Knowledge, Attitude and Practices of Dental Practitioners in Chennai Towards Management of Hazardous Dental Radiological Waste –A Cross Sectional Survey

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Abstract

Background: Management of hazardous dental radiological waste is very important for the dentist to known and practice correct protocol. The aim of the study is to assess the knowledge, attitude and practice among the dental professionals in Chennai, towards disposal of radiographic hazardous waste.

Materials and Methods: One hundred dental practitioners from different part of the city were participated in this study. A set of hundred questions were given to the education qualification divided into 2 groups, those with BDS (UG degree) and MDS (PG degree) and the answers obtained was tabulated and recorded. Descriptive statistics were calculated for all the questions recorded among the education qualification they were divided into 2 groups, those with BDS (UG degree) and MDS (PG degree) in chennai city and chi square test was done to find the association between the questions recorded.

Result: Among the participants, they found a positive association between some questionnaire while assessing the experience of practice whereas based on qualification of the participant they was no association between the questionnaire.

Conclusions: This study is to bring out sustainable social and behavioural change and to reinforce the moral and professional obligations of the dental surgeon towards human health and environment therefore it is important to collect base-line and follow up data to evaluate the outcome of any awareness programs aimed at promoting good hazardous waste management practice.

Keywords: *Attitude, Dental waste, knowledge, Practice and Waste management*

Introduction

The scope of dental practice is expanding day by day. In order to keep pace with the growing demands, dental surgeons have to shoulder a greater responsibility in all aspects of their practice. Proper disposal of hazardous waste generated during routine dental radiology is mandatory to prevent the detrimental effects on the human health and environment. Processing chemicals and lead foils are a source of hazardous waste and have to be disposed off with caution. Unfortunately, this issue has not received as much attention as the mercury in amalgam restorations, even though numerous studies have documented the hazardous potential of radiological waste[1].

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Dental professionals are under increasing pressure to understand and adhere to clinical waste regulations proper management and disposal of clinical waste is vital and there is strict legislation in place to prevent harm being caused to the environment and to human health. Defining different types of waste Clinical waste is defined as 'any waste which consists wholly or partly of human or animal tissue, blood or other body fluids, excretions, drugs or other pharmaceutical products, swabs or dressings, syringes, needles or other sharp instruments'. This type of waste may prove hazardous to any person coming into contact with it unless it is rendered safe. Waste is defined as 'hazardous' when the waste itself or the material or substances it contains are harmful to humans or the environment[2]. The other main waste stream is known as offensive waste, which primarily contains waste that is considered unpleasant due to its appearance and smell, for instance incontinence waste. Other hazardous waste streams typically found in dental practices are fixer and developer from X-ray machines. These must not be mixed prior to disposal and must be sent for disposal via recycling. As well as this, dental study moulds contain gypsum which, when land-filled with biodegradable waste, can produce hydrogen sulphide gas. Hydrogen sulphide gas is highly toxic and malodorous. In accordance with the Environment Permitting (England and Wales) Regulations 2010, gypsum has been banned from normal landfill (containing biodegradable waste) and must go into a separate cell for high sulphate waste. Dental offices that house and operate standard radiography equipment must process the X-ray films using photochemical- fixer, developer, and equipment cleaner. Each of these chemical solutions is unique and requires special handling and disposal procedures. There are a number of hazardous dental wastes that, when disposed of improperly, could cause harm to the environment. Examples include chemical solutions, lead foil film backing, mercury, scrap dental amalgam, fluorescent tubes, and batteries. The fixer that Dental offices use to develop X-ray is a hazardous material that should not be simply rinsed down the drain. Spent fixer solution contains approximately 4000 mg of silver/L[2]. A digital X-ray unit should be utilized to minimize the need for fixer solutions. Spent developer is permitted to be discharged into the sewer or septic systems provided it is diluted with water. It contains a toxic substance hydroquinone when unused, it must be kept separate from dental wastewaters or any access to the local sewage or fresh water. Many cleaners for X-ray developer systems contain chromium, a toxic substance so the supplier should be asked for a cleaner that does not use chromium. Undeveloped film contains a high level of silver and must be treated as a hazardous waste. Once the container is full, a certified waste carrier should be contacted for recycling or disposal. Digital X-ray unit should be used to minimize purchase of new X-ray films[3].

