

Health Care Waste Management in Hospitals of Tabriz, Iran: A Comparison between General and Specialized Hospitals

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Abstract

Background: Health care waste (HCW) management is highly important and has received special attention from the authorities and people. This study was conducted to investigate the management of HCW in general and specialized hospitals of Tabriz, Iran.

Methods: In this descriptive cross-sectional study, field investigations were conducted on gathering data on HCW management activities using the WHO questionnaire including 100 questions through observation.

Results: This study indicated that the total in-use beds in the studied hospitals were 3953 beds. The total amount of generating wastes in the hospitals was 13349.5 kg day⁻¹, of which 10059 kg day⁻¹ (75.4%) was general waste and the remaining 24.6% (3290.5 kg day⁻¹) was categorized as medical waste. The medical waste was categorized further into infectious (3002.50 kg day⁻¹), sharp (171.80 kg day⁻¹), chemical (63.15 kg day⁻¹), and pathological (52.55 kg day⁻¹) wastes. In general and specialized hospitals, 56% and 31% of the waste separation was at a good level, respectively. The results showed that the chemical process (37.5%) was the mostly used method for the treatment of medical waste in the studied hospitals.

Conclusion: Generally, the rate of waste generation in general hospitals was more than that in specialized hospitals. Higher waste generation in general hospitals can be due to the fact that in these hospitals the amount and diversity of the health services provided were more than specialized hospitals. Good separation of general wastes from medical ones, proper health waste management, and training of staff for correct segregation of wastes can lead to a reduction of treatment charges.

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Introduction

Hospitals have a special position in the healthcare system, constitute the major sector for healthcare providers, and are the largest responsible centers for educating skilled people in the health systems.^{1,2} In recent years, the rate of hospital waste (HW) production has significantly increased due

to population growth, increase in the number and variety of health care centers and the growth/development of healthcare topics.¹⁻³ The quantity of produced waste depends on the hospital size, type of general and specialized medical services, number of admitted patients, amount of disposable medical supplies used, etc.^{4,5}

World Health Organization (WHO) has

categorized HWs into two categories including general and hazardous wastes. Hazardous wastes consist of sharps, and pathological, infectious, pharmaceutical and cytotoxic, chemical and radioactive wastes.^{3,6} HWs are also produced in the process of research studies and biologic tests. This definition encompasses blood bags, culture media, other glass containers, surgical gloves, needles, consumed media, and cut off organs.⁷

In total, around 75%-90% of the solid wastes in the healthcare activities belong to non-hazardous waste, and the remaining (10% to 25%) are categorized as hazardous wastes.^{6,8} HWs are a significant concern in many developing countries. Lack of proper management of HW can pose health, safety, and environmental hazards to all stakeholders in such communities.³ Medical wastes require special management and treatment because they contain infectious and hazardous agents. Improper management of produced wastes could lead to the spread of communicable diseases such as hepatitis B (HBV), hepatitis C (HCV), human immunodeficiency virus (HIV) infections, and environmental pollution.^{3,6} Studies have reported that around 630 types of chemical and pharmaceutical wastes are produced in hospitals, approximately 300 of which being hazardous and toxic.^{9,10}

Many studies have investigated the HW management in Iran and across the world and have mainly focused on the quantity of generated HW and their categorization.^{10,11} To improve HW management, having a widespread legal framework, accurate internal management systems, plans for educating and securing the safety of personnel, and plans for estimating the quantity of generated waste and identification of effective/suitable techniques for HW purification and disposal are necessary.

One of the most important issues in HW management is the quality of collecting, storing, transporting, treating, and disposing of wastes. These operations and processes should be accomplished in a way that will pose no threat to patients, staff members, and the public. This study aimed to evaluate the quantity, quality, and management of HW in general and specialized hospitals of Tabriz in 2017.

