

Medical Waste Management in the second largest City of Iran (Mashhad) with Three-Million Inhabitants

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ABSTRACT

Introduction: One of the first and important steps to improve medical waste management is awareness and monitoring of the quality and quantity of medical waste. The aim of this study was to determine the present status of waste generation and the process of waste management in hospitals.

Materials and Methods: This cross sectional study was performed in ten university hospitals in Mashhad. A standard questionnaire was prepared according to the National Health instructions and completed by the project team members who were environmental health experts.

Results: The total waste which was generated in the studied hospitals was 7683 kg/day. The study showed total waste generation in selected hospitals as (61.85%) general medical waste, (34.90%) infectious waste and (3.25%) sharp waste. The average generation rate for total, general, infectious and sharp waste was (2.6, 1.5, 1.01) and (0.08) kg/bed/day, respectively. Mean scores of the different steps of waste management process with respect to National Health instructions were as follows: waste segregation (64%), waste storage (67%), waste transportation (76 %) and waste treatment 63%. There was no significant difference between the average rate of waste generation per bed in public and specialized hospitals (P=0.34).

Conclusion: High rate of infectious waste shows the need for establishing executive rules and standards for medical waste management. Medical managers should update their knowledge and further educating their staff; implying careful and constant monitoring of waste management.

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Introduction

Health Care Waste (HCW) is a byproduct of health care. Waste management is considered as an important issue worldwide. Some types of these waste are more hazardous and life threatening than others. Waste management includes waste collection, packaging, storage, segregation, transport, treatment and disposal.

The amount of medical waste varies from hospital to hospital. Poor management of HCW exposes the community and the environment to infections, toxic and harmful injuries (1). Safe management of wastes is a responsibility of all. It will reduce the burden of disease and lead to savings in health expenditure.

Mismanagement of medical waste can spread infectious diseases like cholera, infectious hepatitis and

skin diseases (2). Many countries have mentioned and focused on waste problems (3- 12).

The most general sources of waste production in hospitals are Emergency, Intensive care and Maternity units, Pharmacy, Mortuary and Pathology laboratories (4, 13). Health care waste management options must be well planned and operated. Improper clinical solid waste management has direct and indirect effects on environmental pollution, health care workers and patients (14). Precise knowledge on waste quality and quantity, and supervision over its management is the first and most important step to improve medical waste management. Therefore the objective of this study was to clarify the present status of waste generation in

hospitals in Mashhad, Iran second city, and the process of waste management.

Materials and Methods

This cross sectional study was performed in 10

Table 1: Characteristics of the hospitals which were surveyed

Facility designation	No. Active beds/day	No Patients/day	No. wards	Description
A(General)	90	55	18	Located in a low to medium densely populated area and treats both general and specialized patients.
B(Specialized)	110	85	9	Located in a medium densely populated area and treats specialized patients.
C(Specialized)	120	84	11	Located in a low to medium densely populated area and it is a center for accident and emergency operations.
D(General)	790	640	48	Located in a high densely populated area and treats both general and specialized cases.
E(Specialized)	80	60	11	A specialized and educational hospital for women health, located in a high densely populated area.
F(Specialized)	110	88	13	Located in a medium densely populated area and offers specialized services for children.
G(General)	301	253	34	Located in a high densely populated area and has both general and specialized departments.
H(General)	852	647	18	Educational, Research and Treatment center, located in a high densely populated area and is the largest center among referral centers in the city (main central public hospital).
I(Specialized)	320	320	18	This educational and treatment center for trauma and emergency is located in a medium densely populated area and treats specialized patients.
J(Specialized)	60	48	5	The only specialized hospital research and training center for ophthalmology in the region, located in a medium densely populated area.

The survey was done in accordance to the National Health instructions for assessment of medical waste management in Iran. A standard questionnaire was prepared with respect to the National Health instructions. It consisted of two parts: general and specialized information about hospitals.

