DEVELOPMENT OF INTEGRATED HOSPITAL WASTE MANAGEMENT SYSTEM FOR PESHAWAR CITY

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ABSTRACT: *Hospital waste management is becoming an emerging issue in most of the developing countries due to its infectious and hazardous nature. Government of Pakistan also took initiative to provide improved medical facilities to their citizens by increasing the capacity of existing facilities and construction of new hospitals in public and private sectors. Generally. the hospital waste is disposed off along with municipal waste which is not a safe practice because of the composition of hospital waste which is quite different form the municipal waste. Thus, it requires special management system for its handling, collection, storage, transportation and final disposal. Mismanagement of hospital waste and current practice of mixing the infectious waste with non-infectious waste can cause adverse health impacts on workers and general public and contribute to transmission of diseases through direct contact, vectors and airborne exposures. In this paper effort has been made to evaluate the existing scenario of HWM and to develop an integrated hospital waste management system for Peshawar city. For this reason, an integrated hospital waste management system has been proposed which collects, transport, treat and dispose hospital waste form all the hospital facilitates located in Peshawar into a common unit. Moreover, some strategic actions and recommendations are also proposed to improve the overall HWM condition.*

Keywords: Hospital Waste Management, risk waste, non-risk waste, Peshawar.

1. INTRODUCTION

During the past few years, commitment of providing better hospital facilities to the citizen has increased in developing countries. Government of Pakistan is also not lagging behind in providing improved medical facilities to their people. Efforts have not only been done in enhancing the capacity of the existing facilities but also in the form of constructing new hospitals in public and private sectors. This effort has not only helped in raising the health status in the country but also demands the great sense of responsibility. Better facilities have also resulted in toxic and hazardous waste that needs special management. Pakistan is unfortunate in this respect that not a single city in Pakistan is managing the wastes of its hospitals. Similar is the situation of Peshawar, one of the major cities of Khyber Paktunkhawa. Recently, there is no proper system in Peshawar City which provides proper handling, processing and disposal of hospital waste. Due to hazardous and infectious nature of hospital waste, its handling, processing, treatment and disposal has currently became an issue for the general public and other stakeholders. Hospital waste is generally classified as pharmaceutical, radioactive, infectious, pathological, genotoxic and chemical wastes.[1]. Hospital waste includes all the waste generated by hospital establishment(s) i.e. hospitals, dispensaries, diagnostic centres, veterinary hospitals, research facilities & laboratories. hospital waste are composed of various infectious waste like human tissues & body parts, animal carcasses, syringes, blades, saws, drugs, vomits, urine, chemicals and fluid from laboratories which are the major source of HIV or AIDS, Hepatitis B and C [2-3]. WHO statistics showed that 80% hospital waste is categorized as non-risk waste while 20% of the waste can create serious health risks to workers and community, if not disposed off in a proper manner [4]. Several national and international laws and guidelines are present for the proper management of hospital waste but regrettably no enforcement of these laws is present . Hospital waste management was below WHO and Pakistan HWMR- 2005 guidelines in most of the hospitals of Rawalpindi and Islamabad [5].

Hospital waste is mostly categorized as risk (infectious, sharps, pharmaceutical, pathological and radioactive) and non- riskwaste.75-90 % of the waste produced by hospital facilities is non-risk however 10- 25 % of the hospital waste is classified as risk waste [4].

Generation rate of Hospital waste is more in developed countries than developing countries due to presence of sophisticated techniques and various social & economic factors. In Western Europe it is around 3.6 kg/bed/day. The daily production of hospital waste in United Kingdom and Sub Saharan African ranges is 2.5 and 0.3-1.5 kg/bed/day respectively. [6].