World Health Organization (WHO) has categorized HWs into two parts including general and hazardous wastes. Hazardous wastes consist of sharps, pathological, infectious, pharmaceutical, cytotoxic, chemical, and radioactive wastes.^{3,6} HWs are also produced in the process of research studies and biologic tests. This definition encompasses blood bags, culture media, and other glass containers, surgical gloves, needles, consumed media, and cut off organs.⁷

Methods

Tabriz, the capital of East Azerbaijan province (northwest of Iran) with an area of 237.45 km² is one of the largest cities in Iran (Figure 1). Based on the latest national census, its population was estimated at 1,773,033 people.¹² This area is located within the latitude and longitude of 38° 3' 59.9976" N and 46° 17' 59.9964". Tabriz city with an elevation range between 1,350 and 1,600 meters above the sea level is surrounded by lone-standing, towering mountains of Sahand and Own-ibne-Ali on the northeast and south, respectively.

Iran hospitals work under the surveillance of the Ministry of Health and Medical Education (MHME). According to MHME definition and based on the type of the hospital activities, hospitals were categorized into two groups of general (G) and specialized (S). In this descriptive cross-sectional study, the quality



Figure 1: Location of Tabriz city in Iran and area of study

and quantity of medical waste in 22 hospitals (14 general hospitals and 8 specialized hospitals) of Tabriz city were investigated in 2016. Data were collected using questionnaires, interviews, and site visits. The principal studied elements were the quantity of generating wastes, degree of separation, procedure of sterilization, and disposal of HWs.

To assess the waste management status in the studied hospitals, we used the WHO's questionnaire which consists of 100 items. The questionnaire data were then supplemented by observations and conducting interviews with managers and staff of the medical waste management.

Results

Quantity and Quality of Generated Solid Wastes in Tabriz Hospitals

The health care solid waste in this study was classified into two groups including general and medical wastes. The medical waste was divided into four subgroups including infectious, sharp, chemical, and pathological wastes. Table 1 displays the quantity of solid wastes in the studied hospitals. In total, there were 3953 in-use beds in the 22 studied hospitals of Tabriz; of them, 1744 beds were related to the general hospitals and 2209 to the specialized hospitals.

The share of in-use beds in daily generation of solid waste in the Tabriz hospitals is shown in Table 2. The total amount of solid wastes for an in-use bed was 3.514 kg day⁻¹. Figure 2 demonstrates the combination of produced hospital waste (kg bed⁻¹) in these hospitals. As Figure 2 and Table 2 show, the total of general and medical wastes for every in-use bed were 2.665 and 0.849 kg day⁻¹, respectively. In the subgroups of medical wastes in the studied hospitals (Figure 2), the amount of infectious, sharp, chemical, and pathological wastes for every in-use bed was 0.766 (90.25%), 0.045 (5.33%), 0.019 (2.24%), and 0.018 (2.18%) kg day⁻¹, respectively.

Figure 3 shows the quantity of total, general, and medical wastes per bed in the general and specialized hospitals. The quantities of total, general, and medical wastes generated in the general hospitals were 5.008, 3.781, and 1.226 kg day⁻¹, for every in-use bed, respectively. As shown in Figure 3, the quantity of all wastes in the specialized hospitals was less than general hospitals. The amounts of total, general, and medical wastes in specialized hospitals were 2.020, 1.548, and 0.472 kg day⁻¹ per in-use bed. Medical waste generation in the present study was almost similar to that of Bdour et al.'s study in the northern part of Jordan (as a developing country); it was showed that the average total of medical waste generation in the public, maternity, and private hospitals was estimated