Developed film has little residual silver and can be placed in the regular solid waste stream. The lead foil inside each X-ray packet is a leachable toxin and can contaminate the soil and groundwater in landfill sites[4]. Indian studies based on safe disposal of radiological hazardous waste are very limited and there is a serious dearth of information regarding the awareness levels of dental practitioners concerning this issue. Hence, we conducted this study to assess the knowledge, attitude and practice of the dental practitioners in Chennai city towards disposal of radiographic hazardous waste. This study was also intended to collect baseline data about the awareness levels among the practitioners and to suggest practically feasible, cost effective methods to improve their compliance with the recommended methods of disposal.

Materials and Methods

The present study was a cross sectional study about the knowledge, attitude and practices among the dental professionals in Chennai towards disposal of radiographic hazardous waste. Ethical Clearance and approval obtained from the institutional review board. The period of recruitment and data collection was between the month of February 2020. Convenience sampling was used to assess the knowledge, attitude, and practice of disposal of radiographic hazardous waste in Chennai city. Inclusion criteria included all individuals willing to participate in the study. Exclusions criteria included who were not ready to answer the questions, not willing to participate in the study.

100 dental practitioners from different parts of the city who were willing to provide information about their

practice of disposal of radiographic hazardous waste were randomly selected for the study. The participants were requested to fill in their educational qualifications, years of practice and type of practice to find out if there is any correlation between these variables and their level of awareness. Based on their educational qualification they were divided into 2 groups, those with BDS (UG degree) and MDS (PG degree). Based on the number of years of experience they were divided into 3 groups, 1-2 years, 3-6 years and >6 years. Based on the type of practice, they were divided into 3 groups, individual, group and hospital based practice. The purpose of the study was explained in detail and the participants were assured that their identity will not be disclosed and confidentiality will be maintained. After obtaining the consent, the practitioners were requested to give their honest answers to all the questions. A structured questionnaire consisting of 12 questions was designed to collect information for this KAP survey (Table I). Each question had 3 options and the participants were requested to pick the correct option. The data collected were analyzed with simple descriptive statistics. The answers for the ten questions related to knowledge and practice were analyzed as correct and incorrect answers and a score was given for each participant based on the number of correct responses. The mean score was calculated along with standard deviation. The percentage of correct responses for each question was calculated and Pearson Chi-Square test was employed to find out if there is statistically significant difference in the KAP scores between the different groups of dental practitioners based on educational qualification, years of experiences and the type of practice. The responses to the two questions relating to the attitude of the practitioners were analyzed using simple descriptive statistics.

Results

Table 1 shows the distribution of questionnaire based on qualification and found that none of the questionnaire had a positive association between the MDS and above and BDS graduate students. Almost, 68% of the dental practitioners properly identified dental X-ray films to be hazardous and 14% opined that the films were non-hazardous, while 18% were not sure about the hazardous potential of dental X-ray films. Only 9% of the practitioners correctly identified used developer solution to be non-hazardous, while 61% of the practitioners were aware that used fixer was hazardous. 27% and 28% of the respondents were not sure about the hazard potential of the developer and fixer respectively. Although 46% of dental practitioners were aware of the right answer, only 34 % of the practitioners followed the correct method in their clinics. Although 65% of the dental practitioners identified the right method of fixer disposal, it was followed only by 6% of dental practitioners. Almost 20% of dental practitioners identified correctly that lead foil should be sent for re-cycling but 68% felt that it must be discarded along with the regular waste and 12% felt that it must be sent to the nearby hospital with radiology department.

Digital radiography is more environment friendly than the conventional film based radiography and this fact was acknowledged correctly by 61% of dental practitioners. 29% of the respondents felt that though digital imaging is environmentally safe, conventional radiographic film is opted in view of the high initial cost of digital radiographic equipment and 10% were of the mistaken notion that the conventional X-ray film is environmentally much safer than digital radiography. Almost 60 % of dental practitioners had correctly mentioned that lead foil, X-ray film and processing solutions are all hazardous to the environment and human health. The additional expenditure that would be incurred in segregating the hazardous waste from the dental clinic was considered worth the money by 49% of dental practitioners and unworthy by 9%; whereas 42% of dental practitioners felt that even though it may be worthwhile, they could possibly implement it only at a later date. 52% of dental practitioners felt that segregation of hazardous waste in clinical practice is always worth the time and effort, 3% disagreed and 45% felt that it may be worthwhile but could be followed only at a later.

