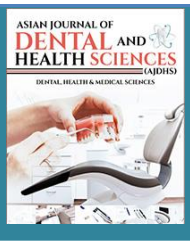

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A cross-sectional survey on the Awareness of Waste Management Practices Among Dental Practitioners in Dental Clinic in Enugu Metropolis

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Abstract

This study was undertaken to examine the level of awareness of waste management practices among dental practitioners at dental clinic in Enugu metropolis. A total of forty-five (45) dental practitioners involved in the study were provided with a self-administered questionnaire comprising the source of dental waste management awareness, knowledge attitude, and practices on dental waste. The investigation showed that the main source of dental waste management was through training/conference 82.2%. Exactly 71.1% of the practitioners were aware of the guideline laid down by the government for BMW disposal while 6.7% were unaware. The majority of the practitioners 82.2 % were aware of different colored bags used to dispose of different types of waste while 11.1 % and 6.7 % of the respondent tick 'No' and 'Don't know' respectively. Only 15.5% knew that pyrolysis is an environmentally friendly technology that converts organic waste to commercially useful by-products, while 11.1% knew that thermoplastics in dentistry cannot be reused and not biodegradable. Few practitioners are aware of the type of incinerator present in their dental clinic 31.1%. However, dental nursing had a higher level of awareness 75.0% over other cadres. Also, the gender variable was not significantly related to the level of awareness (p = .903). Nevertheless, the female's counterpart had a higher level of awareness 33.3 % than the male's counterpart 31.6%. The overall level of awareness of the safe management of dental waste accounted for 31.1% of the respondents. Our findings showed that there was a low level of awareness of dental waste management among the studied population. Nevertheless, it is important to provide a guide for policies and legislation. This is evident from the fact that it is the knowledge of what specifically constitutes waste and the categories of waste that determine how wastes are dealt with or managed. This knowledge is crucial for properly disposing of dental materials, recovering resources, and assessing technical and environmental implications. Moreover, waste management techniques ought to be a regular topic of discussion in training and Continuing Professional Development (CPD) courses.

Keywords: Dental practitioners, waste, management, Practices

INTRODUCTION

Dental healthcare plays an important role in the overall oral health of individuals, and the sector is rapidly growing around the world due to increases in population, healthcare facilities, and improved access for economically weaker sections of society. [1] Dental procedures and oral care generate a significant amount of biomedical waste that should be managed in an environmentally safe and sustainable manner. [1]

Dental waste is associated with different aspects of dentistry, such as oral diagnosis, conservative treatments, periodontology, orthodontics, prosthetics, dental surgeries, X-rays, etc. Dental waste typically includes swabs, latex, glass, plastics, needles, and other waste often contaminated with bodily fluids, as well as chemical hazardous waste including amalgam-derived products such as mercury, silver, and lead. It can be broadly divided into three categories: infectious waste, non-infectious waste, and domestic-type waste. [2, 3, 4, 5]

Management of oral health conditions could potentially yield hazardous wastes in the form of dental amalgam, etchants, used X-ray developers and fixers, lead foil packets, and disinfectants, among others.[4] Amalgam, for example, contains mercury which makes it toxic to both humans and the environment, if not properly disposed. [6, 7] Although its use is gradually waning, the effects of mercury on the entire population and the environment have been a source of global concern. [8, 9] A previous study showed that general dental offices could produce 59 kg of waste per day, while specialist dental offices averagely produced 18 kg of waste per day. Of these generated wastes, 34% were potentially infectious, and 12% were toxic and chemical wastes. [10] Safe management of infectious waste is essential to avoid public health issues such as cross-contamination and transmission of infectious diseases such as HIV or hepatitis. 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.