The specialized part was comprised of four sections as follows: 57 questions on medical waste generation (general waste, infectious waste and sharp waste) and its collection, segregation and packing process, ten questions on waste storage, nine on waste transportation and 24 questions on waste treatment. This questionnaire was completed by the project team members who were environmental health experts. The average daily generation rate and the average daily weight per bed and per patient for total, general, infectious and sharp wastes were calculated. Also, waste generation rate in main central public hospital in different departments including internal medicine, surgery, obstetrics and gynecology and pediatrics was surveyed. For evaluating waste management process includes collection, segregation, packaging, storage, transportation, treatment and safe disposal, Score one was allocated to the presence of enough evidence for adequately performing the mentioned processes, and zero score for the absence of such evidence. The data were analyzed by SPSS version 11 software.

niversity hospitals of Mashhad University of Medical Sciences, Mashhad, Iran. These hospitals were divided into two categories (general and specialized) based on their services (Table 1).

Results

The mean total waste generation rate in studied hospitals was estimated as (7683) kg/day (Table 2).

(61.85%) general medical waste, (34.90%) infectious and (3.25%) sharp waste. 38.15% of the waste was hazardous medical waste. As table 3 shows, the mean generation rate for total, general, infectious and sharp wastes were (2.6, 1.5, 1.01) and (0.08) kg/bed/day, respectively. It was (3.32, 1.91, 1.31) and (0.094) kg/patient/day, respectively. The correlation between the number of active beds and mean general and infectious waste generation rate was statistically significant respectively ($r=0.98$, $P<0.000$, $r=0.86/P=0.001$), but the correlation between the number of active beds and sharp waste was not statistically significant ($r=0.38$, $P=0.31$). Also, the correlation between the number of patients and the mean general and infectious waste generation rates was statistically significant, respectively ($r=0.96$, $P<0.000$ and $r=0.84$, $P=0.003$). However, it was not statistically meaningful for sharp waste ($r=0.39$, $p=0.29$). Table 2 shows waste generation per day in the studied hospital. The main central public hospital with 852 active beds and 647 patients per day had the highest rate of waste generation in one day. There was no significant difference between the average rate of waste generation per bed in public compare to

specialized hospitals (P=0.34). Highest infectious waste (1.87 kg/bed/day and 2.5 kg/patient/day) pertaining to the obstetrics and gynecology specialized hospital (Table 3). The highest rate of general waste was (2.15)

kg/bed/day and (2.65) kg/patient/day belonging to 790-bed public hospitals, a general hospital with a high admission rate per day (640 patients /day) (Table 3).

Table2: waste generation rate in each surveyed hospital

hospital	General waste(kg/day)	Infectious waste(kg/day)	Sharp waste (kg/day)	Total waste(kg/day)
A(General)	96.0	95.0	2.0	193.0
B(Specialized)	200.0	50.0	2.5	252.5
C(Specialized)	200.0	130.0	5.0	335.0
D(General)	1700.0	400.0	30.0	2130.0
E(Specialized)	115.0	150.0	4.0	269.0
F(Specialized)	110.0	46.0	1.5	157.5.0
G(General)	282.0	495.0	128.0	905.0
H(General)	1600.0	1000.0	58.0	2658.0
I(Specialized)	340.0	250.0	17.0	607.0
J(Specialized)	109.0	65.0	2.0	176.0
Total	4752.0	2681.0	250.0	7683.0

Table3: Waste generation rate per bed/kg/day and per patient/kg/day in surveyed hospitals

