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AN INVESTIGATION ON HOSPITAL SOLID WASTE MANAGEMENT IN IRAN

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ABSTRACT

The integrated hospital solid waste management emphasizes the need to conduct a survey based on a standardized method that equally be analyzed at national level. This study aimed to test the usability of a national tool to do integration data analysis of hospital waste management status. Then, a typical study was conducted in Karaj hospitals. Also, critical analysis of hospital's solid waste management aspects was done, and shortcomings in the aspects were identified. The pilot study results showed that the daily per capita waste generations were reported to be 4.2±0.49 kg/available bed, 5.8±0.63 kg/occupied bed, and 10.3±0.9 kg/inpatient. The names of the hospitals were omitted when they were named from H_1 to H_8. So the highest and lowest daily waste generation rate were 5.5±0.35 and 2.6±0.78 kg/available bed in H_7 and H_3 hospitals, respectively. In this study, total infectious wastes per capita were reported to be 2.3±0.39 kg/available bed/day, 3±0.5 kg/occupied bed/day and 5.2±0.84 kg/inpatient/day. Furthermore, the averages per capita of total general waste were 2±0.4 kg/available bed/day, 2.8±0.51 kg/occupied bed/day and 5.1±0.8 kg/inpatient/day. Analysis of the Karaj hospital waste management status showed statue of hospital waste management in 88% of hospitals were ranked moderate when others were achieved to be poor by 12%. The hospital waste management had been evaluated poor in term of collection, transportation and manpower aspects, moderate in the separation and temporary storage aspects and good in the disposal aspect. It was also found that the MOHME tool is appropriate tool to investigate the status of waste management in hospitals.

Keywords: Hazardous waste, Hospital waste, Waste management

1. Introduction

One of the major sources of waste generation are produced by various spectrum of health care providers especially hospitals (Sabour *et al.*, 2007, Wong *et al.*, 1994). Due to having pathogenic microbial factors, hazardous chemical and radioactive substances as well as sharp components, these materials are considered hazardous waste (Adegboye *et al.*, 1994, Prüss *et al.*, 1999). More than ever the risk to the natural environment caused by these materials requires a strict and rigorous supervision in the process of collection, transportation and disposal. Obviously, any negligence in the management of these wastes

may have direct or indirect adverse effect on the environment and human health (Amooei, 2003, Tudor *et al.*, 2005, Da Silva *et al.*, 2005, Akter, 2000).

According to a survey conducted in twenty-two developing countries, 18 to 64% of hospital waste is not disposed properly and leads to the pollution of water resources and the environment (Allegranzi and Pittet, 2007). Thus, the need for better management of hospital waste made developed countries insist on passing legislation that would be instructions for the collection, transportation and maintenance of medical waste. Also, these countries have continued to try to find new technologies for proper treatment and disposal of medical waste. However, research suggests that in the developing countries adequate attention is not paid to the issue of medical waste management and its simultaneous disposal with domestic solid waste is a serious threat to public health and the environment.

Reviewing previous studies in Iran shows that despite the waste laws and its executive regulations, hospital waste management does not take place properly due to inadequate monitoring. Lack of separation of semi-domestic and hazardous waste (Askarian and Vakili, 2005, Farzadkia and Moradi, 2009, Ebadifard *et al.*, 2005, Askarian *et al.*, 2010), lack of necessary facilities for treatment of infectious waste (Mohseni *et al.*, 2001, Farzadkia *et al.*, 2013), inadequate training of staff and lack of foresight personal protective equipment (Raigan Shirazi *et al.*, 2008) are the main problems in the hospital waste management. Improvement of hospital waste management requires complete knowledge and understanding of the quality and quantity of producing waste, storage, collection and transportation of these materials in addition to the methods of their treatment and disposal. Previous studies in the cities of Yasuj (Raigan Shirazi *et al.*, 2008), Qom (Jonidi *et al.*, 2010), Mazandaran (Mohseni *et al.*, 2001), some hospitals of Tehran (Yaghoubifar, 1998), showed that the medical waste management is important subject in Iran.

A medical (Health Care) waste means any infectious and harmful wastes generated by hospitals, health and treatment facilities, medical laboratories and other similar facilities. Other harmless hospital wastes are not included. Due to Iranian regulation, Medical wastes as well as some parts of ordinary, industrial and agricultural wastes which require special type of management are considered as special wastes. Mixing of medical wastes with other wastes and their discharge and dispersion in the environment or sale, use, and recycling this kind of waste is prohibited. Achieving suitable separation of treatment wastes at all the health center in Tehran (capital of Iran), reducing 80% of the medical waste produced disposed as hazardous waste, determination of economic and suitable methods for the environment to dispose the hazardous wastes in Tehran as well as presentation suitable method of separation hazardous wastes and disposing the same shall be deemed as the objectives of the organization in the field of medical wastes management (Tmpird *et al.*, 2008). Currently in Iran, due to policies of Health Ministry, the hospitals (and other major producers of medical waste) have selected on-site treating method as the preferred treatment. Because, according to Act 64 in Iran's Medical Waste Management Regulations, all waste producers in middle-sized and large cites are responsible for treating hazardous-infectious waste and converting it into general waste in on-site facilities(Taghipour *et al.*, 2014)

