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Effect of Audiovisual Educational Media on Dentists' Knowledge of Dental Waste Management in Tabriz City

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ABSTRACT

Introduction: Dental waste management is particularly sensitive due to its dangerous, toxic, and pathogenic agents. The aim of this study was to assess the effect of educational audiovisual media on the awareness of general dentists in Tabriz about waste management methods in dental offices.

Materials and Methods: In this quasi-experimental study (one-group pre-and-post-test design), 80 general dentists were randomly selected. The researcher-made questionnaire on waste management awareness was validated and then distributed. Two weeks after the educational session, including audiovisual media, the same questionnaire was given. To determine the knowledge scores, one point was given for each correct answer and no score was given for incorrect answers and questions without answers.

Results: The mean knowledge of dentists after the educational intervention (13.5±1.1) was significantly higher than that before the educational intervention (8.2 ±1.3) (P <0.0001).

Conclusion: As instructional audiovisual media are effective in increasing dentists' awareness, they should be used more for various subjects, such as waste management practices in dental offices.

Keywords: Dental Waste, Knowledge, Multimedia, Dentistry.

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Introduction

Biomedical waste (BMW) is defined as "any solid, fluid or liquid waste, including its container and any intermediate product, which is generated during its diagnosis, treatment or immunization of human beings or animals, in research pertaining thereto, or in the production or testing of biological and

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animal wastes. In the field of dentistry, mercury waste, waste from dental amalgam, lead, and silver-containing waste were often found and have severe risks for health and are also environmental hazards. This also has an impact and risk of airborne pathogens if it is improperly handled and disposed of. Dental waste production in Iran is 60-80g per person per day. [1] All contaminated wastes such as syringes, needles, and blood-soaked gauze, which leads to infections, must be properly disposed of in various color-coded containers indicated for each category of BMW as per the guidelines. [2]

Healthcare waste can be broadly classified as non-hazardous and hazardous waste. This waste includes equipment and/or materials that have been in contact with blood, tissues, tissue fluids, excreta, or waste from infection wards. Non-hazardous waste includes, among others, sterile packaging, plastic bottles, paper, non-infectious gloves, incontinence pads, empty fluid bags, surgical dressing, masks, etc., whereas hazardous infectious waste includes medicated intravenous bags/lines, medicinally contaminated syringes, needles, diagnostic specimens, etc. Between 75 and 90% of the waste produced by healthcare providers is non-hazardous or general waste. [3]

Dental waste can be broadly divided into three categories: infectious waste, non-infectious toxic waste, and domestic-type waste. [4] Infectious waste contains materials contaminated with blood or other infectious mouth fluids, amalgam, and sharps. Non-infectious toxic dental waste includes materials such as amalgam alloys, acids for electrolytic polishing of metal frameworks, gypsum waste, metal dust, acrylic resin scraps, wasted metal alloys, porcelain, molding plaster, gutta-percha, X-ray films, lead shields from X-ray film packets.[5] Mercury from amalgam waste can contaminate the environment through sludge incineration, landfilling, and direct discharge into wastewater. A study in Urmia reported that waste generation rates for total, domestic-type, potentially infectious, chemical and pharmaceutical, and toxic wastes were 58.9, 33.1, 40.9, 7.7, and 18.2 kg/d, respectively. [6]

Dental hospitals use instruments and materials that are directly exposed to blood and saliva and are, therefore, potential sources of infection. Many chemicals like acrylics, impression materials, and mercury used for restorative purposes may have a possible environmental and human health impact if not handled properly.[7] Due to the considerable risks linked to dental infectious waste, it is crucial to keep it separate from other types of dental waste. [5] Sharps are a significant category of dental waste, which are known to have the risk of injuries in waste collection and transportation and the potential to transmit various diseases, including AIDS, hepatitis C, and B. [3]

It is a common practice, especially in poor and developing regions, to dump most dental solid waste with household or municipal solid waste into landfills without any separation or recycling processes. A study in Sari, Iran concluded that there was no proper management of waste in the dental centers of Sari. [8] Due to the presence of potentially hazardous components, such practices pose a significant risk to population health and the environment. [9] Therefore, the aim of this study was to assess the effect of educational audiovisual media on the awareness of general dentists in Tabriz about waste management methods in dental offices.

