

## REVIEW ARTICLE

## HOSPITAL WASTE MANAGEMENT: EXECUTION IN PAKISTAN AND ENVIRONMENTAL CONCERNS - A REVIEW

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## ARTICLE DETAILS

## ABSTRACT

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Hospital waste is a major environmental concern nowadays. It refers to materials originating from healthcare facilities, that are no more beneficial for living beings. Prior its final disposal it requires proper management and treatment to reduce its deleterious impacts. The purpose this review is to evaluate the waste management and treatment practices/techniques adopted in selected hospitals of Pakistan. The study revealed that the waste management techniques (incineration, landfilling, autoclave and open dumping) in Pakistani hospitals have serious environmental implications. There is also a void in implementation of the existing legal framework for the adequate management and treatment of hospital waste, which can be overcome by adopting environmentally friendly techniques such as low temperature plasma, irradiation technology, reverse polymerization, and bio-converters.

## KEYWORDS

Hospital Waste, Management, Disposal, Environment, Treatment.

## 1. INTRODUCTION

The World Health Organization (WHO) defines hospital waste as the waste produced by hospitals consisting of contagious waste, disinfectants, toxic metals, irradiated waste and unsterilized diagnostic materials [1]. Hospital waste is also defined as perilous waste which is detrimental for the life of living beings. It is produced worldwide in massive amount. Poor management of hospital waste has serious implications on environment and health of people [2]. Hospital Waste Management (HWM) deals with the treatment of precarious waste including hypodermic needles, ligatures, pharmaceuticals and amputated body parts which would otherwise have deleterious impacts. Frequently usage of unfiltered waste results in different ailments due to unhygienic waste management procedures [3]. Unsterilized biomedical waste causes AIDS and Hepatitis B, C predominantly [4].

WHO categorized hospital waste as risk and non-risk waste. Risk waste present around is 15% in which 5% is contagious and 10% is non-contagious waste while the non-risk waste present is about 85% [5,6]. (Figure 1)

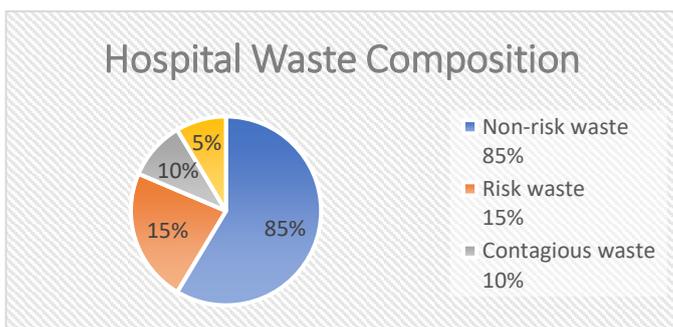


Figure 1: Composition of Hospital Waste

The non-risk waste comprises kitchen waste, packaging materials such as cardboard etc., whereas risk waste include sharps, glass items, repudiated plastic items (contagious waste) and irradiated waste, out dated medications, synthesized solvents (non-contagious waste) [7].

Different waste management techniques are being used to manage waste throughout world. The most common techniques used in Pakistan are open dumping, autoclave, incineration and landfilling. Before final disposal of waste, the number of steps should be followed which include waste segregation (nature and composition) for easy transport ensuring minimum exposure to environment, waste labelling, waste storage and waste treatment (as shown in Figure 2) [8].

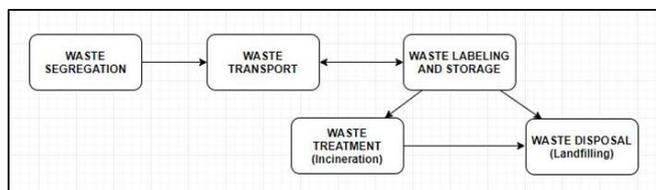


Figure 2: Stages of Hospital Waste Management

Safe hospital waste management is a daunting challenge for developing countries including Pakistan due to inadequate and unsatisfactory management of waste [9]. Pakistan has enacted its Hospital Waste Management Rules 2005 which require public and non-public hospitals to manage hazardous hospital waste, but still they are not implemented or applied duly [10]. Inadequate practices on side of medical staff members and improper monitoring leads to mismanagement of waste [11]. Life cycle assessment of hospital waste management in Gujranwala, Pakistan shows that incineration and landfills both contribute to the high amount of greenhouse gases emissions, for instance the Incinerator led to the emission of about 183.20kg of CO<sub>2</sub> equivalent/tons of waste [12].

