



## SCENARIO OF MANAGEMENT OF MEDICAL WASTE IN US AND UK: A REVIEW

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## ABSTRACT

Medical care plays an important role in protecting the life, health and well-being of the nation. However they have some harmful side, that is the production of Medical Waste which cannot be ignored as it plays a major threat in today's world. Thus the Medical Waste Management is very much important due to hazardous, infectious and dangerous properties of Medical Waste that cause problem to the human. In the recent years, many efforts have been made by environmental regulatory agencies and waste generators to better managing the wastes from healthcare facilities. Government regulations and public awareness regarding Medical Waste issues have made obligatory healthcare systems to adopt certain strategies for managing the Medical Waste. Globally, the Markets of Medical Waste Management is currently practised highest in US and UK. The present article discusses the current Management of Medical Waste processes in US and UK which provides an effective pathway towards the safe and healthy Management of Medical Waste.

**Keywords:** Medical Waste, healthcare waste, Regulation of Medical Waste, Disposal techniques

## INTRODUCTION

Hospitals and pharmaceuticals are a place to serve the patient. Since beginning hospitals are known for the treatment of sick persons and pharmaceuticals for the development of medicines for the treatment of various diseases. Now it is a well-established fact that there are many adverse and harmful effects to the environment which are caused by "Hospital Waste" generated during the patient care. While over viewing the production of Medical Waste all around the world the following facts can be seen out of the total amount of waste generated by health-care activities, about 80% is general waste. The remaining 20% is considered hazardous material that may be infectious, toxic or radioactive. But due to lack of proper management of Waste, they get mixed and the total Waste becomes hazardous.

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Every year an estimated 16,000 million injections are administered worldwide, but not all of the needles and syringes are properly disposed of afterwards. Health-care and pharmaceutical waste contains potentially harmful microorganisms which can infect hospital patients, health-care workers and the general public. On this background, the management of Medical Waste is very necessary.

**Table no 1:** Medical Waste Production

Country	Quantity (kg/bed/day)
UK	2.5
US	4.5
France	2.5
Spain	3.0
India	1.5

## MEDICAL WASTE

According to WHO Medical Waste is defined as "Medical waste is all waste materials generated at health care facilities, such as hospitals, clinics, physician's offices, dental practices, blood banks, and veterinary hospitals/clinics, as well as medical research facilities and laboratories."

### ***Sources of health-care waste***

Major sources of health-care waste:

1. Hospitals
  - a) University hospital
  - b) General hospital
  - c) District hospital
2. Other health-care facilities
  - a) Emergency medical care services
  - b) Health-care centers and dispensaries
  - c) Obstetric and maternity clinics
  - d) Outpatient clinics
  - e) Dialysis centers
  - f) Long-term health-care establishments and hospices
  - g) Transfusion centers
  - h) Military medical services
  - i) Prison hospitals or clinics
3. Related laboratories and research centers
  - a) Medical and biomedical laboratories
  - b) Biotechnology laboratories and institutions
  - c) Medical research centers
4. Mortuary and autopsy centers
5. Animal research and testing
6. Blood banks and blood collection services
7. Nursing homes for the elderly

Minor sources of health-care waste:

1. Small health-care establishments
  - a) First-aid posts and sick bays
  - b) Physicians' offices
  - c) Dental clinics
  - d) Acupuncturists

e) Chiropractors

2. Specialized health-care establishments and institutions with low waste generation
  - a) Convalescent nursing homes
  - b) Psychiatric hospitals
  - c) Disabled persons' institutions
3. Activities involving intravenous or subcutaneous interventions
  - a) Cosmetic ear-piercing and tattoo parlors
  - b) Illicit drug users and needle exchanges
4. Funeral services
5. Ambulance services
6. Home treatment

### ***Effects of Medical Waste***

The improper management in Medical Waste causes major environmental problems which results to air, water and land pollution. Some of the effects of pollution on air, radio activities, land, health and hazards are as follows:

1. Air Pollution

Air pollution can be caused in both indoors and outdoors atmosphere.

- a) In-door air pollution

Pathogens present in the waste can enter and remain in the air for a long period in the form of spores or as pathogens. The in-door air pollution caused due to the chemicals from poor ventilation can cause diseases like Sick Building Syndrome (SBS).

- b) Out-door air pollution

Out-door pollution can be caused by pathogens. The Medical Waste without pre-treatment if transported outside the institution, or if it is dumped in open areas, pathogens can enter into the atmosphere.