The quantities of Hazardous waste from hospitals and other medical facilities are quite less as compared to the non risk waste produced by these facilities but their toxic and hazardous nature demands special attention for their management. Improper segregation, separation and disposal of hospital waste can cause severe environmental problems in the vicinity which may include air, water and land pollution. Pathogens in the form of spores are present in hospital waste which can be easily retained in the air for a long period of time. Separation and segregation of waste at source can dramatically reduce this problem. Open burning and incinerators are two main sources of ambient air chemical pollutants like COx, NOx, and PM Open burning of hospital waste can be fatal due to the direct inhalation of organic gases such as dioxins and furans which are highly carcinogenic in nature [7].

Fazli studies for the hospital waste in Pakistan and showed that 19% of hospitals did not do any kind of segregation of hospital waste, 48 % of hospitals used separate containers for risk and non-risk wastes and 32% were using color coded containers with standard labelling. However, 30% of the hospitals have proper separate system for the segregation of highly infectious waste from laboratories. [4].

Study of hospital waste management in Pakistan showed that segregation, handling, storage and transportation of hospital waste were below WHO and Pakistan HWMR-2005 guidelines in most of the hospitals of Rawalpindi and Islamabad. [5]. Dawn Newspaper in 2007 also raised the issue of improper disposal of hospital waste in various

cities of Pakistan. The report said that the proper and safe practices for the disposal of risk waste have not been given priority by local government in most of the cities including well developed cities like Lahore, Peshawar, Karachi and Quetta. Most of the toxic and high risk waste was dumped in open container which is causing hepatitis among the scavengers and other people dealing with the handling of that waste.

Several technologies are used all over the world for treatment and disposal of hospital waste. Incineration is the most common technique for the disposal of most risk care wastes and is still widely used in most of the developing countries. However, alternate treatment methods like autoclaving, microwave disinfection, chemical disinfection, land disposal and encapsulation etc. Most of the hospitals using on-site incineration, autoclaving, and steam disinfection processes for the treatment of very small amounts of risk wastes they produced. In most of the countries like Brazil, Argentina, Peru, India, Pakistan and Bangladesh incinerators were used for the final treatment and disposal of hospital waste [8]. Study regarding the hospital waste management conducted in Karachi showed that Five (05) out of Eight (08) medical teaching institutes disposed off their high risk waste by using incinerators. [9]

The current study includes the review of the existing situation of hospital waste in Peshawar city and formulating of an efficient, cost-effective and sustainable hospital waste management system in Peshawar for the protection of public health and environment.

2. Material and Methods

2.1. Collection of Baseline Data

Baseline data regarding hospital waste management system in Peshawar City was collected through conducting site visits, interviews with hospital officials, hospital survey, review of existing guidelines and regulations pertaining to the hospital waste management etc. Major wards of (04) government (02) private hospitals, rural health centre and Basic health unit were choose for obtaining the data for the development of integrated hospital waste management system in Peshawar city

2.2. Quantification & Segregation of Hospital Waste

Waste quantification was carried out in various government and private hospitals of Peshawar city. To quantify the waste in the wards of these hospital facilities, segregation as risk and non-risk waste was made in different polythene bags

2.3. Analysis of Existing HWM

Analysis of current hospital waste management practices such as waste segregation & reuse, waste minimization , onsite & offsite storage, internal collection & transport system, treatment & disposal options, health and safety of workers, emergency action plan and waste management plan was done for selected government and private hospitals. This entire practice was done keeping in view the future extension in collection and disposal facilities.

2.4. Development of Integrated HWM System

After the study of the existing system, relevant literature, rules, guidelines and current practices of different hospitals in Pakistan, an integrated model hospital waste management system was devised and most feasible option was proposed for proper disposal of hospital waste.

3. Existing HWM Scenario in Peshawar

There are 16 government and 74 private hospitals in Peshawar city which are the main sources of generation of hospital waste. In government hospitals, condition of hospital waste management is very poor and not upto the mark. Hospital waste is dumped with other waste in an ordinary manner. No proper approach is followed for collection of hospital waste, segregation of waste as risk and non-risk waste, internal transportation, storage and treatment & disposal of waste. Generation rate in government hospitals varies from 0.4 to 2 kg/day/bed. However, in private hospitals it lies between 1.72 to 1.92 kg/day/bed.

