

Quantitative and Qualitative Investigation of Yazd Dental Center Waste

Mehdi Mokhtari,¹ Zahra Derakhshan,¹ Zahra Raeisi,^{1*} Zahra Soltaniyanzadeh,¹ Gholamreza Manuchehri,¹ Fatemeh Babai,¹ and Elham Mahdavian¹

¹Environmental Sciences and Technology Research Center, Department of Environmental Health Engineering, Shahid Sadoughi University of Medical Sciences, Yazd, IR Iran

*Corresponding author: Zahra Raeisi, Environmental Sciences and Technology Research Center, Department of Environmental Health Engineering, Shahid Sadoughi University of Medical Sciences, Yazd, IR Iran. Tel: +09369673654, E-mail: z.raeisi32@gmail.com

Received 2015 November 22; Revised 2015 December 01; Accepted 2015 December 15.

Abstract

Compared to other medical clinics, dental centers produce a relatively small amount of healthcare waste. However, they are responsible for the production of certain amounts of waste that can cause serious health and environmental hazards if not treated properly. Determining the quantity and quality of dental waste is quite necessary to plan the machinery, personnel, and transportation methods. In the current analytical cross-sectional study, 22 dental clinics were randomly selected from among 145 dental centers in Yazd. For each clinic, three samples were manually collected and distributed at the end of the work day once a week (the day was randomly chosen). The components were classified into four groups based on their characteristics and potential risk. Afterward, the collected data were analyzed using Excel. The mean per capita daily waste generation in the Yazd dental clinics was 80.179 g for each patient. In general, the Yazd dental clinics generate approximately 4 tons of waste every year. Out of this amount, infectious waste, domestic waste, chemical-pharmaceutical waste, and sharp waste account for 49.30%, 33.33%, 13.7%, and 4.2%, respectively. The results of the current study and the small amount of waste generated in Yazd suggest that a special safe site should be constructed for infectious, sharp, and keen waste; private companies should collect such waste and transfer it to this site after the waste is disinfected; and the waste should then be transferred to a municipal waste hygienic disposal site. In regard to chemical waste that may contain hazardous materials, like mercury, no suggestions other than safe burial are made.

Keywords: Waste Management, Infectious Waste, Dental Waste

1. Introduction

Due to growth and development in treatment methods, health and medical waste now exists in many different varieties. However, today's waste materials are not commensurate with those of 5 to 10 years ago; therefore, attaining guidelines for managing waste materials produced by health and medical units is necessary to ensure occupational safety, public health, and environment survival (1). Iran's hospital waste management regulations classify medical waste into four groups: a, domestic waste; b, infectious and potentially infectious waste; c, pointed and sharp waste; and d, chemical and pharmaceutical waste (2).

According to the study conducted by Kizlary, dental solid waste is classified into three main groups: a, infectious materials; b, noninfectious materials; and c, domestic materials. This classification is utilized due to its simplicity; however, it is not clear to most medical and health communities. Sharp and pointed materials are labeled as infectious waste that need better management because they might cause damage and disease transfer (3). Among

the waste produced in this sector, the significance of infectious waste material management is an issue that has received special attention in recent years from environmental engineers and healthcare practitioners (4).

In comparison to other medical centers, dental clinics generate relatively less healthcare waste; however, they are responsible for generating a certain amount of waste that can cause serious health and environmental hazards if it is not handled properly (5). Determining the quantity and quality of dental waste is quite necessary for the management of machinery, personnel, and transportation methods. Due to the heterogeneity of dental waste, specifying its components is not easy; therefore, its conduction involves certain problems and challenges. However, provided that there are necessary facilities and careful planning studies are conducted, invaluable results can be obtained for the proper management of such waste (6).

Dental waste includes any type of waste materials that are generated in dental operations and stained with blood or other biological components (7). Dental clinics produce higher amounts of waste compared to other healthcare sectors; however, there has been an increase in these

amounts in recent decades, which is attributed to an increase in the use of plastics and masks, 90% of which are considered solid waste (8). Waste composition varies from one center to another; it is also different in terms of performance, although gloves and paper form 35% of the waste. Overall, the quantity of waste at each clinic depends on the number of patients, as well as on the treatment methods (7).

Since separating or classifying waste reveals its components, it can be considered as the first important step in waste management. In this regard, the method of selecting sample waste from different regions, the sampling method, the distribution method, and determining the percentage of the ingredients of the waste used as the real sample are highly significant (9).

The main objective of this project was to determine the quality and quantity of the various types of dental waste in both general and specialized dental clinics through sampling, physical analysis, and weighing the separated waste generated in the dental offices in Yazd in 2013, as well as performing a statistical analysis of the waste and examining how to manage it.