Systematic planning to improve hospital waste management in each country requires implementation of a comprehensive plan of the current status of waste. Due to the high cost of studies on such programs, a large-scale regional plan was implemented in different parts of the country and its results, in addition to the regional effectiveness were integrated into a national program. During the last three decades, the researchers have carried out several studies on the status of hospital waste management in different cities of Iran (Koushiar *et al.* 2006, Arab *et al.* 2008). A literature review indicated that these studies were extremely expensive and high costs are imposed on the health system; therefore, use of their results is not yet possible in the form of a national program. One reason for the low efficacy results of these studies includes the lack of a standardized, applicable and comprehensive method for assessing the existing status of generation, separation, collection, transportation, temporary storage, disposal and manpower. So, the comparison of the results of these studies was approximately impossible, due to heterogeneous results. In other words, these studies used various methods to analysis the status of waste management in hospital. Thus, using the results of the studies to improve hospital waste management situation has been

difficult and nearly impossible. Therefore, complete knowledge and understanding of the hospital waste management statue cannot be obtained, which is the basis for decision making to improve the current situation. The integrated hospital solid waste management emphasizes the need to conduct a survey based on a standardized applicable and comprehensive method at national level. This study aimed to test the usability of a national tool to do integration data analysis of hospital waste management status. Then, a typical study was conducted in Karaj hospitals. Also, a critical analysis of hospital's solid waste management aspects was performed in keeping with the provisions made rules, and shortcomings in the aspects were identified. With a view to overcoming these shortcomings, indicative strategies and guidelines for action plan preparation were formulated. Solid waste disposal and waste management systems are not satisfactory in many hospitals in Iran (Karamous *et al.* 2007). Little information is available regarding the generation and disposal of medical waste in Iran, and is needed to have better management for the hospital wastes (Askarian *et al.* 2004a, Arab *et al.* 2008). Therefore, the hospitals have found a convenient way to manage their waste according to performance standards. In order to proper programming for the implementation of these standards, this research was carried out by analyzing the current state of medical waste management.

2. Material and Methods

This study was designed in two stages. The first stage related to select an applicable method to evaluate the data of status of hospital waste management. The second stage involved using this method for analysis of the data of Karaj hospital waste management status. The methodology for this study is presented in Fig. 1.

After doing a literature review, to evaluate the current status of waste management in hospitals, the questionnaire prepared by The Ministry of Health and Medical Education (MOHME) in Iran is selected. It seems that the questionnaire developed and validated by The Ministry of Health and Medical Education in Iran is an appropriate tool to investigate the status of waste management in the hospital. Because of all the criteria contained in the questionnaire were based on the World Health Organization (WHO) and United States Environmental Protection Agency (EPA) guidelines. This questionnaire covered all important issues to examine the different aspects of solid waste management. The questionnaire had two parts. The first part included general hospital information (16 questions): hospital name and type; the number of staff, departments and beds; and the latest accreditation degree and etc. The second part consisted questions to evaluate the hospital waste management process in 6 areas including separation (12 questions), collection (5 questions), transportation (4 questions), temporary storage (6 questions), disposal (4 questions) and manpower (7 questions) aspects. To reach homogeneous data, two alternatives (Yes and No) were designed. In order to analyze data, code 1 was assigned to answers which complied with the law (positive) and code 0 was assigned to those which did not comply with the law (negative). Then, frequency of positive and negative responses were calculated for each part of the hospital waste management and were converted in to 0 – 100 to be classified. Six dimensions of health status such: medical mission hospital, environmental health hospital, hospital wastes, hygiene of water and wastewater in hospital, occupational health, and patient's hygiene and infection control was considered. Highest standard in each of the six dimensions of environmental health status was measured equal to the sum of the maximum score for each of the questions and the lowest standard. So, ranking of the hospital waste management status was done in three categories including poor (0 – 60), moderate (60 – 80), and good (80 – 100) (Jonidi Jafari *et al.*, 2013).

In the second stage, the typical study was carried out in 2014 in hospitals across Karaj. All hospitals of Karaj had been selected as statistical population of this study (n=8) by census, including four teaching hospitals, three private hospitals and one social security hospital. The mentioned questionnaire was completed by looking at the hospitals.

Due to the fact that the waste was not weighed at the studied hospitals, separating and weighing operations were done with coordination of the hospital's local director and introduction of the required service personnel. In this section of the study, in addition to training each employee for personal hygiene

standards, an attempt was made to use individuals who had been previously vaccinated against hepatitis B. Sampling and weighing of waste was carried out for four months (one week per month). Four months including the months of each season in year. The study was conducted in 2013 when it was done in one year.