In Africa, Asian and middle-east, it has been noted in previous reports that medical waste is poorly sorted, characterized and disposed, further highlighting its pertinence in the health system framework. [11, 12, 13]

In underdeveloped nations, the difficulties in managing the waste from dental facilities are especially apparent. [14, 15] Managing dental waste according to accepted norms is much more difficult in developing nations due to limited resources resulting in an increase in health risks and environmental contamination from the improper management, storage, transportation, and disposal of clinical waste. This has been linked to a lack of awareness as well as other elements including legislative obstacles and the lack of professional personnel. [15] Dental practitioners are consequently responsible for ensuring that dental waste is treated in accordance with standard criteria. This includes appropriate waste sorting, storage, transportation, and final disposal. This study aimed to investigate the level of awareness of dental waste management techniques among dental practitioners in Enugu, Nigeria, in order to identify challenges and potential action areas.

MATERIAL AND METHODS

Research Design

A cross-sectional survey design was used to determine the level of waste management practices among dental practitioners in FEDCOTTEN

Description of the study Area

The study was carried out at Dental clinic in Federal College of Dental Technology and Therapy, Trans-Ekulu, located at latitude 6°29'07.1"N and longitude 7°29'42.5"E in Enugu, Nigeria. [3] Enugu State is in the southeast geopolitical zone of Nigeria. It is made up of seventeen local governments' area of which three are within the Enugu city (Enugu south, Enugu north, Enugu east), Abia state to the south and Anambra to the west. The state is the home of the Igbo of the south-eastern and few of Idoma/Igala people in Ette. It is largely dominated by people of the Christian belief and a few Muslim and traditional worshipers. Enugu is also located within hours drive from Onitsha and two hours' drive from Aba another very large commercial city both of which are trading centre in Nigeria. The study area, some selected government clinics in Enugu metropolis, Enugu State. The clinic belongs to the college which started in the year 1958 in Lagos and was brought to Enugu in the year 1982. The college trains students to acquire degrees/ higher National Diploma in various fields of works such as Dental Technology, Dental Therapy, Dental Nursing, Social works, Biomedical Engineering and presently running post-graduate program, the college is located at dental avenue Nike Road in East region of Nigeria. [16]

Population of study/ Sample size and sampling technique

As obtained from the health records of the Federal College of Dental Technology and Therapy, Trans- Ekulu, Enugu, and Enugu State Hospital Management Board, Dental sub-district hospital. The clinic workforce has a capacity of 45 staff, this includes males and females.

No sample size was adopted, because of the number of practitioners. This simply means that all the dental practitioners in the selected clinics were involved in the study. A self-administered questionnaire was used to record the type of practice, source of awareness, knowledge attitude, and practices on dental waste. The survey form will be composed of questions framed based on knowledge, attitude, and those regarding the practice of dentists about dental waste management. Confidentiality of the participants will be maintained by coding the questionnaires. The percentage response for each question from all the participants was obtained and the data was subjected to statistical analysis.

Research Instrument and Administration

The research instrument used in this study is the questionnaire. A survey containing a series of questions was administered to the enrolled participants. The questionnaire was divided into two sections, the first section enquired about the response's demographic or personal data while the second section was in line with the study objectives, aimed at providing answers to the research questions. Participants were required to respond by placing a tick at the appropriate column. The questionnaire was personally administered by the researcher.

Reliability of Instrument

The reliability of the research instrument was determined. The Pearson Correlation Coefficient was used to determine the reliability of the instrument. A co-efficient value of 0.05 indicated that the research instrument was relatively reliable.

Method of data collection

Before the initiation of the study, the researcher collected a letter of introduction from the Head of Dental Nursing Department, and approval from the research and ethics committee of the Federal College of Dental Technology and Therapy Enugu to approach the dentist in-charge of Dental clinic for permission to carry out the study. The data collection takes place at the Dental clinic on Mondays through Fridays, with the support of two (2) research assistants. The questionnaire was gathered instantly on-site, and data collection lasted one (2) week.

Method of data analysis

Data collected was analyzed in a simple frequency table and percentage. It was also presented in figures and easy form for easy understanding.

