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The practice of mercury hygiene among Nigerian dentists in three southwestern states

Michael O. Iwaola, Deborah M. Ajayi[1], Funmilayo I.M. Abiodun-Solanke[1], Gbemisola Oke[2]

Faculty of Dentistry, [1]Departments of Restorative Dentistry, [2]Periodontology and Community Dentistry, College of Medicine, University of Ibadan, Ibadan, Nigeria.

Address for correspondence:
Dr. Funmilayo I.M. Abiodun-Solanke,
Department of Restorative Dentistry, College of Medicine, University of Ibadan, Ibadan, Nigeria.
E-mail: abisolimf@yahoo.ca

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ABSTRACT

Background: Dental amalgam has been in use for a very long time in the field of restorative dentistry as an intracoronal restorative material. Despite its long usage, there have been reports about adverse health effects arising from the exposure to minute mercury released from amalgam to the dentists if not properly handled. **Aim:** The aim was to find out the compliance of Nigerian dentists with recommendations on mercury hygiene practices. **Materials and Methods:** A cross-sectional study using self-administered questionnaire consisting of three parts was conducted among registered dentists. The first part of the questionnaire sought demographic characteristics of respondents while second part assessed measures taken by the caregiver himself while working with amalgam and the last part assessed measures taken to control and prevent mercury contamination within the clinical setup. **Result:** There was total compliance with the use of gloves when working with amalgam among the participants. However, the house officers had the highest tendency of always wearing face mask and protective clothing followed by specialist in training. There was a statistically significant difference in the tendency to always wear face mask ($\chi^2 = 21.37$, $P = 0.00$) and protective clothing ($\chi^2 = 24.77$, $P = 0.00$) as against occasional and never wearing them, among the different categories of dentists. Compliance with the use of rubber dam and alternative source of air was found to be generally poor among the professionals studied. More than two-third of all dentists studied never used the two preventive measures. About 78% never used rubber dam when working with amalgam. The method of handling excess mercury was found to be more appropriate among the respondents in the teaching hospitals and poorest among those in private set-up. Furthermore, a great majority (87.5%) of those working in private clinics had never heard of mercury vapor monitoring. **Conclusion:** It was noted that some of the standard mercury hygiene practices such as the use of rubber dam, high volume suction, and water cooling when removing or polishing amalgam restorations were not followed properly.

Key words: Dentists, mercury hygiene, practice

INTRODUCTION

Dental amalgam has served as a dental restorative material for more than 165 years.[1] Despite its long history and popularity, arising from its unmatched low cost, low technique sensitivity, self-sealing property, and longevity, there have been periodic concerns about adverse health effects arising from the exposure to minute level of mercury released from amalgam. Amalgam consists of approximately 50% mercury by weight.[2]

Inorganic mercury has been implicated in a wide variety of multi-systemic health effects particularly neurological and renal systems.[3] However, several studies have found

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that many symptoms attributed to mercury in amalgam restorations are psychosomatic in nature and have been exacerbated greatly by information from media or dentists.[4,5] The National Council Against Health Fraud, USA (2002)[6] in a position paper believed that there is no scientific evidence that the mercury in amalgam fillings cause or contribute to the development of these diseases. This is based on the fact that the amount of mercury released from amalgam restorations and absorbed by the body is small when compared with the mercury found on the earth crust and other sources.

Exposure to mercury starts when undergraduate preclinical dental students place restorations on phantom head and extracted teeth. Improper mercury handling contributes to the mercury vapor in the environment, which on inhalation is rapidly absorbed into the bloodstream from the lungs and may cause an array of hazard.[7]

Dentists are exposed to mercury vapor through direct skin contact with mercury (from freshly mixed dental amalgam) or through exposure from potential sources of mercury vapors that are incidental, such as mercury spill, malfunctioning amalgamators, leaky amalgam capsule, malfunctioning bulk mercury dispensers. Other sources include trituration, placement and condensation of amalgam, polishing and removal of amalgam, vaporization of amalgam from contaminated instruments and often storage of amalgam scrap or used capsule.[8] Exposure to mercury vapor occurs during amalgam filling, but this is reduced by observing appropriate hygiene procedures[9,10] and could be reduced by as much as 90% through the use of high suction.[11] Since dentists work continually with amalgam, they usually have higher risk and level of mercury in their bodies than the general population.[12] The level of mercury in the urine and blood arises from the time when dental students first work with amalgam and last throughout their working experience.[13]