Hospital	General waste (kg/bed /day)	General waste (kg/ patient /day)	Infectious waste (kg/ bed /day)	Infectious waste (kg/ patient /day)	Sharp Waste (kg/ bed /day)	Sharp Waste (kg/ patient/day)	Total waste (kg/ bed /day)	Total waste (kg/ patient/day)	
General*	A	1.06	1.74	1.05	1.72	0.03	0.04	2.14	3.50
	D	2.15	2.65	0.51	0.62	0.04	0.05	2.70	3.32
	G	0.93	1.11	1.64	1.95	0.42	0.5	2.99	3.56
	H	1.87	2.47	1.17	1.54	0.07	0.09	3.11	4.1
Specialized*	B	1.82	2.35	0.45	0.58	0.02	0.04	2.29	2.97
	C	1.80	2.38	1.17	1.54	0.04	0.06	3.01	3.98
	E	1.44	1.91	1.87	2.50	0.05	0.05	3.36	4.46
	F	1.0	1.25	0.41	0.52	0.01	0.02	1.42	1.79
	I	1.06	1.06	0.78	0.78	0.05	0.05	1.89	1.89
	J	1.81	2.27	1.08	1.35	0.04	0.04	2.93	3.66
Mean ±SD	1.5±0.44	1.91±0.59	1.01±0.49	1.31±0.66	0.08±0.121	0.09±0.143	2.6±0.62	3.32±0.88	

The survey of waste generation rate in different departments in the main central public hospital showed the highest rate of total, general and infectious waste to be from the obstetrics and gynecology department which was (2.43, 0.91) and (1.48) kg/bed/day and (4.28, 1.63) and (2.63) kg/patient/day, respectively.

The lowest rate of total, general and infectious waste was (0.90, 0.32), and (0.32) kg/bed/day and (0.92, 0.56) and (0.56) kg/patient/day, pertaining to the pediatrics department. The present study demonstrated the mean performance level of waste management processes in the surveyed hospitals, including separation, storage, transportation, and disinfection to be (64%, 67%, 76%), and (63%), respectively (Table 4).

Table4: The mean of waste management process in surveyed hospitals

hospital	Collection & segregation%	Storage %	Transport %	Treatment disinfection%
A(General)	68.056	80.769	64	45.71
B(Specialized)	62.5	53.846	80	80
C (Specialized)	61.11	57.692	72	71.43
D(General)	50	53.846	64	2.86
E(Specialized)	75	76.923	80	88.57
F(Specialized)	50	69.231	76	74.286
G(General)	70.83	69.2313	84	88.57
H(General)	68.056	84.615	80	94.286
I(Specialized)	65.278	65.385	72	80
J(Specialized)	68.056	53.846	84	2.86
Mean ±SD	64±8.30	67±11.62	76±7.41	63±34.31

Transportation process (76%) was in the most favorable state among medical waste management processes. Our findings revealed that almost 89% of the related staff followed the annually training courses in all studied hospitals.

Discussion

Medical waste generation rate

During the field work in our study 2833 active beds and 2280 patients were studied in 10 hospitals whereas the total amount of waste generation was 7683 kg/day (61.85 % general waste and 38.25% hazardous medical waste). Medical waste generation rate based on the Iranian National Health instructions of waste includes: (80%) general medical waste, (15%) infectious waste and (5%) other types of hazardous medical waste (sharp, chemical and radioactive). World Health Organization (WHO) medical waste standard also estimated a rate of (75- 90%) for general medical waste and (10- 25%) for infectious and hazardous medical waste (14). Therefore, the findings in our study are higher than the expected standard rates.

Our study was done only in one city which was its main limitation however it was multicenter.

The medical waste generation rate in different studies in Iran (Tabriz, Sistan and Baluchestan, Tehran

and Isfahan) reported (2.76 to 4.42) kg/bed/day of total waste, (1.03 to 1.59) kg/bed/day of infectious waste and (1.37 to 2.3) kg/bed/day of noninfectious waste (29.44 to 51.6% infectious, 47.2% to 70.11% noninfectious and 0.45% to 1.2% sharp wastes) (14-17). In addition, in a comparative study on eight hospitals in Iran, Farzadkia showed a medical waste generation rate of (2.5 to 3.01) kg/bed/day which was similar to our findings (18). In our study, infectious waste generation rate was higher (34.90%) than the standard rate, similar to other studies in Iran, but infectious waste generation rate per bed in Mashhad hospitals (1.01 kg/day/bed) was lower than the reported values of other hospitals in other countries (14, 15, 17). Similar studies have been conducted in other countries such as Turkey, Greece and China which showed (0.63 to 1.9) kg/bed/day medical waste production. (4, 9, 19). Cheng survey showed a waste generation rate of (2.41 to 3.26) kg/bed/day for general and (0.19- 0.88) kg/bed/day for infectious medical waste (20). Diaz reported that total medical waste generation of selected hospitals in developing countries varies from (0.01 to 3.2) kg/bed/day and infectious waste rate is estimated as (0.01 to 0.65) kg/bed/day (21). Infectious medical wastes generation rate in Mashhad hospitals were higher than reported values in other countries (1.01 kg/bed/day), but total medical waste generation rate was similar (2.6 kg/bed/day).