Table 1: The amount of solid waste generation in the Tabriz hospitals in a day

Hospital Code	Hospital speciality	In-use bed	Total waste (kg)	General waste (kg, %)	Total medical waste (kg, %)	Medical waste category			
						Infectious (kg, %)	Sharp (kg, %)	Chemical (kg, %)	Pathological (kg, %)
I (G)		50	325	250, (76.90)	75, (23.07)	55, (16.92)	5.5, (1.69)	7, (2.15)	7.5, (2.3)
II (G)		84	360	257.5, (71.52)	102.5, (28.47)	96.5, (26.80)	5, (1.38)	0.75, (0.20)	0.25, (0.07)
III (G)		140	560	419, (74.82)	141, (25.17)	129, (23.03)	8, (1.42)	3, (0.53)	1, (0.17)
IV (G)		96	370	273, (73.78)	97, (26.21)	90, (24.32)	6, (1.62)	0.7, (0.19)	0.3, (0.08)
V (G)		268	910	700, (76.92)	210, (23.07)	195, (21.42)	13, (1.42)	1, (0.1)	1, (0.1)
VI (G)		118	500	355, (71)	145, (29)	139, (27.8)	5, (1)	0.5, (0.1)	0.5, (0.1)
VII (G)		49	139	99, (71.22)	40, (28.77)	37.5, (26.97)	2, (1.43)	0.25, (0.18)	0.25, (0.18)
VIII (G)		205	692	520, (75.14)	172, (24.85)	130, (18.78)	10, (1.44)	12, (1.73)	20, (2.89)
IX (G)		600	2250	1500, (66.66)	750, (33.33)	700, (31.11)	40, (1.77)	7, (0.31)	3, (0.13)
X (G)		64	345	292, (84.63)	53, (15.37)	45, (13.04)	5, (1.45)	2, (0.58)	1, (0.29)
XI (G)		70	198	149, (75.25)	49, (24.75)	44.5, (22.47)	3, (1.51)	0.5, (0.25)	1, (0.5)
XII (G)		96	343	273, (79.6)	70, (20.4)	65, (18.95)	4, (1.16)	0.65, (0.19)	0.35, (0.10)
XIII (G)		300	1223	900, (73.58)	323, (25.41)	298, (24.52)	21, (1.71)	3, (0.24)	1, (0.08)
XIV (G)		125	372.5	310, (83.33)	62.5, (16.66)	55, (14.76)	5, (1.34)	1.5, (0.40)	1, (0.26)
XV (S)		580	1200	1100, (91.66)	100, (8.34)	83, (0.69)	10, (0.83)	7, (0.58)	0
XVI (S)		60	87.5	65, (74.28)	22.5, (25.71)	22, (25.14)	0.4, (0.45)	0.1, (0.11)	0
XVII (S)		254	951	750, (78.86)	201, (21.14)	190, (19.97)	2, (0.21)	6, (0.63)	3, (0.31)
XVIII (S)		160	558.5	410, (73.41)	148.5, (26.58)	129, (23.09)	7, (1.25)	2.5, (0.44)	10, (1.79)
XIX (S)		256	580	420, (72.41)	160, (27.58)	148, (25.51)	8, (1.38)	4, (0.69)	0
XX (S)		201	948.5	671, (70.74)	277.5, (29.25)	266, (28.04)	7.5, (0.79)	3, (0.31)	1, (0.10)
XXI (S)		110	350	275, (78.58)	75, (21.41)	70, (20)	4, (1.14)	0.6, (0.17)	0.4, (0.11)
XXII (S)		67	86.5	70.5, (81.5)	16, (18.49)	15, (17.34)	0.4, (0.46)	0.1, (0.11)	0
Total		3953	13349.50	10059.00, (75.35)	3290.50, (24.65)	3002.50, (22.49)	171.80, (1.29)	63.15, (0.47)	52.55 (0.39)
Waste/bed (kg bed ⁻¹)			3.34	2.52	0.82	0.75	0.043	0.016	0.013

G: General Hospital; S: Specialized Hospital

Table 2: Share of in-use beds in daily generation of solid waste in the Tabriz hospitals

Hospital code	Hospital speciality	Number of in-use beds	Total waste (kg)	General waste (kg)	Medical waste (kg)	Total waste (kg bed ⁻¹ .day ⁻¹)	General (kg bed ⁻¹ .day ⁻¹)	Medical waste (kg bed ⁻¹ .day ⁻¹)
I (G)	General	50	325	250	75	6.500	5.000	1.500
II (G)	General	84	360	257.5	102.5	4.286	3.065	1.220
III (G)	General	140	560	419	141	4.000	2.993	1.007
IV (G)	General	96	370	273	97	3.854	2.844	1.010
V (G)	General	268	910	700	210	3.396	2.612	0.784
VI (G)	General	118	500	355	145	4.237	3.008	1.229
VII (G)	General	49	139	99	40	2.837	2.020	0.816
VIII (G)	General	205	692	520	172	3.376	2.537	0.839
IX (G)	General	600	2250	1500	750	3.750	2.500	1.250
X (G)	General	64	345	292	53	5.391	4.563	0.828
XI (G)	General	70	198	149	49	2.829	2.129	0.700
XII (G)	General	96	343	273	70	3.573	2.844	0.729
XIII (G)	General	300	1223	900	323	4.077	3.000	1.077
XIV (G)	General	125	372.5	310	62.5	2.980	2.480	0.500
XV (S)	Specialised	580	1200	1100	100	2.069	1.897	0.172
XVI (S)	Specialised	60	87.5	65	22.5	1.458	1.083	0.375
XVII (S)	Specialised	254	951	750	201	3.744	2.953	0.791
XVIII (S)	Specialised	160	558.5	410	148.5	3.491	2.563	0.928
XIX (S)	Specialised	256	580	420	160	2.266	1.641	0.625
XX (S)	Specialised	201	948.5	671	277.5	4.719	3.338	1.381
XXI (S)	Specialised	110	350	275	75	3.182	2.500	0.682
XXII (S)	Specialised	67	86.5	70.5	16	1.291	1.052	0.239
Waste/bed (kg bed ⁻¹)						3.514	2.665	0.849