The purpose of present review is to evaluate the waste management practices/techniques adopted by selected hospitals in four provinces of

Pakistan. An effort is also done to ensure whether these management practices are up to the mark and align with national standards. The potential negative impacts on environment resulting from HWM practices are meant to be highlighted, and to identify possible loopholes in the waste management from its segregation to dumping in hospitals of Pakistan.

## 2. METHODOLOGY

This study is comparative analysis of practices and techniques used for the treatment and management of hospital waste in different provinces of Pakistan. Both qualitative and quantitative research methods were used. Strengths and weaknesses in different hospital waste management techniques were also monitored. The research tools used for data collection are as follows:

- i. Interview
- ii. Direct observation
- iii. Questionnaire
- iv. Literature review
- v. Analogues

## 3. RESULTS AND FINDINGS

### 3.1 Hospital Waste Management in Punjab

In province Punjab, various surveys have been conducted in different cities i.e. Sheikhpura, Gujranwala, Faisalabad, Rawalpindi and Lahore, for studying their hospital waste management methodologies [13,14].

Among all, two hospitals of Rawalpindi each from public and private sector are selected for the current review. It is observed that the hospitals are well maintained and have good cleanliness system, but the treatment and disposal of biomedical waste is not satisfactory. The selected hospitals do not have any written protocol or operating system for waste handling [15].

Segregations process is usually followed in these hospitals. Nevertheless, the color-coding scheme does not comply with the Hospital waste management rules 2005 [11]. They are using Blue and red tapes on local polythene bags which is at the risk of damage. Moreover, the collection, transportation and dumping of waste is not in lined with international standards. Waste is dumped at the backyard of hospital. Both these hospitals lack their own incinerator or any treatment facility [15]. And for incineration waste is transported twice a week to Combined Treatment Facility (CTF) established by WHO in 2009, which is insufficient for handling the health-care waste of whole city [11]. Another incineration facility is available at Attock Oil Refinery (Table 1) [16].

**Table 1:** Hospital Waste Management in Rawalpindi, Punjab

List of Hospitals	Waste Segregation	Transportation of Waste	Waste Management Strategies	Waste Treatment	Waste Disposal
Private Hospital	Improper	Manual transportation	No Waste management committee	No on-site facility available	No storage facility; In hospitals backyard
Government Hospital	Improper	Proper methods	Have waste management committee	No on-site facility available	Hospital site

Both hospitals should follow proper policy and operating procedures to deal with the hazardous waste and proper segregation mechanism should be followed.

### 3.2 Hospital Waste Management in Balochistan

In province of Balochistan, hospitals of capital city Quetta are focused. Out of 71 Hospitals of Quetta Four were selected. Shredding, autoclaving, incineration and Incarnation process were used for the treatment of waste. Segregation includes use of boxes of different colors showing

different level of contamination. Non-infectious waste undergoes the process of recycling. There is a need for installation of more incinerators as only single incinerator is installed in Bolan medical complex for waste treatment [17]. Colored waste bins are used for collection of waste in Saleem complex hospital but there is only single bin in other three hospitals. Disposal of waste take place at either hospital's backyard or any other place is selected for waste disposal. Mostly waste is discharged in sewer (Table 2) [18].

**Table 2:** Hospital Waste Management in Quetta, Balochistan

List of Hospitals	Techniques	Percentage of Waste Production	Waste Management Strategies adopted	Disposal of Waste
Civil hospital Quetta	Shredding, Segregation Dumping and disposal of waste	30%	Use of Proper infections control rules and training	Waste is disposed in hospital sites(backyard) or sanitary landfills.
Bolan Medical Complex, Quetta,	Autoclaving, Incineration and dumping, Incarnation (for treating human body parts)	35%	Incinerator is installed	Either in hospital site or in sanitary landfill or sewer.
Saleem Complex, Quetta	Collection Transportation and dumping of waste	10%	Waste bins of different colors	Waste is dumped in open areas due to lack of incinerators
Children Hospital of Quetta	Collection Transportation and dumping	25%	Trolleys and colored coded bags	Waste is dumped in open areas

Overall, the waste production is greater in government hospital. Management of waste is better in private hospitals compared to government hospitals.

### 3.3 Hospital Waste Management in Khyber Pakhtunkhwa (KPK)

In Peshawar hospital waste management practices were reviewed, in accordance with the WHO guidelines, in both private and public sector hospitals such as Rehman Medical Institute (RMI), North West General Hospital (NWDGH) and Lady Reading Hospital (LRH), Hayatabad Medical Complex (HMC) respectively.

