

Structure of solid waste management in hospitals of Bandar Abbas city

Naser Rahmanian¹, Abbas Ghavam^{2*} and Abbas Yazdanpanah³

¹Department of Healthcare Management, Marvdasht Branch, Islamic Azad University, Marvdasht Iran

²Assistant Professor, Department of Environmental Science, Institute of Sciences and High Technology and Environmental Sciences, Graduate University of Advanced Technology, Kerman, Iran

³Assistant professor, Department of Healthcare Management, Marvdasht Branch, Islamic Azad University, Marvdasht, Iran

ABSTRACT

One of the major sources of waste in each city is the hospital centers, which produce a wide range of waste. These wastes should not be mixed with municipal wastes, because the spread of chemical and biological materials containing the dangerous pathogens causes the specific environmental and health hazards. Lack of control and lack of attention to proper management of hospital wastes on how to collect, store, transport and dispose of such waste, will lead to the prevalence of regional and urban epidemics and diseases and waste of money that this is a serious threat to the public health and environment. The aim of this study is to evaluate trends in waste management in hospitals of Bandar Abbas and adapt this process with the national standards. This is an applied study conducted in a descriptive-analytic method. In this study, one sample t method was used. The sample consisted of 107 waste production sites in 8 hospitals in Bandar Abbas that the census method was used. To evaluate the variables, it was used the Health Ministry's standard checklist for hospital waste review. The data was analyzed by SPSS software and using the descriptive and inferential statistics. There is no significant difference between the average total per capita solid waste per bed in hospitals in Bandar Abbas and the average total per capita solid waste per bed set by the Ministry of Health ($t = 1.922$). It means the average per capita waste generation in hospitals in Bandar Abbas is consistent with the regulations of the Ministry of Health. There is a match between the average per capita ordinary solid waste generation with the average ordinary solid waste generation set by the Ministry of Health ($t = 1.631$). It means the average ordinary waste in hospitals of Bandar Abbas is consistent with the regulations of the Ministry of Health. The average duration of waste storage in hospitals of Bandar Abbas is consistent with the average waste storage in accordance with regulations of the Ministry of Health related to similar areas (hot and humid conditions ($t = 22.12$)). This means that the average duration of waste storage in hospitals of Bandar Abbas corresponds to the

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*Corresponding Author: ghavam39@gmail.com

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time determined by the Ministry of Health for the hot and humid weather conditions. Using the above results, it can be concluded that the establishment of environmental health experts at hospitals, daily tracking and proper training for personnel involved in the production, and collection and disposal of hospital wastes could play an effective role in preventing the risks of hospital wastes.

Correct management training and disposal of hospital wastes should be one of the operational objectives of hospital managers and this important issue should be included in planning courses for staff of all hospitals.

KEY WORDS: SOLID WASTE – MANAGEMENT – HOSPITAL – BANDAR ABBAS

INTRODUCTION

Today, increasing waste and environmental pollution and health hazards resulting from it has been raised as one of the most important problems in human societies today, (Chartier, 2014). The whole extent of this waste is so high in which we can find the ordinary household waste to the dangerous chemical and biological contaminants. One of the major sources of waste generation in each city is the hospitals which produce a wide range of waste (Zarei, Taghdisi, Keshavarz Mohamadi, & Tehrani, 2013).

The great thing about the medical wastes is that these wastes should not be mixed with municipal wastes, because the spread of chemical and biological materials containing the dangerous pathogens causes the specific environmental and health hazards. Classification and composition of medical waste with particular attention to the collection and disposal of it include a wide range of different materials, such as ordinary or household-like, infectious, chemical, and pharmaceutical wastes (Chartier, 2014), (Zarei et al., 2013). The household-like wastes includes materials such as paper, cardboard, carton, plastic materials, remnants of food and fruit that if not mixed with the hazardous and infectious materials are safe and they can be collected and disposed of as the household waste (Kumar, Samrongthong, & Shaikh, 2013). The potentially infectious wastes exist in various forms as the contaminated disposable supplies and sharp instruments products containing blood, and laboratory culture media, (Nie, Qiao, & Wu, 2014 and Ndejjo et al., 2015).

