

ASSESSMENT OF MEDICAL WASTE MANAGEMENT IN EDUCATIONAL HOSPITALS OF TEHRAN UNIVERSITY MEDICAL SCIENCES

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Received 12 December 2007; revised 13 February 2008; accepted 10 March 2007

ABSTRACT

The management of medical waste is of great importance due to its potential environmental hazards and public health risks. In the past, medical waste was often mixed with municipal solid waste and disposed in residential waste landfills or improper treatment facilities in Iran. In recent years, many efforts have been made by environmental regulatory agencies and waste generators to better managing the wastes from healthcare facilities. This study was carried in 12 educational hospitals of Tehran University of Medical Sciences. The goals of this study were to characterize solid wastes generated in healthcare hospitals, to report the current status of medical waste management and to provide a framework for the safe management of these wastes at the considered hospitals. The methodology was descriptive, cross-sectional and consisted of the use of surveys and interviews with the authorities of the healthcare facilities and with personnel involved in the management of the wastes. The results showed that medical wastes generated in hospitals were extremely heterogeneous in composition. 42% of wastes were collected in containers and plastic bags. In 75% of hospitals, the stay-time in storage sites was about 12-24h. 92% of medical wastes of hospitals were collected by covered-trucks. In 46% of hospitals, transferring of medical wastes to temporary stations was done manually. The average of waste generation rates in the hospitals was estimated to be 4.42kg/bed/day.

Key words: Medical waste, transportation, treatment, management, healthcare hospital

INTRODUCTION

Medical waste includes materials that are produced in the course of health protection, medical treatment and scientific research; it forms a separate category of medical or health care waste (Republic of Croatia, 1996b and 2004; Capak, 2001; Ropeik and Gray, 2002). However, it seems that the fraction of waste generated at medical institutions, known as special or regulated medical waste (Lee *et al.*, 2004) or otherwise known as clinical waste (WHO, 1994), has not attracted the same level of attention as other types of wastes, particularly in developing countries, despite the fact that medical waste is labeled as hazardous because it poses serious and direct threat to human health (Coad, 1992; WHO, 1999).

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In Iran, as in many other developing countries, no proper and efficient rule has been compiled as yet and also there is no useful information about medical waste management.

In this article the results of a survey on medical wastes in hospitals supported by Tehran University of Medical Sciences (TUMS) in 2007 are presented of generated amount hospital wastes, the condition of waste segregation, the type of storage containers, the temporary storage area, collection procedures, on-site transport and treatment of wastes, off-site transport and disposal of hospital wastes were studied and finally the type of training provided to hospital personnel, and the type of sewerage system used at hospitals were assessed. At the end, measures for improvement of present conditions and solving the identified problems were suggested.

MATERIALS AND METHODS

Data collection

The data gathered were based upon a 10 page questionnaire distributed to 12 hospitals. Questionnaires were used to survey the hospital wastes in terms of collection, transportation, segregation, treatment and disposal and to collect available information for analysis of the system.

Sampling and analysis

The collection of clinical waste samples and analysis were carried out in 2007. The waste characterization study was carried out in accordance with WHO guidelines (WHO 1999; WHO 2001). All of the wastes generated in 12 hospitals were segregated and weighed during a period of one month, manually.

The environmental health experts as well as members of nosocomial infection control committee of hospitals or managers of waste transportation, collection and sorting, recorded the amount of medical waste on the data form. The wastes from hospitals were collected from storage areas. The quantity and composition of the wastes were determined at each hospital.

Parallel to the interviews, the physical compositions of waste in hospitals were determined. Before segregation, The wastes were spread by disinfectant solution (0.5% sodium hypochlorite). Masks and large forceps were used to segregate waste into several types. During segregation, each type of medical waste was discarded into bags. General and medical wastes from outpatient and inpatient services were collected separately. The weighing and analysis of wastes were performed in a special site. The medical wastes were previously sorted into various components such as serum, syringe and needle etc. The weight of each component of the medical waste was recorded on special data forms. Following these procedures, the wastes were transported to a special site for storage and final disposal. This waste composition study was part of a continuing effort to measure and understanding the waste generated in hospitals. The raw survey data was compiled and managed so as to enable the estimation of waste generation quantities and management practices.