Standard procedures used for collection of infectious, non-infectious,

pathological and pharmaceutical waste at all stages (segregation, collection, storage, handling) were observed and compared. The results are tabulated below in Table 3.

**Table 3: Hospital Waste Management in Peshawar, KPK**

Type of Waste	Segregation	Collection	Storage	Handling	Disposal
Infectious Waste	No segregation except NWGH <sup>1</sup> which was unsatisfactory	Specified yellow container in NWGH only	Proper central storage area in RMI and NWGH only	Proper measures in RMI and NWGH	Incineration is carried out by both sectors but incinerators were not working properly in public sector; also some of the waste is handed over to PDA by public sector
Non-Infectious	No segregation in LRH <sup>2</sup> while in others were unsatisfactory	Specified containers in RMI <sup>3</sup> and NWGH only	Proper storage in private; open storage in public hospital	Proper measures in RMI and NWGH	
Pathological Waste	No segregation except NWGH which was unsatisfactory	Specified yellow container in NWGH only	Proper storage in private; open storage in public hospital	Proper measures in RMI and NWGH	
Pharmaceutical waste	Not at all	No specified containers	Proper storage in private; open storage in public hospital	Proper measures in RMI and NWGH	

\* 1 NWGH (North West General Hospital)

\* 2 LRH (Lady Reading Hospital)

\* 3 RMI (Rehman Medical Institute)

In private sector hospitals waste were handled by housekeepers and housekeeping managers were responsible for organizing and managing all these practices at administration level. Waste transportation to proper storage site is done through well designed trolleys and remain there until final disposal that is done by incineration [6,19].

In public sector, sanitary inspectors were responsible at administration level for organization and management. All waste was handled by sweepers but with poor protective measures thus endangering their lives. Trolleys were overfilled. Waste remained in open area until final disposal. Incinerators were there but not working properly. Some of the infected waste generated there was handed over to Peshawar Development Authority (PDA) [19].

Comparatively management practices were quite better in private sector than public sector hospitals

### 3.4 Hospital Waste Management in Sindh

There are about 33 hospitals in public sector and 356 hospitals in private sector, based on the Karachi Strategic Development Plan 2020 (prepared in 2007). According to an estimate of 2005 about 650 tons of infectious waste generated per day that is expected to shoot up to 1120 tons by 2020 [20,21].

The management practices are below desirable level in Karachi. A survey was conducted in eight hospitals, few of the hospitals were segregating their waste at the source along with the protective gears provided to their handlers. Most of the hospitals had separate storage areas but not protected from scavengers. Disposal technique adopted by most of hospitals was incineration with few have adopted landfilling and open burning (Table 4) [19]. According to another report, sharp waste is disposed in open garbage [22].

**Table 4: Hospital Waste Management in Karachi, Sindh**

	Waste Segregation	Proper Handling	Separate Storage Area	Disposal Techniques		
				Incineration	Landfills	Open burning
No of hospitals	2 out of 8	2 out of 8	5 out of 8	5 out of 8	2 out of 8	1 out of 8

## 4.1 DISCUSSION

Keeping in view the infectious nature of hospital waste, many management techniques were used in Pakistan. Nevertheless, there is a room for improvement in effective implementation of relevant rules and new techniques, with the aim of minimizing the waste without compensating the quality of the environment. Lot of researches have been done on the hospital waste and management techniques. Open dumping, incineration, autoclave, shredding and sterilization are the most used techniques for disposal of healthcare waste in Pakistan.

### 4.1 Open Dumping

Deposition of waste collected from healthcare facilities on open land is the most inexpensive and easy-going method used in developing countries [12]. Although it saves the cost, but it is the potential source of infectious diseases and environmental pollution [10]. It also causes significant impacts on population living nearby the dumping site [23,24].

Openly dumped waste is accessible to scavengers and animals. The plastic and sharps can choke and injure the animals [25]. Moreover, the chemical components of the waste are incorporated into the food chains. Therefore, transmitting the infections, and pathogenic microbes through ingestion, inhalation or direct contact. Moreover, the physical agents such as wind, leachate or effluent from the dumping site can transport the toxicity of waste throughout the environment [9,26].

Therefore, open dumping is the inappropriate way of hospital waste disposal and can be taken up only as a last resort.

### 4.2 Landfilling

On lines of dumping waste and incorporating the pollution mitigation concept "engineered landfills" are being developed. These are specialized areas, developed in a manner and covered daily so that waste do not come in contact with atmosphere, soil, and surface water. The landfill is constructed while considering the administrative limitations of the area.

