulate the waste with cement, a method accepted by the World Health Organization. That is, after a hole of sufficient depth is made, it could be filled with about 65% sharps waste, 15% lime, 15% cement, and about 5% water until it hardens, after which it could be covered in soil.

  Alternatively, sharps waste could also be buried in the landfill under a special arrangement with the Solid Waste Management Authority. The sharps waste should be placed in appropriate packaging to prevent breakage during transport and disposal. Whenever sharps waste from the hospital is brought to the landfill, the landfill operators should be informed ahead of time. The landfill operators should designate a special area where the waste can be buried immediately with minimal handling by landfill workers.

- Hospital staff involved in draining out bottles, canisters, or vials of blood or body fluids should be provided with face-shields, gloves, and aprons to protect them from splashes of blood or body fluids.

- As much as possible, waste with high metal content (e.g., thermometers, batteries), halogenated plastics (e.g., plastics made of polyvinyl chloride), organic solvents, and pressurized containers should not be burned in the

Bunnie 2 incinerator. Periodic maintenance of the incinerator should be done in accordance to manufacturer's specifications. Ash residues should be removed regularly, if this is not done already. Waste with high metal content, halogenated plastics, organic solvents, and pressurized containers should not be included in the waste sent to the crematorium for burning. Burning sharps in a drum incinerator may result in additional handling of partially destroyed sharps residues as well as the release of environmental pollutants. Direct burial on site in the manner described above would be preferable.

- A committee should be created to educate the staff about biomedical waste management including sharps management.

Gouyave Health Centre:

- Burning of sharps waste in the open burner results in partially burned residues that have to be handled again for burial. Some sharps residues fall to the ground around the incinerator and pose additional hazards.

  Instead of burning the sharps waste, they could be directly buried on site since the amount of infectious waste is small. The burial area should be clearly marked with signs and fenced in to prevent access to unauthorized persons. A better alternative would be to encapsulate the waste with cement. That is, after a hole of sufficient depth is made, it could be filled with about 65% sharps waste, 15% lime, 15% cement, and about 5% water until it hardens, after which it could be covered in soil.

- Care should be taken when transporting cultures to General Hospital. They should be placed in sealed plastic containers to prevent breakage, if ,this is not already done.

- Because of the inefficiency of the open burn method, the fire hazard, and the release of pollutants, wastes should preferably also be buried on site in deep holes and in an area that is clearly marked with signs and fenced in to prevent access by unauthorized persons or animals.

  If the incinerator is to be used, regular garbage should not be burned. Wastes with high metal content (e.g., thermometers, batteries), halogenated plastics (e.g., plastics made of polyvinyl chloride), and pressurized containers should also not be burned. Burning, if at all, should be limited to bloody dressings, gauze, and other material as well as small tissues. It is essential that the area around the incinerator be kept clean and cleared of all vegetation and combustible material. Periodic maintenance of the incinerator should be done, including regular removal of ash residues to allow good air flow.

- A committee should be formed to deal with biomedical waste management. The committee should implement an educational programme to ensure proper segregation, collection (including sharps management), transport, and treatment of biomedical waste. The programme should be monitored with feedback from the staff.

St. David's Health Centre:

- Cardboard boxes should not be used for sharps unless sharps waste is first collected in rigid, puncture-resistant, plastic containers. The plastic containers can then be sealed and placed in cardboard boxes. Every effort should be made to prevent needle-stick injuries.

- Burning of waste in the incinerator results in partially burned residues and air pollutants. Instead of burning the sharps waste, they could be directly buried on site since the amount of infectious waste is small. The burial area should be clearly marked with signs and fenced in to prevent access to unauthorized persons. An alternative for sharps waste would be to encapsulate. That is, after a hole of sufficient depth is made, it could be filled with about 65% sharps waste, 15% lime, 15% cement, and about 5% water until it hardens, after which it could be covered in soil.

  Alternatively, sharps waste could also be buried in the landfill under a special arrangement with the Solid Waste Management Authority. The sharps waste should be placed in appropriate packaging to prevent breakage during transport and disposal. Whenever sharps waste from the hospital is brought to the landfill, the landfill operators should be informed ahead of time. The landfill operators should designate a special area where the waste can be buried immediately with minimal handling by landfill workers.

  If the incinerator is to be used, regular garbage should not be burned. Wastes with high metal content, halogenated plastics, organic solvents, and pressurized containers should also not be burned. The area around the incinerator should be kept clean and cleared of all vegetation and combustible material. Periodic maintenance of the incinerator should be done, including regular removal of ash residues to allow good air flow.

- Ash residues from the incinerator should not be left on the ground but should be buried on site.

- A committee should be formed to deal with biomedical waste management. The committee should implement an educational programme to ensure proper segregation, collection (including sharps management), transport, and treatment of biomedical waste. The programme should be monitored with feedback from the staff.

Grand Roy Medical Station:

- Cardboard boxes should be used for sharps only if sharps waste is first collected in rigid, puncture-resistant, plastic containers. These hard plastic containers can then be sealed and placed in cardboard boxes. Every effort should be made to prevent needle-stick injuries.

- Burning of waste in the incinerator results in partially burned residues and air pollutants. Instead of burning the sharps waste, they could be directly buried on site since the amount of infectious waste is small. The burial area should be clearly marked with signs and fenced in to prevent access to unauthorized persons. An alternative for sharps waste would be to encapsulate. That is, after a hole of sufficient depth is made, it could be filled with about 65% sharps waste, 15% lime, 15% cement, and about 5% water until it hardens, after which it could be covered in soil.

  Alternatively, sharps waste could also be buried in the landfill under a special arrangement with the Solid Waste Management Authority. The sharps waste should be placed in appropriate packaging to prevent breakage during transport and disposal. Whenever sharps waste from the hospital is brought to the landfill, the landfill operators should be informed ahead of time. The landfill operators should designate a special area where the waste can be buried immediately with minimal handling by landfill workers.

  If the incinerator is to be used, regular garbage should not be burned. Wastes with high metal content, halogenated plastics, organic solvents, and pressurized containers should also not be burned. The area around the incinerator should be kept clean and cleared of all vegetation and combustible material. Periodic maintenance of the incinerator should be done, including regular removal of ash residues to allow good air flow.

- Ash residues from the incinerator should not be left on the ground but should be buried on site.

- A committee should be formed to deal with biomedical waste management. The committee should implement an educational programme to ensure proper segregation, collection (including sharps management), transport, and treatment of biomedical waste. The programme should be monitored with feedback from the staff.

Princess Royale Hospital (based on data from a phone interview):

- Ideally, sharps containers should not be emptied out unless the sharps waste has already been treated and only if a safe method is used to empty the containers with minimal handling. Until such a management system is in place, it is essential that workers be provided with added protection, including face-shields, puncture-resistant gloves and aprons to be worn whenever sharps containers are being emptied. Sharps containers should be washed thoroughly and disinfected prior to reuse.

- Burning of waste in an open pit could pose fire hazards, result in unburned or partially burned residues, and release air pollutants. Until an alternative technology is installed, waste could be directly buried on site instead of burning. The burial area should be clearly marked with signs and fenced in to prevent access to unauthorized persons or animals. An alternative for sharps and other waste would be to encapsulate. That is, after a hole of sufficient

depth is made, it could be filled with about 65% sharps waste, 15% lime, 15% cement, and about 5% water until it hardens, after which it could be covered in soil.

- Ash residues from the open pit should not be left on the ground but should be buried on site to prevent dispersal by wind or runoff.

- A committee should be formed to deal with biomedical waste management. The committee should implement an educational programme to ensure proper segregation, collection (including sharps management), transport, and treatment of biomedical waste. The programme should be monitored with feedback from the staff. Additional information could be disseminated through a hospital newsletter or bulletin.

