

# The Dental Solid Waste Management in Different Categories of Dental Laboratories in Abha City, Saudi Arabia

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**Abstract:** *Aim:* To study the awareness, attitude, practice and facilities among the different categories of dental laboratories in Abha city. *Materials and Methods:* A total of 80 dental technicians were surveyed in the study. The dental laboratories included in the study were teaching institute (Group I), Government Hospital (Group II), Private Dental Clinic (Group III) and Independent laboratory (Group IV). The pre-tested anonymous questionnaire was used to understand knowledge, attitude, facilities, practice and orientation regarding biomedical waste management. *Results:* The knowledge of biomedical waste categories, colour coding and segregation was better among Group I (55-65%) and Group II (65-75%). The lowest standard of waste disposal was practiced at Group IV (15-20%) and Group III (25-35%). The availability of disposal facilities was poor at Group IV. The continuous education on biomedical waste management lacked in all the Groups. *Conclusion:* The significant improvement in disposal facilities was required at Group III and Group IV laboratories. All dental technicians were in need of regular training of biomedical waste management. *Clinical Significance:* The dental laboratories are an integral part of dental practice. The dental laboratories are actively involved in the generation, handling and disposal of biomedical waste. Hence, it is important to assess the biomedical waste management knowledge, attitude, facilities and practice among different categories of dental laboratories.

**Keywords:** Biological waste, biomedical waste management, dental laboratories, dental solid waste.

## INTRODUCTION

The World Health Organization describes the healthcare waste as discarded, untreated materials from healthcare activities, which have the potential of transmitting infectious agents to humans [1]. Dental instruments and materials are exposed to blood and saliva during various dental procedures. Hence, biomedical waste (BMW) management in dental practice is equally critical as in the medical fraternities. Proper BMW disposal is essential for the safety of the dental personnel and the general public at large. Justifiably, the majority of countries control the dental waste under medical waste management regulations. Dental laboratories are an integral part of dental practice. The well-equipped, efficient laboratory is vital across the dental specialties including Prosthodontics, Restorative dentistry, pedodontics, and orthodontics. Most of the restorative dental procedures require the dental laboratories support to complete the planned treatment. During the process of indirect restoration fabrication, the dental laboratories generate various hazardous wastes potentially detrimental to the health and environment. The dental laboratory solid waste classified as infectious waste, non-infectious toxic waste, and domestic waste. The waste suspected to contain the pathogen in sufficient concentration causing disease in susceptible hosts is considered as infectious waste [2, 3]. The Dental prosthesis, occlusal bite blocks, occlusal records, and orthodontic appliances

routinely come in contact with human saliva and blood [4]. The researchers demonstrated the presence of bacteria and fungi over the dental impression on their arrival to the laboratory [5]. Some studies even indicate the existence of bacteria on the denture polishing pastes and wheels. The other infectious waste includes silicones used for maxillofacial prosthesis, gloves and plastic containers used for transporting the dentures and appliances from clinics. The non-infectious toxic wastes are devoid of human fluids contamination but potentially toxic in nature. It includes the acrylic resin scraps, wasted metal alloys, metal dust, porcelain, and gypsum waste. Other non-infectious toxic wastes are amalgam alloys and acids used in electrolytic polishing of metal frameworks. Domestic type wastes are comprised of Paper cups, plastics, sand papers, and household wastes.

The Dental laboratories broadly belong to two categories. The first group operates as an integral part of dental clinics or hospital. The second group is independent of dental hospitals; work as separate establishments to serve the dental fabrication need of clinics. The laboratories of later categories are routinely ignored by regulating bodies from the government. The dental laboratory solid waste is frequently disposed of through the municipal solid waste. The reason for improper disposal is multifactorial; it includes a lack of knowledge, improper attitude of the dental technician and inadequate facilities. The existing dental literature regarding the waste management are conducted predominantly in dental clinics and critically deficient on waste disposal practices at dental laboratories. The knowledge and attitude of personnel, disposal practices and disposal facilities at different

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categories of dental laboratories need to be explored further. The result of the study will help to identify and initiate the corrective measures for acceptable dental solid waste disposal. Hence, this study was designed to assess the knowledge, attitude and practices about dental solid waste management among dental staff at different categories dental laboratories in Abha city, Kingdom of Saudi Arabia.

