Quantity and Quality Analysis and Management of Dental Solid Waste Produced in Private Office in Urmia

[1]Mohtaram Nasrollahi [2]Mohammad-Ali Zazouli [*3]Davoud Balarak [4]Mojtaba Moradi Golrokhi

[1]Professor, Dept. of Microbiology, School of Medicine, Mazandaran University of Medical Sciences, Sari, Iran.
[2]Associate Professor, Dept. of Environmental Health, School of Health, Health Sciences Research Center, Mazandaran University of Medical Sciences, Sari, Iran.
[*3]Lecturer, Dept. of Environmental Health, School of Health, Health Promotion Research Center, Zahedan University of Medical Sciences, Zahedan, Iran. E-mail: dbalarak2@gmail.com
[4]Master Student, Dept. of Microbiology, Students Research Committee, Mazandaran University of Medical Sciences, Sari, Iran.

Abstract

Objective: Dental solid wastes often contain hazardous substances. The first step of management of dental solid wastes includes detection and classification of these substances. This study aimed to qualitatively and quantitatively assess the management of solid wastes by dental offices in Urmia city in 2013.

Methods: This descriptive study was conducted on all private dental offices in Urmia city and six samples were collected of the wastes of each office per season. Samples were manually searched, divided into 16 different categories and weighed by a digital scale. In the next step, the weighed components were classified according to their characteristics and hazardous potential.

Results: The total amount of solid wastes produced by dental offices in Urmia city was 81 kg/day consisting of 28.3% infectious wastes, 59% domestic-like wastes, 9.6% chemical and pharmaceutical wastes and 2.7% toxic wastes. Waste reduction and recycling programs were not performed in any office.

Conclusion: Considering the type and quantity of generated dental solid wastes, especially the infectious wastes and their adverse effects on public health and the environment, a specific strategy must be designed for management of dental solid wastes.

Key words: Chemical and pharmaceutical waste, Dental solid waste, Infectious waste, Urmia.

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Introduction:

Management of dental solid wastes is an environmental dilemma, since they contain hazardous, toxic and infectious agents such as pathological, pharmaceutical and chemical wastes, radioactive agents, sharp objects and cutting blades (1). Based on their potential risks and bioenvironmental significance, dental solid wastes are categorized into domestic-like, infectious, chemical, pharmaceutical and toxic wastes (2). Domestic-like wastes mainly include materials that are not harmful or hazardous for the human or animal health or the environment. Domestic like-wastes comprise the majority of dental solid wastes (3). These wastes can be collected and disposed along with other domestic and household wastes. These include papers, cardboards, plastics, woods, food products, glasses, metals, etc. These materials can be recycled as well (4). Infectious agents also comprise a large portion of dental solid wastes and contain blood-contaminated products, infectious fluids and infected sharp disposable instruments. Infectious agents are classified under the category of hazardous

wastes (5,6). Efficient management of infectious wastes is necessary to ensure public health and safety of environment. Also, measures must be taken to prevent the transmission of HIV infection and hepatitis via dental solid wastes (7). Sharp instruments are a subgroup of infectious wastes that require particular attention since they may cause injury and result in disease transmission. The solid waste collectors in charge of collection, disposal and transfer of wastes are particularly at risk (8). Amalgam is a stable, solid restorative material used for tooth restoration. It is classified as a hazardous waste due to its mercury and silver contents and is among the most important hazardous dental wastes (9). Infectious wastes include materials that contain pathogenic agents capable of causing disease in susceptible hosts (10). However, different definitions and classifications have been proposed for infectious wastes. Due to the existing ambiguity in definition of infectious wastes, two problems may occur. First, some infectious wastes may be mixed with domestic wastes while they are highly pathogenic and hazardous. Second, less infected wastes may be mixed with infectious wastes and increase their quantity. Since no acceptable method exists to determine the level of infectivity of these wastes, authorities define these wastes based on their method of generation and contents (11). In many third-world countries, dental solid wastes are buried along with other domestic wastes without recycling or separation. Due to the presence of infectious agents in dental solid wastes, this can be highly hazardous for the humans and the environment (12). Several studies have emphasized the importance of dental solid waste management in Australia (13), Turkey (14), Brazil (15), Jordan (16), Thailand (17), Greece (18) and New Zeeland (19). The composition of wastes produced by several clinics in a dental school in Turkey was evaluated by Ozbek and Sanin (2004). They manually separated the collected wastes and physically analyzed the waste products. Latex gloves comprised the largest fraction of wastes (14). Only a few similar studies have been conducted regarding dental solid wastes in Iran including studies in Hamadan (1), Shahroud (11), Zahedan (5) and Tabriz (6). This study aimed to quantitatively and qualitatively analyze the management of dental solid wastes in Urmia.