The weighing procedure was as follows:

- Weighing of empty bin (W_b) using a weighing balance. Tied bags containing waste in temporary storage place was weighed using digital balance.
- Filling of the bin with sample waste while shaking the bin constantly to avoid undue void spaces. Finally, the difference between full and empty container was found in any part of hospital waste.
- Weighing of the bin filled with sample waste (W_T) using a weighing balance
- Determination of the average number of inpatients to generate the waste in each hospital at the time of measurements (t)

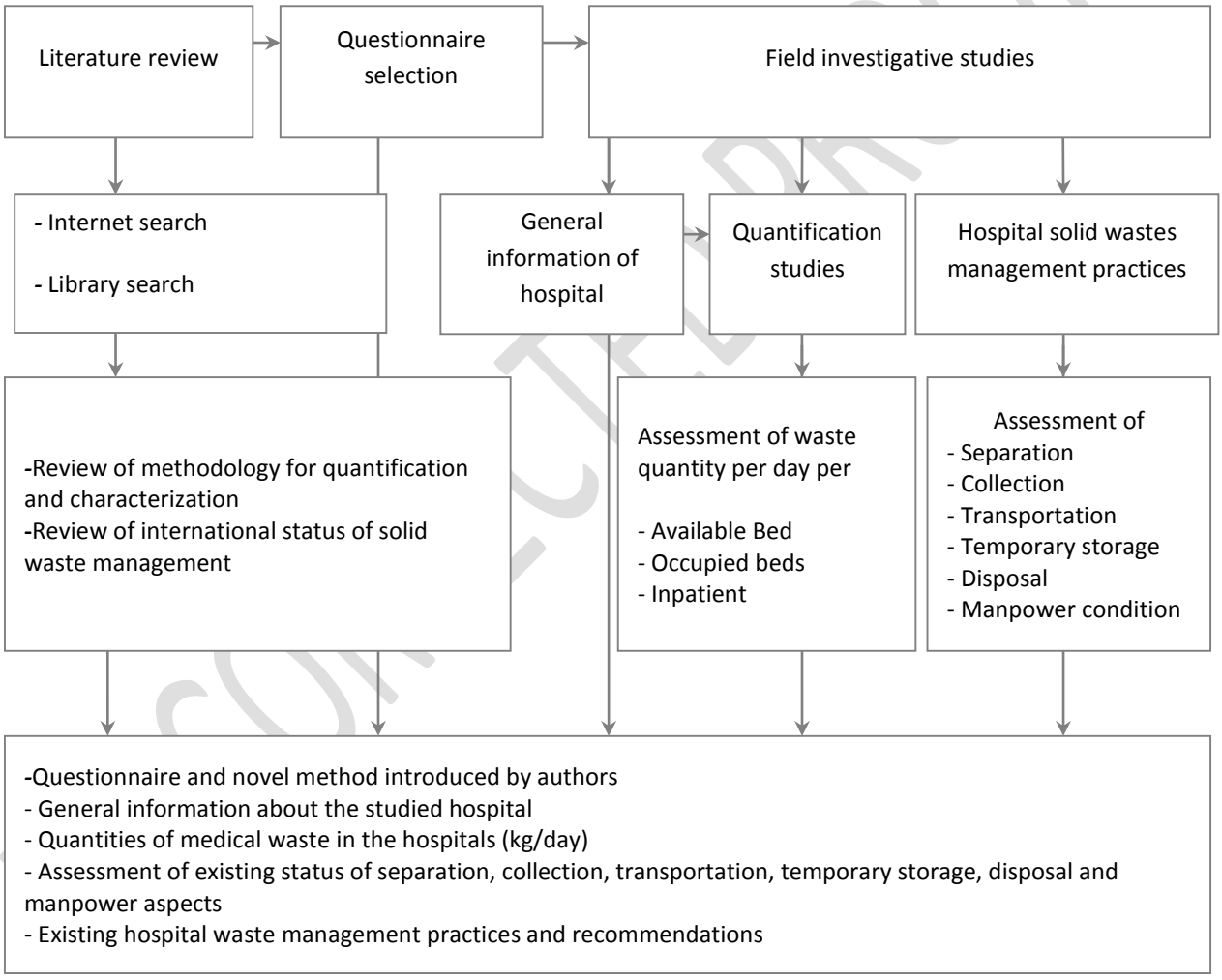

Figure 1. Summarized research methodology

Patients following a six-hour stay in the hospital, defined as outpatients. The presence of more than six hours at the hospital, the patient is hospitalized when were called Inpatient. The waste generated rates (W_G) per occupied bed, available bed, and inpatient per day was calculated by the following equations:

$$W_G = \frac{\sum(W_T - W_b)}{\text{inpatient}} = (\text{kg/ipatient/day}) \quad (1)$$

$$W_G = \frac{\sum(W_T - W_b)}{\text{Available Bed or Occupied Bed}} = (\text{kg/bed/day}) \quad (2)$$

Where in patient is a hospital patient who occupies a bed for at least one night in the course of treatment, examination, or observation; available bed is the number of beds available to provide overnight accommodation for patients; and number of beds occupied obtained due to inpatient bed occupancy rate.

$$\text{Occupancy rate} = \frac{\text{Total number of inpatient days for a given period} \times 100}{\text{Available beds} \times \text{Number of days in the period}} = \% \quad (3)$$

Data had been analyzed using Excel and SPSS software. After obtaining university ethics committee license and relevant introduction letters, this study was conducted. In addition to the bases of principle, and confidentiality, in regards to the collected and use of the information obtained from each hospital, the names of the hospitals were omitted and instead were referred to as H_1 to H_8.