Pharmaceutical Units:

- Moderate quantities of relatively mild liquid or semi-liquid pharmaceuticals such as vitamin solutions, cough syrups, eye drops, saline solutions, intravenous fluids, etc. can be diluted with large amounts of water and discharged into the sanitary sewer. However, the World Health Organization recommends against discharging antibiotics into the sanitary sewer. Further recommendations on the disposal of expired pharmaceuticals will be provided in the draft national biomedical waste management plan.

LONG-TERM RECOMMENDATIONS

Note: These long-term recommendations are provided for the purpose of obtaining feedback from stakeholders in Grenada, including officials of the Ministry of Health and the Environment, Solid Waste Management Authority, and administrators and staff of the hospitals, health centres, medical stations, and other health-care facilities. Feedback and comments on these recommendations will be the basis for the development of a draft national biomedical waste management plan for Grenada.

1. National Laws and Regulations

Regulations on biomedical waste management should be promulgated by the Ministry of Health and the Environment. The following elements should be considered:

- Clear definitions of what constitutes biomedical waste and its categories
- Cradle-to-grave approach to biomedical waste management
- Coordination with hazardous (non-biomedical) waste management laws as well as other laws dealing with health (including prevention of infectious diseases, hospital hygiene and infection control), sanitation, environment (air quality, water quality, land disposal), and occupational safety and health

- Delineation of responsible national and local government authorities for implementation
- Legal obligations of the biomedical waste generator
- Provisions related to record-keeping and reporting
- Provisions related to any fees for transport, treatment, and final disposal
- Provisions related to inspections for the purpose of enforcement, penalties for non-compliance, and legal procedures for handling disputes related to enforcement.

2. Institutional Policy, Administration, and Organization

Every hospital or health care facility should have a written policy on biomedical waste management. The policy should state the facility's objective of providing a system for management of biomedical waste in order to protect patients, staff, and the general public from hazards associated with biomedical waste. It should provide an overview of responsibilities and outline major procedures for biomedical waste management. A sample institutional policy is provided in Appendix A2.

Proper management of biomedical waste depends on good administration and organization. The waste management structure depends on the size and complexity of the facility. For the hospitals, it is recommended that hospital waste management teams be established. Each team should be headed by the hospital administrator who is also the designated contact with the regulatory authority.

The administrator should appoint one member of the team as the Waste Management Officer responsible for the day-to-day operation and monitoring of the waste management system. Because the Waste Management Officer must have access to all members of the hospital staff, it is important that the team include all department heads. Waste management will entail costs so the hospital's financial officer or accountant should also be part of the team. Therefore, the ideal Waste Management Team should be comprised of:

- Hospital Administrator (Chair of the Team)
- Department Heads
- Matron or Senior Nursing Officer
- Infection Control Officer and/or Hospital Hygienist
- Hospital Engineer or Maintenance Supervisor
- Financial Officer or Accountant
- Other staff (with relevant training or responsibilities) as needed

The responsibilities of the Waste Management Team are:

1. To develop a written waste management policy, specific guidelines, and plan for implementation
2. To review and revise (as needed) the policy, guidelines, and implementation plan on a periodic basis

3. To ensure adequate financial and human resources for efficient operation and monitoring of the plan.

As mentioned, one of the above team members should be appointed the Waste Management Officer (this could be the Infection Control Officer, for example). The Waste Management Officer reports directly to the hospital administrator and should have direct access to all staff members. The responsibilities of the Waste Management Officer are:

1. To facilitate communications among members of the Waste Management Team to ensure that proper procedures are implemented, including timely internal collection, emergency procedures, and reporting
2. To monitor and evaluate waste handling and disposal operations with the help of the Infection Control Officer; this may entail a comprehensive risk assessment of all activities with the help of other members of the team
3. To ensure that adequate supplies are available
4. To maintain records of the amounts and types of waste generated, accidents, unusual operational events, and non-compliance
5. To ensure that all staff members are aware of their responsibilities regarding biomedical waste and to work with staff on the training programmes
6. To identify items that need modification in the policy, guidelines, or plan.

Other team members have responsibilities regarding biomedical waste:

- The Department Heads and Matron should ensure that staff within their departments are familiar with the policy, guidelines, and plan, and have received training; they should also make sure any incidents are reported to the Waste Management Officer.
- If the Infection Control Officer is not the Waste Management Officer, the Infection Control Officer should act as a technical consultant to the Waste Management Officer, participate in evaluating waste handling and disposal operations, and work with the Waste Management Officer and others in ensuring that the training programme is implemented
- The Hospital Engineer or Maintenance Supervisor should ensure that the maintenance or engineering staff receives training and should consult with the Waste Management Officer on matters dealing with the treatment technology.
- The Financial Officer should consult with the Waste Management Officer on matters dealing with supplies and budgetary needs, and should investigate options to minimize waste or reduce toxicity through product substitutions (e.g., using non-toxic substitutes for toxic solvents, replacing halogenated plastic disposables with non-halogenated equivalents, finding vendors willing to take back expired pharmaceuticals, etc.).

3. Occupational Safety and Health

Personal protective equipment should be made available to all personnel who handle, transport, and treat biomedical waste. Orderlies and other staff who pick up and transport biomedical waste should be provided with heavy-duty gloves, boots or shoes with thick soles, and coveralls. Gloves are essential to prevent lacerations, burns from hot surfaces (such as with a treatment technology), or contact with any chemical or biological material. Boots or shoes with thick soles and good traction should also be provided to protect from spilled sharps, chemicals, and slippery surfaces. Plastic coveralls provide protection from blood splatter and splashes from body fluids or chemicals. Leg protectors may be used in situations where the legs of waste workers may be in contact with waste bags.

Health-care workers that deal in situations where they may be splashed with blood, body fluids, solvents, corrosive chemicals, or other hazardous liquids should be provided with eye and face protection. They should be used by staff members when discarding free-flowing blood and body fluids in the sewer.

Immunization from viral hepatitis and tetanus is recommended for all waste handlers as well as other health-care staff. Basic personal hygiene is also important and should be emphasized during training. Convenient washing facilities with warm water and soap should be available.

4. Waste Segregation and Classification

Segregation, or the separation of specific types of waste from other types of waste, is key to effective management of medical waste. It is the responsibility of the waste generator. Potentially infectious waste should be segregated from regular garbage as close as possible to the point where the waste is generated. Segregation should be maintained during storage and transport up to the point of treatment. To be effective, the same system of segregation should apply throughout the country.

There are many ways of classifying the different components of biomedical waste. In light of the types of waste produced in Grenada, a simple classification is recommended in Table II focusing on the biomedical waste categories that pose the greatest hazards, as explained below.

Sharps pose a potential disease transmission hazards because of their ability to create a portal of entry through the skin. In particular, needle-stick injuries are a known cause of the spread of infectious diseases and a serious occupational hazard.

Cultures and stocks may contain high concentrations of disease-causing agents. Laboratory workers must use extreme caution to avoid inadvertent exposure to these pathogens and untreated cultures should be rendered noninfectious, preferably on site, prior to disposal.

Inadvertent contact with blood through cuts or mucous membranes has been associated with the transmission of disease by blood-borne pathogens such as HIV and hepatitis B. The risk comes from contact with blood or body fluids in liquid form which is capable of splashing in the eyes or other mucous membranes. Most blood-borne pathogens have a limited ability to multiply or

remain viable longer than a few hours or a few days in dried blood. For this reason, the main focus of concern is liquid blood.