2. Radioactive emissions

Research and radio-immunoassay activities may generate small quantities of radioactive gas. Gaseous radioactive material should be evacuated directly to the outside. The use of such device

requires maintenance of the trap and monitoring of the off-gas.

### 3. Water Pollution

The liquid waste generated when let into sewers can also lead to water pollution if not treated properly. Water pollution can also alter parameters such as pH, BOD, DO, COD, etc. There are instances where dioxins are reported from water bodies near incinerator plants.

### 4. Radioactive effluents

Radioactive waste in liquid form can come from chemical or biological research, from body organ imaging, from decontamination of radioactive spills, from patient's urine and from scintillation liquids used in radioimmunoassay.

### 5. Land Pollution

Soil pollution from Medical Waste is caused due to infectious waste, discarded medicines, chemicals, used in the treatment and ash and other waste generated during treatment processes. Heavy metals such as cadmium, lead, mercury, etc., which are present in the waste will get absorbed by plants and can then enter the food chain.

### **Health impact**

Health-care waste contains potentially harmful micro-organisms which can infect hospital patients, health-care workers and the general public. Other potential infectious risks may include the spread of drug-resistant micro-organisms from health-care establishments into the environment.

Waste and by-products can also cause injuries, for example:

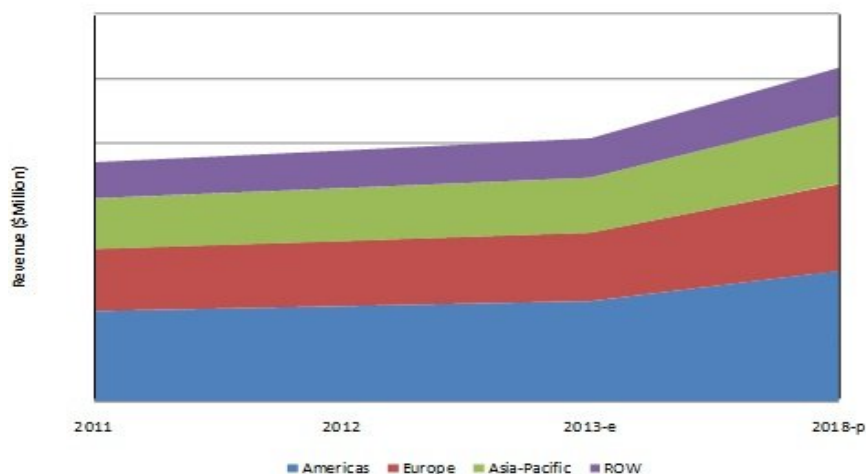
1. Radiation burns;
2. Sharps-inflicted injuries;
3. Poisoning and pollution through the release of pharmaceutical products, in particular, antibiotics and cytotoxic drugs;
4. Poisoning and pollution through waste water; and
5. Poisoning and pollution by toxic elements or compounds, such as mercury or dioxins that are released during incineration

### **Risks associated with waste disposal**

- Although treatment and disposal of health-care waste reduces risks, indirect health risks may occur through the release of toxic pollutants into the environment through treatment or disposal.
- Landfills can contaminate drinking-water if they not properly constructed. Occupational risks exist at disposal facilities that are not well designed, run, or maintained.
- Incineration of waste has been widely practised but inadequate incineration or the incineration of unsuitable materials results in the release of pollutants into the air and of ash residue.
- Only modern incinerators operating at 850-1100 °C and fitted with special gas-cleaning equipment are able to comply with the international emission standards for dioxins and furans.
- Alternatives to incineration are now available, such as autoclaving, microwaving, steam treatment integrated with internal mixing, and chemical treatment.
- Injuries from sharps leading to infection to all categories of healthcare personnel and waste handler.
- “Disposable” being repacked and sold by unscrupulous elements without even being washed.
- Drugs which have been disposed of, being repacked and sold off to unsuspecting buyers.
- Thus the management of medical waste is very much essential<sup>[1,2]</sup>