Hospital waste generated from these facilities are collected, stored and disposed along with municipal waste. Many hospitals in whole city do not have proper arrangements for the safe disposal of hospital waste. However in some hospital segregation was done and segregated non risk waste is transported to designated Peshawar Development Authority (PDA) dumping site and rest of the risk waste was incinerated within the premises of hospital. The radioactive waste produced in IRNUM hospital is stored at an on-site storage facility. Daily waste log was also maintained only for radioactive waste to make sure the control movement of radioactive waste to on-site storage facility. After completing four to five half -life of radioactive waste, radiations are monitored through survey meter provided by the Pakistan Nuclear Regulatory Authority (PNRA). Many hospitals dumped their waste in open space causing air and land pollution. In most of the hospital trash trolleys are used for the collection and internal transportation of hospital waste. There is no waste minimization techniques used in the government and private hospital facilities of the City for segregation of recyclables such as packaging material etc. in order to minimize waste at source.

Health and safety of workers dealing with hospital waste. There is no concept of emergency action plans in case of spillage of chemicals or injury to the staff/ waste handler in all the hospitals

Incinerators are provided by TMA at various designated sites where the hospital waste collected is burned along with the municipal waste, however, these incinerators are not fulfilling statutory requirements and emission standards. Health and Safety of workers is also not up to the mark; no gloves, face masks, industrial aprons, leg protectors, and industrial boots are available for protection of workers dealing with hospital waste. Immunization of workers is also not being practiced in these hospital facilities. There is no concept of emergency action plans in case of any incident or injury to the staff/ waste handler in all the hospitals.

4. RESULTS AND DISCUSSION

For the development of integrated hospital waste management system in Peshawar city major wards of (04) government (02) private hospitals, rural health centre and Basic health unit wereselected. In Lady Reading Hospital (LRH), Pulmonary (A+B), surgical ward (male) and orthopaedic ward (male) were studied. Figures 5.1shows waste segregation practice in LRH. The total waste from these wards were 29.5 kg/day, 13.7 kg/day and 9.3 kg/day respectively. The quantity of risk waste produced in these wards is 6.4 kg/day, 2.7 kg/day and 1.8 kg/day and non-risk waste is 23.1 kg/day, 11 kg/day and 7.5 kg/day respectively. In Hayatabad Medical Complex medical

ward, orthopaedic ward and causality were studied. The total waste from these wards is 15.9 kg/day, 18.3 kg/day and 29.4 kg/day respectively. The quantity of infectious waste produced in these wards was 4.5 kg/day, 3.9 kg/day and 21.6 kg/day and non-infectious waste were 19.5 kg/day, 14.4 kg/day and 7.8 kg/day respectively. The total waste produced in nuclear medicine department of IRNUM hospital is 9.1 kg/day. The quantity of risk waste produced is 3.3 kg/day and non-risk waste is 5.8 kg/day. Similarly for private hospitals data collected and risk and non-risk waste generated from the wards of government, private, rural health centre, and basic health units are summarized in Table 1 below

Table1: Quantification of Risk/Non-Risk Waste Generated/Day From The Wards Of Different Hospital Facilities