While pathological waste has not been generally implicated in disease transmission, it has potentially infective qualities. Moreover, there may be aesthetic, cultural, or religious factors that may determine how pathological waste is treated and disposed. In general, they can be treated in a treatment technology and buried in a sanitary landfill. Placentas and human fetuses can be interred in special burial sites. Placentas have been used for making compost in one facility.

The main concern relating to animal waste would be animal carcasses that have been inoculated with infectious agents or any animals exposed to pathogens such as those that cause transmissible spongiform encephalopathies ("mad cow disease"). This may be a concern associated with the veterinary hospital and veterinary school. Regular abattoir waste is not included in this category.

In many countries, isolation waste is only limited to wastes generated from patients infected with certain highly communicable diseases, specifically defined as Class 4 agents such as Ebola, Crimean hemorrhagic fever, Lassa fever, Marburg, etc. The hospital's infection control committee should determine whether waste from specific isolation rooms should have special handling, treatment, and disposal.

Table II. Biomedical Waste Categories (Classification I)

Waste Category	Description	Examples	Where Found
Sharps	Items that could cut or puncture regardless of whether they are infected or not	Hypodermic needles, syringes, suture needles, scalpel and other blades, lancets, saws, knives, broken or unbroken glass, vials, tubes, pipettes, etc.	Nursing Stations, Laboratory, Emergency Room, Surgery, Maternity Ward, Clinics
Cultures and Stocks	Cultures and stocks of infectious agents and associated biologicals	Human and animal cell cultures, stocks of etiologic agents, discarded live and attenuated vaccine or serum, culture dishes and other devices used to transfer, inoculate or mix cell cultures	Laboratory, Microbiology
Human Blood, Blood Products, and Body Fluids	Free-flowing blood, components or products of blood, and specific body fluids	Free-flowing blood or blood components, semen, vaginal secretions, cerebrospinal fluid, synovial fluid, pleural fluid, pericardial fluid, pertitoneal fluid, amniotic fluid, saliva in dental procedures, and body fluids contaminated with blood	Patient Wards, Surgery, Laboratory, Emergency Room
Pathological Waste	Human pathological waste	Tissues, organs, anatomical waste (recognizable body parts	Surgery, Pathology, Autopsy

Waste	waste	except teeth) removed during surgery, autopsy or other procedures	Autopsy
Contaminated Animal Waste	Waste from animals exposed to infectious agents	Animal carcasses, animal body parts, blood, body fluids, and bedding known to have been exposed to infectious agents	Veterinary Hospitals and Clinics, Research Laboratories
Selected Isolation Waste	Waste generated by patients who are isolated to prevent the spread of highly communicable diseases	Swabs, excreta, soiled dressings, drainage sets, items saturated or dripping with human blood, etc. from patients infected with highly communicable diseases	Isolation Ward

There are other classifications that either fall under the hazardous waste category (which in some countries is defined and regulated separately from infectious waste) and others that may not apply at this time but may describe biomedical waste streams in the future. The additional classifications are shown in Table III.

At present in Grenada, pharmaceutical and hazardous chemical wastes seem to be a concern.

Table III. Additional Waste Categories (Classification II)

Waste Category	Description	Examples	Where Found
Pharmaceutical Waste	Discarded items containing pharmaceuticals	Expired, condemned, or contaminated pharmaceutical products	Pharmacy
Chemotherapeutic Waste	Waste containing cytotoxic, genotoxic, or other hazardous antineoplastic drugs	Chlorambucil, Daunomycin, Melphalan, Mitomycin C, Uracil mustard, Streptozotocin, Cyclophosphamide, etc.	Cancer Therapy
Low-level Radioactive Waste	Waste containing radioactive substances	Pipettes, vials, syringes, needles, gloves, absorbents, etc. contaminated with radionuclides	Nuclear Medicine, Clinical and Research Laboratories
Other Hazardous Chemical Waste	Waste that exhibit hazardous characteristics (corrosive, ignitable, chemically reactive, toxic) in addition to wastes already classified above	Xylene, methanol, Formalin (formaldehyde solution), trichloroethylene, sulfuric acid, glutaraldehyde, mercury from broken thermometers, spent batteries, cleaning solvents, degreasers, potassium cyanide, asbestos, PCBs, etc.	Nursing Stations, Pathology, Autopsy, Dialysis, Radiology, Laboratory, Facility Engineering & Maintenance, Funeral Homes

			Funeral Homes

5. Waste Minimization

It is recommended that all health-care facilities institute a waste minimization programme. Waste minimization is the reduction, to the extent possible, of waste that is destined for ultimate disposal. Potential benefits of minimization include: environmental protection, enhanced occupational safety and health, cost reductions, reduced liability, and improved community relations.

The following are basic techniques of waste minimization: source reduction (including material substitution, process changes, and good practices), resource recovery and recycling, and composting. Some basic concepts of waste minimization and recommended resources are provided in Appendix A3.

6. Labeling, Colour Coding, and Signage

Every container for infectious medical waste must have the international biohazard symbol in a contrasting colour painted or affixed to the container as shown in Figure 41. (Note: The dot in the middle is not part of the symbol; it is used to center the marking if needed.)

Figure 41. International Biohazard Symbol

In addition to the symbol, one of the following warning signs should be painted or marked on the container, whichever is appropriate:

- "Biohazard"
- "Sharps" or "Biohazard" (for sharps containers)

The following colour-coding is recommended:

Table IV. Colour Coding

TYPE OF WASTE	COLOUR OF BAG OR CONTAINER
Potentially Infectious Waste	RED

Sharps	RED
Washable Contaminated Linen	CLEAR (TRANSLUCENT)
Chemical, Pharmaceutical, or Chemotherapeutic Waste	YELLOW
Regular garbage	BLACK

Signage in the form of posters displayed in public areas is helpful, not just as a reminder to health care staff, but also to inform patients and the public about the facility's waste management system. A sample poster is shown in Appendix A4.

7. Waste Collection

Potentially infectious waste should be segregated in clearly marked containers that are appropriate for the type of waste, as shown below.

Table V. Collection Container Specifications

TYPE OF WASTE	SPECIFICATIONS FOR CONTAINER OR BAG
Sharps	- Container should be puncture-resistant, leak-proof on the sides and bottom, durable, and closable (closure should be secure) - Container should be labeled and colour-coded - Container should be designed so that it is easily and safety determined when the container is nearly full
Non-sharps infectious waste (solid/semi-solid)	- Container should be leak-proof, rigid, durable, labeled, and colour coded - Plastic bag should be leak-proof; designed to prevent ripping, tearing, or bursting under normal use; labeled; and colour coded. The plastic bag should be placed inside a rigid container
Non-sharps infectious waste (liquid)	- Container should be leak-proof and durable - Container should be designed such that it can be transported without spillage

Appropriately sized sharps containers should be placed in locations easily accessible to personnel and as close as possible to the immediate area where sharps are used. Examples include phlebotomy area, treatment and examination rooms, nursing stations, operating rooms, emergency rooms, etc. To prevent injuries, needles should not be recapped nor removed from disposable syringes. Sharps containers should not be overfilled.

A rigid, puncture-resistant plastic sharps container specifically designed for needles and syringes is recommended. A reusable container is acceptable as long as the container and its contents can be disinfected in a treatment technology and the sharps can be removed safely. A reusable container should be cleaned on a routine basis.

The Waste Management Officer should regularly monitor sharps collection containers to ensure that they are not overfilled, that full containers are promptly removed, that non-sharps waste are not placed in sharps container, that enough sharps containers are available and located in appropriate locations, and that new staff members are educated on sharps disposal practices. The Waste Management and Infection Control Officers should document any needle-stick

injuries due to sharps collection, assess why the injury took place, and take steps to prevent future injuries.