Methods:

This descriptive cross-sectional study was conducted in Urmia city in 2013. The main objective of this study was to take samples and weigh the dental solid wastes produced by private dental offices in Urmia, qualitatively and quantitatively analyze them and assess their management. All dental offices in Urmia (a total of 165) were selected, among which, 150 agreed to participate in this study. All samples were collected at the end of a workday once every two weeks from each office. Thus, two samples were obtained of each office per month and a total of 6 samples were obtained of each office per season. A total of 900 samples were obtained of all offices during a season. Each component was weighed three times to minimize errors. Weeks with no public holidays were chosen for sampling to minimize the effect of public holidays on the amount of waste produced. Collected samples were immediately weighed in the office using a digital scale (6200 AHK, Iran) with 0.01g accuracy. First, the constituents of the waste sample were separated and then each component was weighed using a digital scale. The weight was reported in grams to two decimal places. Special gloves and masks were used during the process of separation. This process was performed in an empty room and no one other than the researcher was allowed to enter. Sixteen components were recognized and weighed in collected wastes. The obtained value indicated the rate of production of each waste

component at the end of a workday in an office. The 16 components separated included 13 infectious wastes as well as the pharmaceutical, chemical, toxic and domestic-like wastes. Cartridge was included in the category of pharmaceutical and chemical wastes. Toxic wastes included amalgam-contaminated tissues, amalgam-contaminated gauze, amalgam-contaminated cotton rolls, amalgam residues and chips, lead foil, black-colored paper wrapper and outer protective plastic jacket of radiographic films. Chemical and pharmaceutical wastes included empty dental anesthetic carpules and impression paste. Domestic-like wastes included dry tissues and paper towels, dry gauze, dry cotton pellets and cotton rolls, disposable plastic wraps, syringe box and needle caps, papers, cardboards, boxes, newspapers, carbon steel, textiles, black-colored paper wrapper, radiographic film outer protective plastic jacket, empty amalgam caps, disposable cups, rubber, dental stone, paper adhesive tape, clear adhesive tape, adhesive bandages, matches, cellophanes, tea residues, dust and gypsum, syringe box, nylon, plastics, carbon paper, masks and foods. Also, number of patients presented to each office in a workday was determined in order to calculate solid waste generation per person per day. Solid waste generation per person per day was calculated by dividing the solid waste generated per day by the number of patients presented to the office in the respective day. The mean of the 6 values obtained by 6 samplings of each office per season was calculated, which indicated the mean daily solid waste generation of each office for different components. To calculate the mean yearly generation of solid wastes by dental offices, we needed to have the mean number of working days of respective offices per year. Dentists were asked in this regard and it was found that almost all the understudy offices were closed in holidays and weekends. Thus, the mean number of working days was found to be 298 days in 2013 using a calendar. By multiplying the mean daily solid waste generation by 298, the mean yearly solid waste generation for different components was calculated. The collected data were analyzed using SPSS version 18. The mean and standard deviation values were calculated. To eliminate human error in weighing, components were weighed several times and the mean weight was used for statistical analysis. To assess the management of dental waste products, a checklist with 8 questions regarding recycling, separation and sterilization of dental wastes was designed. This checklist has been confirmed by experts in the field and has been used in a previous study (20). Dentists were asked to fill out the checklist.

