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Research article

Dental waste management among dentists of Bandar Abbas, Iran

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Abstract: This study investigates dentists' knowledge and practiced dental waste management in public and private dental clinics and dental offices in Bandar Abbas. A cross-sectional study was conducted on 133 dentists from 124 private dental offices, five government dental clinics, and four private dental clinics in Bandar Abbas. A self-administered questionnaire consisting of 40 questions based on dental knowledge and practices was prepared. The results revealed that only 12.0% of dentists knew about the correct container color for the disposal of human anatomical wastes that is a yellow trash bin. The trash bin was the method of disposal by the majority of dentists for disposal of x-ray film lead foils (52.6%), orthodontic wires (48.9%), and outdated drugs (60.2%). The chemicals used in dentistry and amalgams were mostly poured into the municipal sewage system. It is concluded that dentists, in general, did not have much awareness about dental waste management in Bandar Abbas. Also, most of their performance on waste disposal was not up to the standards. Implementing waste management laws requires constant monitoring and timely training. Therefore, it is necessary to establish a comprehensive system of health care waste management, as in other developed countries, in Iran.

Keywords: dental wastes; waste management; medical waste disposal; hazardous waste; safety; dental offices

1. Introduction

Biomedical waste is a significant source of infection in the community and a major cause of environmental pollution. Inappropriate management of these wastes is a significant source of hospital

infections. Medical wastes produced in dentistry including needles and sharp objects, body tissues, chemical fixers, mercury, silver thiosulfate, lead laminate, amalgam, etc. and the chemicals such as acrylics, molds, and mercury materials used for therapeutic purposes may have an impact on the environment and humans safety. Lead can cause undesirable effects on the ecosystem [1]. Recently, With the increased demand for dental care, there has been rapid growth in public and private dental clinics, which resulted in an increase in the amount of medical waste [2]. It is assumed to be a cause of increased infection and contamination of the environment leading to an elevated possibility of diseases and injuries. There are guidelines for the management of medical wastes provided by the World Health Organization. Unfortunately, these guidelines are not met in a large number of developing countries [3]. The researches carried out in developing countries indicate a low level of awareness and knowledge of dental waste management. Neto et al., in a survey on dry waste management, which assessed 15 dental offices in Brazil, found that 81.8% of dental practitioners did not plan for waste management. They showed that despite the separation of wastes, there was not any sanitary and safety landfill in the office. They also found that there were many deficiencies in waste disposal [4]. Adedigba et al. (2010) evaluated hospital waste management in eight dental clinics in Nigeria and concluded that there were high levels of lead and chromium, mercury, cadmium, and manganese in soil and water samples [5]. A study conducted in the province of Sistan and Balouchestan, Iran, on dental wastes showed that 11.7% were general, 80.6% were infectious, 6.3% were chemicals, and 1.7% were toxic wastes [6]. Koolivand et al. (2012) [8] in their study, which was conducted in Bandar Abbas, showed that there was not any effective plan for waste recycling [7]. In order to protect the environment and society, the law on waste management was approved by the Islamic Consultative Assembly of Iran in 2004. According to this law, every waste producer, including hospitals, clinics and offices are obliged to take measurements on their disposal to be sure thay do not have any adverse effects on human health and also on the environment. Considering the proximity of Bandar Abbas to the Persian Gulf and the risk of water pollution which may cause environmental and health hazards, the need for higher sensitivity to the optimal management of medical wastes and reasonable management of medical waste is inevitable. Therefore, this study aimed to assess dentists' knowledge and practice on dental waste management in public and private clinics and dental offices in Bandar Abbas.

2. Materials and methods

This cross-sectional study was conducted in Hormozgan University of Medical Sciences (HUMS) in 2015–2016. The study included 166 private and public dental offices and clinics in Bandar Abbas. After the literature searches and review, an anonymous questionnaire was developed to collect the data. Based on the knowledge, awareness, and practices of the dentists, a self-administered questionnaire, composed of 40 items, was prepared. The first section of the questionnaire consisted of questions related to respondents' age, sex, and clinical experience. Each question was closed-ended with a Yes/No, and multiple-choice pattern response. The questionnaire was assessed by content validity (taking experts' opinions), and its reliability was evaluated by Cronbach's alpha (0.94).