The high estimated rate of infectious waste generation implicates the unresolved problems in medical waste management regardless of the expanded efforts, particularly in the segregation processes, which requires extra attention.

Medical waste Collection and segregation

Our study showed that in (64%) of hospitals, standard instructions for collection and segregation processes are considered adequate. Dehghani's study (2008) in Tehran city hospitals in the center of Iran reported that collection, separation and packing processes are accomplished in (58%) of the hospitals and (90%) of the related staff have passed the necessary trainings (16). According to Birpinar study, separation of different types of medical waste is constantly accomplished in Istanbul, but (25%) of the hospitals still use inappropriate equipments in waste collection (4), in our study (70%) of the related staff had the appropriate equipment and special clothing. In Yong study, medical waste collection and segregation was done favorably in (73%) of hospitals in China (19).

Therefore, in Mashhad hospitals similar to other cities of Iran medical waste collection and segregation principles were not performed completely which has led to an increase in waste disposal costs and harmed public health conditions. Based on Iran national health instructions of waste, every single medical center is assigned to perform the collection, segregation, and packing processes for its medical waste with adequate consideration of the related principles.

Medical waste Temporary storage

Based on our study medical waste storage procedure was performed in (67%) of cases according to national waste instructions, which is similar to other cities in Iran. One study in 2008 showed that all hospitals in Tehran do have specific sites for storage such as our study, and the storage procedures were done according to the instructions in (67%) of them which is similar to ours (17). In Birpinar's study, (63%) of Istanbul hospitals had temporary storage sites and related procedures based on health principles were done in (94%) of them (4). Considering all these studies, improvement of the waste storage procedures in Iran requires more attention by managers and according to national waste instructions, temporary storage of the hazardous medical waste should be done separately from the general medical waste, away from the hospital staff, employees and patients.

Medical waste Transportation

Based on Iranian national Health instructions of waste, it is forbidden to transport the separated hazardous waste with general type. Our studied hospitals followed (76%) of the national waste transportation standards. In Dehghani's study, (75%) of the hospitals had adequate facilities for medical waste transportation (16).

Medical waste treatment (disinfection)

An appropriate method for treating the hazardous medical waste needs certain considerations on specific factors such as waste type, efficacy of the disinfection method, hygienic and environmental considerations, climate and the continental state, population and the waste amount. Every medical center should choose a hazardous medical waste treatment method and enforce it after the National Health Confirming. National instructions of medical waste treatment were employed in (63%) of the studied hospitals and hazardous medical waste treatment was done by an autoclave (steam sterilization machine) inside nine out of the ten hospitals. Only in one hospital the disinfection process was done outside the hospital. Dehghani's study showed that incineration was done in none of their 12 studied hospitals, and treatment of the hazardous medical waste was accomplished outside the hospitals where they were buried (16).

Jang's study in Korea showed that hazardous medical waste treatment is done by incinerating inside the hospital in 12 hospitals and with steam sterilization in other two studied hospitals (10).

Conclusion

Medical waste generation can be influenced by many factors including number of patients and number of active beds in the hospital, ward type, management of the medical waste and efficient employee training.

Medical waste management processes evaluated in our study revealed our status not to be satisfactory in comparison to the developed countries. Therefore,

defining certain medical waste administrative instructions and standards, updating public information and awareness, employees training, arguing medical waste issues in health departments and infection controlling centers and constant and careful supervision by environmental health experts is necessary to improve patients', employees' and public health.

Further studies in the future are required to assess the

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