The Federation of Dental International (FDI)[14] has recommendations for appropriate mercury hygiene within the dental offices. Furthermore, the International Academy of Oral Medicine and Toxicology[15] had earlier developed a protocol aimed at minimizing exposure to mercury vapor by patients, dentists and other staff and it includes among others use of rubber dam, provision of alternative source of air, use of water coolant during amalgam removal, and use of high volume evacuation. However, there have been no studies to show whether Nigerian dentists are following these recommendations properly. In developing countries like Nigeria, there are no regulatory authorities to keep a check on mercury hygiene practices. It is, therefore, the aim of this study was to find out how compliant Nigerian dentists are with these recommended mercury hygiene practices.

MATERIALS AND METHODS

Study design

This is a cross-sectional study, using self-administered questionnaire which was derived by the authors, based on the objectives of the study and previous relevant studies. Furthermore, the variables in the questionnaire were in line with the FDI mercury hygiene recommendations.[14] The questionnaire was hand delivered to all registered practicing dentists in three conveniently selected states out of the six states that make up the South Western region of Nigeria. The three selected states were Oyo, Osun and Ondo. Information gathered from the Ministries of Health in these states revealed that there were 201 registered practicing dentists. Convenient sampling of the state was done because of the proximity of the location of the chosen states to one another, the mode of distribution of the questionnaire that was adopted and the fact that the study was privately funded.

Two hundred and one copies of structured questionnaires were given to all practicing registered dentists after obtaining their consent. Only 151 questionnaires were returned, out of which 135 correctly and completely filled, were analyzed.

The questionnaires were hand delivered in order to ensure maximum cooperation and a high response rate. Telephone calls were made to confirm the appropriate date for collection following which, one of the authors went back to collect the questionnaires. Pretesting of the questionnaire was done among 30 dentists who attended an update course organized by West African College of Surgeon at the University College Hospital in Ibadan and practiced outside the three states intended to be used for the study, to assess the validity of the questionnaire. As regards the preventive measures undertaken while working with amalgam, a 4 point Likert scale was used (i.e., 4 = always, 3 = sometimes, 2 = rarely, 1 = never) to gather the data.

The questionnaire consisted of three parts. The first part of the questionnaire sought demographic characteristics of respondents. The second part included measures taken by the caregiver (while working with the amalgam) like use of face masks, gloves, eye goggles, changing clothes after each patient, attitude toward using rubber dam and high volume suction. The third part assessed measures taken in a clinical setup to control and prevent mercury contamination. Ethical clearance was sought and obtained from the University of Ibadan/University College Hospital Ethical Review Committee. Ethical approval no was NHREC/05/01/2008a.

Data analysis

Data analysis was carried out using a computer software Statistical package for social sciences (SPSS v.19, IBM Corporation, USA). Simple frequencies means, standard deviation were used as appropriate. Furthermore, likelihood ratio and Chi-square statistics were used to determine the strength of association between categorical variables while $P < 0.05$ was regarded as significant.

RESULT

The majority of the dentists involved in the study were males with male to female ratio of 2.2:1. The mean age of the participants was 35.9 ± 7.4 years. The majority (42.2%) had only worked for 1-5 years, also those working in the teaching hospitals constituted the highest proportion (48.9%) [Table 1].

Compliance with the recommended preventive measures to be taken while working with amalgam was not 100% among the different professional status except with wearing of gloves. The house officers had the highest tendency of always wearing face mask and protective clothing, and this is closely followed by specialists in training. There was a statistically significant difference in the tendency to always wear face mask ($\chi^2 = 21.37$, $P = 0.00$) and protective clothing ($\chi^2 = 24.77$, $P = 0.00$) as against occasional and never wearing them, among the different categories of dentists. The best compliance with protective goggle wearing was seen among the general dental practitioners (GDPs) who reported always wearing the goggle in 26.2% of them, while the highest proportion of those that never wore the goggles was found among the house officers. This association was also significant ($\chi^2 = 20.39$, $P = 0.02$). More than one-third of house officers, specialist in-training, and consultants always used water spray while removing amalgam. Thus, there was no statistically significant relationship between the practice and different categories of dentists. The number of people who never used water spray when the polishing amalgam were almost 3 times the number who used it. This was, therefore, found to be statistically significant ($\chi^2 = 17.53$, $P = 0.04$).

