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Solid Waste Production and Its Management in Dental Clinics in Gorgan, Northern Iran

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Abstract

Background: Waste produced in dental clinics has been the topic of investigations for many years. These waste materials have important health impacts and are hazardous to humans and the environment.

Objective: To investigating solid waste production and its management in dental clinics in Gorgan, northern Iran.

Methods: In this cross-sectional study, 45 of 143 public dental practices and 5 of 25 private dental practices were selected and studied. From each clinic, 3 samples were taken and analyzed at the end of successive working days (Tuesday and Wednesday). Samples were manually sorted into 50 components. The measured components were then classified on the basis of their characteristics, hazard potentials, and WHO classification.

Results: The total annual amount of dental waste produced in public and private dental practices in Gorgan was 12 015.1 and 3135.0 kg, respectively. Production percentages of infectious, domestic, chemical and pharmaceutical, and toxic waste in public dental practices were 38.4%, 33.7%, 6.6%, and 0.6%, respectively. The percentages for private practices were 8.7%, 10.6%, 1.1%, and 0.1%, respectively.

Conclusion: Dental waste management in Gorgan is inadequate; dental waste is not properly segregated, collected, and disposed, as demanded by the WHO. Employees in dentist offices must be trained in correct handling of waste products and the associated risks.

Keywords: Infection control, Dental; Waste disposal facilities; Medical waste disposal; Dental waste; Hazardous waste; Solid waste; Waste management; Waste products; Medical waste; Blood-borne pathogens

Introduction

Daily operation of health care facilities, such as hospitals, medical schools, private surgery clinics, health centers, medical laboratories, and dental practices produce a large amount of waste. Health care waste is defined as any solid, semi-solid, and liquid waste that

is generated during the diagnosis, treatment, and immunization of human beings or animals.^{1,2} The waste can be categorized into two groups of “non-infectious waste” and “hazardous waste,” such as sharps, infectious, chemical, pharmaceutical, and radioactive waste. Non-hazardous waste from health care settings may be regarded as household waste.³ Almost 80% of health

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Received: Feb 26, 2014
Accepted: Apr 27, 2014

Cite this article as: Nabizadeh R, Faraji H, Mohammadi AA. Solid waste production and its management in dental clinics in Gorgan, northern Iran. *Int J Occup Environ Med* 2014;5:216-221.

care waste are treated as regular solid municipal waste; the remaining 20% are treated as hazardous waste.⁴ Dental solid waste is categorized according to the WHO classification.⁵ The majority of the waste produced in dental clinics can be classified into three groups—infectious, chemical, and household waste.⁶ Another form of hazardous waste produced in dental clinics includes x-ray films and fixer, sharps, dental amalgam, chemical disinfectants, and blood-soaked dressings.^{7,8} Many studies revealed that chemical waste (*eg*, amalgam) and sharps, respectively, made 49% and 27% of waste produced in medical centers and dental clinics worldwide.⁹

Mercury is a global concern because thousands of dentists around the world routinely use dental amalgam for filling decayed teeth.¹⁰ According to the Environmental Protection Agency (EPA), dental offices were the source of 50% of all mercury pollution entering publically-owned treatment works in 2003.¹¹ Studies conducted in the USA, Canada, and other countries have demonstrated that dental clinics play a key role in causing the mercury to enter the environment that can lead to adverse effects on human beings.^{12,13} Other hazardous waste of dental clinics, including lead, x-ray films, leaden aprons, foils, and silver used in radiographic fixer, have adverse effects on the environment.^{14,15}

Although dental waste constitutes a small part of the total solid waste produced by the community, its management is of great importance as it includes various potentially infectious and hazardous materials. One of the first steps in the process of developing a reliable waste management system is to analyze the current status of the waste management system. Several studies have so far been conducted in Iran and other countries.^{6,16-18} However, we could not find any study on the characteristics and management of the produced waste in Gorgan, northern Iran. We there-

TAKE-HOME MESSAGE

- Waste produced in dental clinics has been the topic of investigations for many years.
- Almost 80% of health care waste are treated as regular solid municipal waste; the remaining 20% are treated as hazardous waste.
- None of the studied public and private dental clinics in Gorgan, northern Iran, separated waste material, recycled waste or amalgam, or disposed amalgam.
- Dental waste management public and private dental clinics in Gorgan, northern Iran, is inadequate; dental waste is not properly segregated, collected, and disposed.

fore, conducted this study to investigating solid waste production and its management practices in public and private dental clinics in Gorgan, Iran.