Test of Hypothesis

The waste management index (WMI) was used to determine the awareness of waste management practice among dental practitioners. Z-test will also be used to support the WMI test carried out at level of significance 0.05. This is mathematically presented as:

$$Z = \frac{\overline{X}-\mu}{\emptyset/N}$$

Where $\overline{X}$ = Sample mean

μ = Population mean

$\emptyset$ = Standard deviation

N = Sample size

RESULTS

Table 1: Demographic Characteristics of the Respondents n = 45

Variables	Frequency	Percent (%)
Gender		
Male	19	42.2
Female	24	53.3
No response	2	4.4
Marital status		
Married	26	57.8
Single	13	28.9
No response	6	13.3
Cadre		
Dental surgeon	9	20.0
Dental nursing	4	8.9
Dental therapy	11	24.4
Dental technology	13	28.9
Auxiliary staff	4	8.9
Year of service		
0-5	6	13.3
5-10	16	35.6
10-20	14	31.1
20-25	2	4.4
25-35	5	11.1
No response	2	4.4
Qualification		
Ph.D. or higher	1	2.2
Master's degree	4	8.9
Bachelor's degree	24	53.3
Diploma	11	24.4
No response	5	11.1

Table 1 shows the demographic characteristics of the respondents. Female counterparts accounted 53.3% over male counterparts (42.2%). The married individuals were more than single individuals recording 57.8% and 28.9 % respectively. Their cadre was thus: dental surgeon (20.0%), dental nursing (8.9%), dental therapy (24.4%), dental technology (28.9%) and auxiliary staff (8.9%). The majority have been in service for 5-10 years (35.6%) and 10-20 years (31.1%). The majority of the respondents had bachelor's degree 53.3% while other qualifications accounted for a Diploma 24.4 % and a Master's degree 8.9 % and 2.2 % Ph. D.

Research Question 1: What is the level of awareness of waste management practice among dental practitioner?

Table 2: Awareness on dental waste management practices n = 45

Variable	Frequency	Percent (%)
Are different colored bags used to dispose different types of waste		
Yes*	37	82.2
No	5	11.1
Don't know	3	6.7
Used disposable plastic items (e.g., catheter) are disposed in		
Yellow bags*	11	24.4
Red bags*	4	8.9
Black bags	6	13.3
Don't know	24	53.3
Soiled dressing and used impression materials are disposed in		
Blue/white bags	11	24.4
Red bags	5	11.1
Black bags*	12	26.7
Don't know	17	37.8
Used sharps and needles are disposed in		
Yellow bags	8	17.8
Rigid/puncture-proof container*	27	60.0
Red bags	3	6.7
Don't know	7	15.6
Extracted teeth and human tissue are disposed in		
Yellow bags	20	44.4
Red bags*	7	15.6
Black bags	6	13.3
Don't know	12	26.7
Plaster of Paris is disposed of in		
Yellow bags	6	13.3
Red bags	2	4.4
Black bags*	16	35.6
Don't know	21	46.7
Amalgam are disposed of in		
Yellow bags*	17	37.8
Red bags	1	2.2
Black bags	8	17.8
Don't know	19	42.2
Pharmaceutical waste are disposed of in		
Yellow bags*	15	33.3
Black bags	10	22.2
Don't know	20	44.4
X-ray fixer, X-ray developer are disposed of in		
Yellow bags*	13	28.9
Red bags	1	2.2
Black bags	9	20.0
Don't know	22	48.9
Overall level of awareness		
Good	14	31.1
Poor	31	68.9

denotes the right options

From Table 2, 82.2% dental practitioners knew that there are different colored bags used in disposing of different types of waste while 24.4%, 8.9%, and 13.3% knew that used disposable items are disposed of in yellow bags, red bags, and black bags respectively. About 26.7% of the dental practitioners were aware that soiled dressing and used impression materials are disposed of in black bags. Exactly 60.0 % of dental practitioners knew that used sharps and needles are disposed of in rigid/puncture-proof containers while 44.4% of the respondents knew that extracted teeth and human tissue are disposed of in red bags. About 35.6 % had an awareness that plaster of Paris is disposed of in black bags. The majority knew that the following are disposed of in yellow bags: amalgam (37.8%), pharmaceutical waste (33.3%), and X-ray fixer, X-ray developer (28.9%). Specifically, their overall level of awareness of dental waste management practices was not high, only 31.1% were aware.