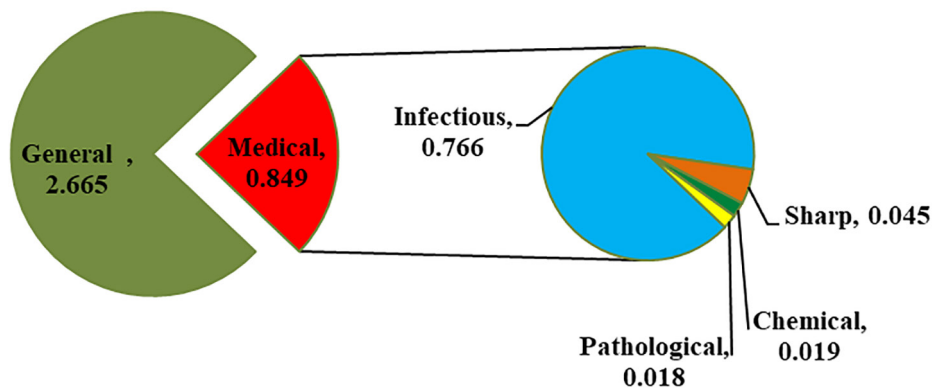


Figure 2: The combination of produced hospital waste (kg bed⁻¹) in Tabriz hospitals

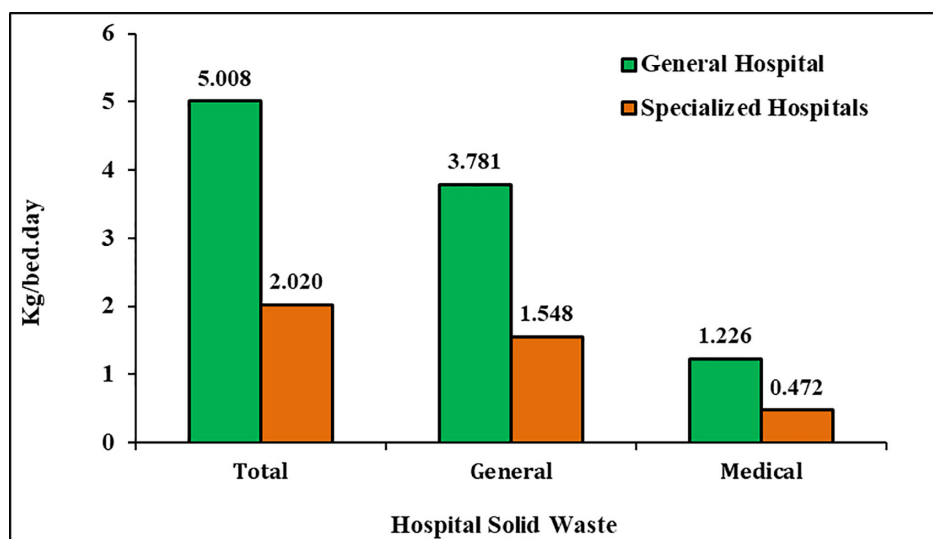


Figure 3: The waste generation in Tabriz city hospitals per in-use bed

to be 3.49 kg bed⁻¹ day⁻¹, 3.14 kg bed⁻¹ day⁻¹, and 1.88 kg bed⁻¹ day⁻¹, respectively.¹³ The results of this study were significantly higher than those reported by Hasan and Rahman, which indicated that the overall total healthcare and hazardous waste generation rates in Khulna city (southwestern division of Bangladesh) were 0.90 and 0.18 kg bed⁻¹ day⁻¹, respectively.¹⁴