Based on WHO, the infectious wastes include the wastes that contain the pathogens to the extent that can cause the disease in the susceptible hosts, (WHO, 2004). There are different opinions in the classification and definition of infectious wastes. The sharp wastes include the needles, syringes, broken glasses and scalpels. Since these components can create the injury and lead the pathogens such as hepatitis and AIDS to enter the human body, therefore it is necessary to separate them from other infectious wastes (Rastegar & Gholami, 2014). The chemical and pharmaceutical wastes includes the drugs, pharmaceutical products and various chemi-

cals that are produced by the specific health activities in these centers. The drugs and chemicals returned or discarded and expired are also part of this category.

Therefore, the particular attention to the separate collection and disposal of them is very important. This is while sometimes seen in Bandar Abbas that for reasons of high cost of solid waste disposal, the illegal and hygienic ways are used to dispose of the wastes. Since the lack of control and lack of attention to proper management of hospital wastes on how to collect, preserve, transport and dispose of such waste will lead to the prevalence of regional and urban epidemics and diseases and waste of money, this is considered as a serious threat to the public health and environment.

This study aimed to assess the waste management process in hospitals of Bandar Abbas and adapt this process with the national standards. So, at first, the aim of this study is to evaluate the waste management process in hospitals of Bandar Abbas and adapt this process with the national standards and secondly, to find the standard deviation and provide the administrative approaches to standardize the structure.

MATERIAL AND METHODS

In this descriptive-analytic study, the research environment was the hospitals of Bandar Abbas, including the university hospitals (Shahid Mohammadi- childrens'), private hospitals (Om-e-Leila and Imam Reza), hospitals affiliated with the police and armed forces (Saheb-al-Zaman, Seyed-al-Shohada and Khatam-ol-anbia) and Persian Gulf hospital affiliated to social security. The study population consisted of 107 waste production sites in the 8 hospitals of Bandar Abbas. (N=107)

The standard waste management checklist of Ministry of Health related to the collection of waste management data in country's hospitals was used by the researcher to collect the data. The standard checklist Ministry of Health has been 105 years that after soliciting the opinion of experts of environmental health department of the Health Center in Hormozgan province and professors of environmental health department at the School of Health in Bandar Abbas, it was summarized to the 42

questions to collect better data. So, the checklist used to collect the research data had 42 questions that was applied for the different stages of hospital waste management, including how to produce waste, status of collection, transportation, weighing, disinfecting and final disposal of hospitals' solid wastes in Bandar Abbas.

The checklist includes six scales that are the per capita waste, disinfecting procedures, management components in waste disposal, waste separation, storage, transportation and methods of final disposal of waste. Questions of subscales are as follows: Per capita waste, questions 7, 8, 9, 10, 11, 12, 13, 14, 15 and 16; that how to measure on these questions is as kg per day. Disinfecting methods, questions 17, 18, 19 and 20; which the method of measurement is based on standard or non-standard methods.

Management components in waste disposal, questions 21, 22, 23, 24 and 25; that the method of measuring them is as yes / no, complete / incomplete. Waste separation, questions 25, 26, 27 and 28, that the method of measuring them is as yes / no, complete / incomplete. Storage and transportation, questions 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43 and 44, that the measurement method is as yes / no, complete / incomplete. Methods for final disposal of wastes, questions 45, 46, 47 and 48, that the measurement method is as yes / no, complete / incomplete. In this questionnaire, obtaining less points means more consistent with the standards of the Ministry of Health.

In this review, after completing the paperwork and obtaining the necessary permits, in collaboration with the Deputy Treatment and Deputy Health of medical university and hospital managers in Bandar Abbas, the research data in hospitals of Bandar Abbas was collected in 4 steps as follows.

FIRST STAGE

The research environments were visited in a field method (waste production sites, including wards, outpatient departments, clinics, diagnostic departments, operating rooms, drug stores, administration and support departments, kitchens and cafeterias) and the solid waste collection sites, people involved in the production process, collection, transportation, storage and final disposal of wastes were identified.

SECOND STAGE

At this stage, it was justified the people involved in the production process to the final disposal of wastes in hospitals on the goal of the study, for this purpose, in coordination with the hospital manager and health experts based in hospitals, the people gathered in the auditorium of the hospital and the functional objectives and

implementation phases of the study were described for them. As the number of people involved in the Shahid Mohammadi hospital was great, 3 briefings were held in this hospital and 2 briefings were held in the children's hospital and Persian Gulf hospital. In other hospitals, a meeting was held to justify the people involved.