Research Question 5: What is their source of information on waste management?

Table 3: What are the sources of awareness for dental waste management n = 45

Sources	Frequency	Percent (%)
Training/Conference	37	82.2
Television	1	2.2
From a colleague	6	13.3

Analyses in Table 3 show the sources of awareness for dental waste management. The main source was through training/conference (82.2%).

Table 4: Dental waste carrier n = 45

Variable	Frequency	Percent (%)
Are there guidelines laid down by government of Nigeria for BMW management		
Yes*	32	71.1
No	3	6.7
Don't know	10	22.2
Is there any biomedical waste disposal policy in your hospital/clinic		
Yes*	17	37.8
No	6	13.3
Don't know	22	48.9
Safe management of dental waste is the		
Responsibility of only government	2	4.4
Team work of dental surgeon, dental nursing, dental therapy, dental technology & auxiliary*	37	82.2
Don't know	6	13.3

denotes the right options

The result in Table 4 shows that 71.1 % of dental practitioners knew that there are guidelines laid down by the government of Nigeria for BMW management While 37.8% knew that there is a biomedical waste disposal policy in their hospital/clinic. Exactly 82.2% of the dental practitioner knew that the safe management of dental waste is a teamwork of dental surgeons, dental nursing, dental therapy, dental technology and auxiliary.

Table 5: General hazards of improper dental waste disposal n = 45

Variable	Frequency	Percent (%)
All are true for hazardous waste except		
Containers to be closed except while removing and adding waste*	24	53.3
Containers must be clean on the outside	4	8.9
Containers are to be compatible with the waste	3	6.7
Any type of containers can be used for dental waste	14	31.1
No response	4	8.9
Is maintaining bio-medical waste records mandatory in your hospital/clinic		
Yes*	17	37.8
No	7	15.6
Don't know	21	46.7
Does your hospital/clinic generate bio-medical waste		
Yes*	20	44.4
No	2	4.4
Don't know	23	51.1

denotes the right options

Table 5 reveals that 53.3 % of the dental practitioners knew that containers must be closed except while removing and adding waste. Exactly, 37.8% of the studied health practitioners knew that maintaining bio-medical waste records is mandatory in their hospital/clinic, while 44.4% work in a hospital that generates bio-medical waste.

Table 6: Certain material/process specific question in relation to dental waste n = 45

Variable	Frequency	Percent (%)
Which of the below is an environment friendly technology that converts organic waste to commercially useful by-products		
Controlled tipping	6	13.3
Double pot method	1	2.2
Plasma pyrolysis*	7	15.6
None of the above	3	6.7
No response	28	62.2
Can thermoplastics in dentistry be reused and are they biodegradable		
Yes	11	24.4
No*	5	11.1
Don't know	29	64.4
Are you aware of the type of incinerator present in your clinic		
Yes	14	31.1
No	7	15.6
Don't know	24	53.3

denotes the right options

Table 6 display findings on certain material/process-specific questions about dental waste. Only 15.5% of the dental practitioners knew that pyrolysis is an environmentally friendly technology that converts organic waste to commercially useful by-products, while 11.1% of the studied population knew that thermoplastics in dentistry cannot be reused and not biodegradable. Exactly 31.1% of the dental practitioner were aware of the type of incinerator present in their clinic.

Hypotheses 1: What cadre of dental practitioners exhibited higher level of awareness?