TABLE 1: DISTRIBUTION OF QUESTIONAIRRE AMONG STUDY PARTICIPANT BASED ON EDUCATIONAL QUALIFICATION

QUESTIONAIRRE		Educational Qualification				Total		P VALUE
		MDS & above		BDS		N	%	
		N	%	N	%			
Opinion on the role of dental X-Ray films in environmental pollution	Correct answer	50	70.4	18	62.1	68	68.0	0.102
	Incorrect answer	21	29.6	11	37.9	32	32.0	
Total		71	100.0	29	100.0	100	100.0	
Opinion on the role of developer in environmental pollution	Correct answer	6	8.5	3	10.3	9	9.0	0.209
	Incorrect answer	65	91.5	26	89.7	91	91.0	
Total		71	100.0	29	100.0	100	100.0	
Opinion on the role of fixer in environmental pollution	Correct answer	44	62.0	17	58.6	61	61.0	0.312
	Incorrect answer	27	38.0	12	41.4	39	39.0	
Total		71	100.0	29	100.0	100	100.0	
Have correct knowledge and practice of disposing developer	Correct answer	14	19.7	4	13.8	18	18.0	0.921
	Incorrect answer	57	80.3	25	86.2	82	82.0	
Total		71	100.0	29	100.0	100	100.0	
Have correct knowledge and practice of disposing fixer	Correct answer	4	5.6	2	6.9	6	6.0	0.326
	Incorrect answer	67	94.4	27	93.1	94	94.0	
Total		71	100.0	29	100.0	100	100.0	
What to do with the lead foil in the film packet	Correct answer	17	23.9	3	10.3	20	20.0	0.342
	Incorrect answer	54	76.1	26	89.7	80	80.0	
Total		71	100.0	29	100.0	100	100.0	
Comparison of digital radiography with film based with regard to environmental safety	Correct answer	47	66.2	14	48.3	61	61.0	0.645
	Incorrect answer	24	33.8	15	51.7	39	39.0	
Total		71	100.0	29	100.0	100	100.0	
Sources for hazardous waste	Correct answer	39	54.9	21	72.4	60	60.0	0.613
	Incorrect answer	32	45.1	8	27.6	40	40.0	
Total		71	100.0	29	100.0	100	100.0	

Cont... **TABLE 1: DISTRIBUTION OF QUESTIONAIRRE AMONG STUDY PARTICIPANT BASED ON EDUCATIONAL QUALIFICATION**

QUESTIONAIRRE		Educational Qualification				Total		P VALUE
		MDS & above		BDS		N	%	
		N	%	N	%			
Opinion on the role of dental X-Ray films in environmental pollution	Correct answer	50	70.4	18	62.1	68	68.0	0.102
	Incorrect answer	21	29.6	11	37.9	32	32.0	
Total		71	100.0	29	100.0	100	100.0	
Opinion on the role of developer in environmental pollution	Correct answer	6	8.5	3	10.3	9	9.0	0.209
	Incorrect answer	65	91.5	26	89.7	91	91.0	
Total		71	100.0	29	100.0	100	100.0	
Opinion on the role of fixer in environmental pollution	Correct answer	44	62.0	17	58.6	61	61.0	0.312
	Incorrect answer	27	38.0	12	41.4	39	39.0	
Total		71	100.0	29	100.0	100	100.0	
Have correct knowledge and practice of disposing developer	Correct answer	14	19.7	4	13.8	18	18.0	0.921
	Incorrect answer	57	80.3	25	86.2	82	82.0	
Total		71	100.0	29	100.0	100	100.0	
Have correct knowledge and practice of disposing fixer	Correct answer	4	5.6	2	6.9	6	6.0	0.326
	Incorrect answer	67	94.4	27	93.1	94	94.0	
Total		71	100.0	29	100.0	100	100.0	
What to do with the lead foil in the film packet	Correct answer	17	23.9	3	10.3	20	20.0	0.342
	Incorrect answer	54	76.1	26	89.7	80	80.0	
Total		71	100.0	29	100.0	100	100.0	
Comparison of digital radiography with film based with regard to environmental safety	Correct answer	47	66.2	14	48.3	61	61.0	0.645
	Incorrect answer	24	33.8	15	51.7	39	39.0	
Total		71	100.0	29	100.0	100	100.0	
Feel that segregation of radiological hazardous waste in clinical practice is worth the time and effort	Correct answer	41	57.7	11	37.9	52	52.0	0.623
	Incorrect answer	30	42.3	18	62.1	48	48.0	
Total		71	100.0	29	100.0	100	100.0	
Feel that the additional expenditure that would occur in hazardous waste aggregation in the clinic is worth the money	Correct answer	39	54.9	10	34.5	49	49.0	0.437
	Incorrect answer	32	45.1	19	65.5	51	51.0	
Total		71	100.0	29	100.0	100	100.0	