THIRD STAGE

At this stage, the designated sites were daily visited and then the process of collecting, transporting, storing, weighing and disposing of the wastes generated was observed and recorded for each site and finally, the completed information related to the various stages of producing solid waste in each hospital was recorded in the standard checklist of Ministry of Health (checklist of visiting the management of the collection, storage, transportation and disposal of wastes in the country's hospitals). It should be noted that the standard checklist Ministry of Health related to the different stages of solid waste disposal in country hospitals has been 105 years that after soliciting the opinion of experts of environmental health department of the Health Center in Hormozgan province and professors of environmental health department at the School of Health in Bandar Abbas, it was summarized to the 42 questions by the researcher to collect better data.

FOURTH STAGE

At this stage, after collecting the data required in all hospitals, the data collected was entered into SPSS 16 software and then using the descriptive and analytic statistics and statistical tests, the per capita production, duration of waste storage and waste management method in the hospitals of Bandar Abbas were compared with the regulations of the Ministry of Health.

In this study, the SPSS 16 software and descriptive statistics including frequency, mean and standard deviation; and inferential statistics including one sample t-test (at the significance level 0.05) were used to analyze the data.

RESULTS

According to the results of this study, the amount and percentage of the waste generated is shown in Table 1. Accordingly, the amount of waste produced daily in hospitals was 1987.45 kg that the waste generation in the university hospitals was 921.45 kg, in the private hospitals 383 kg, in the military and police hospitals 296 kg, and in the social security hospital 387 kg per day.

As seen in Table 1, the highest average total production of waste is in Social Security hospitals in the

Table 1. The quantitative components of the waste by the type of surveyed hospitals

Parameter	Production (Kg / d)	Average (Kg / d)	Standard deviation (Kg / d)	Minimum (Kg / d)	Maximum (Kg / d)	% of ordinary waste production to the total ordinary waste produced	% Of total Production
The total amount of waste produced in university hospitals	921.45	26.32	30.17	5	160	3.387	4.366
The total amount of waste produced in private hospitals	383	14.18	11.23	3	45	2.933	1.279
The total amount of waste produced in military and police hospitals	296	8.96	10.87	4	30	1.199	1.894
The total amount of waste produced at the Social Security Hospital	387	32.25	24.51	7	140	19.5	1.479

amount of 32.25 kg per waste production site and then in the university hospitals with an average 26.33 kg of waste per site. The lowest total waste production is in the military and police hospitals with an average 8.96 kg per waste generation site. It is observed 37.38% of ordinary wastes are created in the university hospitals that this seems natural considering that most active beds are related to the university hospitals and on the other hand, these hospitals are teaching and more staff and university students are working in them. The lowest percentage of ordinary waste production (Alam, Sujauddin, Iqbal, & Huda, 2008) is also related to the military and police hospitals in Bandar Abbas.

According to the study results, the number of active beds and per capita total waste generation in the university hospitals with 325 beds is 2.83 Kg / d, in the private hospitals with 169 active beds is 2.26 Kg / d, in the military and police hospitals with 163 beds is 1.81 Kg / d and in the social security hospital with 107 active beds is 3.61 Kg / d per active bed.

Another important indicator of waste management is the waste storage time in the temporary storage site of waste. The information in this section is presented in Figure 1.

According to the figure, in 62.6% of the hospitals surveyed, the waste storage time in temporary sites was 24 hours and in 25 percent of hospitals, the time was between 24 to 48 hours and in 12.5%, the time was between 48 and 72 hours.

