



Risk Characterization and Quantification of Medical Waste in Qom Province

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Abstract

The term healthcare waste includes all the waste generated within healthcare facilities, research centers, and laboratories of medical procedures. The purpose of this study was to determine the quantities and composition of waste generation and evaluate the hospital waste management and hazard analysis by preliminary risk analysis (PRA) in all hospitals in Qom province, Iran. Results showed that the production of sharp, pharmaceutical, cytotoxic, chemical, pathological, and heavy metals wastes is estimated to be 3.6%, 2.5%, 0.18%, 0.11%, 0.3%, and 0.01% of total wastes, respectively. Analysis and partitioning of heavy metal and cytotoxic waste was reported in this study. Events such as segregation and color-coded containers for pharmaceutical waste, especially cytotoxic waste and heavy metals, and unsupervised waste offsite transport in a hospital without safe facilities were identified as high-risk events. In addition, other events were identified as medium risk. Administrative procedures, maintenance, training treatment plant operators, and integrating training with public education on risks of healthcare waste are among the other issues that should be considered in providing strategies in hospital waste management.

Keywords: Qom; Waste; Risk; Assessment; Hospital

1 Introduction

Public interest in emerging and developing countries to improve health services is growing. In this regard, poor medical waste management within healthcare facilities have been challenged increasingly by several interest groups and communities (1). The term healthcare waste includes all the waste generated within healthcare facilities, research centers, and laboratories of medical procedures. Medical waste is highly "hazardous" and may pose a variety of environmental and health risks. Knowing the types and quantities of waste produced in a healthcare facility is an important first step in safe disposal (2, 3). Waste-generation data are used in estimating the capacities required for containers, storage areas, and transport and treatment technologies. Waste-generation data can be used to establish baseline data on rates of production in different medical areas and for procurement specifications, planning, budgeting, calculating revenues from recycling, optimization of waste-management systems, and environmental impact assessments (4). The aim of this study is the risk characterization and quantification of medical waste in public and private hospitals of Qom province (Iran) by a specific method to evaluate the composition of hospital waste and assess the health and environmental risks associated with medical waste management

2 Materials and Methods

The hospitals of Qom province include seven public hospitals (i.e., Kamkar, Shahid Beheshti, Forghani, Hazrat Masoomeh, ImamReza, and Izadi) and three private hospitals (i.e., Valiasr, Aliebn Abitaleb, and Golpaygani) that location of study area was shown in the figure1. In the first phase of the study, the quantities of waste generated in the hospitals were determined through a 30-day monitoring of the related data. For this purpose, waste records of eight categories of hospital waste components (i.e., infection, sharps, pharmaceutical, cytotoxic, chemical, heavy metals, and pathological and compressed containers) were considered. For all eight categories of waste, labeled sample bags were provided separately. The samples were daily collected and weighted using a digital mass balance. Considering the importance of health impact and environmental hazards of heavy metals and cytotoxic drugs in terms of fate and environmental behavior as well as different treatment and disposal methods depending on the physico-chemical properties of each of these compounds, the composition of cytotoxic waste and heavy metal is checked in this research. The quantity and composition of cytotoxic waste includes vials and cytotoxic drug residues as the most important part of cytotoxic waste was assessed in oncology wards of selected hospitals.



Figure 1: Location of Studied Area

Table 1: Risk Assessment Matrix

		Hazard Severity				
		No effect(1)	Minor(2)	Major(3)	Fatal(4)	Catastrophic(5)
Likelihood of occurrence	Very likely (5)	1	2	3	4	5
	Likely (4)	2	4	6	8	10
	Possible (3)	3	6	9	12	15
	Unlikely (2)	4	8	12	16	20
	Very unlikely (1)	5	10	15	20	25
Low risk 1-4		Medium risk 5-12			High risk 15-25	

The rate of generation and Percentage of heavy metals component (Cd, Cr, Cu, Hg, Zn and Pb) in the hospital's waste were determined, the composition analysis of waste containing heavy metals segregated into a plastic container and identification of heavy metals types was carried by the survey team who had experience in medical waste management. In the next stage, a questionnaire about medical waste management was prepared. This data collection tool, which was based on the order of the Iranian Ministry of Health, includes the process of waste management in the stage of segregation and storage, collection and transportation, treatment, and final disposal (5,6,7).

3 Risk assessment

In the second phase of the study, hazard analysis and risk assessment by using the preliminary risk analysis (PRA) were considered. This is a semi-quantitative technique for risk assessment based on the identification and ranking of potential hazards and risks related to all processes of medical waste management. The level of risk is according to the multiplication of severity and likelihood criteria, presented in Tables 1 and 2 (8, 9).