8. Handling and Transport Within the Facility

Personal protective equipment (PPE) should be worn during any operation where there is a potential for exposure. PPE included gloves, gowns or aprons, masks, face shields, and/or safety goggles or glasses, depending on the operation.

Fully enclosed, wheeled carts should be used when transporting waste through the facility to a storage area or treatment technology. Carts used for potentially infectious waste should be used only for that purpose. They should be cleaned and disinfected on a routine basis.

9. Transport Outside the Facility

Transport of untreated infectious waste outside any health-care facility should be regulated by the Ministry of Health and the Environment. This should involve a cradle-to-grave approach to manage and account for biomedical waste and entail a medical waste tracking system.

The waste generator (hospital or health-care facility) is always responsible for ensuring that its medical waste reaches the off-site destination facility, such as a centralized waste treatment centre or landfill. Health centres and other small facilities should use special care when transporting sharps waste. Small amounts of sharps waste may be transported in fully enclosed transport pouches specifically designed for such purposes.

Infectious waste should be transported in leak-proof, fully enclosed containers or vehicle compartments that are secured when unattended and designed to prevent spillage or leakage during transport. If the vehicle is used for other waste, the infectious waste containers or vehicle compartments should be separated by barriers from the other types of waste. The waste should be labeled with the biohazard symbol.

The vehicle should have identification markings or placards on the sides and back. In keeping with international standards, the placard should be diamond-shaped with black inscription on a white background. The upper half of the diamond-shaped placard should have the international biohazard symbol, the lower half should have the words "INFECTIOUS WASTE" and "IN CASE OF ACCIDENT IMMEDIATELY NOTIFY PUBLIC HEALTH AUTHORITY" and at the very bottom, the number "6" which is the international hazard identification number for toxic or infectious hazards.

The transporter or hauler should have contingency plans in the event of spills or accidents during transport.

10. Waste Treatment

Waste treatment technologies should achieve a high level of disinfection, while minimizing adverse impacts on public health, occupational safety, and the

environment. The technologies should have low air and effluent emissions, reduce waste volume, incorporate validation methods to ensure disinfection, and enhance occupational safety while being cost effective. Recommendations on waste treatment technologies for Grenada will be presented in a separate report entitled "Review and Recommendation on a Medical Waste Treatment Technology."

The waste categories listed under Classification II (expired pharmaceuticals, chemotherapy waste, low-level radioactive waste, and other hazardous chemical wastes) are those that require special handling as hazardous waste. The draft Biomedical Waste Management Plan will provide recommendations for dealing with those waste streams.

11. Final Disposal

Liquid blood and body fluids should be discharged directly and carefully into a sanitary sewer using personal protective equipment (gown, goggles, face shield or mask). Hands should be washed thoroughly after gloves are removed. The facility should check to make sure any effluents to the sanitary sewer are within specified regulatory limits, if any, for wastewater discharges.

In general, treated biomedical waste can be sent along with regular garbage for final disposal in the engineered landfill. If, for some reason, untreated medical waste has to be disposed of in the landfill or if treated sharps have not been destroyed to the point of eliminating needle-stick injury hazards, a special trench or cell can be used for this purpose under a special arrangement with the Solid Waste Management Authority. The waste should be placed in appropriate packaging to prevent breakage during transport and disposal. Whenever waste from the hospital is brought to the landfill, the landfill operators should be informed ahead of time. The landfill operators should designate a special area where the waste can be buried immediately with minimal handling by landfill workers. If necessary, unauthorized entry to the area should be prevented by restricting access, constructing fences, and posting signs such as "BIOHAZARDOUS WASTE AREA – UNAUTHORIZED PERSONS KEEP OUT". However, the preferred method is treatment followed by final disposal.

12. Summary of Biomedical Waste Management Procedures

Table VI outlines in a simplified form the main recommended procedures for segregating, transporting, treating, and disposing of biomedical waste. Regular garbage is included for the purpose of comparison.

Table VI. Summary of Recommended Procedures

Waste Type	Sharps	Cultures & Stocks	Blood & Body Fluids	Pathological Waste		Isolation Waste	(Contaminated Linen)	*Regular Garbage*
Examples	Needles, Syringes, Blood Tubes	Culture dishes	Free-flowing Blood	Tissues, Body Parts	Placentas, Fetuses	Swabs, Soiled Dressing	Bedding	Garbage
Colour	Red	Red	Red	Red	Red	Red	Trans-	Black

Code							lucent	
Marking	Biohazard Symbol, "Sharps"	Biohazard Symbol, "Biohazard"	Biohazard Symbol, "Biohazard"	Biohazard Symbol, "Biohazard"	Biohazard Symbol, "Biohazard"	Biohazard Symbol, "Biohazard"	Biohazard Symbol, "Biohazard"	none
Packaging	Puncture-Resistant Sharps Container	Plastic Bag in a Rigid Container	Leak-proof Container	Plastic Bag in a Rigid Container	Plastic Bag in a Rigid Container	Plastic Bag in a Rigid Container	Plastic or Linen Bag	Plastic Bag or Container
In-House Transport	Covered Cart	Covered Cart	Covered Cart	Covered Cart	Covered Cart	Covered Cart	Covered Cart	Trolley or cart not for bio-medical waste
Storage	Protected Enclosure	Protected Enclosure, 4 °C or 39 °F *	N/a	Protected Enclosure, 4 °C or 39 °F *	Protected Enclosure, 4 °C or 39 °F *	Protected Enclosure, 4 °C or 39 °F *	N/a	Regular storage area
Treatment	TBD	TBD	Discharge Into Sanitary Sewer	TBD	Burial or TBD	TBD	Wash in Hot Water (160 °F or 88 °C) for 20 minutes	N/a
Off-Site Transport (untreated waste)	Special Vehicle	Special Vehicle	N/a	Special Vehicle	Special Vehicle	Special Vehicle	N/a	N/a
Off-Site Transport (treated waste)	Sanitation Truck	Sanitation Truck	N/a	Sanitation Truck	Sanitation Truck	Sanitation Truck	N/a	Sanitation Truck
Disposal	Sanitary Landfill	Sanitary Landfill	Sanitary Sewer	Sanitary Landfill	Interment in Burial Site or Sanitary Landfill	Sanitary Landfill	N/a	Recycling or Sanitary Landfill

N/a=not applicable; TBD=to be determined; *Recommended practice if storage time is long enough to result in putrid smells from decaying organic waste (e.g., more than 48 hours)

13. Contingency Planning

Health-care facilities should develop contingency plans in the event that biomedical waste is spilled, a worker is injured, or the treatment technology is down for repairs.

For clearing up spillage of blood, body fluids, chemicals, or other potentially hazardous substances, personal protection equipment such as gloves and coveralls are needed. If there is any risk of splashing, eye protectors and masks should also be worn. The appropriate respirators may be needed if toxic vapors or dust are involved. Solid residues should be recovered using hand tools such as shovels. If potentially infectious waste is involved, the floor should be cleaned and disinfected after most of the waste has been recovered.

All health-care staff should be trained to deal with injuries and exposures. In the event of an injury, first-aid measures should be applied followed by additional medical attention as needed. With needle-stick injuries, bleeding of the wound should be encouraged and the area washed and cleaned thoroughly. Blood or other tests may be indicated, as well as prophylactic treatment.

Medical monitoring and incident reporting are important parts of contingency planning. Department heads and other members of the Waste Management Team should encourage prompt and accurate reporting for the purpose of ensuring proper medical attention and prophylaxis, and to identify remedial actions to prevent injuries in the future. Incident reporting should not be seen as punitive. Medical monitoring programmes are specifically designed to evaluate the extent of workplace exposure or the effects of known exposures to workers' health.