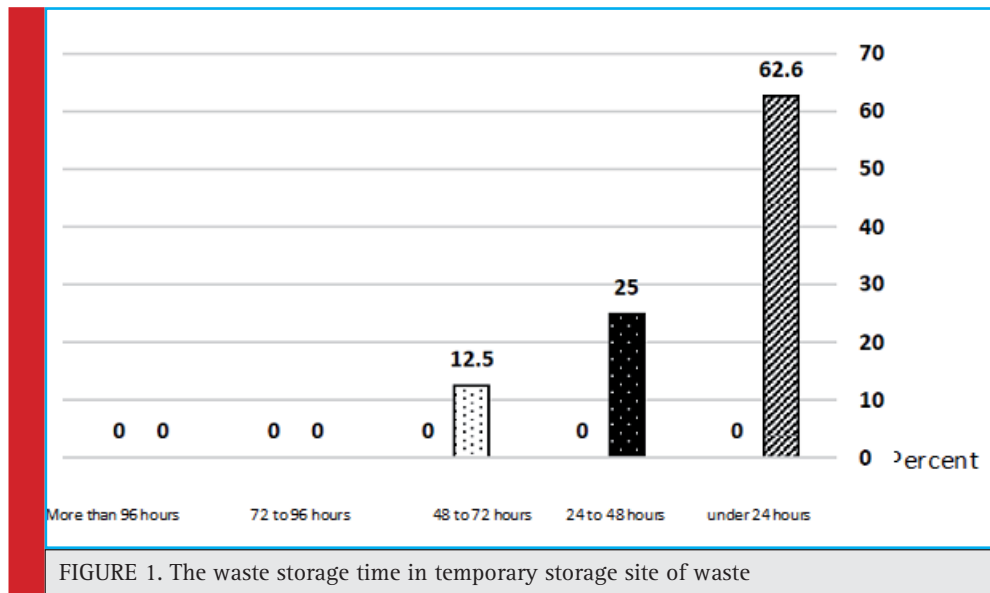
According to the results of this study, most waste storage time in temporary sites is respectively in the police and military hospitals with an average of 56 hours, in Social Security hospitals with an average of 28 hours, in private hospitals with an average of 23 hours and less time keeping waste is in the university hospitals with an average of 21 hours.

1. Lack of disinfection of waste containers
2. Disinfection of waste containers
3. Non-coding and labeling waste separated
4. Coding and labeling the waste
5. The absence of valid contracts with authorized centers for transport and disposal of chemical and pharmaceutical waste
6. Valid contracts with authorized centers for transport and disposal of chemical and pharmaceutical waste

As seen in Figure 2, disinfection and labeling of waste are done in 100 percent of hospitals, but only in 50 per-

Table 2. Per capita waste generation in different hospitals studied

Hospitals	Number of active beds	Ordinary waste per capita per active bed(Kg/d)	total waste per capita per bed(Kg/d)
University hospitals	325	1.34	2.83
Private hospitals	169	1.6	2.26
Military and police hospitals	163	1.33	1.81
Social Security hospital	107	1.85	3.61
All hospitals	758	1.52	2.62



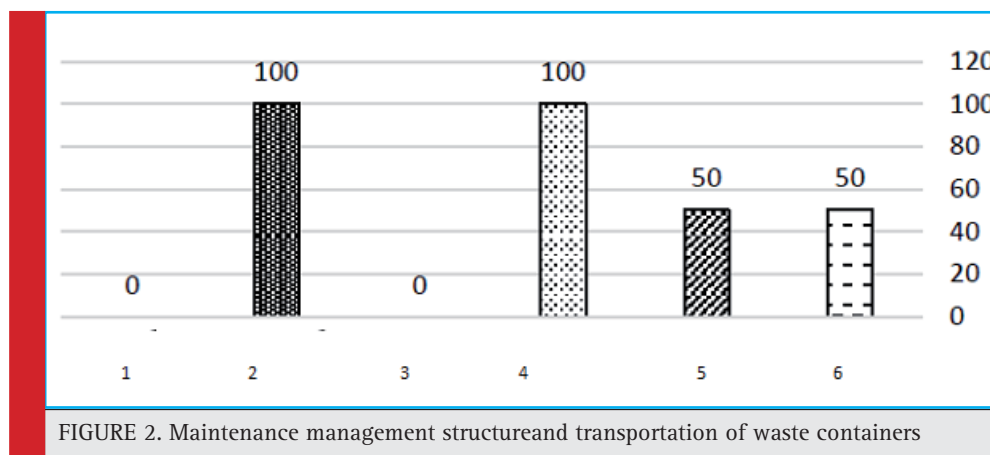
Row	Hospitals by the type of ownership	The average duration of waste storage per hour
1	University Hospitals	21
2	Private Hospitals	23
3	Police Military Hospitals	56
4	Social Security Hospital	28
Total average		32

cent of hospitals, it has been signed with authorized centers to transport and dispose of chemical and pharmaceutical waste.