Table 1: Socio-demographic characteristic of the respondent

Variables	n = 4135	Percentage
Age group (years)		
25-29	26	19.2
30-34	41	30.4
35-39	27	20.0
40-44	19	14.1
45-50	15	11.1
>50	7	5.2
Gender		
Male	93	68.9
Female	42	31.1
Marital status		
Married	103	76.4
Single	28	20.7
Separated	3	2.2
Divorced	1	0.7
Year of practice		
1-5	57	42.2
6-10	30	22.2
11-15	16	11.9
>16	32	23.7
Location of practice (states)		
Ondo	29	21.5
Osun	42	31.1
Oyo	64	47.4
Place of practice		
Teaching hospital	66	48.9
General hospital	61	48.2
Private dental clinic	8	5.9
Professional status of the respondents		
House officer	17	12.6
General dental practitioner	65	48.1
Specialist-in-training	39	28.9
Consultant/specialist	14	10.4

Compliance with the use of rubber dam and alternative source of air was found to be generally poor among the professionals studied. More than two-third of all dentists studied never used the two preventive measures. 77.8% never used rubber dam when working with amalgam. Regarding the use of high volume suction, 35.7% of the consultants reported always practicing the measure, followed by 12.8% of the specialist in training but 47.1% house officers, 35.4% GDP, and 28.2% specialist in training never used the means. There was, therefore, a statistically significant relationship between the preventive measures and the categories of dentists studied ($\chi^2 = 22.2$, $P = 0.01$) [Table 2].

All the respondents in private practice use amalgam capsules, while 92.4% and 70.5% of those working in teaching and general hospitals respectively use capsules. The use of bulk amalgam was almost exclusively used in a general hospital. Most (72.8%) of the trituration done in the teaching hospital was by amalgamator while trituration was mainly carried out manually in the general and private hospitals by mortar and pestle. However, there was no statistically significant difference in the type of amalgam used or the method of trituration among the different hospital settings. Furthermore, the habit of closing amalgam capsules after use was not common as only 17.5% of the respondents always performed this action. The majority (66.2%) of the amalgamator used had protective lid. Twelve participants were not sure of whether theirs had the protective lids or not [Table 3]. As regards the measures taken in the surgery to prevent mercury contamination during amalgam use and manipulation, many (68.7%) of the respondents in the teaching hospitals,

40% in general hospitals and 16.7% in the private clinics claimed to squeeze excess mercury into a bowl of water. The practice of squeezing excess mercury into wash hand basin was common (50%) among respondents in the private practice while 18.8% and 37.5% of those in the teaching hospital and general hospital respectively squeezed excess mercury into cotton wool and dropped in the waste bin. There was no statistically significant difference in the methods of handling excess mercury among respondents working in public and private establishment (likelihood ratio $\chi^2 = 5.34$, $P = 0.25$) [Table 3].

The great majority (87.5%) of the respondents working in the private sector had never heard of mercury vapor monitoring while almost two-third of those in teaching and general hospitals had heard. 84.8% of those that were knowledgeable about it were ready to subject themselves to periodic mercury vapor monitoring [Table 4].

Figure 1 shows that about two-third of the respondents kept their amalgam waste in a basket, 23.7% in a special container with water and only 8.9% reported sending it to the waste management office.