The Department of Health has developed national guidelines on the management of hospital waste. Color is used to differentiate containers for storing various types of hospital waste at the generation point (Table 1). Infectious waste should be stored in a yellow marked strong leak proof bag or container. Chemical and pharmaceutical waste is should be stored in a brown marked plastic bag or container. Black marked plastic bags in containers are to be used for storing general waste. Sharp objects or equipment are to be stored in a yellow marked puncture proof container with lids.

Sharp, infectious, pathological, and chemical wastes were all collected in yellow plastic bags. In some wards, the site survey showed that these wastes were also mixed with general waste.

Table 1 .Showing the types of containers used to collect different types of hospital waste

Types of waste	Container	Color used by hospitals	Recommended colors
General	Plastic bag in blue bin container	Black plastic bag	Black plastic bag
Chemicals, and pharmaceutical	Plastic bag in yellow/ blue bin container	Yellow plastic bag	Brown plastic bags/ container
Clinical, infectious, pathological	Plastic bag in yellow/ blue bin container	Yellow plastic bag	Yellow plastic bags/ container
Sharps	Yellow bin in yellow bin container	Yellow bin	Yellow bin

3. Results and discussion

In this section, findings are presented in three parts: general information, quantity, and management of hospital solid waste.

3.1. General information about the studied hospital

General information of the studied hospital is given in Table 2.

Table 2. General information for the studied hospital

Hospitals	Number of approved beds	Number of operating beds	Number of wards	Establish year of hospital	Number of personnel
H_1	199	117	9	1982	406
H_2	200	115	15	1991	543
H_3	225	211	10	1979	474
H_4	350	181	15	2000	500
H_5	316	314	17	2001	825
H_6	190	133	6	1951	492
H_7	70	70	7	1971	320
H_8	190	178	12	1963	508

The average number of beds and employees was 174 and 508, respectively. All hospital centers have an environmental health specialist with bachelor degree. Moreover, all environmental health specialists were present in the health and hospital infection control committee, and passed courses relating to solid waste.

3.2. Generation of medical waste in Karaj

As can be seen in Fig 2, the medical waste generation rates were reported to be 4.2±0.49 kg/available bed, 5.8±0.63 kg/occupied bed, and 10.3±0.9 kg/inpatient. The results also showed that these generation rates were different from one hospital to the other hospital. So the highest and lowest daily waste generation rate were 5.5±0.35 and 2.6±0.78 kg/available bed in H_7 and H_3 hospitals, respectively. Results of studies in different provinces, apart from confirming this issue, showed that the rate of waste generation per bed for the provinces of Semnan 3.6, Esfehan 3.14, Fars 3.30, Markazi 3.24, Yazd 3.45, Ardebil 3.53, Boushehr 3.8, Zanjan 2.92, Azarbayjan Gharbi 3.20, Guilan 3.16, Qom 2.87 (Sabour *et al.*, 2007), Kashan 3.44 (Mostafaei *et al.*, 2004), cities of Tehran 2.7 (Hassan *et al.*, 2008), Babol 2.01 (Amooei, 2003), Shiraz 4.45 (Askarian *et al.*, 2004b), Mashhad 1.67 (Sadeghi, 2001), Tabriz 3.48 (Taghipour and Mosaferi, 2009) and Yasoj 5.5 kg/day (Raigan Shirazi *et al.*, 2008).