Data analysis

The quantities of hospital wastes were presented in terms of kg/day for total amount of waste generation. These data were used to determine the quantities of waste generated by each type of hospital. The data gathered from the questionnaire were compiled with a computer and were analyzed using statistical excel and SPSS software.

RESULTS

Hospitals status

All educational hospitals of the Tehran University of Medical Sciences are situated in Tehran. Table 1 shows the specification of hospitals.

Hospital waste generation

Wastes generated in various activities carried out in the hospitals can be classified into cultures and stocks of infectious agents, pathological, blood and other fluids, sharps and surgery wastes, laboratory, food preparation, radioactive wastes, dialysis, cobalt therapy, biological wastes, cardboard, paper documents and discarded linens categories.

The total amount of waste generation rate in all hospitals was 13000-13500kg/day and the average of waste generation rate in the hospitals was estimated to be 4.42kg/bed/day.

Hospitals waste composition

The waste composition of the hospitals is shown in Fig. 1. In 42% of hospitals, hazardous chemical wastes were generated that consisted of halogen hydrocarbon (17%), radioactive (33%) and others (50%). The percentage of medical waste composition in some hospitals is shown in Table 2.

Kinds of hospitals waste and containers

This study revealed that some amount of hazardous waste is stored in the same containers as the domestic wastes and no control measures exist for the management of these wastes. The results showed that in 58% of hospitals, paper and household wastes were segregated from total medical wastes and in 96% of hospitals infectious wastes were segregated. All the hospitals had provided plastic bags and strong plastic containers for infectious waste such as empty containers of antiseptics used in the hospitals. In 58% of hospitals, infectious wastes were segregated from other wastes. The 42% of hospitals used both

Table 1: The specification of studied hospitals

Hospital Code	Departments	Active Beds	Hospital activity	Total amount of waste generation (kg/day)
A	27	477	public	1800
B	13	599	public	1800
C	14	150	public	500
D	7	120	public	100
E	8	142	public	170
F	8	198	public	130
G	28	528	public	2500
H	3	95	public	100
I	7	120	public	1000
J	7	200	public	130
K	2	51	public	120
L	8	106	public	2100

Table 2: The percentage of medical waste composition in some hospitals

Hospital code	Paper and Cardboard	Plastic and Serum	Glass	Textile	Organic waste	Metals	Sum
A	20	35	4	10	30	1	100
E	10	20	20	10	38	2	100
H	10	35	5	25	20	5	100
K	20	25	9.8	15	30	0.2	100
L	12	31	1	20	35	1	100

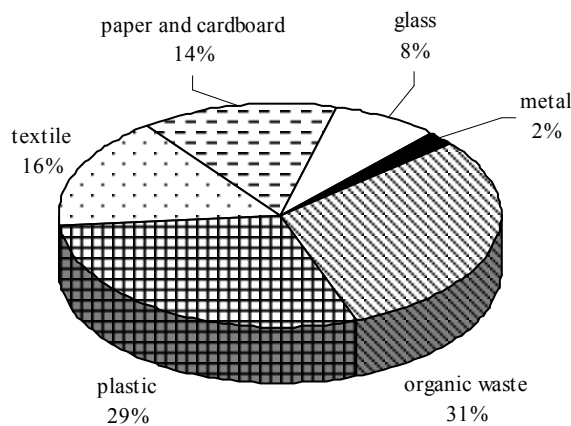


Fig. 1: The waste composition of studied hospitals

plastic bags and containers, 28% use only plastic bags, 17% used only plastic containers and 16% used only paper and textile bags for storing their household wastes. Among the hospitals included in this study, 50% chose yellow, 17% selected blue, 8% selected red and 8% chose white as the color for infectious waste containers. In general, in most of the hospitals, suitable and adequate numbers of containers were used and are kept at proper places.