## MATERIAL AND METHODS

The study was conducted in the Abha-Khamis Mushaihi city Kingdom of Saudi Arabia during the first semester of 2014. The Abha City is the largest city in the southern part of the Kingdom of Saudi Arabia. The city has several dental treatment facilities; it includes the College of Dentistry dental clinics, three government dental specialty treatment hospitals, twelve private specialty dental clinics and four private, independent dental laboratories. The approval for the research proposal was obtained from institution research ethics committee. The study population included the dental technicians across all the laboratories. The study was a cross-sectional study, with stratified sampling. Total of 90 dental technicians were working in all the dental laboratories, out of which 80 consented to participate in the study. The participation rate was at 88.9%. The exclusion criteria were the subjects not willing to participate in the study. The study group comprised of four groups with twenty subjects from each group. The Group I consisted of the dental technicians working in a dental teaching hospital; Group II included the laboratory technicians working at government dental hospital. The technician at private dental clinics laboratories considered as Group III and Group IV were technicians at independent dental laboratories. A written consent was obtained from all the study participants. The data collection was done through the anonymous, pre-designed, pre-tested and structured questionnaire. The pretesting was carried out on 20 subjects among target populations to determine the variation in the language, terminology, interpretation of question and response options in the questionnaire. According to the participant's feedback, the required modification was incorporated in the questionnaire. The internal consistency of the survey instrument was ascertained by Cronbach's alpha coefficient (0.891) analysis. The question consisted 29 closed-ended questions to assess the knowledge, practice, disposal facilities and education regarding biomedical waste management among the dental technicians. The questionnaire was self-administered, the purpose of the study was explained to all members and collected back immediately after the completion. The resultant data was analysed using SPSS software version 19 for proportions to interpret the results.

## RESULTS

Table 1 indicates the improper BMW disposal risk was recognized by only 45% (9) in Group IV, and 55% (11) among Group III. The risk awareness among Group II was at 85% (17) and Group I was 75% (15). The knowledge regarding the different BMW categories, was at 40% (8), 11% (5), 25% (5), 15% (3) for Group I, II, III, IV respectively. The information regarding BMW colour coding and segregation at source among Group I was at 65% (13) and 55% (11) respectively. The Group IV subjects had the least information on colour coding and segregation at 5% (1) and 10% (2).

The knowledge of disinfection methods, disposal options was also at lowest among the Group IV at 10% (2) and 5% (1). The Group III was slightly better at 15% (3) and 5% (1). The information on national and institutional BMW disposal regulations was surprisingly less among all the studied groups. Only 5-25% of the participants across the groups were aware of BMW regulation applicable to dental practice.

The positive attitude towards BMW disposal was relatively high and uniform among all groups (Table 2). It was at an average of 75-90%. The majority of respondents agree that good BMW management and handling is the integral part of their work.

The third segment of the questionnaire (Table 3) was about the BMW disposal practice at dental laboratories.

The result indicated color specific bags for BMW disposal was utilized by 20% of Group IV, followed by Group III (25%), Group I (45%) and Group II (65%). The 20% (4) subjects from Group IV practiced proper disposal of heavy metals and amalgam and 35% (7) of subjects from Group III. The favorable heavy metal and amalgam disposal was practiced by 65% (13) for Group II and 55% (11) from Group I. Only 25% (5) amongst Group IV and 35% (7) from Group III dental technicians were utilizing puncture-proof container to dispose of sharp objects. 20% (4) and 25% (5) practiced the disinfection of solid waste prior disposal among Group IV and Group III respectively. Though the solid waste disinfection practice was better at Group I (45%) and Group II (86%), still at inadequate proportion.