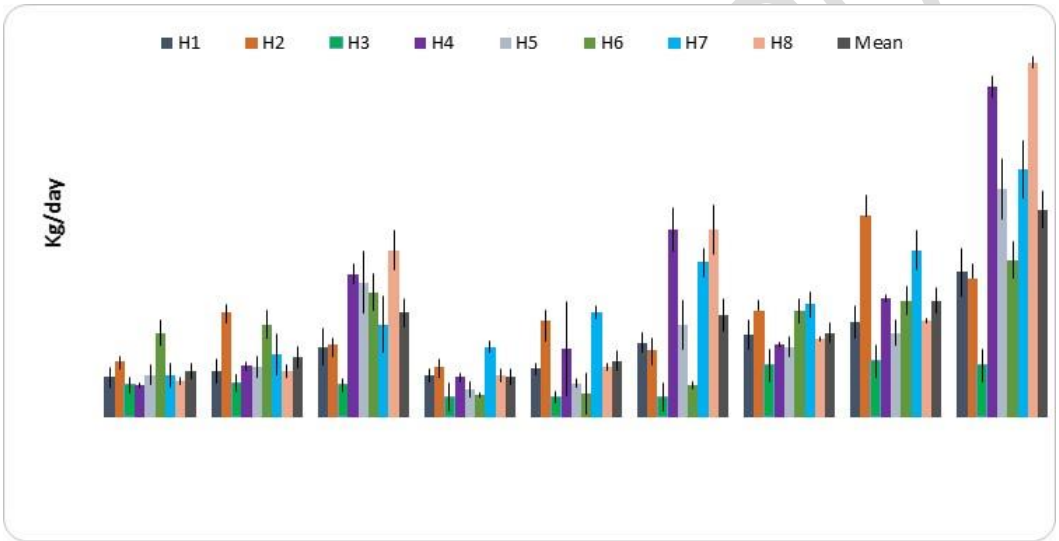

Figure 2. Quantities of medical waste generation rate in the hospitals of Karaj

In this study, total infectious wastes per capita were reported to be 2.3±0.39 kg/available bed/day, 3±0.5 kg/occupied bed/day and 5.2±0.84 kg/inpatient/day. Furthermore, the averages per capita of total general waste were 2±0.4 kg per available bed per day, 2.8±0.51 kg per occupied bed per day and 5.1±0.8 kg per inpatient per day. Per capita of infectious waste in the studies conducted in Yasouj and Babol were 1.5 and 0.67 kg/bed/day, respectively (Amooei, 2003, Raigan Shirazi *et al.*, 2008). In other studies, Silva et al (2005) reported an average rate of biological-infectious waste production of 0.57 kg/bed/day. The high generation rate of infectious waste compared to non-infectious waste in the studied hospitals to other studies can be due to the lack of a systematic plan for the operation of waste separation. Thus, it is suggested that those who are responsible for the hospital waste management should place operation of hospital waste separation at the origin of their agenda. Existing experience attributed to waste management in the developed countries, indicate that these practices can reduce infectious waste to a normal amount in hospitals (15 to 20 %) (Raigan Shirazi *et al.*, 2008).

Authoritative references reported that waste production rate in developing countries was 1-2 kg/bed/day (Raigan Shirazi *et al.*, 2008, Parandeh and Khanjani, 2012). Also, some of the external sources have reported waste production rate as the following:

A study conducted in Dhaka reported the per capita was 1.2 kg/bed/day (Patwary *et al.*, 2009). Studies of waste generation rates in the European countries, hospitals indicated that this index was 3.6 kg/bed/day in Germany, 1.7 kg/bed/day in the Netherlands and 3.3 kg/bed/day in England(Majlesi *et al.*, 2007). A study conducted in Brazil estimated average of hospital waste as 3.5 kg/bed/day (Da Silva *et al.*, 2005). According to the released results, the above mentioned value was 2.41 to 3.26 kg/bed/day in Taiwan (Cheng *et al.*, 2010), 1.3 kg/bed/day in Libya (Sawalem *et al.*, 2009), 1.5-3.9 kg/bed/day in Canada, 2.4 kg/bed/day in Tanzania (Mato and Kassenga, 1997), 0.5-2 kg/bed/day in India (Prüss *et al.*, 1999), 1 kg/bed/day in Thailand (Kerdsuwan, 2000), 1.2 kg/bed/day in Bangladesh (Patwary et al, 2009), and 3.3 kg/bed/day in southern Brazil (Da Silva *et al.*, 2005). Other comparisons of the generation rate have also been summarized in Greece, Cameroon, and Turkey. In Greece, The average total hazardous medical waste unit generation rates varied from 0.012 kg/bed/day, for the public psychiatric hospitals, to up to 0.72 kg/bed/day, for the public university hospitals (Komilis et al, 2012). Total quantity of wastes generated in the Health Care Facility in Cameroon is not reported based on number of beds. The waste stream is complex and heterogeneous with an average waste generation rate estimated at 44.9 kg/day (Mangaa *et al.*, 2011). In Turkey, It was found that the estimated quantity of medical waste from the hospitals is about 22 tons/day and the average generation rate is 0.63 kg/bed/day (Birpınar *et al.*, 2009).