Materials & Methods

In this interventional quasi-experimental study (one-group pre-test-post-test design), the target population was dentists working in Tabriz at the time of the study. Based on the awareness level of 20% in Pawar et al. using an alpha error of 0.05 and 80% power, the

minimum sample size was 77. [10] The sample size was calculated using G-power software. A total of 80 dentists were recruited for the study. Dentists were selected from all dentists in Tabriz by stratified random sampling based on the years since graduation. The list of dentists in Tabriz was divided into groups of less than 5 years, 5-9 years, 10-15 years, and more than 15 years from graduation, and then 20 dentists were randomly selected from each.

The inclusion criteria for the study consisted of licensed general dentists currently practicing in Tabriz who were willing to participate and were available during the study timeframe. The exclusion criteria included specialists and dentists who do not actively engage in clinical practice, as well as those who had participated in Continuing Medical Education (CME) programs on waste management within the previous year. Additionally, any dentist who failed to complete either the pre-test or post-test questionnaires would be excluded from the analysis. The institutional review board approved this research with the ethics code IR.TBZMED.REC.1400.613.

Data collection methods and tools

A pre-intervention phase

To assess dentists' knowledge and practices related to waste management in dental offices, a structured, pre-designed questionnaire (Supplementary File I) was used. Its content and face validity were assessed by eight professors in public health, health education, and oral medicine. Based on their feedback, a few changes were made to clarify the meaning of some sentences. The questionnaires were distributed among 10 dentists (who were not part of the main research population). CVR=0.83 and CVI=0.79 were obtained, which indicates the appropriate validity of the questionnaire. Cronbach's alpha coefficient was calculated based on the results of 20 dentists. The Cronbach's alpha was 0.86 which was considered acceptable. Intraclass Correlation Coefficient (ICC) for test-retest reliability was calculated after re-administering the questionnaire after two weeks. ICC was calculated to be 0.82 (with a 95% confidence interval: 0.74-0.91), which indicates the reliability of the questionnaire.

The questionnaire consisted of two sections. The first part of the questionnaire asked about gender and years since graduation. The second part pertained to the dentists' knowledge of waste management with 15 questions. Each person's score at each stage of the test was calculated as follows: one point was awarded for each correct answer, and zero points for incorrect answers and unanswered questions (therefore, the maximum score was 15 points and the minimum possible score was 0). The questionnaires were delivered to the dentists' private offices and they were assured that the information would remain confidential and that there was no need to include their names and surnames (dentists were randomly assigned numbers from 1 to 80). Dentists completed the questionnaire in their office and then the questionnaires were collected.

Intervention phase

The video was designed with clear graphics, animations, and voiceovers. The video was divided into three chapters, covering the collection and disposal procedures for quasi-household, infectious, and toxic waste generated in the dental office. The first chapter focused on proper methods for collecting quasi-household waste, stressing the importance of

distinguishing waste categories to prevent cross-contamination. The second chapter outlined disposal guidelines for infectious materials (e.g., anything potentially contaminated with blood or bodily fluids), and the third addressed toxic substances, like specific chemicals and mercury from dental amalgams. Emphasis was placed on safety protocols to protect healthcare workers and the environment.

The video had a duration of 15 minutes; the content was developed based on established medical and dental waste disposal protocols. In order to ensure accuracy and reliability, authoritative references were consulted, including guidelines from health organizations and final version was approved by oral medicine professors. On the pre-test day, dentists received a video link on waste management practices via their smartphones and were instructed to watch it the same day. Those who did not access the link were excluded from the study.