Name of the Hospital	Name of the Ward	Waste Type		
		Risk (kg/day) (Pathological, Sharps, Pharmaceutical waste, Chemical Waste)	**Total Non-Risk Waste kg/day**	**Total waste Kg/day**
Government Hospitals				
Lady Reading Hospital	Pulmonary (A+B)	6.4	23.1	29.5
	Surgical Ward B (Male)	2.7	11	13.7
	Orthopedic (Male)	1.8	7.5	9.3
Hayatabad Medical Complex	Medical Ward	4.5	19.5	15.9
	Orthopaedic Ward	3.9	14.4	18.3
	Casualty	21.6	7.8	29.4
IRNUM Hospital	Nuclear Medicine Department	3.3	5.8	9.1
Khyber College of Dentistry	All wards & OPD's	36.6	26	62.6
Private Hospitals				
Rehman Medical Institute	Cardiology	9.6	18.3	27.9
	Department of Surgery	31.2	10.8	42.00
	Pead Ward	22.8	32.4	55.2
Kuwait Teaching Hospital	Medical Ward	3.6	17.4	21.00
	Surgical Ward	2.7	15.1	17.80
	Operation Theatre	7.5	5.5	13.00
Rural Health Centre	Operation Theatre	2.4	1.5	3.9
Basic Health Unit	Out Patient Department	0.7	0.8	1.5

There are 16 government and 74 private hospitals in Peshawar city. Moreover there are 03 rural health centres and 48 basic health units which are working in Peshawar city. Based on the above survey the waste generation rate calculated for government hospital is 0.45 kg/bed/day, private hospitals 0.33 kg/bed/day, rural health units is 0.24 kg/bed/day and for basic health units it is found to be 0.7 kg/bed/day.

Thus the total waste generated from all hospital facilities located in Peshawar city is calculated to be 2665.80 kg/day which is summerized in Table 2

Table 2: Risk Waste Generation in Hospital Facilities in Peshawar

Sr. No	Type of Healthcare Facilities (A)	Number (B)	Total Bed Strength (C)	Risk waste (kg/bed/day) (surveyed values) (D)	Total Risk waste (kg/day) (C x D= E)
01	Government Hospitals	16	4090	0.45	1840.50
02	Private Hospitals	74	2378	0.33	784.74
03	Rural Health Units	03	29	0.24	6.96
04	Basic Health Units	48	48	0.7	33.60
Total			**6545**		**2665.80**

The waste generation has been projected for the design period of 15 years. It is estimated that after 15 years in 2029, the population will be increased up to 5.56 million with a growth rate of 3.56% [10]. Currently, total numbers of beds available for a population of 3.29 million in all the hospital facilities of Peshawar City are 6,545. Assumption has been made that number of beds in all hospital facilities will increase upto 11,116 in next 15 years at same growth rate. Based on the methodology adopted for calculation of infectious waste, average waste generation rate is 0.73 kg/bed/day. Accordingly, the waste generation for the design period has been worked out to be 8114.68 kg per day.

5. Recommendations

The following recommendations regarding integrated hospital waste management system have been proposed on the basis of analysis of existing system, literature review, rules and legislations regarding hospital waste management, survey of hospitals and environmental consideration like local climate, physical, economic and social factors. These recommendations are as follows:

- The centralized hospital waste Management system has been proposed for managing the hospital waste generated from government and private sector for Peshawar city under relevant Government Department i.e Environmental Protection Agency (EPA), and Health department Government of Khyber Pakhtunkhwa.
- In all the hospital facilities, waste bags will be weighed and data will be maintained about risk and non-risk waste generation separately for the evaluation of HWMS.
- For storage and disposal of sharps & syringes, new standardized sharp containers are proposed.
- It is recommended that segregation at source should be done at all the hospital waste for which number of bins is proposed for various government hospitals, private hospitals, rural health centres and basic health units as shown in Table 3.
- A standardized system of onsite storage is proposed. Risk and Non-risk waste bins will be provided both inside and outside the wards for hospital waste segregation. Also, for this purpose white, blue and yellow plastic bags are proposed for storage of general waste, recyclables and infectious/risk waste respectively.