1. The absence of Safety Box to collect the sharp waste

2. The existence of Safety Box to collect the sharp waste
3. The lack of organs and limbs cut and dead fetus
4. Failure to collect the organs and limbs cut and dead fetuses in accordance with regulations
5. Collecting the organs and limbs cut and dead fetuses in accordance with the regulations
6. Collection along with other wastes
7. Separately storage method of chemical and pharmaceutical wastes

As seen in Figure 3, the chemical, pharmaceutical and biological wastes are separately kept in 75% of hospitals studied. Also, in all the hospitals that have the pathological wastes (organs and limbs cut and dead fetus, etc), these wastes are collected according to regulations of the Ministry of Health. This graph also shows that in the majority of hospitals studied (87.5%), there is the safety box for collecting the sharp wastes.



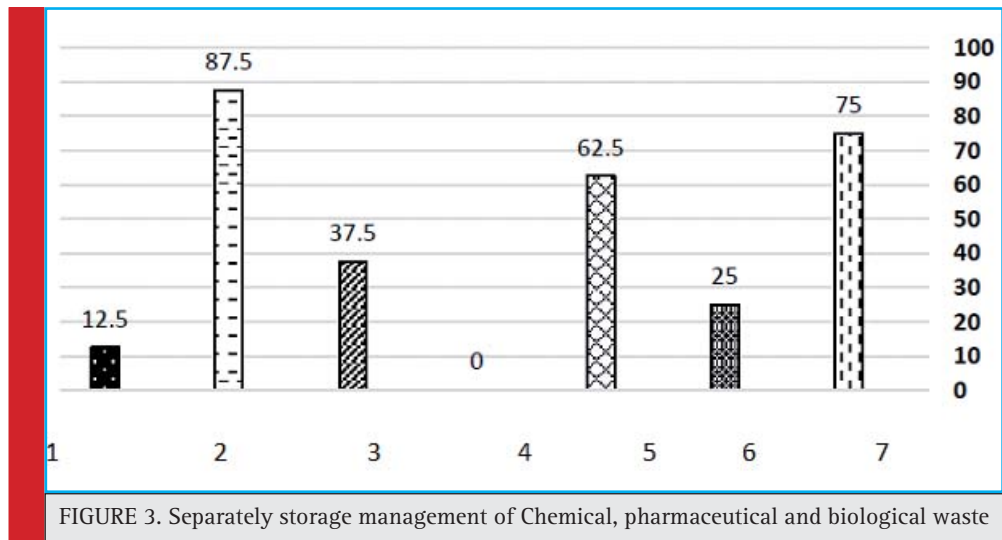


FIGURE 3. Separately storage management of Chemical, pharmaceutical and biological waste

Table 4. Comparing the total production of solid waste (infectious and non-infectious) in the hospitals of Bandar Abbas with the regulations approved by the Ministry of Health and Medical Education

Variables	Average	t	Significance *
Statistical indicators			
Average per capita production of solid waste per active bed in hospitals in Bandar Abbas	2.62	1.922	0.09
Average per capita production of solid waste per active bed set by the Ministry of Health	2.7		

The above table shows that there is no significant difference between the average total per capita solid waste per bed in hospitals in Bandar Abbas and the average total per capita solid waste per bed set by the Ministry of Health ($p < 0.01$, $t = 1.922$). The average total per capita solid waste generation in hospitals in Bandar Abbas corresponds to the average total per capita solid waste determined by the Ministry of Health.

DISCUSSION

Per capita waste production in hospitals studied in Bandar Abbas was obtained 2.62 kg/b.d. In this study, except ordinary wastes (1.5 per active bed per day, i.e. 57.25% of the total waste production), other wastes was considered infectious that the amount of these wastes is 1.12 kg/b.d, i.e. 42.74% of total wastes generated. In a same study, entitled the hospital waste management in hospitals in West Azerbaijan in 2007, the amount of waste generated per bed per day had been equivalent to 0.95 kg/b.d that the amount increased to 3 kg/b.d in 2012 that is consistent with the amount of waste generated in this study (2.62 kg/b.d) (2).