### **Medical Waste Management Markets**

Environment and safety regulations for medical waste management have set standards for the treatment and storage of medical waste. The European and American regulatory bodies are stringent when it comes to the handling of medical waste. The healthcare and pharmaceutical companies are major medical waste generators. This has helped in the expansion and growth of the medical waste management market globally. As seen from the above figure, the Medical Waste Management market is highest for US which is then followed by Europe. The Medical Waste Management market is expected to reach a value of \$10.3 billion by 2018, at a CAGR of 4.9%. Pharmaceutical waste management leads the market and is estimated to reach a market size of \$5.8 billion by 2018.<sup>[3]</sup>



**Figure 2: Medical Waste Management Markets all over the world**

## MEDICAL WASTE MANAGEMENT IN US

### Legislation

1. Medical Waste Tracking Act
2. State Medical Waste Regulations
3. US EPA Regulations
4. DOT Regulation
5. OSHA Regulation

### Definition

According to Medical Waste Tracking Act, Medical Waste can be defined as "Any solid Waste which is generated during the diagnosis, treatment or immunization of human beings, animals, in research pertaining thereto, or in the production or testing of biologicals".

### Medical Waste Management

- A. Generation
- B. Waste Characterization
- C. Transportation
- D. Treatment, Destruction and Disposal

#### A. Generation

The generators of Medical Waste are classified as small generators and large generators. The large generators may include hospitals, dental clinics, physicians, laboratories, autopsies, funeral homes. There are also small generators

which produce less than 50 pounds of medical waste. The generation of Medical Waste can be reduced by

1. Public Education
2. Waste Minimization by source reduction
3. Waste Management Plan

### Public Education

Public education may greatly influence the reduction of at least small generators of the Medical Waste to a large extent. The educational efforts should include:

1. A proper understanding of the medical Waste and its safe management process
2. Give knowledge to generators of proper disposal techniques.
3. Persons who use syringes and needles at home should be provided knowledge of proper disposing them.
4. Pamphlets should be distributed which would help the waste handlers in identifying potential infectious waste.
5. Make aware the employees of the potential of the Waste and to make them understand the ways to handle them.

### Waste Minimization by source reduction

Minimization of Medical Waste from source can be reduced by following

1. Proper waste audits that would emphasize the reduction of Medical Waste production
2. A plan for proper segregation techniques
3. Proper education and training given to the employees

This plan should define all medical waste handled by the facility, those responsible for their management, and procedures for handling them at the point of generation

#### **B. Waste Characterization**

The Waste characterization is done according to its various properties from among the various classes. The appropriate category is selected

#### **Waste Management Plan**

The medical Waste Management Plan is central to any Medical Waste Management Programme.

**Table 2:** Waste Characterization

<b>Types</b>	<b>Description</b>
Hazardous Waste	
Sharps	Sharps are items that could cause cuts or puncture wounds.
Infectious Waste	It is material suspected to contain pathogens (bacteria, viruses, or fungi) in sufficient concentration or quantity to cause disease in susceptible hosts.
Pathological Waste	It consists of tissues, organs, body parts, blood, body fluids and other waste from surgery and autopsies on patients with infectious diseases.
Pharmaceutical Waste	It includes expired, unused, spilt and contaminated pharmaceutical products, prescribed and proprietary drugs, vaccines and sera that are no longer required and need to be disposed of carefully.
Chemical Waste	It consists of discarded solid, liquid and gaseous chemicals.
Radioactive Waste	Radioactive wastes are materials contaminated with radionuclides.
Non-Hazardous Waste	Non-hazardous or general waste is waste that has not been in contact with infectious agents, hazardous chemicals or radioactive substances and does not pose a sharps hazard.

#### **C. Transportation**

The Medical Waste that is not treated at the site of generation are to be transported to treatment or disposal facility. The remainder Waste that are obtained from Incinerator ash or autoclaved Waste must be handled and transported to appropriate transport facility.

#### **Waste Management Plan**

The transporter's Waste Management Plan should contained all procedure and policies for the safe and effective management of Medical

Waste. The policies and the procedure must be available to the public.

### **Operation**

It is necessary that Medical Waste should be transported, properly segregated and identified. Vehicles designed should ensure safe management of Medical Waste and also it should have such structure that it gives least stress to structure of Medical Waste containers. It is the duty of the transporters that they follow proper transportation practices. The various practices is to avoid mechanical loading devices, Medical Waste should be transported in different containers than Non-Medical Waste, weekly cleaning and disinfection practices, cleaning of recycled containers.

### **Monitoring and Record keeping**

Transportation process should be monitored and recorded so that the Waste are properly transported to the disposal facility and all the record be maintained by proper documentation work of the source, type and amount, the intended treatment method, and the parties responsible for the ultimate proper disposal.

