

Environmental and Health risks Associated with Dental Waste Management: A Review

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Abstract

Proper management of dental waste is a crucial issue for maintaining human health and the environment. The waste generated in the dental clinics has the potential for spreading infections and causing diseases, so improper disposal of these dental wastes can cause harm to the dentist, the people in immediate vicinity of the dentist, waste handlers, general public and the environment through production of toxins or as by-products of the destruction process. Staff that provide dental healthcare ought to be aware of the proper handling and the system of management of dental waste used by different dental hospitals. The method of investigation adopted in the paper involved a desk study in which documents and records relating to dental waste handling were studied to obtain background information on existing dental waste management in Nigeria other countries of the world are also mentioned as examples. Additionally, information on generation, handling, segregation, risk associated during handling and treatment of dental medical waste were sought in order to determine the best method for safe disposal. This article provides dentists with the information they need to properly dispose of mercury and amalgam waste, and provides suggestions for managing the other wastes that result from the day-to-day activities of a dental office such as: used X-ray fixers and developers; cleaners for X-ray developer systems; lead foils, shields and aprons; chemiclave/chemical sterilant solutions; disinfectants, cleaners, and other chemicals; and, general office waste. Additionally, this study may be beneficial for authorities and researchers of developing countries to work towards improving their present Dental waste management system.

Keywords: Clinic, dental, disposal, environment, waste management,

1 Introduction

Human beings use the environment in three basic ways: as a *resource bank*- the environment supplies them with raw materials needed to maintain their existence, and their social and technological structures; as a *habitat* – people require more space per individual than any other species and as *sink* for *wastes*- human beings produce more waste than other species (Babanyara *et al.*, 2010). Hospital's main aim is to provide treatment and safeguard the health of the people against illnesses. Over the decades the growth of the medical sector around the globe combined with an increase in the use of disposable medical products have contributed to the large amount of medical waste generated. The management of health care waste as a complicated issue requires training, awareness, and financial resources (Abdulla *et al.*, 2008; Mbongwe *et al.*, 2008). Dentistry is a part of health care services and dental waste management is a category that needs to be organized (Hiltz, 2007). Although dental centers are considered a minor source of health care waste, but they generate a certain amount of hazardous waste. Dental offices produce a variety of wastes such as domestic/municipal-types, infectious, toxic, pharmaceutical and chemical wastes. Each fraction requires a specific approach for collection, treatment and disposal (Hiltz, 2007; Al-Rabeah, 2002). Dental Waste management refers to the generation, collection, processing, transport and disposal of dental waste. If not handled properly it can contaminate land, air and water sources. Mercury from dental amalgam is considered the most problematic waste due to its toxic potential (Al-Khatib & Darwish 2004). Mercury can enter the environment as solid waste by the disposal of extracted teeth as well as through the wastewater collection system by the disposal of amalgam particles during dental operations (Chin *et al.*, 2000). As such, proper management of dental waste is important for both environmental and public health reasons.

According to (Mushtaq *et al.*, 2008) dental waste (DW) is classified into two main groups, non-risk or non-hazardous waste and risk or hazardous waste. Additionally, Al-khatib *et al.*, (2009) opined that non-risk waste are not infectious and non-hazardous, and it comprises mainly office solid waste that originates from Dental clinics and do not contain any substance that would pose a hazard to mankind/animal health or to the environment, the typical components of non-risk waste are paper, cardboard, plastics, wood, food waste, glass and metal, these types of waste can be recycled or put into the trash and disposed of as regular non-risk waste. While risks or hazardous dental waste consists of mercury-containing amalgam, silver-containing X-ray fixer and films, cleaning solution, lead or lead-containing foil and vests, and pharmaceutical waste. Lead, mercury and silver can be dangerous to mankind and may pollute the Environment if not properly handled and disposed of (Mushtaq *et al.*, 2008). A significant increase in the quantity of dental solid waste generated globally has been noted due to the increased use of plastic barriers, gloves and masks, believed to compromise about 90% of the

solid waste. This is due to increased safety measures implemented as well as the replacement of reusable items with disposable ones (Al-khatib *et al.*, 2009). Direct contact of the eyes, skin, nose and mouth with dental waste can lead to infections such as *Escherichia coli* infection, tuberculosis (TB), as well as ill-health such as digestive problems including diarrhoea (Rushbrook *et al.*, 2000). Human immunodeficiency virus (HIV) and hepatitis B virus (HBV) have been found to be transmitted in dental treatment. It has been established that, worldwide, about 5.2 million people (including 4 million children die each year from waste related diseases (Aktar, 2000 and Babanyara *et al.*, 2013). In Nigeria and indeed in many developing countries of the world, medical/dental wastes is seldom a subject of discussion, neither is it an issue in scholarly debates nor object of scientific research (Sridhar *et al.*, 2009). In low income countries, medical waste rarely receives attention; rather, it is handled as part of the municipal waste stream (Appleton and Ali, 2000). Within hospital in developing nations, systems of separation are seldom in place and general waste is frequently mixed up with the infectious and hazardous waste. Its management is often poor and fraught with difficulties (Rushbrook *et al.*, 2000; UNEP, 1996; WHO, 1999). In Nigeria, generators of dental wastes have, for long time, assumed treatment methods based on techniques suitable for treatment of municipal solid waste (Adedigba *et al.*, 2013). It is common to see green vegetables growing luxuriantly on waste dumps in Nigeria alongside discarded sanitary pads, syringes, plasters, bandages and other medical waste dumped at such refuse sites. Such vegetable, lust and green, are harvested and sold in our markets and unassuming public consume these “deadly foods” with no suspicion of health effects (Sridhar, et al 2009). Therefore, there is the need for an appropriate risk assessment that informs both policy makers and the public with the information currently available on the health and environmental risks associated with improper dental waste management. This study may be beneficial for authorities and researchers of developing countries to work towards improving their present dental waste management system.