Materials and Methods

This cross-sectional study was conducted in 2012, in Gorgan, the capital of Golestan province, northern Iran (latitude: 36° 50' 19" N, and longitude: 54° 26' 05" E). There were 143 active public and 25 active

Table 1: Type and amount of waste produced in studied dental practices in 2012. Figures in the parenthesis are percentage from the total waste, 15 150.1 kg

Waste description	Weight (kg) and percentage of waste produced	
	Public dental practices	Private dental practices
Infectious solid waste	5818.5 (38.4)	1314.2 (8.7)
Domestic solid waste	5112.3 (33.7)	1600.2 (10.6)
Chemical solid waste	993.0 (6.6)	211.4 (1.4)
Toxic waste	91.3 (0.6)	9.2 (0.1)
Total solid waste	12 015.1 (79.3)	3135.0 (20.7)

Table 2: Type and amount of the infectious waste produced in studied dental practices in 2012. Figures in the parenthesis are percentage from the total waste, 7152.8 kg.

Waste description	Weight (kg) and percentage of waste produced	
	Public dental practices	Private dental practices
Latex gloves	1789.4 (25.1)	394.9 (5.5)
Used ampoules	637.7 (8.9)	83.5 (1.2)
Saliva-contaminated paper towel	517.2 (7.3)	117.5 (1.6)
Stick mouth	505.0 (7.1)	84.0 (1.2)
Suction head	499.3 (7.0)	99.0 (1.4)
Nylon gloves	463.1 (6.5)	165.5 (2.3)
Needles and sharps	259.9 (3.6)	39.5 (0.6)
Saliva-contaminated gauze	253.0 (3.6)	48.5 (0.7)
Saliva-contaminated cotton	252.4 (3.5)	58.0 (0.8)
Syringes plastic	216.0 (3.0)	81.8 (1.1)
Blood-contaminated paper towel	115.3 (1.6)	24.5 (0.3)
Blood-contaminated gauze	92.0 (1.3)	35.5 (0.5)
Dental floss	71.6 (1.0)	26.6 (0.4)
Blood-contaminated cotton	67.0 (0.9)	25.0 (0.4)
Dental mirror	38.8 (0.5)	14.0 (0.2)
Medicine ampoule packaging	18.1 (0.3)	6.6 (0.1)
Surgical blade	12.0 (0.2)	4.3 (0.1)
Extracted teeth	6.5 (0.1)	2.5 (0.0)
Tongue blade	4.2 (0.1)	3.0 (0.0)
Total infectious waste	5818.5 (81.7)	1314.2 (18.4)

private dental practices in the city. These practices included orthodontics, endodontics, restorative surgery, prosthodontics, and periodontics clinics, as well as non-health sectors—administrative and service units. Using a random stratified sampling method, we selected 45 public and five private dental practices. Before sampling, we informed the in-charge dentist of the objectives of the study and upon his/her agreement, detailed instructions about the study subjects, categorization of waste components, and other important issues on the management of lab waste were given to the dental clinic employees. The employees were then asked questions about their dental management practice.

From each clinic, three samples were taken and analyzed on Tuesdays and Wednesdays of the second month of each season. Samples were taken at the end of each clinic hours, and after transfer to a suitable location, were analyzed. Samples were manually sorted into 50 components and measured by a scale with an accuracy of ± 0.01 kg. Samples were weighed three times; the mean weight was recorded. The components were then classified according to the WHO classification and kept in black bags for domestic waste, orange bags for infectious waste, brown bags for chemical waste, and safety box for sharps, with labels specified the amount and type of the waste.⁵ During this operation, all workers used appropriate personal protective equipment such as tarpaulin gloves, impermeable boots, face masks, and were vaccinated against hepatitis B and tetanus.

Results

Of 143 public and 25 private dental practices studied in 2012 in Gorgan, 15 150.1 kg solid waste was collected (Table 1). The type and weight of infectious, domestic, chemical, and toxic waste produced in the studied clinics are shown in Tables 2-5.

Latex gloves, mixed gypsum, solvents/disinfectants, and radiographic film covering were the most common infectious, domestic, chemical, and toxic waste produced in both public and private dental practices. None of the studied clinics separated waste material, recycled waste or amalgam, or disposed amalgam. All public dental clinics studied used safety box; only 20% of private clinics did so.

Discussion

Public and private dental clinics in Gorgan produced a total of 15150.1 kg waste in 2012. A similar study conducted in Shahrud reported that the total annual waste produced in dental offices were 2425.5 kg. The share of infectious, domestic, chemical and pharmaceutical, and toxic waste were 46.0%, 43.8%, 9.2%, and 1.0%, respectively.¹⁹ Another study conducted by Nabizade, *et al*, in Hamadan showed that the total annual waste produced in dental offices was 41947.4 kg, of which domestic waste, potentially infectious waste, chemical and pharmaceutical waste, and toxic waste constituted 71.2%, 21.4%, 7.3%, and 0.2%, respectively. Only seven fractions including gypsum, latex gloves, nylon, dental impression material, used ampoules, saliva-contaminated paper towels, and saliva ejectors, constituted almost 80% of the waste produced.¹⁷ This is similar to the observed distribution of domestic solid waste in our study.