2. Materials and Methods

This was a cross-sectional study with an analytical approach, conducted to determine the quantity and quality of dental waste in the governmental dental centers in Yazd. First, a list of dental centers in Yazd (both private and governmental) was retrieved from the medical deputy. Cluster sampling was carried out in which a total of 22 centers were selected for the survey: 20 offices out of 141 general practitioner and specialist offices and 2 out of 4 public and private clinics. Sampling in each cluster was done using simple random sampling with the help of a random number tabulation. The waste produced by these clinics was investigated once a week (the day was also selected randomly) over two months.

According to the abovementioned method, the total number of subjects was 164 units, out of which 160 were general and specialized doctors and 4 were clinics. Samples were retrieved at the end of the work day. This study was conducted from April 2013 until July 2013. Before the samples were collected, the study was explained to the dentists and their receptionists. The samples retrieved at the end of each work day from each clinic were physically analyzed (weighed with a scale) after being transferred to a proper place.

After each sampling phase, the amount of generated waste was examined both quantitatively and qualitatively. The procedure was as follows: first, the sample was manually separated into its components, which were then

weighed with a laboratory scale with a precision of hundredths and up to 2 digits after the decimal according to grams. To provide a high level of safety during transportation, manual separation, and weighing, suitable gloves and masks were utilized. Each component was weighed three times, and then the mean was calculated. The calculated illustration indicated the production rate of the different waste components of each clinic at the end of the work day. Moreover, the number of patients referred to each clinic was specified to determine the total generated waste per capita for each patient. In the next phase, calculating the average waste production of each clinic, the average daily waste generation of the different components of each clinic was determined. To specify the annual waste generation in the studied dental clinics, it was necessary to know the average annual working hours of each clinic, which was accomplished by asking the dentists. It was reported that almost all the clinics did not work on holidays; therefore, referring to the calendar of the year 2012 - 2013, the working hours were 292 days. By multiplying the average daily generation of the different waste components by the abovementioned figure, the amount of the annual generation of the different waste components was calculated in the 22 participating dental clinics. Afterward, it was time to generalize the calculated values to the whole population (Yazd). By dividing the total number of the dental clinics in the city (145 clinics) by the number of the sample clinics (22 clinics), the coefficient was determined; the corresponding coefficient was 6.6 for the dentistry offices. By multiplying this coefficient by the amount of the annual production of the different waste components in the dental clinics, the total amount of annual production in all the dental clinics in Yazd was calculated. Afterward, to calculate the percentage of each component using Excel, the waste was categorized into four groups: domestic waste, chemical and pharmaceutical waste, potentially infectious waste, and pointed and sharp waste. It is worth noting that according to the objective of the study, there was no need to conduct any specific statistical tests; calculating the percentages only was enough.

The classification used here was based on the importance of the environment and the risk-causing potential of waste, as well as the classification proposed by WHO and the related studies that have been conducted so far (10).

3. Results and Discussion

Based on the study's calculations, the per capita waste generation of each patient in the dental clinics of Yazd was 80.179 g per day, and the total annual waste generation was 3837.302 kg. The highest amount of waste production was related to infectious waste with an amount of 1891.674 kg

per year, which accounts for 49.30% of all the produced waste (Table 1). After infectious waste, the second most produced waste was the domestic type, with an amount of 1249.041 kg per year, accounting for 33.33% of the total. The amount of chemical and pharmaceutical waste was 505.349 kg per year, which accounts for 13.17%. The least generated waste was pointed and sharp waste, with an amount of 141.2374 kg per year (4.2%) of all the waste. Figure 1 presents the production share of each sector according to their types.

Table 1. Annual Generation of the Different Waste Components in Yazd Dental Clinics

Waste Type	Kg/Year	Percentage
Infectious	1891.674	49.30
Pointed and sharp	161.2374	4.2
Chemical and pharmaceutical	505.349	13.17
Domestic-type	1279.041	33.33
Total	3837.302	100

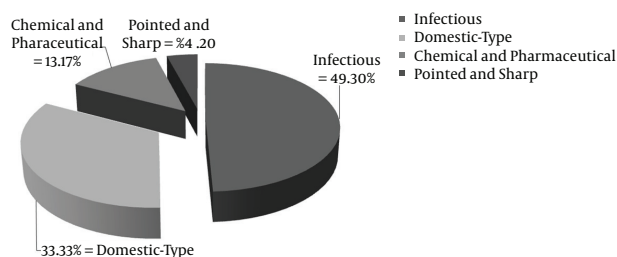


Figure 1. The Percentage of Generated Waste According to Type in Yazd Dental Clinics

The average per capita waste generation in the Yazd dental clinics was 80.179 g per day for each patient. In general, an annual amount of 4 tons of waste is produced in the Yazd dental clinics. Out of this amount, the highest rate belongs to infectious waste with 1891.674 kg (49.30%). The second highest rate belongs to domestic type or normal waste with 1279.04 kg (33.33%), followed by chemical-pharmaceutical waste with 505.349 kg (13.17%), and pointed and sharp waste with 161.273 kg (4.2%).