As mentioned above, the values show that waste generation rates per bed varied between different countries, different cities of a country and even the different hospitals of a city. In the previous conducted studies in Iranian hospitals such as Fars (Askarian *et al.*, 2004a) and Tabriz (Taghipour and Mosaferi, 2009) as well as hospitals in Brazil (Da Silva *et al.*, 2005) and Jordan (Bdour *et al.*, 2007), similar differences were observed. The causes of these differences can be attributed to the following; condition and capacity of a hospital, the nature and quality of medical services, standard of equipment, hospital location, variety of sections of the hospital (for example surgery, general and etc.), hospital observance of health standards, cultural, economic and social context, the number of patients and students (for training), laboratory areas, use of disposable materials, number of registered surgeons, type of medical equipment, use of disposable products in the hospital, attention to different aspects of hospital waste management (especially separation, recycling, reuse and purification of infectious waste and different levels of staff training in regards to waste management) (Da Silva *et al.*, 2005, Taghipour and Mosaferi, 2009, Nemathaga *et al.*, 2008, Askarian *et al.*, 2004a). In this study, normal regression analysis showed that the number of inpatient and ward are highly effective in hospital solid waste generation ($p_{value} < 0.005$).

3.3. Hospital waste management

The status of hospital waste segregation at source is shown in Fig. 3a. The most frequent of medical waste separation status was moderate (62%). In this part, the highest percentage of negative response (100%) was related to the strict observance of standards of waste separations at source. The results revealed that one of the reasons for incomplete waste separation in these hospitals was the lack of initial training of nurses and new personnel, while service sectors personnel were constantly changed or replaced. Thus indicating that it is necessary to repeat trainings constantly similar conditions were reported by Sawalem *et al.*, (2009). Accordingly, it is suggested that trained and experienced individuals should be used when dealing with the management of solid waste. Furthermore, if possible, lower turnover and job displacement should take place. The other cause of inattention to the strict observance of standards of waste separation in the origin is related to the condition of a severally ill patient. In such cases, a need for giving more services leads to inattention of health personnel to waste separation. The primary responsibility of hospital waste separation is placed on its producers (such as doctors, nurses, and paramedics). As long as health care staffs are not aware of this issue and do not execute it, it will not be modified under any circumstances (Mousavi *et al.*, 2005). Unfortunately, at present this responsibility is mainly placed on the waste collection sector. Obviously only the separation of mixed wastes will not solve the problem, but also strongly increases the unhealthy condition. Also, recycling of any segregated wastes is not currently being practiced on-site.

Moreover, results indicate that hospitals in collection aspect were poor 62%, and moderate 38% (Fig. 3b). In this part, the oversight in washing and disinfecting waste bins after each use, and the lack of labeling

waste bags were of the main shortcomings observed. Lack of labeling of waste bags leads to the failure to identify waste inside the bags during temporary holding and eliminates the ability to track fluctuations in waste production in hospital wards. Thus, any sudden increase or decrease in the waste generation cannot be tracked and removed in different sections.

Looking at the hospitals revealed that in 85% of them, designated people were not assigned to collect and transport solid waste. While it is very important to apply specialized waste-workers in collecting solid waste, it is suggested to use an adequate number of trained people in collecting and transporting hospital waste. In the study of the hospital solid waste management in five hospitals in the city of Tehran the presentation of improvement approaches, Farzadkia *et al.*, (2011*)* concluded that health level of the collecting system in 20% of centers was poor and in 40% was good. These results are close to our findings. In some studies, the main reasons for the poor condition of hospital waste collection are items such as: manual waste collection and the inappropriate condition of solid waste collection frequency (Coker *et al.*, 2009, Al-Khatib and Sato, 2009).

Site surveys at the hospitals showed that most wards did not have a temporary storage room for putting containers that get full during the day or at night. But all hospitals have a temporary storage room outside of the hospital building. So, the collected wastes from the wards were directly transferred to temporary storage outside of the hospital building. In this stage, findings showed that 100% of hospitals were in poor condition (Fig. 3c). Looking at hospitals revealed that most of the waste management problems are related to workers performance. For example, while collecting and transporting waste workers do not take into consideration the color of the containers and the mixing of wastes. In most cases, active waste in the black and yellow bags are mixed together and therefore infectious waste led to the infection pollution of the contents of the black bags. So, all separation practices done at the source were useless. This statue was seen in other studies (Coker *et al.*, 2009, Akter *et al.*, 2002, Rasheed *et al.*, 2005).The result mentioned above, despite training classes with the content of waste management, confirmed inefficiency of teaching in the studied hospitals. Creating the necessary infrastructure and Forcing employees to adhere to the rules and regulations by the managers are basic and essential items for hospital waste separation (Akter, 2000).

Fig. 3d presents that the employees member status were poor in 37.5%, moderate in 25%, and good in 37.5% of hospitals. In this dimension, the use of specialized waste-workers for collection and transportation of solid waste in the hospital and cleaning of the area obtained the lowest percentage of positive responses. Also, findings showed that only 37.5% of hospitals, with the exception of wearing uniforms, do not require wearing thick gloves, boots and respirators. A hospital waste survey in private hospitals in Fars province showed that only in 66.7% of the studied centers did staff members use safety equipment such as special clothes, gloves, mask, boots, etc, in waste transportation training when promoting awareness to workers on masses of hospital waste (Askarian *et al.*, 2004b).