Waste Separation in Tabriz Hospitals

In different countries, different segregation methods are used according to their local standard; however, color-coded and labeled bags are used for segregation of HWs in developed countries.^{3, 15} In Iran, Ministry of Health and Medical Education (MHME) is responsible for HCWs management. Waste segregation in Iran is performed in color-coded bags and container. The colors of bags and containers for the storage of general, infectious, chemical, pathological wastes in the hospitals were black, yellow, and white, respectively which were in accordance with national standards. In the studied hospitals, safety box was used for separation of sharp wastes. Based on the MHME checklists, the waste separation condition in the hospitals was categorized into three levels including good, moderate, and weak. In the good level, no infectious waste should be detected in black bags containing general waste. In the moderate level, infectious waste is detected in black bags containing general waste, or sharp waste is found in bags containing infectious waste. In the weak level, infectious waste is detected in the black bags. Figure 4 illustrates the current conditions of waste separation in the general and specialized hospitals.

Solid Waste Treatment Activities

According to the waste management regulations of Iran, the municipalities are supposed to receive treated HCWs, and healthcare facilities are responsible for treating their wastes. They should treat the solid wastes or contract with private companies for the treatment

of generated wastes. According to the obtained results from the studied hospitals, treatment activities were accomplished through chemical processes, autoclave, hydroclave, and dry heat. The information on the treatment process of Tabriz hospitals is presented in Table 3. The proportion of each treatment procedure used by hospitals is illustrated in Figure 5.

Discussion

The total amount of solid wastes in the studied hospitals was 13349 kg day⁻¹, of which 10059 (75.35%) was related to general and the rest, 3290 kg day⁻¹ (24.65%), was medical waste. The quantities of infectious, sharp, chemical, and pathological waste were 3002, 172, 63, and 53 kg day⁻¹, respectively. The amounts of waste in general hospitals with 1744 in-use beds and specialized hospitals with 2209 in-use beds were 6649 kg day⁻¹ and 6700 kg day⁻¹, respectively. The quantities of general, infectious, chemical, sharp, and pathological wastes in the general hospitals were 6297.50 (73.33%), 2079.50 (24.22%), 132.50 (1.54%), 39.85 (0.46%), and 35.8 (0.44%) kg day⁻¹, respectively. The corresponding values for specialized hospitals were 3761.50 (78.99%), 923 (19.38%), 39.3 (0.83%), 23.30 (0.49%), and 14.40 (0.30%) kg day⁻¹, respectively.

Hospital of IX with 600 in-use beds and waste generation of 2250 kg day⁻¹ was the highest waste producer hospital in Tabriz. The reason for this can be the fact that this hospital is the largest hospital (600 in-use beds) in Tabriz and is equipped with high tech instruments and consequently good services. The hospital of XXII with 67 in-use beds and generation 139 kg day⁻¹ HW was the lowest generator of waste among Tabriz hospitals. As shown in Table 1, the most generated infectious and sharp wastes were related to IX hospital which was 700 and 40 kg day⁻¹, respectively. The highest generation of chemical and pathological wastes was related to XIII hospital that was 12 and 20 kg day⁻¹, respectively.