TABLE 2: DISTRIBUTION OF QUESTIONAIRRE AMONG STUDY PARTICIPANT BASED ON EXPERIENCE

QUESTIONAIRRE RECORDED		Experience in years						Total		P-value
		1-10 YEARS		11-20 YEARS		MORE THAN 20 YEARS				
		N	%	N	%	N	%	N	%	
Q01. Opinion on the role of dental X-Ray films in environmental pollution	Correct answer	57	65.5	8	80.0	3	100.0	68	68.0	0.062
	Incorrect answer	30	34.5	2	20.0	0	.0	32	32.0	
Total		87	100.0	10	100.0	3	100.0	100	100.0	
Q02. Opinion on the role of developer in environmental pollution	Correct answer	7	8.0	1	10.0	1	33.3	9	9.0	0.035*
	Incorrect answer	80	92.0	9	90.0	2	66.7	91	91.0	
Total		87	100.0	10	100.0	3	100.0	100	100.0	
Q03. Opinion on the role of fixer in environmental pollution	Correct answer	53	60.9	6	60.0	2	66.7	61	61.0	0.015*
	Incorrect answer	34	39.1	4	40.0	1	33.3	39	39.0	
Total		87	100.0	10	100.0	3	100.0	100	100.0	
	Yes	14	16.1	3	30.0	1	33.3	18	18.0	0.084

Cont... **TABLE 2: DISTRIBUTION OF QUESTIONAIRRE AMONG STUDY PARTICIPANT BASED ON EXPERIENCE**

Have correct knowledge and practice of disposing developer	No	73	83.9	7	70.0	2	66.7	82	82.0	
Total		87	100.0	10	100.0	3	100.0	100	100.0	
Have correct knowledge and practice of disposing fixer	Yes	5	5.7	0	.0	1	33.3	6	6.0	0.089
	No	82	94.3	10	100.0	2	66.7	94	94.0	
Total		87	100.0	10	100.0	3	100.0	100	100.0	
Q08. What to do with the lead foil in the film packet	Correct answer	17	19.5	3	30.0	0	.0	20	20.0	0.024*
	Incorrect answer	70	80.5	7	70.0	3	100.0	80	80.0	
Total		87	100.0	10	100.0	3	100.0	100	100.0	
Q09. Comparison of digital radiography with film based with regard to environmental safety	Correct answer	54	62.1	6	60.0	1	33.3	61	61.0	0.001*
	Incorrect answer	33	37.9	4	40.0	2	66.7	39	39.0	
Total		87	100.0	10	100.0	3	100.0	100	100.0	
Q10. Sources for hazardous waste	Correct answer	51	58.6	8	80.0	1	33.3	60	60.0	0.056

Cont... **TABLE 2: DISTRIBUTION OF QUESTIONAIRRE AMONG STUDY PARTICIPANT BASED ON EXPERIENCE**

	Incorrect answer	36	41.4	2	20.0	2	66.7	40	40.0	
Total		87	100.0	10	100.0	3	100.0	100	100.0	
Q11. Feel that segregation of radiological hazardous waste in clinical practice is worth the time and effort	Correct answer	44	50.6	6	60.0	2	66.7	52	52.0	0.069
	Incorrect answer	43	49.4	4	40.0	1	33.3	48	48.0	
Total		87	100.0	10	100.0	3	100.0	100	100.0	
Q12. Feel that the additional expenditure that would occur in hazardous waste aggregation in the clinic is worth the money	Correct answer	39	44.8	7	70.0	3	100.0	49	49.0	0.032*
	Incorrect answer	48	55.2	3	30.0	0	.0	51	51.0	
Total		87	100.0	10	100.0	3	100.0	100	100.0	

Discussion

Although dental radiology is an integral part of clinical practice, many of the dental practitioners are unaware of the radiological hazardous waste disposal methods, which were reflected in their poor mean score. Hence, designing a KAP study to assess the current opinions of the dental practitioners about dental radiological hazardous waste management was mandatory, as it would be an eye opener for the practitioners in the future. Our results showed that the radiographic hazardous waste was improperly disposed by most of the practitioners. The results are similar with the previous studies.