Table 7: Relationship between cadre and level of awareness

Variable	Awareness				
	Good	Poor	Total	Fisher's exact	*p*-value
Cadre				4.228	.390
Dental surgeon	3(33.3)	6(66.7)	9		
Dental nursing	3(75.0)	1(25.0)	4		
Dental therapy	2(18.2)	9(81.8)	11		
Dental technology	5(38.5)	8(61.5)	13		
Auxiliary staff	1(25.0)	3(75.0)	4		

Our data in Table 7 shows that the cadre of the dental practitioners were not significantly related to their level of awareness (p = .390). However, dental nursing 75.0% had a high level of awareness than other cadres.

Hypotheses 2: What gender displayed a higher level of awareness?

Table 8: Relationship between gender and awareness level

Variable	Awareness				
	Good	Poor	Total	Chi-square	*p*-value
Gender				.015	.903
Male	6(31.6)	13(68.4)	19		
Female	8(33.3)	16(66.7)	24		

Table 8 shows that gender was not significantly related to awareness level (p = .903). Nevertheless, females had a higher level of awareness (33.3%) than the males (31.6%).

DISCUSSION

Wastes management services are essential services that must be provided in every society, nonetheless very little is known on what exactly constitute a waste. Hence, it is important to have a clear guide as to what could be classed as waste. Dental waste management has not received much attention in developing countries and segregation of dental waste into risk and non-risk waste is usually not performed in most oral health facilities. Workers have little awareness of hazards associated, and disposal techniques are poor.

In the present study, (71.1%) are aware of the guideline laid down by government for BMW disposal, (6.7%) said No, and however, (22.2%) of the participants were uncertain regarding the legislative aspect around the law aspect. This is in line with the Studies conducted in Rajasthan and Delhi also concluded that the knowledge was insufficient in regard to the regulations and laws behind BWM. [17] Which are concurrent with those in Southern India where 28% of participants were unaware of the laws. [18]

Few participant knew that there are different colored bags used in disposing different types of waste (82.2%), 24.4%, 8.9% and 13.3% knew that used disposable items are disposed in yellow bags, red bags and black bags respectively, which is similar to the studies conducted in in Enugu, Nigeria, Davangere and Chennai Cities in India. [14, 19, 20] It worth noting that uniform color coding and labeling system for the different categories of hospital waste affects the efficiency of collection and handling and the integrity of the final waste treatment processes.

About (28.9%) dispose X-ray fixer, X-ray developer in yellow bags and 48.9% said don't know which is not permitted because lead is heavy metal that affects neurological development and functions. [21] Similarly, a study in Iran showed that 78% of the facilities studied disposed of lead foil packets with general waste. [22]

Lead foil packets are the waste products left behind after conventional X-rays are taken. The lead could leach into the soil and ground if disposed into landfills, causing environmental pollution. Lead waste should be returned to manufacturers for recycling or disposal. [23] Intake of high levels of lead can predispose one to reproductive defects, nerve defects, cancers, hypertension, impairment in kidney function and immunological impairments

About (37.8%) of the respondents said they disposed Amalgam in yellow bags in contrast to the studies conducted in India and Palestine. [24, 25] Earlier report by Owusu *et al.* [15] in Ghana found an unsatisfactory practice with amalgam disposal. A study in India reported that 79% of the respondents disposed of their generated amalgam waste together with general waste, while 13% of them disposed of this waste in other inappropriate ways. [12] In a facility-based study in Iran, it was found that 92% of the facilities disposed of amalgam waste in toilets as well as the sewer system. [22] A study done in Palestine found that over 80% of generated amalgam waste was disposed of into either the clinic garbage or drain. [26]

This is similar to the study conducted by Sudhir. [19], in which 11.3% of the participants reported disposal of silver amalgam into the common bin, the recommended method by the American Dental Association (ADA). [27]

About (82.2%) of the respondents said main source of awareness for dental waste management is training/conference, which is similar to a study conducted by Daou *et al.*[28] in Lebanon, in which 41% of the involved participants received training programs on health care waste management. The level of awareness was adequate there is an appreciable need for more education, monitoring, and empowerment concerning waste management in Dentistry.