Waste collection methods and time duration

In 58% of hospitals, the wastes were collected at the end of each shift at 8:00am., 4:00pm. and

12:00pm. At the end of each shift, hospital wastes were collected and transported to a temporary storage area by hospital staff. In 17% of hospitals, medical wastes were collected daily and in 25%, the collection program was unsteadily. The medical wastes were collected by trolley or manually. In 46% of hospitals these wastes were collected by trolley in 46% manually and in 8% both systems were applied. The staff employed for handling the wastes in all hospitals used almost complete personal protective equipment (the protective equipment included special dress, shirt and trousers along with at least two of the following: gloves, mask, boots, and apron).

Temporary storage site

In all studied hospitals, there were temporary storage sites. The distance between these sites to the nearest department was about 10-100m. These sites included metal containers (10%), concrete rooms (10%), special rooms (30%), used barrels (10%) and open enclosure sites (40%). The infectious and non-infectious wastes were kept in separate containers and were not mixed in the hospital's temporary storage area. Only 67% of hospitals had a well sanitized and secured temporary storage area and the others (33%) had well secured but poorly sanitized temporary storage areas. The storage time in those sites were 12-24h (75%) and 24-48h (25%).

Off-site waste transportation

The off-site waste transportation from hospitals was done by Tehran municipality and personnel were well instructed about collection and transportation. There were good facilities for medical waste in 75% of hospitals, but in 83% of them, there were no control on transportation processes. Several ways were used to carry the medical wastes to vehicles: manual (17%), spade (17%), loader (8%) and others (58%). The medical wastes were transported daily by covered trucks (92%) and pickups (8%).

Treatment and final disposal of waste

No incinerator for medical waste was in the hospitals; but as shown in Table 3, some waste

recycling in hospitals were done. All hospitals disposed of their domestic waste at the same site as the municipal waste, and the medical wastes were buried in landfills. The 33% of hospitals had treatment facilities for hazardous wastes but the equipment that are needed for emergency situations were found only in 17% of hospitals. Wastes from all hospitals were transported to a Tehran landfill area (Kahrizak landfill), purpose, located about 30km away from the city. Radioactive wastes from all hospitals were collected and disposed off by the Atomic Energy Organization. Liquid pharmaceutical and chemical wastes were poured into the sewage system in all hospitals.

Table 3: The amount of recycled and not recycled wastes of medical wastes

Kind of waste	Recycled		Not recycled		Sum	
	Sample No.	Amount (%)	Sample No.	Amount (%)	Sample No.	Amount (%)
Paper and cardboard	8	67	4	33	12	100
Lamp	5	42	7	58	12	100
Battery	3	25	9	75	12	100
Plastic	5	42	7	58	12	100
Thermometer	4	33	8	67	12	100
Barometer	1	17	11	83	12	100
Metal cans	5	42	7	58	12	100
Syringe and needle	2	17	10	83	12	100
Glass	5	42	7	58	12	100
Radiology photograph	5	42	7	58	12	100
Textile	4	33	8	67	12	100
Others	4	33	8	67	12	100

Control measures

Some control measures were used in hospitals of TUMS for medical waste management:

- Control of container carrying to storage site (19%)
- Providing materials that were needed for collection and transportation (19%)
- Proper changing of medical waste bags (25%)
- Direct controlling of waste collectors (18%)
- Overload prevention of wastes (18%)
- Monitoring of disposal processes (1%)

Labor safety and training programs

Some of the hospitals had provided the following essential equipments for the safety of employees, housekeeping employees, in-patients and out patients:

- Protective clothing for personnel who handled

the wastes (100%)

- Disinfection or autoclave facilities for disposables and reusable for pretreating certain types of wastes (0 %)
- Health surveillance of labors (25%)
- Existing of environmental health department (58%)
- Medical waste experts (33%)

The hospital personnel were trained about handling and management of medical wastes, infection control and protection, hospital personnel and protection against medical waste hazards, e.g., Hepatitis B and C, AIDS, and Typhoid. 15% of managers, 45% of nurses and 40% of labors were trained about medical waste disposal. The training methods consisted of lecturing (29%), workshop (32%), brochure (7%), slides and clips (7%) and

face-to-face training (25%). The training programs have been conducted by environmental health specialists that work in hospitals or NGOs.