In a study conducted by Nabizadeh et al., the total amount of waste from the general dental clinics in Hamadan was 14662.67 kg. The highest amount of waste production was related to potentially infectious waste with an amount of 7614.13 kg (51.93%), followed by domestic waste with an amount of 5595.83 (38.16%). The annual amount of generated chemical and pharmaceutical waste

was 1388.45 kg (9.47%) and the lowest amount was related to toxic waste with an amount of 64.26 kg per year (0.44%). The study concluded that the average per capita waste produced in the general medical clinics of Hamadan was 48.72 kg per day (11).

Ghanbarian et al. (2011) studied 25 dental clinics in Shahroud. They reported that the total amount of waste produced in the dental clinics was 2425.48 kg per year. The amounts of infectious, domestic, chemical and pharmaceutical, and toxic waste were 46%, 43.8%, 9.2%, and 1%, respectively (12).

Jonidi Jafari et al. (2007) conducted a study entitled: The quantitative and qualitative investigation into dental wastes in Hamadan. They indicated that the total annual waste from the specialized dental clinics was 2685.42 kg. The domestic type potentially infectious, chemical, pharmaceutical, and toxic waste percentages were 48.45%, 43.85%, 7.33%, and 0.37%, respectively (13).

A study entitled The Generated Dental Wastes in Shiraz was conducted by Ghanbarian et al. The results of their study indicated that the total generated waste was 62661.60 kg per year. The domestic type potentially infectious, chemical, pharmaceutical, and toxic waste percentages were 55%, 33%, 11%, and 1%, respectively (14).

A similar study was conducted in Greece by Kizlary et al. In this study, sampling was done during two months, and the samples were divided into three major categories: a, infectious and potentially infectious waste; b, non-infectious toxic waste; and c, solid household waste. The three categories of waste formed 74%, 26%, and 0.5% of all the solid waste of the dental laboratories, respectively (3).

In another study conducted by Vieira et al. (2009) in Brazil, it was indicated that 24.3% of the dental waste was infectious and potentially infectious materials, 48.1% was noninfectious, and 27.6% was domestic (7).

By taking a look at the illustration presented in Figure 1 and the tabulations and comparing them with the amounts generated in different parts of the world, one can understand that the results of the present study are in line with those of other studies; therefore, it can be concluded that according to the similarity between the type and amount of the generated waste in the Yazd dental centers and other parts of the world, the management patterns of other countries can be utilized in Yazd to optimally manage the dental waste or at least to create a proper scientific approach in Yazd. However, it should be noted that the amount and composition of dental waste is different from one clinic to another and at different times (13).

According to the abovementioned points on the optimal management of dental waste, it should be stated that one cannot rely on just one principle; there should be proper planning and a pattern based on other successful

Table 2. Estimating the Mean and Standard Deviation of the Different Types of Waste According to gr/day for Each Patient in Yazd Dental Clinics^a

Clinic Type	N.	Normal	Infectious	Chemical	Pointed and Sharp
General and specialized	22	26.72 ± 25.41	39.52 ± 26.11	10.55 ± 7.05	3.36 ± 4.51

^aValues are expressed as mean ± SD.

management systems (13).

With regard to the types of materials and different components with various characteristics in dental waste, the proper management of such waste should be performed according to its special features. Unfortunately, given the observations and studies, it was determined that no specific action is being done by the municipality and other relevant organizations in Yazd regarding the comprehensive management of dental waste. Based on the observations made, it was found that no major activity for the reduction, separation, and recycling of waste is done in dental offices.

In general, the most important measure that can be taken for the proper management of dental waste is to prevent the combination of the different parts of these waste materials and to separate them based on their risk-causing potential. Therefore, dentists need to be trained on the reduction of waste generation, recycling, and separating waste materials according to their characteristics. Moreover, guidelines need to be proposed by the relevant organizations (6).

Because Iran's hospital waste management regulations (2) emphasize disinfecting the waste generated by health and medical centers, Yazd must adopt a specific plan to manage infectious, pointed, and sharp waste in dental clinics. Since there is a small amount of dental waste in Yazd, it is recommended that a special safe site should be constructed for infectious, sharp, and keen waste, and private companies should collect such waste and transfer it to this site, where the waste will be disinfected and transferred to a municipal waste hygienic disposal site. In regard to chemical waste that may contain hazardous materials, like mercury, no suggestions other than safe burial are made. However, it is necessary to figure out effective approaches to deal with the hazardous waste produced in health and medical clinics. A special burial site and the observance of the proper principles of safe burial or the construction of a standard place to burn the waste can also be an appropriate approach.