The questionnaire consisted of 2 sections. The first section included four demographics questions, and the second consisted of questions related to the awareness and practices of dental care waste management. This section consisted of a table with 23 yes/no and 13 multiple-choice questions about the awareness and practice of dental waste. The author visited the dental facilities and distributed

questionnaires between dentists. A completed questionnaire was collected on the same (or consecutive) day. After collecting questionnaires, the data were analyzed using SPSS 16 software. Descriptive statistics (frequency distribution and percentage tables, statistical indices, and mean and standard deviation) and Chi-square test (Two ways and one way) were conducted on the data. $P < 0.05$ was considered as significant.

3. Results and discussion

A total of 133 of the dentist from 124 private dental offices, five government dental clinics, and four private dental clinics participated in this study. A total of 166 questionnaires were distributed among dentists of the private and government dental clinics and offices. The overall response rate was 80%. The demographic characteristics of the participants are shown in Table 1. All dentists, regardless of the type of specialty who worked in government(62.5%) and private dental clinicis (57.1%) and dental offices (77.5%) in Bandar Abbas, were questioned in this study regarding the management of dental waste. The majority of dentists were under the age of 40 years (65.4%).The majority of the dentists had the experience of fewer than five years (65.4%)**.** There was not any statistically significant association between the responses given by dentists in government dental clinics and private dentist's offices for the majority of the questions ($P = 0.05$).

Table 1. Percentage distribution of the respondent's dentist profile.

Variables		Frequency (%)
Gender	Male	67(50.4)
	Female	66(49.6)
Specialty	All dental specialties	133(80)
Location	Dental offices	124(77.5)
	Government dental clinics	5(62.5)
	Private dental clinics	4(57.1)
Age	20–30 years	41(30.8)
	30–40 years	46(34.6)
	40–50 years	39(29.3)
	>50 years	7(5.3)
Years of work	1–10 years	87(65.4)
	10–20 years	34(25.6)
	20–30 years	12(0.9)

Table 2 shows the awareness of the dentists regarding dental waste management in Bandar Abbas. The results of the present study show that 63.2% of dentists were aware of different categories of wastes. It was interesting to notice that nearly half of the dentists (48.9%) were not aware of color codings for different categories of medical wastes.

A statistically significant difference was found on the dentists' awareness regarding Iran's medical waste management law ($P < 046$). Dentists in the age group 20–30 years old, were less aware of this law (39.0%).

Table 2. Awareness of dentists regarding dental waste management

Questions	Yes (%)	No (%)
Awareness regarding different category of wastes	84(63.2)	49(36.8)
Awareness regarding various color coding of BMW	68 (51.1)	65 (48.9)
Awareness regarding Iran BMW management law	75 (56.4)	58 (43.6)
You know the requirements for hazardous waste classification	84 (63.2)	49 (36.8)

Dentist's response to the practices of dental and biomedical waste management is described in Table 3. Almost half of the dentists (53.4%) separated the waste. A total of 33.8% did not categorize wastes as hazardous. Almost half of the dentists (53.4%) did not use colored bags. Most of the dentists (73.7%) did not have a wastewater treatment system, and most (75.2%) of dental office wastewaters were discharged directly into the municipal sewage system. Besides, other chemicals used in these offices, including x-ray film stabilization, sterilization, disinfectant, etc. were mainly (76.7%) dumped into municipal wastewater. 56.4% of dentists did not put x-ray shields foils or aprons in the trash bin .Most dentists (74.4%) pour fluorescent lamps and batteries into the trash bin. Only 27.1% had chair-site separators for amalgam. Most dentists (66.2%) did not record the amount of produced waste. A statistically significant difference was found in the dentists' practice and among different categories of dentists' age with the dumping chemicals into the sewage system ($P < 047$). Dentists under 30 years of age had the highest level of chemicals disposal in the sewer (70.7%).