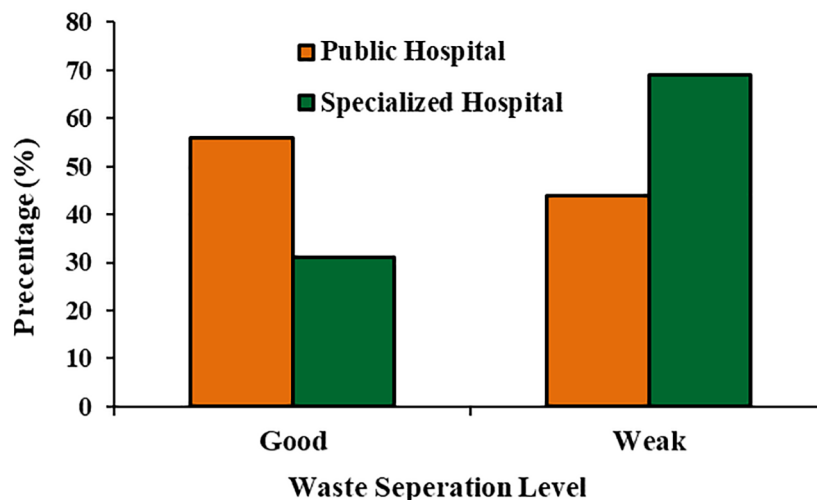


Figure 4: Waste separation status of general and specialized hospitals in Tabriz

Table 3: Solid waste treatment processes in Tabriz hospitals

Hospital code	Type of hospital	Treatment method			
		Chemical	Autoclave	Hydroclave	Dry heat
I (G)	G	*			
II (G)	G	*			
III (G)	G			*	
IV (G)	G				*
V (G)	G		*		
VI (G)	G			*	
VII (G)	G		*		
VIII (G)	G	*			
IX (G)	G		*	*	
X (G)	G	*			
XI (G)	G				*
XII (G)	G		*		
XIII (G)	G		*	*	
XIV (G)	G		*		
XV (S)	S	*			
XVI (S)	S	*			
XVII (S)	S		*		
XVIII (S)	S	*			
XIX (S)	S		*		
XX (S)	S			*	
XXI (S)	S	*			
XXII (S)	S	*			

G: General hospital; S: Specialized hospital

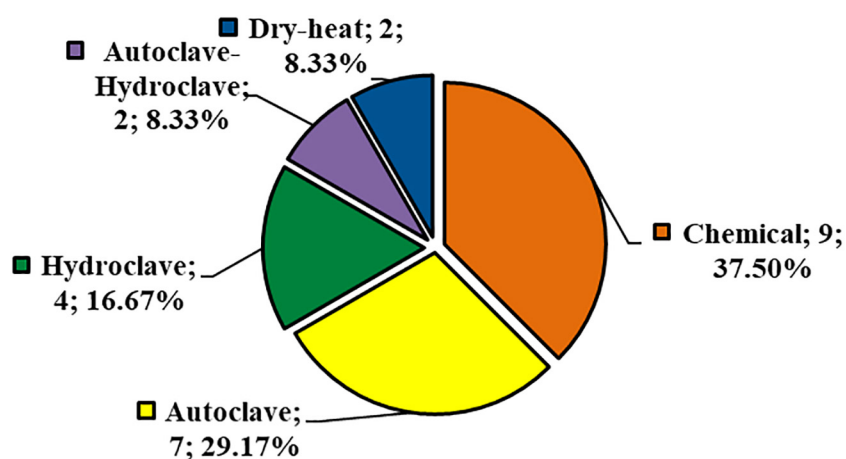


Figure 5: The treatment processes used in Tabriz hospitals

The per bed quantity of waste in the current study was more than those reported by Gao et al., which was 0.18 kg bed⁻¹ in 209 randomly selected rural township health centers in China.¹² WHO has reported that hazardous waste generation in hospitals in the developed countries is more than developing countries, as in the high-income countries the average hazardous waste generation for a bed is more than 0.5 kg day⁻¹ and in low-income countries is less than 0.2 kg day⁻¹. However, during the last years the total quantity of HW has been increasing in the developing countries.³ One of the reasons for the increase of medical waste per in-use bed in the present study can be the project of Health System Evolution Plan (HSEP) in Iran over the last decade. The project is heavily funded by government and insurance companies,

providing affordable services to the people and public referred to hospitals for receiving low-cost services.¹⁶

The maximum amount of total, general, and medical waste per bed in the studied hospitals was 6.5, 5, and 1.5 kg day⁻¹ which was related to I hospital (a general hospital with 50 beds). The minimum amount of total, general, and medical waste per in-use bed was related to XXII (67 beds), XXII, and XV (580 beds) hospitals, respectively, both of which were specialized hospital.