The results of the study revealed (Table 4) inadequate disposal facilities at Group III and Group IV working place. The 15% (3) of Group IV respondents had coloured container while only 5% (1) had puncture proof containers for waste disposal at the working place. The availability of these containers was also insufficient at Group III respondents working area with corresponding values of 25% (5) and 30% (6). The disposal facilities at Group I and Group II was significantly better at 65-85%. The monitoring agency visits for these facilities was only 5% at Group IV, followed by group III (45%), Group I (45%) and Group II (65%).

Though 25% of the study respondents had learned about BMW disposal in their curriculum, there were very few reorientation programs to update the knowledge (Table 5). The Dental Technician at Group IV had no reorientation programs conducted or attended. The Group II subjects had better exposure to reorientation program with 55% (11) respondents attended these reorientation scientific activities.

## DISCUSSION

The dental practice generates the infectious, non-infectious toxic and domestic waste. The potentially infectious dental solid wastes are blood/saliva soaked paper towels, gauze, cotton roll, latex gloves, syringes, dental floss, and surgical blades. The dental laboratories handle the potentially infectious objects like dental bridges and prosthesis, matrix bands, dental impressions, wax, interocclusal records. Toxic wastes produced at laboratories include dental amalgam and heavy metal waste. Proper handling and disposal of the potentially infectious and toxic waste is critical for the

**Table 1. Biomedical waste knowledge among different groups.**

BMW* knowledge	Group I	Group II	Group III	Group IV
	n= 20(%)	n= 20(%)	n= 20(%)	n= 20(%)
Risks of improper BMW disposal	15(75)	17(85)	11(55)	9(45)
Different categories of BMS waste	8(40)	11(55)	5(25)	3(15)
Colour coding of Waste disposal	13(65)	11(55)	4(20)	1(5)
Importance of Segregation at source	11(55)	14(70)	7(35)	2(10)
Specific disinfection methods before disposal	8(40)	11(55)	3(15)	2(10)
Proper disposal option for various waste	9(45)	13(65)	1(5)	1(5)
Waste disposal regulation in Saudi Arabia	5(25)	2(10)	5(25)	2(10)
BMW regulating agency in Saudi Arabia	5(25)	2(10)	1(5)	1(5)
BMW regulations awareness at your work place	8(40)	9(45)	5(25)	1(5)

\*BMW: Biomedical waste

**Table 2. Attitude regarding BMW\* among surveyed dental technician.**

Favourable attitude	Group I	Group II	Group III	Group IV
	n= 20(%)	n= 20(%)	n= 20(%)	n= 20(%)
Believe and follow reducing BMD generation at source	17(85)	17(85)	18(90)	15(75)
Requirement of disinfection of waste before disposal	18(90)	16(80)	18(90)	17(85)
Proper segregation and disposal – part of our responsibility	18(90)	17(85)	18(90)	16(80)
Continuous update on BMW disposal is essential for health professional	18(90)	17(85)	19(95)	13(65)
Do you think effluent treatment plant essential for dental colleges to treat infected water	19(95)	17(85)	19(95)	17(85)

\*BMW: Biomedical waste

**Table 3. Biomedical waste disposal practice in surveyed groups.**

Correct BMW* disposal practice	Group I	Group II	Group III	Group IV
	n= 20(%)	n= 20(%)	n= 20(%)	n= 20(%)
Disposal in colour specified container	9(45)	13(65)	5(25)	4(20)
Sharp objects disposal in puncture proof container	13(65)	11(55)	7(35)	5(25)
Reported injury due improperly disposed waste	4(20)	1(10)	3(15)	4(20)
Proper disposal of mercury containing waste	11(55)	13(65)	7(35)	3(15)
Proper disposal of substance containing silver, nckel, chromium and lead waste	9(45)	13(65)	7(35)	4(20)
Always disinfect BMW before disposal	9(45)	13(65)	5(25)	4(20)