Post-intervention phase

To evaluate how the educational program influenced the dentists' knowledge and practices, the same questionnaire was administered two months after the first. The scores obtained before and after the training were compared and the effectiveness of the training was determined.

Statistical analysis

The data was analyzed with IBM SPSS 17.0. (Armonk, NY: IBM Corp). For categorical data, frequencies and percentages were utilized. The Shapiro-Wilk test was utilized to investigate the normality of data. The Paired Sample T Test was used to compare the pre- and post-results. A One-Way ANOVA test was used to compare the means across the four groups. If the p-value was less than 0.05, it was considered statistically significant.

Results

In this study, 80 dentists were surveyed, 3 of whom did not watch the video; therefore the knowledge, of 77 dentists was examined before and after the intervention. Males were 39 (50.64%) and females were 38 (49.36%). The mean age of participants was 37.4±2.6. The mean pre-intervention scores for the four groups, categorized by years since graduation, are presented in Table 1.

Table 1. Pre-intervention scores in four groups based on years since graduation

Years since graduation	Number	Mean± SD of Pre-intervention score	95% confidence interval for mean		Minimum	Maximum
			Lower bound	Upper bound		
< 5	20	8.8±1.0	8.362	9.238	7	10
5-9	20	8.4±1.3	7.830	8.970	7	10
10-15	19	7.9±0.9	7.495	8.305	6	10
>15	18	7.7±1.7	6.915	8.485	6	10

The results of the level of awareness of general dentists in Tabriz city about dental office waste management methods before the educational intervention showed that the average score was 8.2. Comparison of pretest results of the four groups is presented in Table 2. One-way

ANOVA test showed that there was no statistically significant difference in pre-intervention knowledge scores across the four groups.

Table 2. Comparison of the pretest results for the four groups

Source	Sum of Squares	Degree of freedom	Mean Square	F	P- value*	η^2
Between-groups	13.23	3	4.41			
Within-groups	120.55	73	1.65	2.67	0.053	0.099
Total	133.79	76	1.76			

* One-Way ANOVA

A comparison of the mean scores of awareness of general dentists in Tabriz city about dental office waste management methods by paired t test showed that the mean awareness score (8.2±1.3) significantly increased after (13.5±1.1) the educational intervention (Mean difference 5.3± 0.53; CI:5.16-5.40; t(76)=86.77; p<0.0001).

Table 3 shows the percentage of correct responses for each question before and after the educational intervention. Notably, questions 5,7,13, and 15 regarding participants' understanding of risks of amalgam wastes, classification of BMW and timing of retraining on BMW management showed the highest increases. Overall, the findings suggest that the educational intervention was effective in enhancing participants' understanding of key concepts of BMW management.

Table 3. Changes to the correct answers of the participants for each question

Question	Correct answer (%) Pre-test	Correct answer (%) Post-test	% change
1	61.3	96.4	57.2
2	54.1	93.2	72.2
3	81.2	100	23.1
4	71.5	90.8	27.0
5	36.4	87.2	139.5
6	50.6	88.3	74.5
7	31.7	69.5	119.2
8	53.2	87.6	64.6
9	86.7	100	15.3
10	60.6	92.4	52.4
11	44.8	79.3	77.0
12	45.1	89.7	98.8
13	36.3	84.8	133.6
14	51.4	87.1	69.4
15	34.2	86.3	152.3

Discussion

The results of the present study showed that the mean knowledge of dentists after the educational intervention increased significantly. This finding aligns with previous research suggesting that educational videos can be a powerful tool for improving knowledge retention and engagement among healthcare professionals. Abdo et al. (Kuwait, 2019) demonstrated a significant improvement in the knowledge, attitude, and practices of Environmental Service Workers (ESWs) concerning the management of infectious and sharps waste following the educational intervention.[11] Similarly, Cayo-Rojas et al (Peru, 2023) showed that dentists' awareness of BMW disposal significantly improved immediately after the educational intervention.[12] These studies align with each other regarding the effectiveness of audiovisual materials. Educational videos provide engaging, clear, and structured content that enhances knowledge retention and learner engagement among healthcare professionals.