Table 2: Severity of Consequence Criteria

No effect	Has no effect on health
Minor	Minor injury
Major	Injury
Hazardous	Serious or fatal injury
Catastrophic	Death

4 Results and Discussion

Waste estimation of the hospitals was performed according to eight types of medical waste. The average daily medical waste generated in the hospitals of Qom province are presented in Table 3. These data are shown according to the number of each hospital from 1 to 10, in the order of the hospital listed in the previous section. The results of waste generation in hospitals show that about 2363 kg/day medical waste is produced and, accordingly, the rate of hospital waste generation per bed is 1.2 kg/bed/day. About 93% of the province's special medical waste is dedicated to the production of infectious waste. Other results also showed that the production of sharp, pharmaceutical, cytotoxic, chemical, pathological, and heavy metal wastes is 3.6%, 2.5%, 0.18%, 0.11%, 0.3%, and 0.01% of total wastes, respectively. The findings of this study are like those of Ghafuri and Naizadeh about the composition and quantity of cytotoxic waste from oncology wards. They showed that the mean production rate of medical waste in two hospitals of Qom province was 1.73 kg/bed/d, including 92% infection waste (1.67 kg/bed/d), 2.5% sharp, 5% pharmaceutical waste, and cytotoxic waste was 293.5(gr/d), which is equal to 0.07% of total medical waste generation (4). Compared with these studies, other reports from Iran showed different results. Farzadkia et al. reported hospital waste as 2.3 Kg/bed/day; Askarian et al. reported a medium rate of 8.025 Kg/bed/day at private hospitals of Shiraz, Iran; Alimohamad et al. estimated a medium rate of 4.38Kg/bed/day at Shariati Hospital of Tehran; Overall, these results show that medical waste rates vary widely and must be estimated by local measurements (10,11,12). Results about partitioning of

heavy metals and cytotoxic drugs in hospital wastes is indicated in Figure 1 and 2. Figure 1 demonstrated that the highest percentages of ferrous metals in hospital wastes in Qom province are related to Zn and Cu however, other amounts of Hg and P are also not negligible. This result is comparable with study results of Liu et al. about Characteristics and evaluation of heavy metals concentration

in the Medical Waste Incinerator Fly Ash (13). Results of Partitioning of cytotoxic drugs in Figure 3 show that maximum percentage of drug cytotoxic wastes is related to Cyclophosphamide. The results of the risk analysis of hospital Waste Management in hospitals of Qom province are shown in Table 4.

Table 3: Average Daily Generation (kg/day) of Hospitals Waste in Qom province

Hospital No	Beds Number	Infection	Sharp	Pharmaceutical	Cytotoxic	Chemical	Heavy metals	Pathological	Pressurized Container
1	234	240	5.5	1.7	-	-	-	-	-
2	540	400	24	12	2.5	0.18	-	0.006	0.12
3	245	300	8.4	6	-	-	-	0.0025	-
4	158	167	8.5	6.7	0.16	1.5	0.012	-	-
5	110	233	5.8	7.5	-	0.2	-	4.5	0.09
6	100	263	5.6	4	-	-	0.27	0.0026	-
7	110	90	7.5	4.1	-	-	-	-	0.02
8	158	187	4.3	3.6	1.7	0.5	-	1.33	0.035
9	118	95	8.68	9.15	-	0.2	-	1.26	-
10	233	224	6	4.41	-	-	-	-	-
total	2012	2200	85	59	4.36	2.63	0.282	9.55	0.255

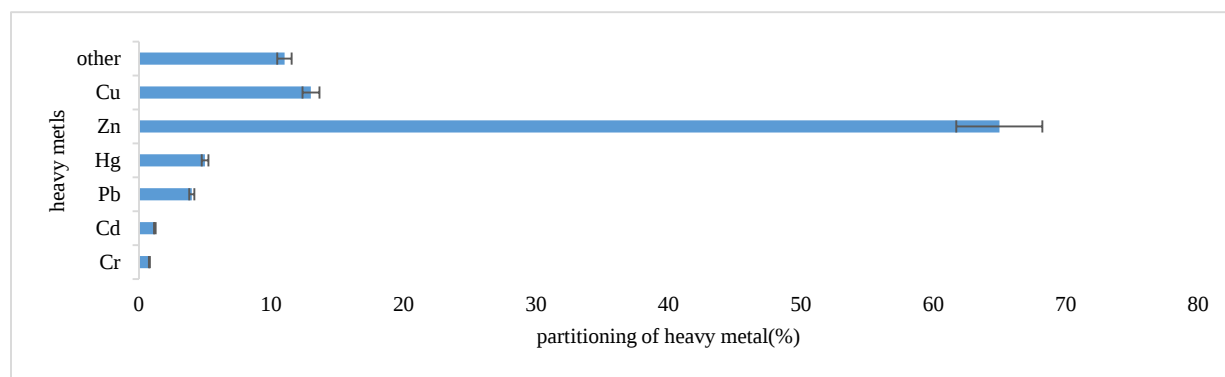


Figure 2: Partitioning of heavy metals in hospital wastes (%)