Results:

In the current study, of 165 private offices available in Urmia city, 150 participated in this study, comprising approximately 90% of the population. Total amount of waste produced in these dental offices was about 81 kg/day. If we generalize this value to the entire population of dentists (165 offices), this value will be 89.1 kg/day. The value per dentist will be 0.54 kg (calculated by dividing the total daily waste by the number of dentists). Table 1 and Figure 1 show the amount and percentage of waste constituents; the greatest fraction belonged to domestic-like wastes in an amount of 48 kg/month (0.592). The solid waste production per capita is calculated by multiplying the mean value of daily wastes by the number of days in a year.

Table 2 shows the percentage of the main constituents of infectious wastes. As seen in Table 2, infectious wastes comprise of 13 constituents; the largest fraction belongs to extracted teeth and latex gloves. Also, the results showed that dentists do not take any action with regard to reduction or recycling of wastes in their offices. Results regarding the management

of solid wastes are shown in Table 3.

Table 1- Annual production rate of the constituents of solid wastes by dental offices in Urmia

Type of waste	Daily production (kg/day)	Monthly production (kg/day)	Yearly production (kg/day)
	Mean (SD)	Mean (SD)	Mean (SD)
Domestic-like wastes	48 (0.75)	1440 (22.5)	17280 (270)
Infectious wastes	23 (0.44)	690 (13.2)	8280 (158.4)
Chemical and pharmaceutical wastes	7.8 (0.19)	234 (5.7)	2808 (68.4)
Toxic wastes	2.2 (0.11)	66 (3.3)	792 (39.6)
Total	81 (1.49)	2430 (44.7)	29160 (536.4)

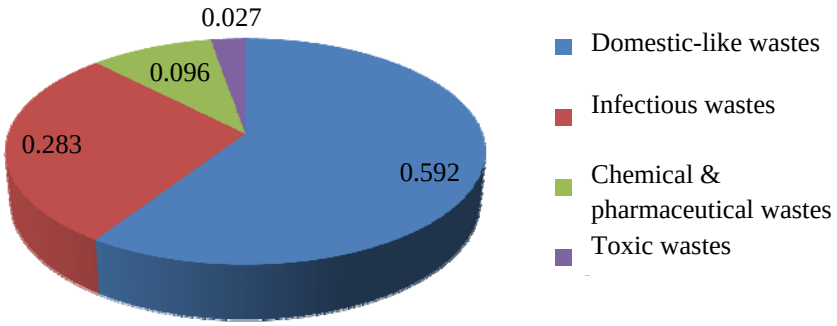

Figure 1- Percentage of solid waste constituents

Table 2- Production rate of components of infectious wastes

Type	Amount (kg/day)	Percentage
Saliva-contaminated tissues (infectious)	0.828	3.6
Extracted teeth (infectious)	5.1	22.2
Latex gloves (infectious)	4.53	19.7
Needles, sharp objects and cutting blades (infectious)	2.37	10.3
Blood-contaminated tissues (infectious)	2.18	9.5
Blood- and saliva-contaminated gauzes (infectious)	0.4	1.73
Saliva-contaminated cotton rolls (infectious)	0.506	2.2
Nylon gloves (infectious)	0.253	1.1
Saliva-contaminated cotton rolls (infectious)	0.874	3.8
Wooden sticks (infectious)	1.46	6.34
Syringes (infectious)	1.76	7.65
Blood-contaminated cotton pellets (infectious)	2.21	9.6
Other infectious agents	0.49	2.12

Table 3- Management of solid wastes generated by dental offices

Waste reduction programs	None
Solid waste separation programs	Performed in only 40% of offices
Waste recycling programs	None
Management of sharp objects and cutting blades	Separation from other wastes performed in 100% of offices
Management of empty amalgam caps	Direct disposal in the garbage in 100% of offices
Management of amalgam residues and chips	Separation from other wastes performed in 100% of offices
Presence of silver recycling unit	None
Method of sterilization	40% heat sterilization, 60% autoclave sterilization