\*BMW: Biomedical waste

safety of patients, professionals, public, and the environment. The study reports from Nabizadeh R *et al.* [6] suggests, the dental waste constituted of 71.15% domestic waste, 21.40% potentially infectious waste, 7.26% chemical and 0.18% toxic waste. They observed highest dental solid waste was produced by denture maker (37.96%), followed by a general dentist (34.95), practical dentist (20.69) and

specialist dentist (6.40%). A study by Kizlary E *et al.* [7] at Greek reported dental BMW had 94.7% infectious waste, 2% non-infectious and 3.3% domestic waste by weight. The higher percentage of infectious waste in this study was due to the inclusion of hazardous waste like metal and amalgam as infectious waste. According to the authors, BMW production rate was at 513 g/practice/day, and 486 g/practice/day was

**Table 4. Available disposal facilities at the work place.**

Disposal facilities	Group I	Group II	Group III	Group IV
	n= 20(%)	n= 20(%)	n= 20(%)	n= 20(%)
Colour specified container in laboratory	13(65)	17(85)	5(25)	3(15)
Puncture proof container to dispose sharp objects	15(75)	16(80)	6(30)	1(5)
Proper methods to dispose chemicals used at laboratory	13(65)	17(85)	3(15)	3(15)
Heavy Metal waste disposal	13(65)	16(80)	3(15)	1(5)
Government BMW* monitoring agency visit anytime	9(45)	13(65)	9(45)	1(5)

\*BMW: Biomedical waste

**Table 5. BMW education among the dental technicians.**

BMW education	Group I	Group II	Group III	Group IV
	n= 20(%)	n= 20(%)	n= 20(%)	n= 20(%)
Learnt BMW disposal in curriculum	5(25)	13(65)	6(30)	5(25)
Attended reorientation programme on BMW	2(10)	11(55)	2(10)	0(0)
Any reorientation programme conducted at your facility	3(15)	8(40)	2(10)	0(0)
Have you received special training in BMW disposal management	3(15)	7(35)	3(15)	1(5)

\*BMW: Biomedical waste

the potentially infectious waste. The similar results were reported by Cristina Dutra Vieira *et al.* [8] according to them the dental solid waste included 24.3% infectious waste, 48.1% non-infectious waste and 26.7% domestic-type waste. The overall projection of these studies indicates the dental waste composition is similar to WHO biomedical waste report from other medical specialties. It shows the proper dental solid waste management requires the equal importance like in medical fraternity.

The previous studies [9] have suggested; the prosthodontic clinics produced the highest dental BMW among all the dental subspecialties, followed by restorative and orthodontic dentistry clinics. The denture fabrication, impression making procedures are the major part of prosthodontic clinics. The impression materials amount to 30% of total solid waste generated in dental practice. It could be the reason for the maximum amount of waste generation from this subspecialty. Effective production laboratory support is crucial for prosthodontic, restorative and orthodontic specialties. The adequate knowledge; proper disposal practice is essential from dental technicians for overall efficient BMW management. The results of the study showed the knowledge regarding bio-medical waste management was inadequate across the groups. The Group IV had considerable ignorance level with only 15% knew about different BMW categories and color coding. The knowledge level among Group I (35%) and Group (40%) though better, still inadequate. Sudhir KM *et al.* [10] observed the similar result regarding the knowledge level. The solid waste segregation at the source is necessary for the volume reduction of potentially infectious waste, decrease in waste treatment cost and recycling of paper, plastic materials. The results of the present

study indicate the knowledge regarding segregation was also inadequate among Group IV (10%) and Group III (35%). The Group II were better at 70% knowledge level. The previous studies have demonstrated the presence of potentially harmful microorganism in the dental solid waste 2. The dental casts and impressions received at laboratories also had the microbes over them [11]. Hence, it is strongly advised to disinfect the hazardous waste prior to their disposal. It is helpful in preventing the dissemination of multi-resistant bacteria into the environment. Experience on appropriate disinfection methods for BMW was unsatisfactory among all groups, particularly among Group IV (10%) and Group III (15%).