### **Training**

Proper training to the staff engaged to the transportation of Medical Waste should be properly trained. The training should include

Explanation of Contingency plans

Instruction about the safety and personal protection and Recognition of the Medical Waste and also Proper usage of record keeping

### **Contingency Planning**

It is the development of a plan of action or event of an accidental spill, loss of containment, equipment failure or other unexpected circumstance

#### **D. Treatment, Destruction and Disposal**

The various treatment options for Medical Waste are

1. Incineration
2. Thermal treatment
3. Chemical treatment

4. Heat
  - a) Steam autoclave
  - b) Microwave systems
  - c) Dry heat and hot air systems
  - d) Plasma
5. Chemical agents
  - a) Chlorine compounds
  - b) Ozone
  - c) Alkali
  - d) Other disinfectants<sup>[4, 5, 6]</sup>

## **MEDICAL WASTE MANAGEMENT IN UK**

### **Legislation**

1. In Northern Island and Scotland
  - A. The Waste Management Licensing Regulation
  - B. The Pollution Prevention and Control Regulation
2. In England and Wales
  - A. The Environment Permitting (England and Wales) Regulation

### **Medical Waste Management Process**

- A. Definition and Classification
  - B. Waste Minimization, segregation, color coding and storage
  - C. Transport, packaging and operations
  - D. Treatment and disposal
- A. Healthcare waste definition and classification**

Medical waste in UK is of two types

- A. Non-Hazardous Waste
- B. Hazardous Waste

Non-Hazardous Waste is further classified into two types

1. Clinical Waste

2. Non- Clinical Waste

iv. Others

Non-Clinical waste is further classified as

v. Infectious Gypsum

1. Non-Infectious Waste
2. Sharps
3. Non-Infectious Gypsum Waste

Cytotoxic and Cytostatic Medicines is further classified

- i) Sharps
- ii) Other medicinally contaminated Sharps
- iii) Non-Medicinal Contaminated Sharps

Hazardous Waste is further classified as

1. Clinical Waste
2. Non-clinical Waste

Non-Clinical Waste is further classified as

Clinical Waste is further classified as

1. Dental amalgam
2. Healthcare chemicals without Hazardous properties
3. X-Ray fiber and developers

1. Infectious
2. Cytotoxic and Cytostatic medicines




Infectious Waste further classified as





- i. Non-Infectious Waste: Chemicals present
- ii. Infectious Waste: No chemicals Present
- iii. Infectious Waste: Chemicals present

**B. Waste minimization, segregation, color-coding and storage**

Waste policies should incorporate a programme to see the volumes and types of Medical Waste that are produces and to implement steps that would minimize Medical Waste. The first main step is to identify the site where the Waste is produced. The second step is to identify the causes for the production of the Waste. Finally, Waste policies should be developed which would include various steps to minimize the Waste

**Table 3:** Color-coding to segregation system

Color	Description
Yellow 	<b>Waste which requires disposal by incineration</b> Indicative treatment/disposal required is <b>incineration</b> in as suitably permitted or license facility.
Orange 	<b>Waste which may be “treated”</b> Indicative treatment is to be “rendered safe” in a suitably permitted or licensed facility, usually <b>alternative treatment plants (ATPs)</b> .
Purple 	<b>Cytotoxic and cytostatic waste</b> Indicative treatment is required is <b>incineration</b> in a suitably permitted or licensed facility

Black 	<b>Offensive / Hygiene waste</b>  Indicative treatment / disposal required <b>landfill</b> or <b>municipal incineration</b> / <b>energy from waste</b> at a suitably permitted or licensed facility.
Red 	<b>Anatomical waste for incineration</b>  Indicative treatment / disposal required <b>incineration</b> in a suitably permitted facility.
Blue 	<b>Medicinal waste for incineration</b>  Indicative treatment / disposal required <b>incineration</b> in a suitably permitted facility.
White 	<b>Amalgam Waste</b>  For <b>recovery</b>