Sewage treatment system

Some of the hospitals had sewage treatment system prior to disposal. In 60% of hospitals, sewage was transported into absorbent wells and in 30% of hospitals, the sewage was treated by facilities located inside the hospitals. In others, sewage was discharged into the near streams.

DISCUSSION

In 1990, a study that was conducted on medical waste of Semnan province showed that the average generation rate of medical waste in hospitals is 0.8-1.8kg/bed/day (Nouri Sepehr, 1990). In a study performed in 1991 in hospitals of Tehran, the waste generation rate was reported to be 2.71kg/bed/day (Mohammadi-Baghaee, 2000). The waste generation rate in Dar es Salaam (Tanzania) hospitals in 1993 was reported to be between 0.84 and 5.8kg/bed/day (Mato and Kaseva, 1999). In 1996, a study showed that the average generation rate of hospital waste was 3.9kg/bed/day in Fars province (Askarian and Vakili, 2001). In khoozestan province, a study in 1996 showed that the total number of beds in that province was 3537 and the average generation rate of hospital waste was 2.38kg/bed/day (Amouee, 1996). In 1996, a study performed on Tehran hospital waste and showed that the average generation rate of hospital waste was 2.87kg/bed/day. This study showed that in 89.5% of hospitals, the storage time was 24h and Tehran Municipality was the responsible for medical waste transportation (Karimzadegan, 1996). According to WHO report in 1999, average generation rate of Teaching hospital waste was 4.1-8.7kg/bed/day (WHO, 1999). In a study that was conducted on medical waste of Shiraz province in 2001, revealed that the average generation rate of hospital waste was 3.93kg/bed/day (Askarian and Vakili, 2001). A study was conducted in 2001 on hospital waste in Mazandaran province and showed that the average generation rate of hospital waste was 1.1-1.3kg/bed/day. Also, this study showed that the medical waste was carried to temporary storage site manually in 45% of

hospitals and in others, those carried by trolley (Mohseni, 2001). Another study was conducted for medical waste of Mashhad province in 2001 and showed the average generation rate of hospital waste was 1.67kg/bed/day (Sadeghi, 2001). A study on medical waste of Fars province showed that the waste generation rate was 4.45kg/bed/day (Askarian *et al.*, 2004). In 2005, a study on medical waste of Rasht city showed that the average generation rate of hospital waste was 1.67kg/bed/day (Ashrafi, 2005). A study that was conducted on Medical waste of Jordan showed that the waste generation rate was 3.49kg/bed/day for public hospitals (Bdour, 2007). So, the average generation rate of medical waste in this study is more than other provinces in I.R.Iran, but is corresponded with WHO guidelines. A study that was conducted on UK (United Kingdom) hospitals showed that 80% of hospitals have used yellow, heavy-duty, high-density polyethylene (HDPE) containers (Blenkharn, 2006), while in this study, 17% of hospitals have used plastic containers. In a study that was conducted on European hospitals showed that there were incinerators for Hospital waste disposal (except Sabadell Hospital), while in this study there is no incinerator in any hospital (Muhlich *et al.*, 2003). It seems that the studied hospitals need a disposal process to better manage the hospital waste and especially infectious waste.

The following discuss some of the problems and procedures associated with medical wastes of TUMS:

- Lack of comprehensive waste disposal plans for the disposal and technical aspects of hazardous wastes.
- Lack of treatment facility such as incinerator or autoclaves for treatment of pathological and infectious wastes.
- Lack of continuous on the segregation, collection, transportation and final disposal of infectious and other medical wastes.
- Lack of knowledge and awareness among the personnel in hospitals about the consequences of the potential risk of infectious, hazardous waste and environmental impact.
- Lack of proper guidelines, legislation, regulations and instructions on health care waste management such as segregation, collection and

disposal of various categories of wastes in suitable manner to render it harmless.

-Disposal of liquid waste into the municipal sewerage system without any prior treatment.

In hospitals of TUMS:

-The basic approach to medical waste management is to reduce the quantity of waste at source as far as possible. Hospital wastes should be recycled whenever feasible, with due regard to environmental aspect, to reduce the quantity of material entering the waste system.