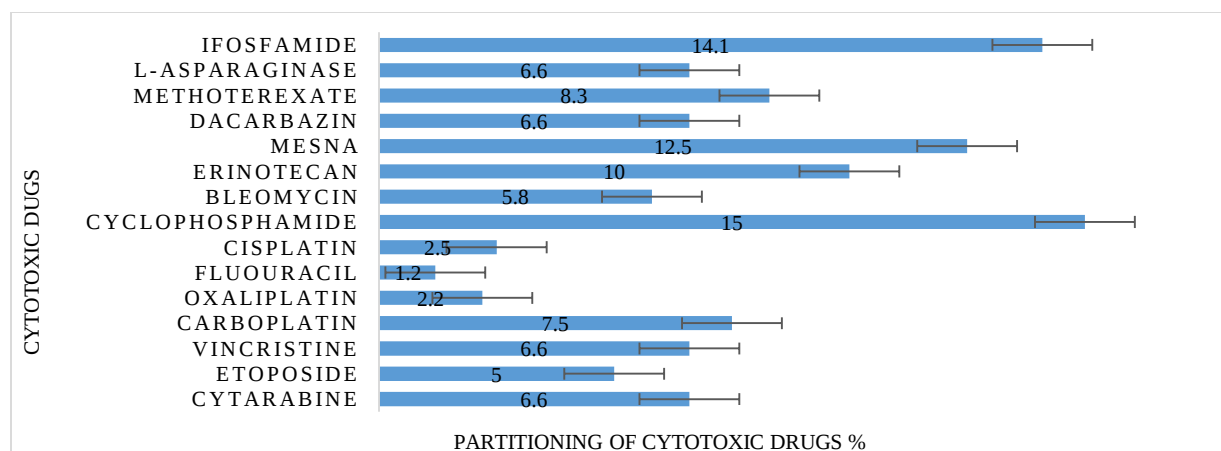


Figure 3: Partitioning of cytotoxic drugs in cytotoxic wastes (%)

Table 4: Risk Analysis of Hospital Waste Management

Stage of waste management	Events	Hazard Identification	Control of Risk	Risk Analyze		
				Likelihood	Severity	Risk
Segregation and Storage	Segregation and color-coded containers for pharmaceutical waste especially cytotoxic waste and heavy metals is not predicted	- Hazards from genotoxic and cytotoxic waste - hazard from heavy metals - Incidence of contamination by biohazards	-pharmaceutical and cytotoxic waste should be separated and stored carefully away from other waste - Modification and improvement of Interim storage sites with the national regulation	4	4	16
	Interim storage does not comply with the national regulation			3	3	9
Collection and Transport	Lack of planning and forecasting of collection routes in hospital unit	- The spread of infection in the sensitive area of hospital and increase risk of disease - Unsupervised waste management poses a high risk of disease transmission among health-care workers, waste workers and the general public	-Collection routs of waste must be start from the most sensitive areas and follow a fixed route around other medical areas and interim storage locations -Waste containers, trolleys and vehicles are maintained and cleaned regularly. - Develop active monitoring program for offsite transport of waste	3	4	12
	Transport trolleys Are not appropriately sized according to the volumes of waste generated and periodically disinfected.			3	3	9
	Unsupervised waste offsite transport in hospital without safe facilities			4	4	16
Treatment and Final Disposal	location and surroundings of the treatment site and disposal facility is not appropriate	-Spread of contamination and health threats -Survival of pathogenic microorganisms and increase of needle stick for worker and public	- Development of a hospital waste management plan that should comply with national regulations - Treatment plant operators - Cleaning staff - Employees to be trained	3	3	9
	Improper disposal of sharps In hospitals without disposal facilities			4	3	12
	Lack of sufficient knowledge in the operators of disposal facilities			3	3	9

The risk assessment process reported in this table relates to each of the waste management processes including segregation and storage, collection and transportation, treatment, and disposal; however, the waste management situation investigated in the hospital did not comply with Iranian regulation. Based on the results, events including segregation and color-coded containers for pharmaceutical waste (especially, cytotoxic waste and heavy metals) and unsupervised waste offsite transport in a hospital without safe facilities were identified as high-risk events and other events were identified as medium risk. According to the results of Farzadkia et al. about Management of Hospital Waste in Tehran, Iran, conditions of waste storage systems

and collection planning were unsuitable; also, the reported results are consistent with the present study (11). Moreover, the study of Mansouri on the preliminary hazard analysis as a tool for risk assessment of sari hospital waste indicates the high risks in the hospital waste management system [14,15]. In another study, Sefuhi conducted a risk assessment on the healthcare waste in the Hospital of Batna City (Algeria). According to the results of the preliminary hazard analysis and Risk Assessment Matrix, this researcher reported that sharps, infectious waste, and human anatomical waste are in the area of high risks. This result is different from the results of this study. However, it is consistent with the results of a study of Alwabr with the subject of medical waste in

hospitals of Yemen, where it was reported that the events of waste handling processes were in high-risk levels by the PRA analysis technique (8,9).

5 Conclusion

Based on the results of the present study, setting a plan that involves a strategy for implementing improved waste management and the allocation of roles, responsibilities, and resources is of high necessity. Such a plan would lead to developing a policy on regional and cooperative methods of healthcare waste treatment with considering minimization, separation, handling, transport, treatment, and final disposal (16). One of the important results of this study is the composition of hospital waste and heavy metal content and the genotoxicity of oncology wastes released into the environment (17). Administrative procedures, maintenance, training treatment plant operators, and integrating training with public education on risks of healthcare waste are among the other subjects that should be considered in providing strategies in hospital waste management.

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