Table 2: Preventive measures undertaken while working with amalgam

Types of preventive measures	Always *n* (%)	Sometimes *n* (%)	Rarely *n* (%)	Never *n* (%)	Total *n* (%)	χ^2 (*P*)
Wearing of gloves						
House office	17 (100.0)	—	—	—	17 (100.0)	
General dental practitioners	65 (100.0)	—	—	—	65 (100.0)	
Specialist-in-training	39 (100.0)	—	—	—	39 (100.0)	
Specialist/consultants	14 (100.0)	—	—	—	14 (100.0)	
Wearing of face make						
House officer	17 (100.0)	—	—	—	17 (100.0)	21.37 (0.00)
General dental practitioners	40 (61.5)	25 (38.5)	—	—	65 (100.0)	
Specialist-in-training	37 (94.9)	2 (5.1)	—	—	39 (100.0)	
Specialist/consultants	11 (78.6	3 (21.4)	—	—	14 (100.0)	
Use of protective goggle						
House officer	1 (5.9)	3 (17.6)	7 (41.2)	6 (35.2)	17 (100.0)	20.39 (0.02)
General dental practitioners	17 (26.2)	17 (26.2)	12 (18.5)	19 (29.1)	65 (100.0)	
Specialist-in-training	3 (7.7)	16 (41.0)	13 (33.3)	7 (7.1)	39 (100.0)	
Specialist/consultants	1 (7.1)	8 (57.1)	4 (28.6)	1 (7.1)	14 (100.0)	
Wearing of protective clothing						
House office	15 (88.2)	2 (11.8)	0 (0.0)	0 (0.0)	17 (100.0)	24.77 (0.000)
General dental practitioners	33 (50.8)	23 (35.4)	5 (7.7)	4 (6.1)	65 (100.0)	
Specialist-in-training	32 (82.1)	2 (5.1)	1 (2.6)	4 (10.3)	37 (100.0)	
Specialist/consultants	9 (64.3)	1 (7.1)	2 (14.3)	2 (14.3)	14 (100.0)	
Eating and drinking in the clinic						
House officer	1 (5.9)	2 (11.8)	3 (17.6)	11 (64.7)	17 (100.0)	17.11 (0.05)
General dental practitioners	1 (1.5)	12 (18.5)	26 (40.0)	26 (40.0)	65 (100.0)	
Specialist-in-training	0 (0.0)	3 (7.7)	17 (43.6)	19 (48.7)	37 (100.0)	
Specialist/consultant	0 (0.0)	1 (7.1)	1 (7.1)	12 (85.8)	14 (100.0)	
Use of water spray with amalgam removal						
House officer	6 (35.3)	5 (29.4)	4 (23.5)	2 (11.8)	17 (100.0)	8.38 (0.49)
General dental practitioners	13 (20.0)	31 (47.7)	14 (21.5)	7 (10.8)	65 (100.0)	
Specialist-in training	14 (35.9)	18 (46.2	6 (15.4)	1 (2.6)	39 (100.0)	
Specialist/consultants	5 (35.7)	6 (42.9)	1 (7.1)	2 (14.3)	14 (100.0)	
Use of water spray when polishing amalgam						
House officer	0 (0.0)	3 (17.6)	7 (41.2)	7 (41.2)	17 (100.0)	17.53 (0.04)
General dental practitioners	6 (9.2)	21 (32.3)	20 (30.8)	18 (27.7)	65 (100.0)	
Specialist-in-training	2 (5.1)	12 (30.8)	16 (41.0)	9 (23.1)	39 (100.0)	
Specialist/consultants	5 (35.7)	2 (14.3)	3 (21.4)	4 (28.6)	14 (100.0)	
Rubber dam placement						
House officer	0 (0.0)	0 (0.0)	4 (23.5)	13 (76.5)	17 (100.0)	10.10 (0.34)
General dental practitioners	0 (0.0)	4 (6.2)	7 (10.8)	54 (83.1)	65 (100.0)	
Specialist-in-training	1 (2.6)	0 (0.0)	10 (25.6)	28 (72.8)	39 (100.0)	
Specialist/consultants	0 (0.0)	1 (7.1)	3 (21.4)	10 (71.4)	14 (100.0)	
High volume suction						
House officer	2 (11.8)	6 (35.3)	1 (5.9)	8 (47.1)	17 (100.0)	22.20 (0.01)
General dental practitioners	2 (3.1)	20 (30.8)	20 (30.8)	23 (35.4)	65 (100.0)	
Specialist-in training	5 (12.8)	14 (35.9)	9 (23.1)	11 (28.2)	39 (100.0)	
Specialist/consultants	5 (35.7)	5 (32.7)	4 (28.6)	0 (0.0)	14 (100.0)	
Alternative source of air						
House officer	0 (0.0)	2 (11.8)	0 (0.0)	15 (88.2)	17 (100.0)	7.08 (0.31)
General dental practitioners	0 (0.0)	3 (4.6)	13 (20.0)	49 (75.4)	65 (100.0)	
Specialist-in-training	0 (0.0)	1 (2.6)	5 (12.8)	33 (84.6)	39 (100.0)	
Specialist/consultants	0 (0.0)	1 (7.1)	1 (7.1)	12 (85.7)	14 (100.0)	