-Waste management requires a system approach, involving the handling, storage, transport; treatment and disposal of waste by methods that at all stages minimize the risk to health and the environment.

-All hospital personnel should be made aware of the potential risk of mishandling waste. This study has created awareness regarding the magnitude of the problem of waste management in hospitals of TUMS and has generated interest for systematic control efforts for hospital waste disposal. Hospital waste management cannot succeed without the willing co-operation and participation of all categories of personnel.

ACKNOWLEDGEMENTS

We would like to thanks staff of hospitals and Mrs. Zahra Poormardi and Mrs. Nassibeh Dinari for their cooperation in Tehran University of Medical Science for this research.

REFERENCES

Amouee, I., (1996). Evaluation of hospital waste collection, transportation and disposal in Khoozestan province. Tehran, Iran: MS Thesis of environmental health engineering of Tarbiat Modarres University.

Askarian, M., Vakili, M., (2001). Evaluation of medical waste disposal in Fars province. *Med. Res.*, **1**: 41-53.

Askarian, M., Vakili, M., Kabir, G., (2004). Results of a hospital waste survey in private hospitals in Fars province, Iran. *Waste Manage.*, **24**: 347-352.

Ashrafi, D., (2005). Evaluation of medical waste management in Rasht city hospitals. Tehran, Iran: MS Thesis of environmental health engineering of Tehran University of medical sciences.

Bdour, A., (2007). Assessment of medical wastes management practice: A case study of the northern part of Jordan. *Waste. Manage.*, **27**: 746-759.

Blenkharn, J. I., (2006). Standards of clinical waste management in UK hospitals. *Hosp. Infect.*, **62**: 300-303.

Capak, K., (2001). Management of medical waste. Republic of Croatia: In Proceedings of annual meeting of sanitary inspectors.

Coad, A., (1992). Managing medical waste in developing countries, Geneva: World Health Organization-Report of a Consultation on Medical Wastes Management in Developing Countries.

Karimzadegan, H., (1996). Survey of hospital waste collection, transportation and disposal in Tehran province. Tehran, Iran: MS Thesis of environmental engineering of Azad University of Science and research.

Lee, B. K., Ellenbecker, M., Moure-Ersaso, R., (2004). Alternatives for treatment and disposal cost reduction of regulated medical wastes. *Waste. Manage.*, **24**: 143-151.

Mohammadi-Baghaee, D., (2000). Principles of Medical Waste Management, 1st Ed. Shaharab Company., 63-67.

Mato, R. R., Kaseva, M. E., (1999). Critical review of industrial and medical waste practices in Dar es Salaam city. *Resour. Conserv. Recy.*, **25**: 271-287.

Mohseni, A., (2001). Evaluation of medical waste collection, transportation and disposal in public and private hospitals in Mazandaran province. *J. Mazandaran. U. Med. Sci.*, **11**: 45-52.

Muhlich, M., Scherrer, M., Daschner, F. D., (2003). Comparison of infectious waste management in European hospitals. *Hosp. Infect.*, **55**: 260-268.

Nouri Sepehr, M., (1990). Evaluation of hospital waste in Semnan province. Tehran, Iran: In Proceedings of seminar of solid waste management and its health problems.

Republic of Croatia, (1996b). Regulations on waste types. Republic of Croatia: Official Gazette.

Republic of Croatia, (2004). Law on waste. Republic of Croatia: Official Gazette.

Ropeik, D., Gray, G., (2002). Risk. Houghton Mifflin Company, 158-163.

Sadeghi, A., (2001). Assessment of collection and disposal management of hospital waste in Mashhad city. Tehran, Iran: MS Thesis of environmental health engineering of Tehran University of medical sciences.

WHO, (1994). Management of Medical Waste. Jordan: WHO Regional Center for Environmental Health Activities (CEHA).

WHO, (1999). Safe management of wastes from health-care activities. Geneva: Switzerland.

WHO, (2001). Health care waste management. Rapid assessment tool for country level. 2nd draft.