In this study, the amount of waste generation in general hospitals per bed was higher than specialized hospitals. The ratios of general/specialized hospital waste for the total, general, medical, infectious, sharp, chemical, and pathological waste were 2.284,

2.121, 2.899, 2.854, 4.270, 2.166, and 3.356 kg day⁻¹. Farzadkia et al. showed that the waste generation rate for every in-use bed in educational hospitals in Iran University of Medical Sciences (IUMS), Iran, was 2.5 to 3.01 kg day⁻¹, and the general and infectious wastes were 85 to 90% and 10 to 15% of the total generated wastes.¹⁷

Usually, healthcare services in general hospitals in Iran are more extensive than specialized hospitals, so the solid waste generation in the general hospitals is more than that produced in specialized ones. Also, the amount of patient referral in general hospitals is higher than specialized ones because of insurance coverage and low cost for patients. Another possible reason for this is that all general hospitals are educational, which can affect the increase in the waste generation in these hospitals.

In terms of waste separation appropriate and healthier condition, Tabriz hospitals seem to suffer from serious problems; however, general hospitals were more suitable than specialized ones. In the general hospitals, 56% of waste separation activities were classified as the good level, while 44% was categorized as the weak level. In the specialized hospitals, 31% of the waste separation was considered as good, whereas 69% was classified as weak. Based on the collected data, no moderate level was observed in the general and specialized hospitals of the study area. Ali et al. in 2017 reported that waste segregation, collection, storage, transportation, and disposal practices of HWs in developing countries were not appropriate and this could lead to various occupational and environmental risks.³ In a study conducted by Awodele et al. on assessment of medical waste management in seven hospitals in Lagos, Nigeria, it was found that in one hospital both general and medical wastes were disposed as mixed wastes.¹⁸ Gao et al. showed that the most remarkable unsafe medical waste actions were related to packaging wastes in unsealed containers, using biohazard container without labeling, improper disposal methods of medical waste, weak staff training, and low rates of centralized disposal.¹² The study of Abd El-Salam in 2010 on HCW management in El-Beheira Governorate, Egypt, showed that some of medical wastes were mixed with general wastes.¹⁹

In other studies, some problems about HCWs separation including inappropriate source separation,^{16, 20} inadequate financial and human resources,¹⁹ no color coding,^{21, 22} lack of training of waste management staff,^{23, 24} and lack of registration of waste composition and quantity¹⁴ have been reported. These lead to mixing some hazardous medical waste with general wastes.^{5, 19, 25} Poor waste segregation practices were observed in the studied hospitals. Knowledge and awareness of hospital staff about proper waste management can lead to reduction of the harmful

effects of the present HWs management. Despite strict rules about HW management, failure to monitor the proper enforcement of the regulation on proper management of waste, failure to penalize and referring the offenders to the legal authorities, and justifying the hospital managers about the effectiveness of HWs on the health of people and environment are other weaknesses in the proper treatment of wastes in the present study.

The result showed that treatment activities were accomplished through chemical processes, autoclave, hydroclave, and dry heat; two hospitals (IX and XIII) used both autoclave and hydroclave technology for treatment. Rafiee et al. found that based on technical, economic, social, and environmental aspects, the hydroclave and autoclave techniques were the best method for treating HCWs.²⁶ Awodele et al. reported that all the hospitals used the services of Lagos Waste Management Authority (LAWMA) for disposal and treatment of their medical wastes (hydroclave technique), except one hospital which used on site treatment method using an incinerator to treat its wastes.¹⁸ A study carried out by Abd El-Salam showed that the most frequently waste treatment method used in El-Beheira Governorate, Egypt was incineration technique, despite the fact that due to air pollution problems incineration is an outdated technology.¹⁹

According to WHO guidelines and Iranian MHME regulations, when general wastes are mixed with medical waste, all the wastes should be considered as medical waste and must be managed according to medical waste management instructions. If proper waste separation takes place at the source of waste generation, the general wastes would not be mixed with medical waste. Therefore, the medical waste load for treatment is reduced, and consequently the cost would be reduced.

Conclusion

According to the results of this study, the waste generated rate in general hospitals was more than specialized ones. The main reason for this can be provision of more extensive health care services in general hospitals. The lack of separation of medical wastes from general ones, ignoring the HCWs management rules, and inadequate education of the staff for waste segregation lead to mixing the generation of HCWs. This has led to a significant increase in the cost of medical waste treatment in hospitals. Chemical treatment has improved as an acceptable method and a good process for medical waste treatment. The installation of autoclave and hydroclave should be considered as the most appropriate instrument for treating infectious waste instead of chemical treatment.

Conflict of Interest: None declared.

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