If the treatment technology is shut down for repair or periodic maintenance, facilities should have alternatives, such as long-term storage areas and/or arrangements with other facilities to transport and treat their biomedical waste at other sites.

14. Employee Training and Public Education

Employee training and public education are key components of biomedical waste management. The objectives of training and education are:

1. To prevent occupational and public exposure to infectious waste and related health hazards
2. To foster responsibility among health care workers regarding medical waste management
3. To create awareness and educate patients and visitors about the risks related to medical waste and elicit their cooperation in preventing exposure.

It should be the responsibility of the Waste Management Officer and Infection Control Officer to ensure that training programmes and annual refresher courses or seminars take place.

Formal training of all health care personnel on biomedical waste management is critical for a successful waste management programme. Training can be in the form of staff workshops, seminars, in-service training, or classroom-type instruction. Separate training activities can be tailored and targeted to three different groups in a health care facility:

- Administrative managers and clerical staff
- Medical doctors, nurses, lab technicians, and other health care professionals
- Cleaners, porters, waste handlers, and other auxiliary staff

General employee training programmes should include the following:

- Overview and rationale of the health care facility's policy on waste management and the objectives of the policy
- Roles and responsibilities of each staff member in implementing the policy
- Risks associated with medical waste, the basic elements of infection, and the importance of safe practices
- Waste classification
- Procedures for waste minimization
- Procedures for waste segregation including labeling and colour coding
- Overview of the fate of medical waste after collection: handling, storage, transport, treatment, and final disposal
- General cleaning, disinfection, and contingency procedures for spills and accidents.
- Reporting procedures for accidental exposures to infectious waste (needle-sticks, blood splashes, etc.) or improper collection, handling, or treatment practices.

For health care providers, the following additional precautions should be emphasized:

- Special care has to be taken when dealing with sharps waste. Sharps containers should not be overfilled. Needles should not be manually removed from syringes.
- No attempt should be made to remove items from an infectious waste bag or container. If an infectious waste item is accidentally placed in a regular garbage bag, the entire mixture should be treated as potentially infectious waste.
- Hazardous chemicals, such as mercury and formaldehyde, and pressurized containers such as aerosol cans, should not be mixed with potentially infectious waste.

Waste handlers and treatment technology operators should receive specialized instruction. In addition to the above topics, training programmes for them should also include:

- Specific procedures for handling, including identifying the types of waste in bags and containers through their colours and labels; when to seal bags; how bags are sealed; how bags are picked up and deposited; how bags should be carried; procedures for handling sharps containers; and ergonomic issues.
- Specific procedures for storage (if needed) and transport of medical waste, including how to keep waste segregated, loading and unloading bags, and the proper use of carts

- Safe practices and use of protective equipment such as gloves and footwear
- Emergency response to spills and other accidents
- General operating principles of the treatment technology
- Occupational safety, health, and environmental issues related to the treatment technology
- Specific technical procedures for the operation and monitoring of the treatment technology, including the loading and unloading of waste, start-up and shut-down procedures, understanding equipment monitoring data, and the use of controls
- Emergency response to equipment alarms and failures, including how to detect abnormal conditions and malfunctions
- Maintenance procedures related to the treatment technology
- Removal of residues from the treatment technology

Public education may be done through the placement of posters (see for example Appendix A4), handouts, and/or verbal instruction to patients and visitors explaining the facility's colour coding and labeling system. Importantly, patients and visitors should be instructed: (1) not to place regular garbage into red bags or containers marked with the international biohazard symbol, (2) not to open or handle any biohazardous waste containers, (3) to keep children away from any biohazardous waste containers, and (4) to report any spills or accidents involving a biohazardous waste container immediately and to refrain from touching any of the spilled contents.

APPENDIX A1: Sources of Information

List of Facilities Visited

The following facilities were visited between February 11 to 13, 2002:

1. Ministry of Health and Environment, Ministerial Complex, St. George's
2. Solid Waste Management Authority
3. Gouyave Health Centre, Gouyave
4. Grand Roy Medical Station, Gouyave
5. Perseverance Landfill
6. Old dumpsite
7. General Hospital, St. George's
8. LaQua Brothers Crematorium (viewed from the outside)
9. St. Augustine Medical Services (private hospital), Grand Anse
10. Gittens Agencies (private pharmacy)
11. St. David's Health Centre, Petit Esperance, St. David's
12. Princess Alice Hospital, St. Andrew's

List of Stakeholders

The consultant met with the following individuals in the approximate order shown below between February 11 to 13, 2002:

1.	Ms. Eunice Sandy-David	Permanent Secretary of Health
2.	Mr. Patrick Moore	Chief Environmental Health Officer
3.	Mr. Allan Edwards	Senior Environmental Health Officer
4.	Mr. Francis Balwant	Senior Environmental Health Officer
5.	Dr. Alister Antoine	Medical Officer of Health and National Epidemiology
6.	Mr. Selby Da.Breo	Solid Waste Management Authority Manager
7.	Ms. Joan Lewis	Family Nurse Practitioner, Gouyave Health Centre
8.	Dr. Albert Fletcher	Dentist, Gouyave Health Centre
9.	Nurse L. Joseph	Grand Roy Medical Station
10.	Mr. Alford Nelson	Perseverance Landfill Supervisor
11.	Mr. Junior Charles	Machine Operator, Perserverance Landfill
12.	Sr. Lyneve Bailey	Department Supervisor and former Infection Control Coordinator, General Hospital
13.	Ms. Anne Pivott	Histology, General Hospital
14.	Ms. Rossamond Roberts	Pathology, General Hospital
15.	Ms. Veronica Alexander	Pathology, General Hospital

16.	Ms. Sonia Edwards	Senior Bacteriologist, General Hospital
17.	Ms. June Salhab	Laboratory, General Hospital
18.	Ms. Agatha Clarke	Director, Laboratory Services, General Hospital
18.	Ms. Alma Smith	Consultant, Community Health Services, Ministry of Health
20.	Nurse Anne Francis	Chief, Community Health Nurse, Ministry of Health
21.	Ms. Angela Gitten	Health Information Officer, Ministry of Health
22.	Ms. Agnes Banfield	Surveillance Nurse, Ministry of Health
23.	Mr. Benedict Newton	Chief Pharmacist, Ministry of Health
24.	Dr. L.N. Amechi	Managing Director, St. Augustine Medical Services
25.	Sr. Angela Naraine	Nurse, St. Augustine Medical Services
26.	Sr. Sandra Rowe	Nurse, St. Augustine Medical Services
27.	Mr. Devon Nedd	Laboratory Assistant, St. Augustine Medical Services
28.	Mr. Leonard Gittens	Inventory Control Manager, Gittens Agencies
29.	Ms. Ester Henry-Fleary*	Administrator, Princess Royale Hospital, Carriacou
30.	Mr. Franklin Gittens	Deputy Director of Hospital Services, General Hospital
31.	Ms. Ruby Despaigne	Engineer, General Hospital
32.	Ms. Rachel Samuel	District Health Nurse, St. David's Health Centre
33.	Matron Joseph	Princess Alice Hospital
34.	Ms. Stephanie Sandy	Princess Alice Hospital

* interviewed by telephone

List of Documents Obtained and Other References

The following documents were obtained during and after the site visit:

1. Waste Management Act of 2001 (Act No. 16 of 2001), Government Printing Office, St. George's, Grenada
2. List of Health Centres and Medical Stations in each Parish, provided by the Ministry of Health
3. List of Physicians and Dentists in Grenada, provided by the Ministry of Health
4. District Medical Officers Yearly Report: January-December 2001, Epidemiological Unit, Ministry of Health, September 1, 2002
5. Site Layout and Contour Plan, Perseverance Landfill Site, provided by the Solid Waste Management Authority, Grenada
6. Site Layout and Contour Plan, Dumfries Landfill Site, Carriacou, provided by the Solid Waste Management Authority, Grenada