The Saudi Arabian government has formulated the Bio-Medical Waste (Handling and Management) Rules in 1998 and later revised in February 2001. The law incorporates all persons who generate, collect, transport, treat and dispose of the biomedical waste in any form [12]. The rules regulate the handling and disposal of BMW including human anatomical waste, blood, body fluids, medicines, soiled, liquid & biotechnology waste. Previous studies concluded the insufficient information about national and institutional regulations resulting in BMW discharge into the wastewater system and household disposal sites [13, 14]. This procedure endangers the human health and environment to the potential risk. The study respondents from all the evaluated group were ignorant (5-10%) about the existing regulation of the biomedical waste management and handling law in Saudi Arabia.

The research results exhibited the good BMW disposal attitude among all the evaluated groups. Similar to the previous study reports [15], the majority of the respondents (80-

85%) across all the groups agreed on the lesser generation, better segregation and disinfection of dental solid waste. Total of 85-95% of the respondents is of the opinion, the continuous update on BMW disposal and treatment plant necessity at an institute.

The disposing of the waste in color coded, and puncture proof containers were least observed at Group IV (25%) and Group III (35%) respondents. The Group I and Group II were slightly better at 65%. Similar disposal practice result was observed by the researchers like Taiwo, JO *et al.* [16] and Charania ZK *et al.* [17].

The dental amalgam is still widely used as a direct restorative material and used in the laboratory for die preparation. The laboratory utilizes the alloys from nickel, chromium and silver for the crown, bridge, implant and removable prosthesis fabrication. Improper handling and disposal of dental amalgam is known to cause the neurotoxicity, soft tissue toxicity, allergenicity and ecological damage [18]. The heavy metals like chromium known to cause liver, Kidney and respiratory damages [19]. The heavy metal landfill is attributed to soil and underground water contamination [20]. The results of the present study like other studies [21] indicated only 15% of Group IV, and 35% of Group III were disposing of amalgam and metal in the proper method. The Group I (55%) and Group II (65%) technicians followed the better disposal methods. The disinfection of waste prior to disposal was practiced by 20-25% subjects in group IV and Group III.

The results of the study notice the poor infrastructure for dental solid waste disposal. Disposal facilities like color coded container, puncture-proof containers, and facility to dispose of the metal were severely inadequate at Group IV (5-15%) and Group III (15-30%) working place. The disposal facilities were substantially better with Group I (65-75%) and Group II (80-85%). According to the feedback, the government monitoring agencies visit to evaluate the practice was almost non-existent at Group IV working place with only 5% respondents confirmed the visit.

The researchers strongly advocate the continuous training and reorientation programs to update, emphasize the proper BMW handling [22]. The results indicate the technician at Group IV had no reorientation program to update the knowledge while 55% of Group III had experienced the reorientation programs. The study also shows the insufficient BMW handling information in the dental technicians educational curriculum.

The results of the study exposed the gap in the knowledge and practice among all the four categories of respondents. The Group IV and Group III respondents performed poorly in all waste handling and disposal parameters. The independent dental laboratories and private dental clinics had poor adherence to dental solid waste disposal guidelines. The government monitoring agencies are required to monitor and regulate these dental facilities more stringently to reinforce the safe BMW practices.

The authors of the opinion, more studies are required to understand the waste disposal management especially at independent dental laboratories across multiple cities. The results of the research will help to understand the trend and develop the measures to improve the disposal practices.

## CONCLUSION

Within the limitation of the study, it can be concluded the there was considerable variation in the knowledge, facilities, handling and disposal of BMW among dental technicians evaluated. The study concludes the need to update the curriculum, regular orientation training programs and strict implementation of guidelines for BMW management. There is an urgent need to upgrade the disposal facilities at independent dental laboratories and private dental clinical to correct the deficient practices. The monitoring agencies needs to supervise the strict implementation of BMW regulations at private sector establishments.

## CONFLICT OF INTEREST

The authors confirm that this article content has no conflict of interest.

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