About (17.8%) of the practitioners disposed sharps and needle in yellow bag container, which is similar to study, conducted in New Zealand, in which 24.4% of participants disposed of them into the common bin. [29] In present study, more than half of the respondents (60.0%) of the practitioners reported that they are using puncture proof bags to dispose of sharps/needles, which is the ideal method. This is in agreement with the studies conducted in Kenya and Ajman, United Arab Emirates [30, 31] in which 61% and 56% of respondents applied the recommended manner for sharps/needles, respectively.

A cross-sectional study that included 595 private and public dental offices and clinics in Shiraz University, Iran revealed about 90% of dental workplaces and facilities that arranged their contagious waste with interior waste and only 60% of centers utilized a standard system for sharps transfer. [32] Another study in Lebanon clearly expressed that only 28% practitioners segregated sharp waste in an appropriate container; only 70% of dentists reported treating their infectious waste before disposal; about two thirds of the surveyed dental practitioners do not follow the local guidelines; and half of them do not provide the proper precautionary measures while managing the dental wastes. [28]

This materials are contaminated with blood or other infectious mouth fluids and it is essential to avoid public health issues such as cross-contamination and transmission of infectious diseases such as HIV or hepatitis through decontamination by first using an autoclave, steam auger, dry heat, microwave, or chemical disinfection prior to their disposal alongside non-hazardous waste streams or incinerated at temperatures above 1100 ^{0}C. [1]

The overall level of awareness of the safe management of dental waste accounted for (31.1%) of the respondents which is similar to a study conducted by Kishore *et al.* [33] in New Delhi, with reported awareness of 36% among participant but lower than high level of awareness reported by other researchers; Janakiram and Vidyapeetham. [24] in Bangalore in which 57.6% were aware, while other studies conducted by An. [20] in Chennai City reported awareness of 72% while only 33.4% of the study sample received professional training on waste management in Jeddah Saudi Arabia. [34] This shows that awareness of waste management policy varies between cities. They should be made aware of the recent advances in the waste disposal, and practical application of proper waste management must be included in the dentistry. Global awareness should be created regarding the correct methods of waste disposal as well as about incorporating new methods to recycle waste wherever possible.

CONCLUSION

Dental care plays an essential role in the general health of individuals and the public, and the development of a significant amount of biological waste is unavoidable during oral care and dental operations. Our findings showed that there was a low level of awareness for dental waste management among the studied population. Nevertheless, it is important to provide a guide for the purposes of policies and legislations. This is evident from the fact that, it is the knowledge of what specifically constitute a waste and the categories of wastes that determines how wastes are dealt with or managed. Further research is needed to understand how novel dental materials degrade thermally. A wide range of novel nano-materials, resins, composites, and ceramics are being created to meet the varied criteria/characteristics required in different dental applications. However, nothing is known about the fundamental properties of these materials' separate

components. This knowledge is crucial for properly disposing of dental materials, recovering resources, and assessing technical and environmental implications. Moreover, waste management techniques ought to be a regular topic of discussion in training and Continuing Professional Development (CPD) courses. As awareness and understanding grow, administrators and managers may also have a larger responsibility to guarantee that a supportive work environment and the required resources are available.

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Author's Contributions:

All authors investigated the study, did literature searches and did data Validation and Visualization. All the authors reviewed and approved the final draft, and are responsible for all aspects of the work.

Competing Interests

Authors have declared that no competing interests exist.

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Ethical consideration

Ethical approval with reference No: DREC/RS/011/23 was obtained from the Research and Ethics Committee of Federal College of Dental Technology and Therapy, Trans-Ekulu, Enugu State, Nigeria

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