Figure 3e shows hospital solid waste disposal status. As presented, most hospitals (75%) were in good condition. Moreover, this study revealed that autoclaving are also used as a treatment method for infectious waste at six hospitals. The autoclave situated beside the temporary waste storage. On the other hand, findings showed that the highest percentage of positive response (100%) was allocated to the delivery of general and safe waste from the hospital to the city hall. In hospitals where treatment of medical waste was not performed, waste was collected daily by municipality. Based on the results of the previous studies in the cities of Yasuj (Raigan Shirazi *et al.*, 2008), Qom (Jonidi *et al.*, 2010), Mazandaran (Mohseni *et al.*, 2001), some hospitals of Tehran (Yaghoubifar, 1998), Brazil (Da Silva *et al.*, 2005), South Africa (Nemathaga *et al.*, 2008), L-sea, Egypt (Abd El-Salam, 2010), Addis Ababa (the largest city in Ethiopia) (Debere *et al.*, 2013) and Istanbul (Alagoz and Kocasoy, 2008).

In the storage stage, most of the hospitals (63%) were ranked to be moderate (Fig. 3f). Moreover, the lowest percentage of positive response (12%) was related to the weighing type and detailed daily record of the types of producing waste. It was also observed that most hospitals did not have all the desirable terms of temporary storages, although essential requirements were met. As temporary storages at the hospitals of Karaj was in a better condition compared to previous similar studies in the cities of Yasuj

(Raigan Shirazi *et al.*, 2008), Bookan, Mahabad, Saghez, and Miandoab (Habibzadeh *et al.*, 2007), Qom (Jonidi *et al.*, 2010), and some hospitals in Tehran (Farzadkia *et al.*, 2011).

Overall, statue of hospital waste management in 88% of hospitals were ranked moderate when others were achieved to be poor by 12% (figure not shown).

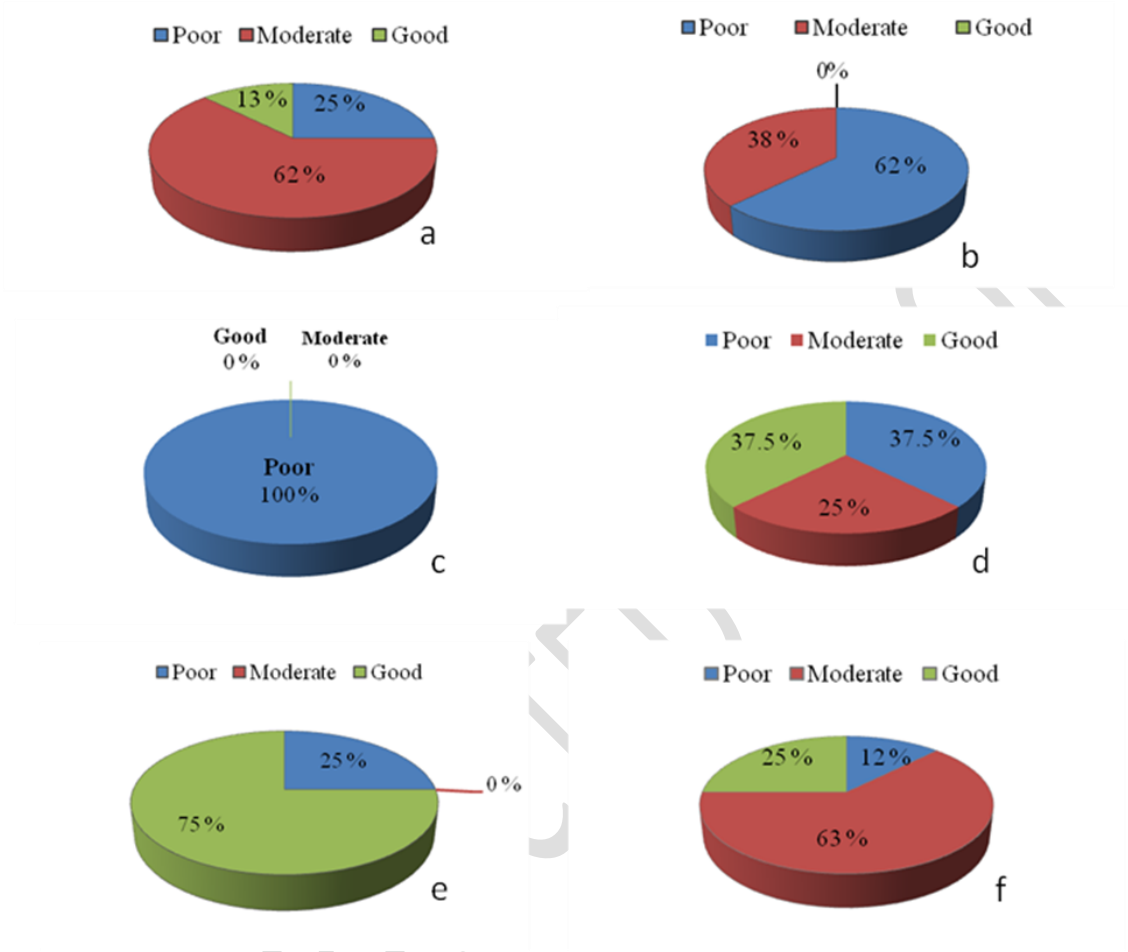

Figure 3. Various status of hospital solid waste management: **a)** separation at the source, **b**) collection from wards, **c**) transportation, **d**) employees member, **e**) disposal, **f**) temporary storage