In the study of Dehghani et al that was done in hospitals of Arak University of Medical Sciences, entitled the review of medical waste management status, the results showed that the rate of waste production is 4.42 kg/b.d, which is consistent with this study (Dehghani, Azam, Changani, & Dehghani Fard, 2008). The results also show that per capita waste generation was higher in our study compared to the study of Al-Khatib et al with 0.59 to 0.93 kg/b.d medical waste production (Al-Khatib, Al-Qaroot, & Ali-Shtayeh, 2009), study of A.B.Wahab et al with 0.37 to 1.25 kg/b.d infectious waste in public hospitals and 0.12 and 0.28 kg/b.d in private hospitals (Wahab & Adesanya, 2011) and the study of Cheng.Y.W et al with 0.19 to 0.88 kg/b/d infectious waste production.

On the other hand, according to the results obtained in this study, 57.25% of the ordinary wastes and 42.47% of infectious wastes constitute the total wastes generated in the hospitals. The infectious waste generated in this study compared to the Taghipour's study in Tabriz were higher (29.4 percent) (Taghipour & Mosaferi, 2009). The study of Farzad Kia et al in which the infectious waste was 10 to 15 percent in Tehran educational hospitals (Farzadkia, Moradi, Mohammadi, & Jorfi, 2009)

is not consistent with this study. In a study of Davoodi conducted in the hospitals of Mashhad, it was 34.90% (Davoodi et al., 2014) and in the study of Alam MM et al, it has been reported that the infectious waste (at a rate of 37%) is more than the present study (Alam et al., 2008).

Furthermore, in the study of Nemathaga F conducted in South Africa and in Limpopo Province, the average percentage of the components of medical wastes was 60.47% ordinary wastes and 30.32 % infectious wastes that these results are almost consistent with the results of this study (Nemathaga, Maringa, & Chimuka, 2008). According to this study (Table 2), per capita waste production in university hospitals is 2.38 kg/d, in private hospitals is 2.26 kg/d, in police and military hospitals is 1.81 kg /d and in social security hospitals is 3.61 kg/d/b. It seems that high per capita waste generation can be due to the hospital inappropriate management structure, early replacement of hospital administrators and inexperience of environmental health expert based in the hospital.

According to the results of Figure 1, most waste storage time in temporary sites is respectively in the police and military hospitals with an average of 56 hours, in Social Security hospitals with an average of 28 hours, in private hospitals with an average of 23 hours and less waste storage time is in the university hospitals with an average of 21 hours. It seems that one of the reasons for long-term accumulation of waste in public hospitals is associated with the traffic problem of vehicles to collect and transport waste in military areas as well as the lower volume of daily waste than the volume of trucks carrying the waste. According to Figure 4, in 62.5% of hospitals, the pharmaceutical and chemical waste final disposal method is the sanitary landfill. In 25 percent of these hospitals, the methods of container making and piling up are used for final disposal of the wastes and in 12.5 percent of the hospitals studied, it is used other methods. The sanitary landfill and incineration methods are not used in any of the hospitals.

CONCLUSION

Lack of control and lack of attention to proper management of hospital wastes on how to collect, store, transport and dispose of such waste will lead to the prevalence of regional and urban epidemics and diseases and waste of money that this is considered a serious threat to the public health and environment. On the other hand, due to urban sprawl and population growth, the pace of creation of institutions and medical centers such as the hospitals and paying attention to the management of hospital wastes are necessary. Therefore, the present study was conducted in this regard that the results of this study showed total per capita waste generation in

hospitals of Bandar Abbas is 2.62 kg/b.d that 1.5 kg is related to the household-like wastes (ordinary) and 1.12 kg belong to the infectious wastes including the sharp waste, pharmaceutical waste, chemical and hazardous wastes, pathological wastes and genotoxic waste.

According to the World Health Organization (2014), which is approved by the Ministry of Health, 85% of waste generated in hospitals are without risk or ordinary and only 15 to 25% of them constitute the hazardous waste. While in the hospitals studied, 42.74 percent of hospital wastes are infectious and hazardous that is more than the amount recommended by the World Health Organization and the Ministry of Health. It seems that this is often due to neglect and lack of awareness of the environmental hazards and pollution and economic losses caused by mixing the ordinary and infectious wastes in all stages of production, transportation and storage of waste in hospitals.