7. "Health in the Americas 1998," Special Program for Health Analysis, Pan American Health Organization website. http://165.158.1.110/english/sha/prflgre.html
8. "Health Systems and Services Profile: Grenada, Carriacou & Petite Martinique," 1st Edition, Organization and Management of Health Systems and Services Program, Division of Health Systems and Services, Pan American Health Organization, Washington, DC, October 2001.
9. Maps of Grenada, Carriacou, and Petite Martinique

List of Digital Photographs Obtained

About 150 digital photographs were taken during the site visits. Below are brief descriptions and the number of photographs obtained:

1. Gouyave Health Centre: waste containers – 10
2. Gouyave Health Centre: incinerators – 5
3. Gouyave Health Centre: on-site burial area – 1
4. Gouyave Health Centre: dental clinic – 2
5. Grand Roy Medical Station: waste containers – 3
6. Grand Roy Medical Station: incinerator – 2
7. Map of SWMA collection zones - 3
8. Perseverance landfill layout – 4
9. Dumfries landfill layout – 3
10. Perseverance Landfill: entrance – 2
11. Perseverance Landfill: collapse area – 4
12. Perseverance Landfill: leachate pond – 3
13. Perseverance Landfill: waste containers – 1
14. Old Dumpsite: trench – 1
15. Old Dumpsite: equipment – 1
16. General Hospital: entrance – 1
17. General Hospital: new construction – 3
18. General Hospital: waste containers – 19
19. General Hospital: policy document – 1
20. General Hospital: wards – 4
21. General Hospital: laboratory – 5
22. General Hospital: sluice room drain – 6
23. General Hospital: model of new construction – 2
24. General Hospital: incinerator site – 3
25. St. Augustine's: entrance – 1
26. St. Augustine's: waste containers – 5
27. St. Augustine's: incinerator – 5
28. Princess Alice Hospital: entrance, parking, van – 5
29. Princess Alice Hospital: staff – 1
30. Princess Alice Hospital: poster – 1
31. Princess Alice Hospital: wards – 1
32. Princess Alice Hospital: waste containers – 5
33. Princess Alice Hospital: old incinerator – 2
34. Princess Alice Hospital: new incinerator – 2
35. Princess Alice Hospital: open burning – 5

36. St. David's Health Centre: entrance – 3
37. St. David's Health Centre: staff – 1
38. St. David's Health Centre: waste containers – 8
39. St. David's Health Centre: incinerator – 3
40. St. David's Health Centre: sewage tank – 1
41. St. David's Health Centre: dental clinic – 2
42. St. David's Health Centre: ambulance – 1
43. Maps of Grenada, Carriacou, Petite Martinique – 10

APPENDIX A2: Sample Institutional Policy

Purpose: To provide a system for management of biomedical waste in order to protect patients, staff, and the general public from hazards associated with biomedical waste

Responsibilities: All staff must be familiar with the policy, guidelines, and implementation plan and participate in training dealing with biomedical waste management. Department Heads and Matron should ensure that staff within their departments are familiar with the policy, guidelines, and plan, and have received training. The Waste Management Officer is responsible for day-to-day implementation and monitoring of biomedical waste management. The Waste Management Team is responsible for the policy, guidelines and plan.

Policy:

Occupational Safety: Appropriate personal protective equipment must be used when dealing with biomedical waste. Waste handlers will receive immunization from viral hepatitis and tetanus.

Waste Minimization: The institution is committed to minimizing the impact of our waste on the environment. Staff members are responsible for participating in waste reduction and recycling programmes.

Classification: The following categories of waste are considered biomedical waste and must be handled cautiously as biohazardous or hazardous waste: sharps; cultures and stocks; human blood, blood products, and body fluids; pathological waste; contaminated animal waste; selected isolation waste; pharmaceutical waste; chemotherapy waste; low-level radioactive waste; and other hazardous chemical waste.

Segregation: Biomedical waste will be segregated throughout the facility. Segregation should take place at or as close as possible to the point where the waste is generated, and segregation should be maintained during storage and transport up to the point of treatment.

Labeling and Colour Coding: Every container for infectious biomedical waste must have the international biohazard symbol in a contrasting colour painted or affixed to the container, along with the words "Biohazard" or "Sharps" whichever is appropriate. The following colour coding will be used:

TYPE OF WASTE	COLOUR OF BAG OR CONTAINER
Potentially Infectious Waste	RED
Sharps	RED
Washable Contaminated Linen	CLEAR (TRANSLUCENT)
Chemical, Pharmaceutical, or Chemotherapeutic Waste	YELLOW
Regular garbage	BLACK

Red bags will be available in treatment rooms, surgical suites, emergency room, nurses' stations, and isolation rooms. Sharps containers will be available in medical and surgical wards, laboratory or phlebotomy stations, nurses' stations, treatment rooms, emergency rooms, and other areas easily accessible to personnel near the area where sharps are used.

Collection, Storage, Transport, and Treatment: The procedures for biomedical waste management are summarized in the table below.

Training: Formal training will be provided to all health-care personnel on biomedical waste management. Staff is required to attend the in-service training or workshops and refresher course.

Contingency Planning: Copies of the institution's contingency plans for waste spillage or other emergencies are found in _____. Staff should be familiar with the contingency plan. Spills will be managed by the housekeeping staff under the supervision of the Waste Management Officer.

Reporting: Any incidents such as biomedical waste spills, needle-stick punctures, or other injuries associated with biomedical waste should be reported immediately to the Waste Management Officer (name _____).

SUMMARY OF BIOMEDICAL WASTE MANAGEMENT PROCEDURES

Waste Type	**Sharps**	**Cultures & Stocks**	**Blood & Body Fluids**	**Pathological Waste**		**Isolation Waste**	**(Contaminated Linen)**	*Regular Garbage*
Examples	Needles, Syringes, Blood Tubes	Culture dishes	Free-flowing Blood	Tissues, Body Parts	Placentas, Fetuses	Swabs, Soiled Dressing	Bedding	Garbage
Colour Code	Red	Red	Red	Red	Red	Red	Clear	Black
Marking	Biohazard Symbol, "Sharps"	Biohazard Symbol, "Biohazard"	Biohazard Symbol, "Biohazard"	Biohazard Symbol, "Biohazard"	Biohazard Symbol, "Biohazard"	Biohazard Symbol, "Biohazard"	Biohazard Symbol, "Biohazard"	none
Packaging	Puncture-Resistant Sharps Container	Plastic Bag in a Rigid Container	Leak-proof Container	Plastic Bag in a Rigid Container	Plastic Bag in a Rigid Container	Plastic Bag in a Rigid Container	Plastic or Linen Bag	Plastic Bag or Container
In-House Transport	Covered Cart	Covered Cart	Covered Cart	Covered Cart	Covered Cart	Covered Cart	Covered Cart	Trolley or cart not used for biomed-ical waste
Storage	Protected Enclosure	Protected Enclosure, 4 °C or 39 °F *	N/a	Protected Enclosure, 4 °C or 39 °F *	Protected Enclosure, 4 °C or 39 °F *	Protected Enclosure, 4 °C or 39 °F *	N/a	Regular storage area
Treatment	(describe treatment technology)	(describe treatment tech)	Discharge Into Sanitary Sewer	(describe treatment tech)	Burial or (describe treatment technology)	(describe treatment technology)	Wash in Hot Water (160 °F or 88 °C) for 20 minutes	N/a
Off-Site Transport (untreated waste)	Special Vehicle	Special Vehicle	N/a	Special Vehicle	Special Vehicle	Special Vehicle	N/a	N/a
Off-Site Transport (treated waste)	Sanitation Truck	Sanitation Truck	N/a	Sanitation Truck	Sanitation Truck	Sanitation Truck	N/a	Sanitation Truck
Disposal	Sanitary Landfill	Sanitary Landfill	Sanitary Sewer	Sanitary Landfill	Interment in Burial Site or Sanitary Landfill	Sanitary Landfill	N/a	Recycling or Sanitary Landfill