X-ray film, lead foil and processing solutions used in the radiology are all hazardous to the environment and human health, if not disposed in the proper manner[5]. These wastes may be classified as hazardous or non-hazardous waste, depending on the concentrations of silver and lead.

The permissible exposure limit (PEL) recommended by the Occupational Safety and Health Administration and the Mine Safety and Health Administration and the recommended exposure limit set by the National Institute for Occupational Safety and Health is 0.01 mg/m3 for all forms of silver.[5]**.**The adverse effects of chronic exposure to silver are a permanent bluish-gray discoloration of the skin (argyria) or eyes (argyrosis)[6], liver and kidney damage, irritatation of the respiratory tracts, intestinal tracts and changes in the blood cells. X-ray film with large dark areas contains more silver. X-ray films like the used fixer can be collected in a container labelled hazardous waste and sent to the silver reclamation center to recover the silver[7].

Silver in used fixer solution is in the form of silver thio-sulphate presents a greater environmental concern. Silver concentrations in the used fixer generally range from 8 to 12 g/L[7]. The ideal method of disposing the used fixer is to store it in a labeled plastic container and send to silver reclamation facility/chemical processing agencies for recycling[8]. In addition, if dental assistants do not wash their hands or change their gloves after processing intraoral films, lead oxide might adhere to the gloves or hands and be introduced onto instruments and dental paraphernalia used in the mouths of patients. This is important because inorganic lead is easily dissolved in human saliva[9]. It should not be placed in the regular waste container or disposed into the drain. It must be collected separately labeled as hazardous waste or stored separately to be sent for recycling. According to Tsuji et al, the amount of lead waste produced by a dental office can be significant[8]. In their study, they have concluded that a full mouth radiographic series would generate 11.2 grams of waste lead. They reported that although the amount of lead introduced into the oral cavity during radiographic procedures would be relatively small, the elimination of sources of lead exposure, especially for children, is important[8]. The level of lead in children's blood that is of medical concern is constantly being lowered[1,10]. . Moreover, a disproportionately high dental caries burden, has been reported in the disadvantaged portion of North American society[11, 12].So, human health concerns exist when dental assistants handle lead foil.

The unused developer solution contains hydroquinone, which is a toxic substance and cannot be disposed into the drain .The hydroquinone is used up during the developing process, hence developer solution which is used and not contaminated with fixer is considered to be non-hazardous[13]. The correct method of disposal of used developer is to dilute it and dispose it in the regular drain[4].

Digital radiography is environmentally friendlier than the conventional film based radiography[14]. Digital radiography eliminates the need of X-ray film, processing solutions, as well as storage or disposal of these materials. Thus, the digital imaging does not contribute any unpleasant effect towards the environment.

A study done by Teschke K et al, reported that solutions used to process the of X-ray films contains chemicals, which are known to cause or exacerbate asthma[15]. Hence it is the responsibility of all the dental practitioners to protect the environment by following proper waste disposal method of radiographic hazardous waste. The deficit of knowledge about hazardous waste management in dental radiology among dental practitioners may be due to the lack of awareness campaigns, continuing dental education programs, time constraints and monetary concerns. As the present scenario demands the use of dental radiographs in every field of dentistry, an in-depth understanding about the proper waste disposal methods has become the need of the hour.

It is important that the methods of disposal of hazardous dental radiological waste are simple, practical and economical to ensure long-term compliance. We have suggested a few possible solutions:

1. Lead foil inside the intra-oral film packet can be easily segregated by dropping them off in a separate container meant for that purpose. This container should be left on the processing table and should be periodically sent for recycling.

2. Condemned or damaged lead screens and aprons have to be subject to lead foil recycling program.

3. Dental assistants processing the radiographs should be instructed to change their gloves or wash their

hands thoroughly before handling dental instruments to avoid transfer of lead from the foils and storage containers onto the patients, especially in children.

Conclusions

To bring about sustainable social and behavioral change and to reinforce the moral and professional obligations of the dental surgeon towards human health and environment, all interventions should be evidence based. Therefore, it is important to collect base-line and follow-up data to evaluate the outcome of any awareness programs aimed at promoting good hazardous waste management practice.

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