Table 3 Detail of proposed waste bins and sharps container for onsite storage of risk waste, non-risk waste, recyclables and sharps

Sr. No.	Hospital Facilities	No . of beds	In Wards		Outside Wards		Proposed No. of Sharps Containers
			Proposed No. of Non-risk Waste bins (10 L)	Proposed No. of Risk Waste bins (10 L)	Proposed No. of risk waste bins (100 L)	Proposed No. of waste bins for recyclables (100 L)	
1	Government Hospitals	4090	4090	4090	82	82	136
2	Private Hospitals	2378	2378	2378	48	48	79
4	Rural Hospital Units	29	29	29	1	0	1
5	Basic Hospital Units	---	0	0	1	0	1
6	Dispensaries	29	29	29	1	1	1
7	TB Clinic	52	52	52	1	0	1
Total		**6,578**	**6,578**	**6,578**	**134**	**131**	**219**

- Risk waste from all the private and government healthcare facilities will be transported in covered truck to central storage area for treatment. It is proposed that there should be 04 no. of vehicles which will collect waste from government, private, rural health centres and basic health units on daily basis. It is proposed that out of 04 vehicle 02 vehicles will collect waste from government hospitals and 02 vehicles will collect hospital waste from remaining hospital facilities.
- Central storage facility is proposed to be constructed in Peshawar under Peshawar Development Authority. The storage facility will have a non-permeable floor surface. Different area(s) will be designated for storage of general waste, sharps container, infectious waste and recyclables
- The risk waste from all the healthcare facilities will be treated by incineration in a common treatment facility. After treatment, the treated waste (ash) will be disposed off through regular municipal solid waste disposal methods in a landfill site or onsite ash pits specially designed for the proposed incineration system. The incinerator will be pyrolytic type with air controlled equipment's, operated at 800kg/ hr for the 10 hours. Major specifications has been shown in Table 4

- **Table 4 Specification of proposed Incinerator**

Description		
Quantity of Risk Waste to be treated	8114.68	kg/day
Operating Time	10	hrs/ day
Capacity	800	kg/hr
Moisture Content	30	%

Fuel Type		GAS
Type of Incinerator		Pyrolytic
Residence time		3 seconds
Standard design	1st Chamber	800 Celsius Pyrolytic System.
	2nd Chamber	1,000-1,200 Celsius Eliminate Pollution.
Primary Chamber should have following specification		
Thickness of steel plate (Furnace wall)		Not less than 8 mm.
Heat resistance		Not less than 1,000 Celsius
Primary & Secondary Air Fan (Blower)		1 Set
Start-up Burner		1 Set
Temperature Controller & Thermocouple		1 Set
Secondary Chamber should have following specification		
Temperature in the combustion chamber		800-1,200 Celsius
Thickness of steel plate		Not less than 8 mm.
Heat resistance		Not less than 1,200 Celsius.
Start-up Burner		1 Set
Temperature Controller & Thermocouple		1 Set

- An emergency action plan should be proposed to deal with accidental injuries. Wearing of high quality gloves and face masks will be made mandatory for the workers involved in collection of waste. Vaccination of all the workers will be carried out for safety purposes.
- Training and Awareness should be done among all the workers in hospital facilities for the better implication of this hospital waste management system
- A hospital waste management cell will also be established for monitoring of model healthcare waste management programme. Tree plantation will be carried out around the boundary wall of the proposed treatment facility to improve the environmental and aesthetic condition of the final disposal site**.**
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6. CONCLUSION

Several national and international laws and guidelines are present to cope with hospital waste generated from various hospital facilities but hospital waste management is still a problem of great concern due to lack of attention. The consequences of improper hospital waste management leads towards many environmental and public health issues which if not addressed can cause a great harm to the environment, workers of hospital and general public due to its infectious and pathogenic nature. However in this paper deficiencies in existing hospital waste management has been found and an integrated hospital waste management system is devised for Peshawar city which provide detailed guidelines and efficient management of hospital waste. It not only improve the current situation of HWM but also reduce the health and environmental effects posed by improper hospital waste management. This research will also aid other cities to develop an efficient hospital waste management system.

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