4. Conclusion

Finally, in regard to the optimal management of the waste produced in health and medical centers, it is sug-

gested that not only should the waste producers be trained to perform methods to reduce the amount of waste materials, separate them, or recycle them inside their centers, but they should also be trained in how to collect and transfer each component of the waste (domestic, potentially infectious, chemical-pharmaceutical, toxic, and pointed and sharp) in accordance with available guidelines.

Acknowledgments

The authors would like to thank the research vice-chancellor of Shahid Sadoughi University of Medical Sciences.

Footnote

Authors' Contribution Mehdi Mokhtari, Zahra Derakhshan, and Zahra Raeisi participated in the design of this study, coordinated the activities, and revised the manuscript; Zahra Soltaniyanzadeh and Gholamreza Manuchehri participated in the design of the study and the final revision of the manuscript, and helped in analyzing the data; Fatemeh Babai and Elham Mahdavian performed the data collection, carried out the statistical and technical analysis of the data, participated in the design of the study, and drafted the manuscript. All the authors read and approved the final manuscript.

References

1. Beiglu M. A. . A report of survey on Qazvin hospital wastes [In Persian]. Qazvin: Qazvin Municipality; 2002.
2. Waste Management Guidelines for dental products 2001. [updated 2001]. Available from: <http://www.kodak.com>.
3. Kizlary E, Iosifidis N, Voudrias E, Panagiotakopoulos D. Composition and production rate of dental solid waste in Xanthi, Greece: variability among dentist groups. *Waste Manag.* 2005;25(6):582-91. doi: 10.1016/j.wasman.2004.10.002. [PubMed: 15993342].
4. Pruss A, Giroult E, Rushbrook P. Safe management of wastes from health-care activities. 1999.
5. Osamong LA, Gathece LW, Kisumbi BK, Mutave RJ. Management of dental waste by practitioners in Nairobi, Kenya. *AJOL.* 2005;2(1-2).
6. Nafez A, Karbord A, Sharifi M, Jabbari R, Abu Torabi M. Quantitative and qualitative investigation into dental wastes in Ghazvin (In Persian). *Health Sys Res.* 2012;7(6).

7. Vieira CD, de Carvalho MA, de Menezes Cussiol NA, Alvarez-Leite ME, Dos Santos SG, da Fonseca Gomes RM, et al. Composition analysis of dental solid waste in Brazil. *Waste Manag.* 2009;**29**(4):1388–91. doi: [10.1016/j.wasman.2008.11.026](https://doi.org/10.1016/j.wasman.2008.11.026). [PubMed: [19167203](https://pubmed.ncbi.nlm.nih.gov/19167203/)].
8. Ozbek M, Sanin FD. A study of the dental solid waste produced in a school of dentistry in Turkey. *Waste Manag.* 2004;**24**(4):339–45. doi: [10.1016/j.wasman.2003.08.002](https://doi.org/10.1016/j.wasman.2003.08.002). [PubMed: [15081060](https://pubmed.ncbi.nlm.nih.gov/15081060/)].
9. Al-Widyan MI, Oweis RJ, Abu-Qdais H, Al-Muhtaseb M, Hamasha S. Composition and energy content of dental solid waste. *RESOUR CONSERV RECY.* 2010;**55**(2):155–60. doi: [10.1016/j.resconrec.2010.08.006](https://doi.org/10.1016/j.resconrec.2010.08.006).
10. WHO . Safe Management of Wastes from Health Care Activities. 1999.
11. Nabizadeh R, Kulivand A, Jonidi Jafari A, Younesian M, Omrani G. Evaluation of dental solid waste in Hamedan. *Dent Med.* 2009;**22**(1):66–73.
12. Ghanbarian M, Khosravi A, Ghanbarian M, Ghanbarian M. Quantitative and qualitative investigation into dental wastes in Shahroud [in Persian]. *The Journal of Knowledge and Health.* 2011;**2**(6).
13. Jonidi Jafari A, Koulivand A, Nabizadeh R, Younesian M. Investigating on quantity and quality and management of dental solid waste produced in private offices in Hamedan, 2007. [in Persian]. *Teb va Tazkiyeh.* 2010;**76**:73–8.
14. Ghanbarian M, Majlesi M, Samaei M. The study of dental waste generated in dental offices in Shiraz. *Res Dent Sci.* 2013;**10**(4):246–51.