*If storage time is long enough to result in putrid smells from decaying organic waste

APPENDIX A3: Waste Minimization

Waste minimization is the reduction, to the greatest extent possible, of waste that is destined for ultimate disposal, by means of reuse, recycling, and other programmes. The potential benefits of waste minimization are: environmental protection, enhanced occupational safety and health, cost reductions, reduced liability, regulatory compliance, and improved community relations. The following is the recommended hierarchy of waste minimization techniques in order of decreasing preference:

1. **Segregation** – making sure waste items are in the appropriate container. Staff training is essential to keep regulated medical waste, hazardous waste such as mercury, low-level radioactive waste, and regular trash separated from each other.

2. **Source reduction** - minimizing or eliminating the generation of waste at the source itself; source reduction should have a higher priority than recycling or reuse. Users, waste managers, and product standardization committees should be aware of what waste is generated by the products they buy. Source reduction requires the involvement of purchasing staff. Steps should be taken to reduce at the source regulated medical waste, hazardous waste, low-level radioactive waste, as well as regular trash. Some specific source reduction techniques include:

    a. **Material elimination, change or product substitution**, e.g., substituting a non-toxic biodegradable cleaner for a cleaner that generates hazardous waste; employing multiple-use instead of single-use products; using short-lived radionuclides instead of radium-226 needles in cancer treatment

    b. **Technology or process change,** e.g., using non-mercury-containing devices instead of mercury thermometers or mercury switches; using ultrasonic or steam cleaning instead of chemical-based cleaners

    c. **Good operating practice**, e.g., improving inventory control; covering disinfecting solution trays to prevent evaporative losses; using the minimum formulation recommended for an application

    d. **Preferential purchasing** such as selecting vendors with reduced packaging

3. **Resource recovery and recycling** - recovery and reuse of materials from the waste stream. Some specific examples include:

    a. Recycling newspapers, packaging material, office paper, glass, aluminum cans, construction debris, and other recyclables
    b. Purchasing products made of post-consumer recycled material
    c. Composting organic food waste

d. Recovering silver from photographic chemicals

4. **Treatment** - treatment to remove and concentrate waste, preferably in process rather than end-of-pipe treatment. An example might be the use of filters and traps to remove mercury from wastewater.

5. **Proper Disposal** – when all possible waste minimization options have been exhausted, the remaining waste should be disposed in the method with the least environmental impact.

The commitment of top management, active involvement of individuals from different departments, communication, and educational programmes are essential to a successful waste minimization programme.

APPROACHES TO WASTE MINIMIZATION

There are four basic stages in the development of a waste minimization programme. These are: planning and organization, assessment, feasibility analysis, and implementation.

The initial stage of planning and organization entails getting healthcare management to be committed to waste minimization (reflected in a formal policy statement), setting overall goals, and staffing a task force to get key personnel from affected departments involved.

The assessment phase begins with the collection of data regarding waste streams, processes and operations which are sources of these wastes, types of practices and process control, waste analysis, information on input materials, and economic information. A medical waste analysis (described below) is a valuable tool for the assessment phase. Flow diagrams and material balances are useful in identifying sources and attempting to quantify losses or emissions. It may be necessary to prioritize waste streams based on quantity, toxicity, environmental impact, potential liability, regulations, cost, and other factors.

An assessment team of selected staff people with the assistance of outside consultants should review the data, inspect specific areas of waste generation, come up with waste minimization alternatives, and screen and select options for study. With regards to municipal solid waste, the assessment team needs to determine the recyclability of materials.

In the feasibility analysis phase, a technical and economic evaluation is conducted of the selected options. Among the criteria for technical evaluation are worker safety, maintaining quality of product or service, compatibility with existing operating procedures and work schedules, minimal disruption to install a new system or process, space availability, etc. The economic evaluation uses standard measures of comparative analysis such as payback period, return on investment, and net present value.

The final phase is implementation. This entails obtaining funding, education and communications programmes, installing new equipment or initiating new procedures, and evaluating the performance. A demonstration may be

necessary to evaluate an option before final installation. Education and communications programmes are essential. They must be designed to reach out to the entire staff, tap existing channels of education, provide education on a continuing basis especially for new staff, and respond to feedback from employees.

There are various measures to determine the effectiveness of waste minimization. The initial method is to simply compare recorded quantities of waste generated before and after implementation. However, since waste generation may be dependent on rate of operation, the ratio of waste generation rate to some measure of rate of operation (such as number of occupied beds per day) is another way to analyze waste reduction. Another measure is to analyze the waste minimization project's impact on the institution's cash flow which may reflect reduced cost for waste management and raw materials. In some instances, waste reduction may be expressed in terms of the ratio of input material consumption to rate of operation. These measurements are complicated by processes or services that generate waste infrequently or intermittently, and some evaluation methods may be more appropriate to specific units in the facility rather than the entire facility.

MEDICAL WASTE ANALYSIS

A medical waste analysis or assessment can provide data on the sources of waste, compositions, generation rates, and waste flow within the facility. Medical waste analysis involves preparation, data collection, analysis, and recommendations. Preparation entails defining goals, planning, enlisting the cooperation of key personnel and department heads, and a preliminary "walk-through" of the facility. Data can be collected in-house using self-audit forms and questionnaires. Another approach is to employ an outside consultant. The need for representative sampling determines the time period for data collection. Data collected for a few days provides a snapshot of the waste flow. Collecting data for two or more weeks requires greater staff effort but it may reveal important variations during different days of the week. A third approach is to install a computerized waste tracking system for long-term data collection. A "waste sort" (separating and weighing components of waste collected during a time period) provides a more detailed analysis of waste composition and requires personal protective equipment.

From the data, one establishes the flow of waste and generation rates of every unit of the facility. Data on waste composition can be used to evaluate classification and segregation practices. Over-classification (treating non-infectious waste as infectious waste) and lack of segregation (commingling regular waste with infectious or hazardous waste) add significantly to treatment and disposal costs. A waste analysis can uncover inefficiencies, estimate the true costs of waste management, and establish the levels of compliance to policies. Waste analysis is essential in waste minimization as well as in related goals such as developing recommendations for cost reduction, improving compliance, and reducing risk and liability.

SUGGESTED WASTE MINIMIZATION OPTIONS

Some suggested waste minimization methods for different types of waste are summarized below. The table shows the areas in a hospital where recyclable solid waste is generated and the types of common recyclables found. The health-care facility may have to explore and negotiate with firms to accept materials for reuse and recycling or to help develop markets for recyclables.