Landfill is considered as a final disposal site after applying any modern waste treatment technique. The landfilling is significant as it prevents the contamination of soil, release of harmful gases and bad odor into air and contact with vector animals, birds and microbes [27]. Nevertheless, if not constructed properly it can contaminate ground water and soil compensating their quality [25].

Currently, there are two landfill sites in Karachi at Gond Pass and Jam Chakro. Administrative authorities are about to improve them upto scientific level for generating electricity too. In Lahore, scientific landfill has recently been developed at Lakhodair, that started operations in April 2016 [28,29].

### 4.3 Incineration

Incineration is the process of burning substances at high temperatures in

closed assemblies known as furnaces. In the process, the substances are completely oxidized and the microbes are either killed or denatured [30]. The process is also significant to use for minimizing waste as it reduces the volume by 20-30% and mass of waste by converting it into harmless ash [31]. Reduced volume favors the landfilling at disposal stage. The incineration is useful for entities that are 60% combustible.

The drawback of incineration includes its high installation and maintenance costs, and harmful emissions due to chemical composition of the waste [32]. The considerable toxic emissions from incinerators include carcinogenic furans, dioxins and mercury [25,33]. In developed countries, dioxin control methods involving addition of carbon and calcium hydroxide to flue gases is carried out. But it is an expensive technique and not feasible for all healthcare facilities, thus creating the demand for alternative technique [23].

The harmful emissions from the incinerators can be controlled by regulating its operating conditions such as ensuring complete combustion at temperature higher than 800o C. The pollutant control equipment should be fitted with incineration facility to meet standard emission criteria [34].

#### 4.4 Autoclave

It is a low heat process, which uses steam or hot water, and specific pressure to disinfect the hospital waste. The temperature range for this low-heat thermal process is 93o to 177o C [30]. Autoclave is efficient for disinfecting sharps, blood contaminated entities, bandages, gowns, gauzes, non-chemical materials and the like. For the hospital waste that is meant to be disposed of, autoclaving is done to clean the material of bacteria before landfilling. The sterilization occurs at optimum temperature of 160o C [9]. Nevertheless, the temperature range may vary based on the residence time and pressure i.e. Temperature of approx. 120o C at pressure of 15 pounds per inch square (psi) for 160 minutes, or temperature of approx. 135o C at 31 psi for 45 minutes [35].

The environmental hazard of autoclave is the aerosolizing of toxic chemicals present in the waste. The aerosols can deposit on the equipment, or release into the immediate environment posing threats to workers and air quality (Autoclaves for Medical Waste) [36]. Nevertheless, it is safer than incineration as it does not have toxic emissions. But, it does not reduce the volume of waste material as incineration does. Therefore, it occupies larger space in landfills [31].

#### 4.5 Shredding

Shredding in combination with microwave or autoclave, is used as an alternative to incineration [37]. Shredding is the method of cutting the waste into small pieces or de-shaping them. It reduces the volume i.e. required with autoclave and sterilizing techniques for efficient disposal. It also ensures that infectious sharps, and waste might not be reused [21].

### 5. RECOMMENDATIONS

Day by day technology makes rebellion in our lives and also helps humans to make their environment pollution free. Hospital waste is the biggest problem to manage in environmental friendly way so there is a myriad of techniques to manage, control and destroy the hospital waste some of which are discussed above and some of their alternatives are discussed below: Shredding of medical waste which includes (blades, sharps) can be rotated at 1750 revolutions per minute and dissolve in disinfection solution and this wet waste than dried by hot off- gas in closed chamber, this technique reduce the waste about 80%. It is an alternative of shredding with autoclave and microwave ,which need high maintenance cost and energy [32,38]. Irradiation technology can be used instead of incinerator, it doesn't produce toxic gases like dioxins and furans and reduce the mass of waste about 80% and it operates at room temperature and there is no need of any extra material for operating the system [39]. Ozone gas produced as the end product of irradiation technique, can be used for sterilization processes and help in managing the hospital waste [40-55].

### 6. CONCLUSION

Hospital waste is a matter of serious concern in Pakistan due to inadequate waste management practices. Methods of waste management (segregation, transport, storage, treatment, disposal) are calling improvement in both public and private sector hospitals of Pakistan. Furthermore, there is a dire need of modifying the technological processes of waste treatment to reduce the negative environmental impacts (noxious gases). Development of monitoring systems on lines of Hospital

Waste Management (2005) rules, and capacity building of the management labor is necessary, as safe handling of hospital waste is indispensable for human health as well as for the environment.

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