Furthermore, the present study showed that knowledge of dentist regarding BMW management was moderate (8.1/15). Limited awareness and substandard practices in BMW management, along with insufficient knowledge about dental material recycling, may stem from inadequate emphasis on these subjects within dental undergraduate curricula. Previous studies have reported varying levels of knowledge and compliance among dental professionals. Jamkhande et al. (India, 2019) found that while 94.6% of dentists were knowledgeable about BMW legislation, only 81.2% had registered with a local BMW service agency. [13] Naidu et al. (2019, India) found a high level of awareness of BMW management regulations by 86.6% of clinicians and 78.1% of academicians. [14] One of the reasons for the discrepancy in the results of the studies is the tool used to measure the level of awareness. Different studies have used various researcher-made questionnaires with different levels of difficulty, resulting in inconsistencies in the knowledge scores obtained.

Tompe et al., in a systematic review, concluded that the knowledge of BMW management among dental professionals was generally insufficient. [15] Implementing ongoing education, training programs, and short courses focused on cross-infection control and BMW management can effectively enhance the understanding and practices of dental staff. Training programs should be regularly conducted for personnel directly handling BMW to enhance their awareness of proper management protocols and associated risks.

In the present study although not significantly different, the pre-intervention awareness of dentists above 15 years since graduation was lower than that of others, suggesting that CME programs are necessary. Several factors could contribute to this trend; experienced dentists may have undergone their initial training prior to the emphasis on waste management protocols in dental education, or they might be more inclined to rely on established routines rather than adopting updated practices. This variance in awareness levels among different groups of dentists has been observed in previous studies as well. Raghuvanshi et al. (India, 2018) found that while 100% of institution-based dentists were aware of BMW categories, 80% of private practitioners had this knowledge. Despite high awareness, 41% of institution-affiliated dentists disposed of chemical waste directly into the sewer. [16]

Cayo-Rojas et al. showed that differences in demographic and professional backgrounds such as marital status, type of educational institution attended (private vs. public), level of professional experience, and academic involvement can influence the extent and durability of

knowledge retention. [12] In Iran, the Ministry of Health and Medical Education is responsible for BMW management. The management of infectious and sharp waste generated by dental facilities involves segregation at the source followed by treatment methods such as incineration. Although regulations mandate proper disposal, challenges persist regarding the uniform application of protocols, infrastructure limitations, and variability in staff training. [17] Singh et al. (Nepal, 2018) found that most participants demonstrated a positive attitude toward the safe management of BMW. While a majority of students expressed favorable views on BMW management policies, over half were unaware of the official guidelines set by the Government of Nepal. [18]

Addressing these issues through targeted educational programs is essential to ensure the safe disposal of infectious waste. Hospitals usually have their own BMW disposal facility, but dental offices usually rely on companies specializing in BMW management. These companies provide training, guidelines, and reliable waste collection services, which facilitate compliance with regulations and promote safer handling of hazardous materials. [19] However, the primary responsibility for waste disposal rests with the dentist.

This study has some limitations. First, the sample size was limited to dentists practicing in Tabriz, which may affect the generalizability of the findings to other regions. Additionally, it assessed knowledge following the educational intervention and did not evaluate long-term retention or actual changes in waste management behavior. In this study, the indication of video viewing was based solely on opening the link, not necessarily watching it completely. Future research should include follow-ups to assess knowledge retention and compliance over time, as well as observational audits for more objective behavioral measures. There is a need for randomized controlled trials to compare the effectiveness of various training methods (e.g., workshops and online modules) in improving dentists' BMW management knowledge and compliance.