Table 3: Measures taken in the surgery to prevent mercury contamination during amalgam use and manipulation

Place of practice	Bulk amalgam (Hg and alloy) *n* (%)	Amalgam capsules *n* (%)	Amalgam pellet *n* (%)	Total *n* (%)	LR (*P*)
Type of amalgam used					
Teaching hospital	2 (3.0)	61 (92.4)	3 (4.6)	66 (100.0)	3.86 (0.08)
General hospital	18 (29.5)	43 (0.0)	0 (0.0)	61 (100.0)	
Private dental clinic	0 (0.0)	8 (100.0)	0 (0.0)	8 (100.0)	
Total	20 (14.8)	112 (83.0)	3 (2.2)	135 (100.0)	
	Manually with pestle/ mortar *n* (%)	Amalgamator *n* (%)	Others *n* (%)	Total *n* (%)	
How do you mix your amalgam?					
Teaching hospital	16 (24.2)	48 (72.8)	2 (3.0)	66 (100.0)	2.20 (0.25)
General hospital	40 (65.6)	21 (34.4)	0 (0.0)	61 (100.0)	
Private dental clinic	6 (75.0)	2 (25.0)	0 (0.0)	8 (100.0)	
Total	62 (45.9)	71 (52.6)	2 (1.5)	135 (100.0)	
	Always *n* (%)	Sometimes *n* (%)	Rarely *n* (%) Never *n* (%)	Total *n* (%)	
If you use amalgam capsule, do you close after use?					
Teaching hospital	12 (21.1)	24 (42.1)	17 (29.8) 4 (7.0)	57 (100.0)	2.92 (0.33)
General hospital	6 (13.9)	20 (46.5)	15 (34.9) 2 (4.7)	43 (100.0)	
Private dental clinic	1 (12.5)	2 (25.0)	5 (62.5) 0 (0.0)	8 (100.0)	
Total	19 (17.5)	46 (42.6)	37 (34.3) 6 (5.6)	108 (100.0)	
	Yes *n* (%)	No *n* (%)	I don't know *n* (%)	Total *n* (%)	
If you mix with amalgamator, does it have a protective lid?					
Teaching hospital	32 (66.7)	7 (14.6)	9 (18.8)	48 (100.0)	1.8 (0.63)
General hospital	13 (61.9)	5 (23.8)	3 (14.3)	21 (100.0)	
Private dental clinic	2 (100.0)	0 (0.0)	0 (0.0)	2 (100.0)	
Total	47 (66.2)	12 (16.9)	12 (16.9)	71 (100.0)	
	Into a bowl of water *n* (%)	Wash hand basin *n* (%)	Into cotton wool and drop into waste bin *n* (%)	Left on the floor *n* (%)	Others *n* (%)	Total *n* (%)	
Where do you squeeze the excess mercury into?							
Teaching hospital	11 (68.7)	2 (12.5)	3 (18.8)	0 (0.0)	0 (0.0)	16 (100.0)	5.34 (0.25)
General hospital	16 (40.0)	7 (17.5)	15 (37.5)	1 (2.5)	1 (2.5)	40 (100.0)	
Private dental clinic	1 (16.7)	3 (50.0)	2 (33.3)	0 (0.0)	0 (0.0)	6 (100.0)	
Total	28 (45.2)	12 (19.4)	20 (32.2)	1 (1.6)	1 (1.6)	62 (100.0)	

Table 4: Responses to mercury vapor monitoring

Responses to mercury vapour	Yes *n* (%)	No *n* (%)	Total	χ^2 (*P*)
Have you ever heard of mercury vapor monitoring?				
Teaching hospital	40 (60.6)	26 (38.4)	66 (100.0)	7.68 (0.02)
General hospital	38 (62.3)	23 (37.7)	61 (100.0)	
Private dental clinic	1 (12.5)	7 (87.5)	8 (100.0)	
Total	79 (58.5)	56 (41.5)	135 (100.0)	
	Yes *n* (%)	No *n* (%) I don't know *n* (%)	Total	χ^2 (P)
If yes, will you be ready to subject yourself to periodic mercury vapor monitoring?				
Teaching hospital	33 (82.5)	4 (10.0) 3 (7.5)	40 (100.0)	0.94 (0.92)
General hospital	33 (86.8)	2 (5.3) 3 (7.9)	38 (100.0)	
Private dental clinic	1 (100.0)	0 (0.0) 0 (0.0)	1 (100.0)	
Total	67 (84.8)	6 (7.6) 6 (7.6)	79 (100.0)	