**Table 4:** Waste segregation chart

S. No.	Waste type	Waste receptacle	EWC Code	Example description	Primary transport class and UN number
1.	Domestic type waste	Black bag	20 03 01	Mixed municipal waste	N / A
2.	Offensive (healthcare)	Yellow and black stripped bag	18 01 04	Offensive waste from human / animal healthcare	N / A
	Offensive (municipal)		20 01 99	Offensive waste, municipal	
3.	Anatomical waste (chemically preserved)	Red-lidded, rigid yellow container	18 01 06 and 18 01 03 and/or 18 01 02	Clinical waste, human/ animal anatomical, chemical preserved, for incineration only	Class 6.2 UN 3291



	Anatomical waste W2(not chemically preserved) H9		18 01 03 and/or 18 01 02 or 18 02 02 and/or 18 02 03	Clinical waste, human/ animal anatomical, not chemically preserved, for incineration only	
4.	Infectious Waste contaminated with chemicals	White bag	18 01 03 and 18 01 06 and / or 18 01 07 Or 18 02 02 and 18 02 05 and/ or 18 02 06	Clinical waste, infectious, containing from humans/animal healthcare, for incineration only	Class 6.2 Un 3291
5.	Infectious waste (not containing chemicals or medical incineration)	Orange bag or Orange-lidded, rigid yellow container	18 01 03 Or 18 02 02	Clinical Waste, infectious, from human/animal healthcare, suitable for alternative treatment	Class 6.2 UN 3291
6.	Sharps, non-medicinally contaminated	Orange-lidded, yellow sharps box	18 01 03 Or 18 02 02	Clinically waste, sharps, infectious, non-medicinally contaminated, suitable for alternative treatment	Class 6.2 UN 3291
7.	Other medicines (in original packaging or not in original packaging)	Two blue-lidded, rigid yellow containers (one for solid, one for liquid)	18 01 09 or 18 02 08 and/or 20 01 32	Clinical waste, medicines (not cytotoxic and cytostatic) from animal/ human healthcare, for incineration only	N / A
8.	Dental amalgam	Leak-proof rigid container with Hg suppressant	18 01 10	Dental amalgam and mercury including spent and out-of-date capsules, excess mixed amalgam	N / A

				and contents of amalgam separators	
9.	Photographic wastes	Leak-proof rigid container with Hg suppressant	09 01 04	X- ray fiber	N / A
10.	Radioactive waste	Red bag	18 01 03 or 18 02 02 if infectious	Healthcare waste contaminated with radioactive material	Un number will depend upon isotope

**C. Transport, Packaging and operation**

The Carriage Regulation which refers to the Carriage of Dangerous Goods and Use of Transportable Pressure Equipment regulation specify the requirements for:

- Classification
- Packaging
- Marking

- Labeling
- Documentation

This regulation requires that all the dangerous goods be identified using a four-digit number (UN number) and a description (proper shipping name) and are assigned to a “class” of dangerous goods. Once the UN number of a substance is known, ADR provides information on the packing group, packaging instruction and any special packing provisions that apply

**Table 5: Packaging instructions**

S. No.	Dangerous goods (UN number)	Proper shipping name	Packing instructions	Packaging instructions
1.	Category A			Three-part packaging
	UN 2814	Infectious substance affecting humans	P620	
	UN 2900	Infectious substance, affecting animals	P620	
2.	Category B (UN 3291) a	Clinical waste	P621 LP621	Rigid packaging or wheeled bins

3.	Medicinal waste b		P001	Boxes, drums
	UN 1851	Medicine, liquid, toxic		
	UN 3248	Medicine, liquid, flammable, toxic		
4.	Dental amalgam (UN 2025)	Mercury compound, solid	Limited quantity	Boxes, drums
5.	Aerosols (Un 1950)	Aerosols	Limited Quantity	Box

The packaging instruction changes as the code changes for the different containers. The personnel that are involved in all these processes should be trained properly and all the work should be documented

### C. Treatment and Disposal

Criterion A: Reduction in pathogen numbers

Criterion B: Destruction of anatomical waste

Criterion C: Unstable and recognizable

Criterion D: The rendering safe of pharmaceuticals and chemicals within the waste. Healthcare waste in treatment and disposal systems can be classified into two broad types High temperature (incineration processes) and Non-burn / low temperature alternative technologies<sup>[7, 8]</sup>

### CONCLUSION

In the current scenario, the Government agencies and Non-Government agencies accentuates on Management of Medical Waste. The present article focusses on the Medical Waste characterization into different types according to the source of generation, currently practised in US and UK. It also focusses on the various transportation, disposal and treatment procedures and techniques for the management of different types of Medical Waste in US and UK.

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