Sources and Types of Common Recyclable Waste in a Hospital

Sources	OCC	NP	MG	WP	CP	CPO	Al/M	G	P1	P2	P5	P6	PP	other
Shipping/Recvg	x	x		x		x	x						x	1
Food Service	x						x	x	x	x		x		2
Laboratory	x		x	x	x	x				x	x		x	
Patient Care	x	x	x	x	x	x	x	x		x	x			
Admin. Offices	x	x	x	x	x	x								
Radiology, CT	x			x	x			x		x	x			3
Surgery	x		x	x	x			x		x	x	x		
Pharmacy	x		x	x		x		x		x				
Dialysis	x	x		x	x		x			x				
Doctors' Offices		x	x	x	x					x				
Medical Records		x		x	x	x	x							
Housekeeping	x			x						x				4
Facility Mgt	x			x			x			x				5
Public Areas		x	x				x	x						
Hospital-wide														6

Legend: OCC - corrugated cardboard packaging; NP - newspaper; MG - magazines; WP - white office paper; CP - coloured ledger paper; CPO - computer printout paper (greenbar, bluebar); Al/M - aluminum and metal beverage, food, and other cans; G - glass including clear glass; P1 - PETE plastics (soda bottles); P2 - HDPE (milk jugs, dialysis solutions, food stuffs, cleaning solutions); P5 - polypropylene (sterile irrigation fluid bottles); P6 - polystyrene (food service and supply packaging); PP - polystyrene (Styrofoam) packaging peanuts; Other: 1 - stretch wrap; 2 - grease, organic food waste, aerosol cans; 3 - film, silver recovery; 4 - aerosol cans; 5 - wood, aerosol cans, construction & demolition debris, palettes. 6 - other recyclables found hospital-wide include durable goods such as furnishings, clipboards, old computer equipment, desks, drapes, mattresses, carpets, binders, dishware, phone directories, printer cartridges, etc. [Source: *An Ounce of Prevention: Waste Reduction Strategies for Health Care Facilities*, C.L. Bisson, G. McRae, and H.G. Shaner, American Society for Healthcare Environmental Services (American Hospital Association), Chicago, Illinois, 1993.]

An extra effort needs to be invested in segregating recyclable from non-recyclable waste. The facility should develop an internal system for collecting paper, glass, aluminum, and other recyclables. This may entail investing in recycling equipment and collection containers. There may be recycling and waste-hauling companies who could provide recycling services.

In addition to paper, glass, and aluminum recycling, other ideas for recycling include: identifying markets for plastic waste which comprise a significant percentage of solid waste from hospitals; recycling or proper disposal of batteries; special recycling programmes for bulky materials (old mattresses, furniture, stretchers, etc.); and recycling of construction and demolition waste. There may be opportunities for recycling of scrap aluminum, wallboard, wood, metal piping, wiring, etc.

Another major potential for hospitals is composting to recycle organic wastes such as food, yard, and wood fiber (low-grade paper and boxboard) scraps.

The purchasing departments of healthcare facilities play a major role in "closing the loop" by seeking out and purchasing products made mostly of postconsumer recycled material. They can also reduce waste generation by purchasing goods

for their durability and "reprocessability," selecting products with minimal packaging, and working with supplier to support waste minimization. A product management approach can identify opportunities for reducing waste through purchasing, inventory control, changes in packaging, and working with suppliers.

RESOURCES

Many resources are available to assist health care organizations develop an effective waste minimization programme in their facilities (see box insert). Books such as *Guidebook for Hospital Waste Reduction Planning and Program Implementation, An Ounce of Prevention: Waste Reduction Strategies for Health Care Facilities,* and *The Waste Not Book* provide valuable information and practical suggestions.

RECOMMENDED READINGS ON WASTE MINIMIZATION

Waste minimization model plans and guides including a chemical waste minimization plan, mercury-virtual elimination plan, and guide to environmentally-preferable purchasing: Hospitals for a Healthy Environment (an American Hospital Association and U.S. Environmental Protection Agency partnership). (available at www.h2e-online.org)

On-line resources on waste minimization for hospitals and laboratories, Minnesota Technical Assistance Program (MnTAP), University of Minnesota, School of Public Health, Division of Environmental and Occupational Health. (www.mntap.umn.edu)

Waste Minimization in the Healthcare Industry: A Resource Guide. J. Emmanuel, EPRI, Palo Alto, CA: 1999. TR-113841. (EPRI, 3412 Hillview Avenue, Palo Alto, CA 94303; 800-313-3774)

Environmental Management in Healthcare Facilities, Edited by K. D. Wagner, C.D. Rounds, and R. Spurgin, W.B. Saunders Company, Philadelphia, Pennsylvania, 1998. (W.B. Saunders Company, The Curtis Center, Independence Square West, Philadelphia, PA 19106; 800-545-2522; http://www.harcourthealth.com/)

Guidebook for Hospital Waste Reduction Planning and Program Implementation, Glenn McRae and Hollie Gusky Shaner, RN, American Society for Healthcare Environmental Services (American Hospital Association), Chicago, Illinois, 1996. (AHA Services, Inc., P.O. Box 92683, Chicago, IL 60675-2683; 800-AHA-2626)

An Ounce of Prevention: Waste Reduction Strategies for Health Care Facilities, C.L. Bisson, G. McRae, and H.G. Shaner, American Society for Healthcare Environmental Services (American Hospital Association), Chicago, Illinois, 1993. . (AHA Services, Inc., P.O. Box 92683, Chicago, IL 60675-2683; 800-AHA-2626)

The Waste Not Book, Public Affairs Division, Minnesota Hospital Association, Minneapolis, Minnesota, 1993. (Minnesota Hospital and Healthcare Partnership, 2550 W. University Avenue, Suite 350-S, St. Paul, MN 55114-1900; 800-462-5393; www.mhhp.com)

"Facility Pollution Prevention Guide," EPA/600/R-92/088, U.S. Environmental Protection Agency, Risk Reduction Engineering Laboratory, Office of Research and Development, Cincinnati, Ohio, 1992. *

"Hospital Pollution Prevention Study," EPA/600/2-91/024, prepared by R. Linett for Department of Veterans Affairs, Washington, DC, and Risk Reduction Engineering Laboratory, Office of Research and Development, Cincinnati, Ohio, July 1991. *

"Guides to Pollution Prevention: Selected Hospital Waste Streams" (formerly titled "Guide to Waste Minimization in Selected Hospital Waste Streams"), EPA/625/7-90/009, U.S. Environmental Protection Agency, Risk Reduction Engineering Laboratory, Cincinnati, Ohio, June 1990. *

"Waste Minimization Opportunity Assessment Manual," EPA/625/7-88-003, U.S. Environmental Protection Agency, Hazardous Waste Engineering Research Laboratory, Cincinnati, Ohio, 1988. *

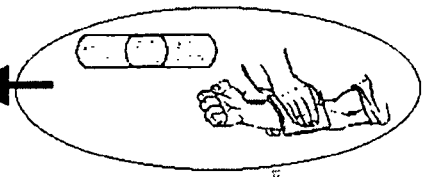
(* Contact EPA Publications at 800-490-9198 or check out http://www.epa.gov/epahome/publications.htm for EPA reports.)

APPENDIX A4: Sample Poster

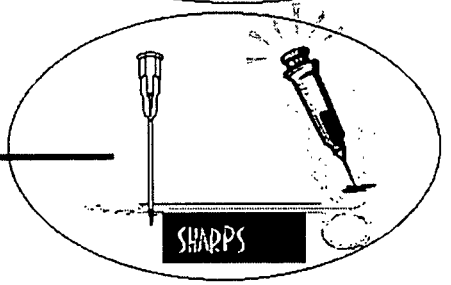
HEALTHCARE WASTE
MANAGEMENT SYSTEM

RED BAGS

BIOMEDICAL WASTE
arising from direct patient care

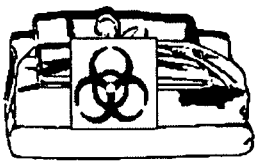


SHARPS CONTAINERS



CLEAR BAGS WITH
BIOHAZARD LABEL

CONTAMINATED LINEN



YELLOW BAGS

CHEMOTHERAPY,
PHARMACEUTICAL &
CHEMICAL WASTE

BLACK BAGS

REGULAR TRASH