In another study on the composition of dental solid waste in a private dental university and one public dental health service in Brazil, it was found that the total amount of dental waste, including domestic, infectious, and non-infectious waste was 27.6%, 24.3%, and 48.1%, respectively.¹⁸ Comparison of the current study with the report of Vieira¹⁸ revealed that the fraction of domestic waste plus non-infectious waste produced by dental clinics (91.1%) in

Table 3: Type and amount of the domestic waste produced in studied dental practices in 2012. Figures in the parenthesis are percentage from the total waste, 6712.2 kg.

Waste description	Weight (kg) and percentage of waste produced	
	Public dental practices	Private dental practices
Mixed gypsum	1792.3 (26.7)	373.3 (5.6)
Nylons	1111.3 (16.6)	356.0 (5.3)
Gypsum	366.8 (5.5)	78.5 (1.2)
Plastics	300.4 (4.5)	119.7 (1.8)
Carton, and cardboard	244.5 (3.6)	54.3 (0.8)
Metals	228.5 (3.4)	63.8 (1.0)
Dry paper towel	228.4 (3.4)	225.0 (3.4)
Food waste	222.5 (3.3)	62.0 (0.9)
Glass	158.7 (2.4)	83.6 (1.2)
Food waste packaging	94.4 (1.4)	33.3 (0.5)
Dry cotton	91.5 (1.4)	23.8 (0.4)
Mask	91.3 (1.4)	26.9 (0.4)
Tea slag	90.6 (1.3)	25.7 (0.4)
Dry gauze	67.3 (1.0)	22.5 (0.3)
Ear cleaner	8.0 (0.1)	5.8 (0.1)
Sticking plaster	5.0 (0.1)	2.8 (0.0)
Cigarette filter	3.3 (0.0)	1.4 (0.0)
Shan	3.0 (0.0)	2.2 (0.0)
Gown	2.5 (0.0)	9.5 (0.1)
Foil	2.0 (0.0)	30.1 (0.4)
Total general waste	5112.3 (76.2)	1600.2 (23.8)

Table 4: Type and amount of the chemical waste produced in studied dental practices in 2012. Figures in the parenthesis are percentage from the total waste, 1204.4 kg.

Waste description	Weight (kg) and percentage of waste produced	
	Public dental practices	Private dental practices
Chemical substances: solvents, disinfectants	525.0 (43.6)	56.2 (4.7)
Paste molding	408.0 (33.9)	132.2 (11.0)
Film packet's lead foil	60.0 (5.0)	23.0 (1.9)
Total solid waste	993.0 (82.4)	211.4 (17.6)

Gorgan was more than the corresponding fraction in a city of Brazil (51.9%). Findings of a study in Babol, northern Iran, showed that domestic solid waste, infectious waste and sharp, and hazardous chemical waste constituted 86.3%, 13%, and 0.7% of the produced solid waste in dental clinics, respectively.²⁰ In contrast, in another study conducted in *Sistan va Baluchestan* province, it was found that domestic waste, potentially infectious waste, chemical and

Table 5: Type and amount of the toxic waste produced in studied dental practices in 2012. Figures in the parenthesis are percentage from the total waste, 100.5 kg.

Waste description	Weight (kg) and percentage of waste produced	
	Public dental practices	Private dental practices
Radiographic film covering	56.9 (56.6)	5.8 (5.8)
Amalgam-contaminated gauze	20.4 (20.3)	0.9 (0.9)
X-ray	5.4 (5.4)	1.9 (1.9)
Amalgam-contaminated dental roll	4.5 (4.5)	0.4 (0.4)
Amalgam-contaminated paper towel	4.0 (4.0)	0.2 (0.2)
Total solid waste	91.3 (90.8)	9.2 (9.2)

pharmaceutical waste, and toxic waste constituted 11.7%, 80.3%, 6.3%, and 1.7%, respectively²¹.

Approximately all of the studied public and private dental practices used a standard method for sharps disposal. Sharps were collected in safety boxes, put in hydroclave, and placed in landfills. A similar study conducted by Danaei, *et al*, in Shiraz indicated that Only 60% of centers they studied used a standard method for sharps disposal.¹⁶ None of the studied public and private dental practices used amalgam recycler. Similarly, other studies conducted in *Sistan va Baluchestan* province and Hamadan reported that all of the amalgam waste was simply added to the local sewage system.^{17,21} The study from Shiraz also reported that <10% of centers studied recycled the amalgam and lead foil pockets waste to the manufacture.¹⁶ Therefore, there is no proper waste management of dental waste in Gorgan. Furthermore, we found that dental waste, except needles and sharps, is often mixed with domestic waste during collection and disposal, which is in keeping with the results reported by Al-Khatib, *et al*.²² Considering the importance of correct collection and disposal of dental waste and its effect on control of several communicable diseases, assessment and monitoring of the situation in Gorgan and other cities of the country are imperative.

Acknowledgments

The authors thank the dentists and health care workers of the studied dental clinics.

Conflicts of Interest: None declared

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