Conclusion

The results of the present study showed that educational audiovisual intervention significantly enhanced the awareness of general dentists in Tabriz regarding waste management practices in dental offices.

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Conflict of Interest

There is no conflict of interest to declare.

Author's Contribution

Fatemeh Dabaghi Tabriz contributed to the study concept and design, edited and reviewed the manuscript for important intellectual content, and is the guarantor and project administrator. Mehdi Abed Kahnamouei interpreted the data, supervised the study, and edited and reviewed the manuscript for important intellectual content. Ali Sani and Katayoun Katebi contributed to data acquisition and analysis and drafted the manuscript. All authors have read and approved the final manuscript.

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Supplementary file 1

Dear Dentist

This study aims to evaluate the effect of audiovisual educational media on dentists' knowledge of dental waste management. Your cooperation is highly appreciated. There is no need to write your name and data confidentiality will be observed. Please choose one answer for each question.

Code: ……..

Time: First ☐ Second ☐

Age: Gender: years since graduation:

1. Which of the following is classified as infectious (biohazard) waste in a dental office?
A. Unused gloves
B. Extracted teeth
C. Empty anesthetic cartridges
D. Used cotton rolls

2. Which of the following best describes the correct management of sharps waste in a dental clinic?
A. Rinsed and placed in biohazard bags
B. Placed in a puncture-proof, leak-resistant container labeled for sharps
C. Discarded with general clinical waste
D. Recycled after autoclaving

3. What color-coded container is typically used for sharps disposal in dental clinics?
A. Red
B. Yellow
C. Green
D. Black

4. Amalgam waste should be disposed of in:
A. Regular trash bin
B. Sharps container
C. A designated amalgam separator
D. Biohazard bag

5. Why is it essential to handle dental amalgam waste separately from other clinical waste?
A. It contains silver, which can corrode other materials
B. It has a high risk of infection
C. It contains mercury, which is toxic and environmentally hazardous
D. It is classified as radioactive by health authorities

6. What is the correct procedure for disposing of blood-soaked gauze?
A. Flush it down the sink
B. Place in general waste
C. Dispose in biohazard (red) bag
D. Burn immediately

7. What type of waste are lead foils from dental X-ray films considered?
A. Infectious waste
B. Radioactive waste

C. Hazardous waste
D. General waste

8. Which of the following is a recommended strategy for reducing waste generation in a dental practice?
A. Using single-use items for all procedures
B. Burning all waste on-site
C. Choosing reusable and sterilizable instruments where appropriate
D. Mixing all waste

9. Which of the following is an example of pharmaceutical waste in a dental office?
A. Used gloves
B. Expired local anesthetic vials
C. Cotton rolls with blood
D. Extracted teeth with amalgam

10. Expired dental materials should be:
A. Used until finished
B. Mixed with regular trash
C. Returned to the manufacturer or disposed as chemical waste
D. Diluted with water and flushed

11. What is the most appropriate action when disposing of a used disinfectant solution from dental operatory surfaces?
A. Pour it directly into the sink without dilution
B. Mix it with general waste for disposal
C. Store it in a labeled chemical waste container for safe disposal
D. Leave it to evaporate in a well-ventilated room

12. How often should sharps containers be replaced?
A. Every day
B. When they are 3/4 full
C. Once a month
D. Only when full

13. Glutaraldehyde used for instrument sterilization is considered:
A. Non-hazardous liquid waste
B. Infectious waste
C. Chemical waste
D. General waste

14. A dental assistant accidentally places used gloves and a broken anesthetic cartridge into the same bin. What should be done next?
A. Leave the items as they are, since both are from clinical use
B. Remove the cartridge and place it in sharps waste, while leaving the gloves
C. Remove both items and re-sort them into their appropriate waste containers
D. Spray disinfectant in the bin to neutralize contamination

15. Training on waste management protocols for dental staff should be conducted:
A. Once during hiring
B. Every 5 years
C. At regular intervals
D. Only for new technologies

Thank You