Based on the results of this study, we can conclude that the per capita production of solid waste per bed as well as the average duration of waste storage in the temporary site of waste at hospitals of Bandar Abbas is almost accordance with the standards recommended by the World Health Organization and the Ministry of Health. But there is no consistency in the waste composition, the infectious waste ratio to the total waste generated and the proportion of infectious and hazardous waste in hospitals of Bandar Abbas is about 2 times the amount recommended by the World Health Organization and the Ministry of Health that it should be prevented the mixing of infectious and ordinary waste, especially in production by implementing more effective training programs and making a commitment and responsibility in all employees involved in the infectious waste production and performing ongoing monitoring by managers and health experts in hospitals as well as the university students in different fields in hospitals. Moreover, it is necessary to force the hospital officials and administrators in implementing the waste management rules.

OFFERS

With respect to the implementation of effective training programs for managers and personnel involved in the production, transportation and disposal of hospital waste, it is recommended at first the training needs of different groups involved in the production of hospital wastes are determined based on scientific principles and then the required training programs are developed and implemented based on these results.

In the educational needs of different groups based on scientific principles involved in the production of hospital wastes were determined and then based on the results required training programs developed and implemented.

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REFERENCES

- Al-Khatib, I. A., Al-Qaroot, Y. S., & Ali-Shtayeh, M. S. (2009). Management of healthcare waste in circumstances of limited resources: a case study in the hospitals of Nablus city, Palestine. *Waste Management & Research*, 27(4), 305-312.
- Alam, M. M., Sujauddin, M., Iqbal, G. M. A., & Huda, S. M. S. (2008). Report: Healthcare waste characterization in Chittagong Medical College Hospital, Bangladesh. *Waste Management & Research*, 26(3), 291-296.
- Chartier, Y. (2014). Safe management of wastes from health-care activities: World Health Organization.
- Davoodi, R., Eslami Hasan Abadi, S., Sabouri, G., Salehi, M., Ghooshkhaneh, H., Rahmani, S., Gharaeian Morshed, M. (2014). Medical Waste Management in the second largest City of Iran (Mashhad) with Three-Million Inhabitants. *Journal of Patient Safety & Quality Improvement*, 2(4), 160-164.
- Dehghani, M., Azam, K., Changani, F., & Dehghani Fard, E. (2008). Assessment of medical waste management in educational hospitals of Tehran university medical sciences.
- Farzadkia, M., Moradi, A., Mohammadi, M. S., & Jorfi, S. (2009). Hospital waste management status in Iran: a case study in the teaching hospitals of Iran University of Medical Sciences. *Waste Management & Research*, 27(4), 384-389.
- Kumar, R., Samrongthong, R., & Shaikh, B. T. (2013). Knowledge, attitude and practices of health staff regarding infectious waste handling of tertiary care health facilities at metropolitan city of Pakistan. *Journal of Ayub Medical College Abbottabad*, 25(1-2), 109-112.
- Ndejjo, R., Musinguzi, G., Yu, X., Buregyeya, E., Musoke, D., Wang, J.-S., Williams, P. (2015). Occupational health hazards among healthcare workers in Kampala, Uganda. *Journal of environmental and public health*, 2015.
- Nemathaga, F., Maringa, S., & Chimuka, L. (2008). Hospital solid waste management practices in Limpopo Province, South Africa: A case study of two hospitals. *Waste Management*, 28(7), 1236-1245.
- Nie, L., Qiao, Z., & Wu, H. (2014). Medical Waste Management in China: A Case Study of Xinxiang. *Journal of Environmental Protection*, 2014.
- Rastegar, A., & Gholami, H. (2014). Survey of Solid Waste Management in Small and Large selected Hospitals of Tehran. *www.sjimu.medilam.ac.ir*, 22(2), 149-157.
- Taghipour, H., & Mosaferi, M. (2009). Characterization of medical waste from hospitals in Tabriz, Iran. *Science of the total environment*, 407(5), 1527-1535.
- Wahab, A., & Adesanya, D. (2011). Medical waste generation in hospitals and associated factors in Ibadan Metropolis, Nigeria. *Res J Appl Sci Eng Technol*, 3, 746-751.
- WHO (2004). National Health-Care Waste Management Plan 2004 (pp. 7-23).
- Zarei, F., Taghdisi, M. H., Keshavarz Mohamadi, N., & Tehrani, H. (2013). Health Promoting Hospital: A pilot study in Bo-Ali hospital, Qazvin, Iran. *Journal of Fasa University of Medical Sciences*, 3(3), 215-223.