DISCUSSION

This study revealed that the population of dentists studied were not properly following the recommended guidelines on mercury hygiene practice, as it was observed that use of rubber dam and alternative source of air was grossly deficient among the dentists. This is consistent with findings by Kulkarni *et al.*[13] who reported that 76.5% of undergraduate dental students and 69% of practicing dentists in India had never used rubber dam. This observation may be attributed to the facts that most dentists may perceive rubber dam use as time consuming or are not aware of recent modifications that simplified the use of rubber dam, while other possibly lack competence in applying rubber dam. Based on this fact, it is suggested that undergraduate dental training should include the use of rubber dam isolation technique.

Also as revealed in the present survey, the habit of eating and drinking in the dental surgery was not common among respondents. However, compliance with the use of protective clothing in the dental surgery was higher among the trainee house officers and resident doctors but least among the general practitioners and consultants. This could be due to the fact that because house officers and resident doctors

are still undergoing training, they will have a tendency for always wearing protective clothing and also follow other rules and regulations guiding the profession to avoid being sanctioned while the GDPs and consultants might feel that they have reached the peak of their career.

The World Health Organization has cautioned against heating dental amalgam through drilling without water spray and stated that open heating of amalgam should never be carried out.[14] It thus recommended the use of water spray coolants when polishing or removing amalgam as friction generates heat and releases mercury vapor. Furthermore, FDI[14] and Goyer[16] advocated the use of water spray, high velocity evacuation and rubber dam when polishing and removing amalgam as these measures reduce exposure to the patient and dental staff.

In this study, two-third of respondents left their amalgam waste and used capsule in wastes basket and did not know where they were disposed off. In their study, Kulkarni *et al.*[13] reported that about half of their respondents did not know where the amalgam waste and used capsules were disposed off. Studies have been carried out to estimate mercury waste generation from dental clinics. The dental waste water stream study conducted by the University of Illinois at Chicago and the Naval Dental Research Institute revealed that the average dental can generate up to 4.5 g Hg/day/chair. A study conducted by Drummond *et al.*[17] estimated that 4000 kg/year of mercury was generated from dental offices and 1000 kg/year of mercury flowed into the waste water of the region. Mercury should, therefore, be an environmental concern both within the dental office and when disposing off amalgam waste.[18] However, the amount of mercury released into the environment through this source is minimal when compared with the amount of the mercury discharged into the sewers, stream, and lakes by industries in developed countries. Most European countries have, therefore, adopted a more stringent regulation on mercury use that requires chair side amalgam traps and amalgam separators in dental offices and implementation of mercury recycling programs by industries.[5]

In general, the proportion of respondents that squeeze excess mercury into a bowl was found to be higher in this study that previous ones.[19,20] Sadiq[19] reported that only 11.7% of the dentists discarded their excess amalgam properly in a close container with water while 30% of dentists stored the scrap in a bottle with water in a survey conducted in dental clinics in Pune,[20] even though one of the American Diabetes Association recommendations[21] of storing it under spent X-ray fixer solution was also correctly followed by 34% in this survey.

It was observed in this study that over half of the respondents had heard about mercury vapor monitoring but none was undergoing this, even the majority 84.8% of them would be ready to subject themselves to this practice. Kulkarni *et al.*[13] reported that only a handful of dentists (30% male and no female) were periodically monitoring the mercury vapor. Our observation may not be unconnected to lack of regulatory authority that regularly checks the compliance with this precautionary measure.

CONCLUSION AND RECOMMENDATIONS

In this study, it was noted that some of the standard mercury hygiene practices such as use of rubber dam, high volume suction, and water cooling when removing or polishing amalgam restorations were not followed properly by dentists. It is, therefore, recommended that continuous training of all the personnel concerning the need for appropriate hygiene practices when working with amalgam and amalgam contaminated instruments should be given. Furthermore, compliance of dentists to recommended mercury hygiene practice must be periodically evaluated by the regulatory authorities.

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