Table 3. the practice of dentists regarding biomedical waste management in dental office and clinics

Questions	Yes (%)	No (%)
Do you segregate waste?	71 (53.4)	62 (46.6)
Do you categories your waste into hazardous waste?	88 (66.2)	45 (33.8)
Do you have chair-side separators for amalgam?	36 (27.1)	97 (72.9)
Do you use colored bags for waste disposal?	62 (46.6)	71 (53.4)
Is your office wastewater discharged into municipal sewage pour?	100 (75.2)	33 (24.8)
Do you dump chemicals into the sewage system? (X-ray film stabilization, sterilization, disinfectants, etc.)	102 (76.7)	31 (23.3)
Do you rinse amalgam from chair-side separator?	60 (45.1)	73 (54.9)
Do you have a sewage treatment system?	35 (26.3)	98 (73.7)
Are you recording the amount of infectious waste?	45 (33.8)	88 (66.2)
Are you a sharps container label and symbol use?	86 (64.7)	47 (35.3)
Do you throw fluorescent tubes and batteries in the trash bin?	99 (74.4)	34 (25.6)
Do you put x-ray shields foils or aprons in the trash bin?	58 (43.6)	75 (56.4)

Table 4 shows the knowledge and practice of dentists regarding dental wastes. One-way Chi-square test was used to analyze the homogeneity of the frequency distribution of each question. In answer to the question, what classification is used for extracted teeth?, the infectious category was correctly reported by only over half (57.1%) of the dentists. 60.9% dentists correctly made sharp choices. 44.4% of dentists were aware of the grouping of expired drugs in the cytotoxic group. The category of soiled waste correctly was selected for dental and cotton molds by 51.1%. Only 12.0 % of the Dentists were aware of yellow color containers, which are used for the disposal of human

anatomical waste. More than half of the dentists (58.6%) were aware of disposing of sharp objects in yellow containers. Nearly one third (33.1%) of the dentists put extra amalgam in the trash bin. Surprisingly 23.3% of dentists disposed of infected needles in the trash bin. Our results show that 44.4% of dentists poured the solutions of radiology film preparation directly into the urban sewage system. Lead foils and X-ray films were directly disposed to the trash bin by 52.6%. Almost half of the dentists (48.9%) had not any specific method of disposing of the orthodontic wire and hook; They dumped these materials directly into the trash bin . Most dentists (60.2%) threw outdated drugs into the trash bin . 45.1% of dentists evaluated in this study used authentic collector as the final waste disposal method.

Table 4. Knowledge and practice of dentists regarding dental waste.

Questions	Options	(%)	*P*-value
Which of the following classifications for tooth extraction?	Infectious waste	76 (57.1)	<0.001
	Cytotoxic waste	21 (15.8)	
	Infected/cytotoxic waste	23 (17.3)	
	I don’t know	13 (9.8)	
What are the categories for needle and syringe disposal?	Infected waste	36 (27.1)	<0.001
	Sharps	81 (60.9)	
	Chemical	12 (9.0)	
	General	4 (3.0)	
Which a category for disposal of expired drugs is?	Chemical	51 (38.3)	<0.001
	Cytotoxic waste	59 (44.4)	
	Biotechnological waste	9 (6.8)	
	I don’t know	14 (10.5)	
Category of dental mould and cotton	Solid waste	19 (14.3)	<0.001
	Soiled waste	68 (51.1)	
	Infectious waste	26 (19.5)	
	I don’t know	20 (15)	
Human anatomical wastes should be disposed in?	Yellow container	16 (12.0)	<0.001
	Red container	40 (30.1)	
	Blue/white container	19 (14.3)	
	I don’t know	58 (43.6)	
Sharps should be disposed in?	Yellow container	78 (58.6)	<0.001
	Red container	25 (18.8)	
	Blue/white container	13 (9.8)	
	Don’t know	17 (12.8)	
How do you store extra amalgam	Trash bin	44 (33.1)	0.119
	Close container with water	25 (18.8)	
	Close container	34 (25.6)	
	other(don’t use / in a fixer)	30 (22.6)	