4. Conclusions

Piloting this method in Karaj hospitals showed the hospital waste management was poor in collection, transportation and employees member aspects. The hospital waste management was concluded to be moderate in separation and temporary storage aspects when the results showed that the hospital solid waste disposal status (75%) was in good condition. In general, statue of hospital waste management in 88% of hospitals were ranked moderate.

The names of the hospitals were omitted when they were referred from H_1 to H_8. So the highest and lowest daily waste generation rate were 5.5±0.35 and 2.6±0.78 kg/available bed in H_7 and H_3 hospitals, respectively. The pilot study results showed that the daily per capita waste generations were reported to be 4.2±0.49 kg/available bed, 5.8±0.63 kg/occupied bed, and 10.3±0.9 kg/inpatient. In this study, total infectious wastes per capita were reported to be 2.3±0.39 kg/available bed/day, 3±0.5 kg/occupied bed/day and 5.2±0.84 kg/inpatient/day. Furthermore, the averages per capita of total general waste were 2±0.4 kg/available bed/day, 2.8±0.51 kg/occupied bed/day and 5.1±0.8 kg/ inpatient/day.

Table 3- Existing hospital waste management practices and recommendations

Dimension	Current practices	Recommendations
Separation	The normal trash, freezer, stainless, washable and suitable size, equipped with healthy bags, robust, strong and suitable color is used in various wards and locations. Color coded containers are used to separate various waste types. However, in many wards, there is mixing of waste. General waste is often mixed with pathological or infectious waste Pathological and infectious wastes are also sometimes mixed	Waste separation principles at the source to be observed exactly. So Environmental health education is needed for nurses on hospital waste management followed by strict monitoring for compliance. Proper containers with correct color codes are needed in all wards to prevent mixing of the different waste types. Radioactive waste separately collected according to regulations and under the supervision of the Health physics. A list of the types and sources of hazardous waste is prepared in hospitals.
Collection	Solid waste bags and safety box after filling three-quarters of their capacity to be closed.	Washing and disinfection of garbage to be done after every discharge. Bags of solid waste are properly labeled.
transportation	In the studied hospitals, medical solid waste recycling ban was observed. Waste is collected least twice per day from the wards; in different hospitals, the time of waste collection and	To transportation of the solid waste to the temporary storage used wheeled trolley, bin or wheeled carts specific transporting solid waste. Washing and disinfection of bins to be done after every discharge.
temporary storage	In studied hospitals, there was a temporary storage. Waste is temporarily stored there before being taken to each handling practice. Some of the waste leaks out, especially fluids from infected and pathological waste. The room is not locked	Weighing and exact record the types of producing solid waste to be done daily and documented. The central storage room should be properly cleaned to reduce the possibility of any spread of diseases. All waste going to the central storage room should be inspected so that there are no leakages. The storage room should be properly secured to avoid any unauthorized person entering
Disposal	All centers deliver their general, safe and infectious waste to the municipality (city hall).	Approved non-incineration method to disinfecting sharp and infectious waste at the source of use. Ensuring that all infectious waste is autoclaved and hidroclaved is still needed
manpower	In most studied hospitals, specific workers were not applied to collect and transport solid waste. When collecting solid waste, workers except wearing uniforms, do not respect anything such	To the collection and transportation of solid waste in hospital and cleaning landscaping to be used proprietary manpower and their use should be avoided in food-related activities. When handling solid waste, personnel must use personal protective

Overall, the status of waste management was far beyond the expectations among studies hospitals. Although officials of these hospitals considered lack of financial resources as the main cause of these problems, successful experience of hospital waste management inside and outside of the country confirms that by applying some modifications, the present condition can be improved to a desirable level. Accordingly, setting an operational program and careful monitoring of its optimal execution by hospital manager is necessary. The main focus of these programs should be primarily on minimizing waste production, especially hospital waste.

5. Recommendations

It is suggested that scholars who want to study in this field use this method (the questionnaire prepared by MOHME) and report in a similar way. The results of this study confirmed that the questionnaire prepared by MOHME is appropriate tool to investigate the status of waste management in hospitals, and in the light of proposed scoring and analyzing it can provide the opportunity of comparing the results of different studies. It is suggested that improving quality of elements of waste production, separation and collecting, and transportation be placed on each hospitals, agenda. The summarized recommendations are given in Table 3. Most of the recommendations require only a commitment to hospital waste management by both the staff and its management to be implemented, without any much additional financial budget.

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