Discussion:

This study aimed to qualitatively and quantitatively analyze the management of wastes generated by dental offices in Urmia city in 2013. Dental clinics were not included in this study. The results showed that the total waste produced by private dental offices in Urmia city was 2,430 kg per month and 29,160 kg per year. Thus, annually more than 29 tons of dental wastes are generated by private dental offices in Urmia. Although this value appears to be small in comparison with the total domestic wastes produced in Urmia, adequate management of these wastes seems necessary considering their specific characteristics and hazardous potential. For proper solid waste management, strategies must be implemented to decrease the production of wastes and separate and recycle them as much as possible. None of these are currently performed for dental wastes produced in Urmia and this indicates poor performance in this regard. Such a poor performance has also been reported in Shahrood and Hamadan cities and none of the above-mentioned measures are taken in these cities (1,11). Waste production can be decreased by reducing the use of disposables and using materials and products with less hazardous potential and with smaller packaging. The most important measure to manage dental wastes is not to mix the wastes. A study conducted in Hamadan showed that total dental solid waste production was 24 tons (1). In our study, solid wastes were divided into 16 categories; which is similar to previous studies (1, 14). Our results showed that the main fraction of dental solid wastes belonged to domestic-like wastes, comprising 59.2% of total wastes. In a similar study conducted in Greece, the greatest fraction of solid wastes belonged to infectious wastes, comprising 94% of total wastes. The percentage of domestic-like and non-infectious wastes was 6% (18). However, in our study domestic-like wastes comprised the greatest fraction of total solid wastes. Such a difference in results may be explained by the fact that in Greece, dental clinics were evaluated, which mostly performed restorative treatments; thus, the infectious wastes comprised the highest fraction of total wastes; whereas, in our study, private dental offices were evaluated that had higher amounts of recyclable wastes such as papers, cardboards, boxes, plastics, nylons and glasses. This finding is in accordance with the results of a study conducted in Brazil. The only difference is that recycling is performed for domestic-like wastes in Brazil and thus, this type of waste comprised 40% of their total solid wastes (15); while this value was 20 to 30% higher in Iran since no recycling is performed. In our study, infectious agents comprised 11.7% of dental solid wastes; although this value is small, this rate is concerning since in case of absence of appropriate management, it may cause disease transmission. These wastes must be collected separately and they should be auto-clave sterilized prior to disposal (11). In Turkey, by separating and sterilizing latex gloves by dentists, the volume of potentially infectious wastes decreased by 35% (14). This is in line

with the studies conducted in Iran but is in contrast to the international studies. Such a controversy in results may be due to the recycling of domestic-like wastes in other countries. But, in Iran no recycling is performed for domestic-like wastes and this type of waste is mixed with infectious and non-infectious wastes and disposed (1, 11). Constituents of these wastes are variable and so is their management. Thus, mixing these wastes with other wastes does not seem logical. Domestic-like wastes have recyclable components such as paper, cardboard, plastic and glass and they can be collected and disposed along with domestic wastes (13). In some solid waste classifications, infectious agents are categorized separately from toxic and pharmaceutical wastes. But, some others categorize these under the same category since they are both hazardous wastes. These wastes in Iran comprise 10 to 20% of all wastes, which is in agreement with our findings (1, 11). Inappropriate management and not recycling the amalgam residues in dental offices result in the disposal of this hazardous toxic agent along with other solid wastes. Safety box for collection and safe disposal of sharp objects and cutting blades rarely used in dental offices in our study, which is similar to the findings of other studies performed in Iran (1, 11) but in contrast to studies conducted in other parts of the world such as Brazil, Turkey and Greece (14,15,18) since they all reported the use of safety boxes.

Conclusion:

Based on the results, it can be concluded that domestic-like wastes comprise the largest fraction of dental solid wastes. Considering the quantity and hazardous nature of dental solid wastes particularly the infectious wastes and their adverse effects on public health as well as the environment, proper strategies must be necessarily designed for efficient management and safe disposal of these wastes.

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