Continued on next page

Questions	Options	(%)	*P*-value
How do you dispose infected needles	Trash bin	31 (23.3)	0.276
	Break the needle & dispose	25 (18.8)	
	needle burner	39 (29.3)	
	puncture- resistant container	38 (28.6)	
How do you dispose developer and fixer	Direct in sewer	59 (44.4)	<0.001
	After diluting the sewage poured	58 (43.6)	
	Return to producer	2 (1.5)	
	Others(recycle…)	14 (10.5)	
How do you dispose X‑ray film lead foils	Trash bin	70 (52.6)	<0.001
	Maintenance & disposal	47 (35.3)	
	separately	7 (5.3)	
	Burial in the soil	9 (6.8)	
	Silver recycling buyers		
How dental orthodontic wires and hooks are disposed	Trash bin	65 (48.9)	<0.001
	Deformation & disposal	40 (30.1)	
	Recycle or reuse	8 (6.0)	
	Other	20 (15.0)	
How to dispose of expired medicines	Trash bin	80 (60.2)	<0.001
	Deformation & disposal	33 (24.8)	
	Burial in the soil	3 (2.3)	
	secure burial	17 (12.8)	
What is the final disposal of dental waste	Municipal waste bin	36 (27.1)	<0.001
	Authentic collector	60 (45.1)	
	Recycling Center	10 (7.5)	
	Valid & authorized landfill	27 (20.3)	

If Dental offices do not comply with sanitary requirements, they can be a cause of transmitting infectious diseases to patients and even dentists themselves. Dental wastes such as mercury, lead, processing solutions from X-ray units, sharps, and blood-soaked dressings are used in dentistry. If these wastes were not correctly discarded, it can lead to a potential threat to the environment [8]. It is reported that dentists are recruiting improper operation of waste production and disposal in their clinics and offices in Iran. There is not any effective effort to minimize waste, separation, reuse, and recycling in the dental offices of Iran [9,10].

Dentists' awareness of the medical waste management law in dentistry makes them ineffective. Therefore, this study was conducted to evaluate the knowledge and practice of dentists in Bandar Abbas. The results of this study provide essential insights into Bandar Abbas's dentists dental waste management efforts. In this study, slightly more than a third of the dentists (36.8%) were not aware of the different categories of wastes, and approximately a third of the dentists (33.8%) did not categories waste into hazardous waste. According to recent studies, there was a higher level of awareness in India [11,12] while studies conducted in Iran show a lower level of awareness and practice [10]. 48.09% of the dentists were not aware of the color coding used for waste disposal, similar to Pandey's study in Pakistan and Sing study in India [13,14]. In this study, they observed that 53.4% of dentists did not use a colored bag for waste disposal, and also 46.6% did not do the waste separation, which showed a different rate of awareness compares to other studies [2]. Our results also showed that slightly

less than half (43.6%) of dentists were unaware of Iranian waste management laws. In our study, a significant difference between different ages of dentists and their knowledge on Iranian Waste Management Law ($P < 0.046$) was observed. It can be reffered to the fact that most dentists in iran are young and have less than ten years of work experience. In-service training on waste management can have a great impact on raising the awareness and also effective performance of the dentists.

When asked about the category of an extracted tooth, 57.1% correctly said that it comes under the category of infectious wastes which was in line with the Singh study [14]. Six hundred and nine percent of dentists correctly reported the category of needles which comes under the category of sharps wastes. This result was in contrast to sing study in India, where only 23.7% of dentists were aware [14]. 40.41% of the dentists correctly reported the outdated and contaminated drugs as cytotoxic wastes. These results were similar to the study by Naidu in India [11]. Cytotoxic wastes, including all items contaminated with cytotoxic drugs, are put in a non-chlorinated yellow container, sealed and labeled as cytotoxic. Outdated cytotoxic drugs will be returned to the manufacturer or supplier for incineration at temperature > 1200 ℃. The antibiotic and other drugs are discarded in a yellow bag with a biohazard label. Dilution in water and discharge into a sewer for solutions containing vitamins, cough syrups, IV solutions and eye drops, salts, amino acids is recommended [15]. In the present study, 60.2% of the dentists disposed outdated medicines into a trash bin. A study which was conducted in Shiraz, Iran showed that none of the dental offices in Shiraz were in compliance with the standards for the drug disposal [10].

Only 12.0% of dentists in this study were aware of the correct container color for disposing human anatomical wastes (yellow containers). A study by Naidu and et al,. in India showed that in total, 41.2% of dentists were aware about yellow containers [11].

In answer to the question about disposing of infected needles, 29.3% of dentists used needle burner that is an optimal method for sharp objects disposal, and 23.3% put it directly into a trash bin whicgh was in line with o the results of study conducted in New Zealand [16]. The results of the one-way chi-square test showed that various methods had been used to infected needle disposal by dentists, and their knowledge is low about the correct methods ($P = 0.276$). The results of a study conducted in Sari, Iran showed that 9.6% of dentists directly disposed sharps wastes in a trash bin, and 78.9% of dentists used cutter or safety boxes for sharp wastes disposal [17]. A study in conducted in Shiraz, Iran showed that 36.4% of dentists disposed sharp wastes as a domestic waste [10]. Sharp wastes should be collected in puncture-proof containers (safety boxes) and incinerated or autoclaved before disposal.

In Iran, water and sewage systems of dental clinics in many centers are directly connected to the municipal sewage system. Slightly over half of the dentists (54.9%) in this study dumped the chemicals used for radiography and disinfection directly into municipal wastewater. There was a significant difference between the different age groups of dentists and the answer to this question ($P < 0.047$). There was a higher rate of chemical disposal to sewage in the 20–30 years old group dentists. It may indicate lower awareness of young dentists about dental waste management and specify the need for education for young and new dentists.

It is estimated that between 8 and 14 percent of the mercury content in the urban wastewater system is related to dental offices. The separators remove 96.9% of amalgam according to ISO standard [18] .Amalgam is a source of mercury wellknown as a neurotoxin and nephrotoxic [19]. Storing of scrap amalgam in a fixer solution in an adequately labeled sealed container is the recommended method of disposal by the American Dental Association. It can also be sent to a recycler to retrieve the silver and use it for other purposes. This study revealed that only 27.1 % of dentists had

chair-side separators for amalgam. Only 33.1% of dentists put extra amalgam in a trash bin, and 22.6% do not use amalgam in offices or put it in a fixer. 25.6% of dentists in this study used close containers as a disposal methods, which was similar to sings' study in India [14]. The results of the one-way chi-square test showed that various methods had been used to dispose of amalgam by dentists, and they has little knowledge on the correct methods ($P = 0.119$).

A survey conducted by Nabizadeh in Iran showed that 100% of amalgam waste was simply added to the local sewage system and all sharp wastes were added to domestic wastes [9]. The study conducted in Shiraz, Iran showed that 61.7% of extra amalgam was put in the trash bin as domestic waste [10]. A study by Zazouli in Iran revealed that 91.7 % of amalgam waste was placed into the toilet trash bin, and sewer system [17]. A study by Sudhakar and Chandrashekar in India indicated that 39.1% of participants did not separate their extra amalgam or mercury and disposed it directly into municipal solid wastes [20].

Fixer liquid, along with advent solution, is widely used for oral radiology. The fixer liquid is classified as a hazardous material because it contains a high concentration of silver and should not be directly discharged into the sewer or trash bin .Silver recycling is the best way of its managment. However, as in other studies in Iran, 88% of dentists dumped fixer liquid and advent solution in the municipal sewage system [10,17] which was in line with Al-Khatibs' study in Palestine and Singhs' in India [3,14].

Lead-containing products cannot be considered as municipal solid wastes and must be disposed of as hazardous or recycled wastes. In response to the question, the dispose method of X-ray film and lead foils? 52.6% of dentists declared that they put it into the trash bin as domestic waste, and 6.8% reported that they had sold it for recycling purposes. This result was in line with Naidus' in India and other studies in Iran [9,11,17].

According to OSHA (Occupational Safety and Health) regulations, orthodontic wires are considered as sharp wastes because the end of orthodontic wires can penetrate the skin and become contaminated with blood. Therefore they must be disposed of as sharp wastes. In this study, 48.9% of dentists disposed them directly into the trash bin, and 30.1% deformed them and then disposed, which is not considered to be a correct method. These results were similar to Sudhir and Naidu's studies in India [2,11].

4. Conclusion

Our study shows that dentists, in general, did not have sufficient awareness of dental waste management in Bandar Abbas. Also, mostly they do not meet the waste disposal standards. Therefore, continuous training of dentists, especially at the start of their work in offices and clinics, on the management of dental wastes is essential in raising their awareness. In order to protect the environment from pollution, as well as to ensure the safety of health care workers and patients, medical waste management programs are especially effective in preventing water and soil contamination. Implementing waste management laws requires constant monitoring and training. Therefore, it is necessary to establish a comprehensive system of health care for waste management in Iran as those of developed countries.

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Conflicts of Interest

The author declare no conflict of interest.

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