2. Methodology

The method of investigation adopted in the paper involved a desk study in which documents and records relating to dental waste handling were studied to obtain background information on existing dental waste management in Nigeria other countries of the world are also mentioned as examples. Additionally, information on generation, handling, segregation, risk associated during handling and treatment of dental medical waste were sought in order to determine the best method for safe disposal.

3. Categories or Classification of Hazardous Dental Waste

The table below shows the different fractions of dental waste found in dental clinics, such fraction are domestic-type (general waste), potentially infectious, toxic and chemical and pharmaceutical wastes. (See table 1)

Table: 1. Classification/categories of Dental wastes components

Waste fractions	Waste components
Potentially infectious wastes	Blood-contaminated paper towel, saliva-contaminated paper towel, blood-contaminated gauze, saliva contaminated gauze, blood-contaminated cotton, saliva-contaminated cotton, blood contaminated dental roll, saliva-contaminated dental roll, nylon glove, latex glove, syringe, saliva ejector, sharps and needles, extracted teeth, dental mirror, surgical blades, tongue blade, inseparable components
Chemical and pharmaceutical wastes	Used medicine ampoules, wax, dental impression material, calcium hydroxide
Toxic wastes	Amalgam-contaminated paper towel, amalgam-contaminated gauze, amalgam-contaminated cotton, amalgam contaminated dental rolls, film packet's lead foil, amalgam particles, radiography film, inseparable components
Sharp wastes	Syringe and needles, saliva ejector, extracted teeth, dental mirror, surgical blade, tongue blade.
Domestic/general wastes	Paper, cardboard, plastics, wood, food waste, glass and metals, these types of waste can be recycle or put unto the trash and disposed of as regular non-risk waste

Source: (Ali *et al.*, 2014)

4. Public Health Risks Associated with Dental Waste

The proportion of dental waste can significantly contribute to the amount of pollutants generated in an environment if its disposal is not well managed (Plate, 1). Additionally, there is cross- infection risks associated with mismanaged waste. Such cross infection may be from human scavengers (Plate, 2) who are reported to visit waste dunghills to pick victuals (Coker *et al.*, 2009) and are predisposed to deadly infections such as HIV, hepatitis among others (Rao 2008).

Plate 1: Medical Waste Scavenging in Bangladesh
Nigeria



(Source: Babanyara et al, 2013)

Plate 2: Medical Waste Scavenging in Ibadan
Nigeria



(Source: Coker et al, 2009)

Hazardous wastes such as chromium, cadmium and amalgam have been known to have adverse effects on humans. Chromium is known to have a potential to cause liver, kidney and respiratory damage while cadmium may cause kidney disorders and lung cancer (Michael et al, 2010). Amalgam is not only one of the major hazardous wastes produced at dental clinics, it also acts as a neurotoxin and is considered to be the most toxic non-radioactive element and the most volatile heavy metal known in nature (EPA 2000, Al-Khatib & Darwish 2004). Other possible harmful effects of dental amalgam include oral galvanism, soft tissue toxicity, allergenicity and ecological grievances (Rao 2008).

Mercury is highly toxic to human and wildlife. In humans, mercury is toxic to the nervous system (brain and spinal cord), particularly the developing nervous system of a fetus or young child. Effect seen in children with elevated mercury exposure include lowering cognitive abilities, impaired hearing, Poor-coordination. Chronic, elevated exposure to mercury also affects the kidney, liver and immune system. Routinely used consumables such as gloves, rubber dams and other chlorine-containing materials are usually disposed of by means of incineration. This process is known to release vapors containing dioxin, which has been associated with cancer, defects in reproductive and foetal development, neurotoxicity, hormonal and immune disorders (Floret et al., 2003).

Lead, another heavy metal commonly used in dental clinics has been implicated in causing neurological disorders in children and reproductive problems among women following either acute or chronic exposure (USEPA 2007).

5, Environmental Risks Associated with Dental Waste

Discarded waste that finds itself in landfills can lead to soil and underground water pollution (National Wildlife Conservation 1999). (UN, 2003; Darwish & Al-Khatib 2006) buttressed that mercury is an important constituent of amalgam filling material and is one of the major concern because of the many ways (like the un-used filling material or incinerated amalgam waste or an extracted amalgam filling which has been removed from the tooth) the chemical can come into contact with soil, water, surface water, and air as a result of improper disposal. When mercury waste is incinerated, the volatilized mercury precipitates to the environment and will enter the soil, surface water and food chain. When mercury waste is disposed of down the drain, there is potential for contamination of water and/or sludge at the wastewater treatment plant or septic system. Mercury can also lead to accumulation in both aquatic and terrestrial food webs when released to the environment and the amount will depend on the size and age of the organism (Babanyara, et al., 2013).

For these reasons, knowledge of waste disposal mechanisms, proper management alternatives and environmental impact assessments are necessary for proper waste management. In most technologically advanced countries of the world, the management of dental waste is a well-established, controlled and monitored process (Michael et al., 2010)

6. Global Perspective of Dental Waste Management Practice

6.1 Dental Waste Management in Iran

In a study conducted by (Ali et al., 2014) in Iran they reported that the total dental waste production in dental

offices is 87.09%. Where, general dental offices, specialist dental offices and dental clinics are responsible for 67.68%, 20.58%, and 11.74% of this amount respectively. Additionally, the percentages of different fraction of waste in dental centers such as domestic-type, potentially infectious, toxic, and chemical and pharmaceutical waste constituted 40.72%, 39.32%, 13.58%, and 6.38% of the total waste production. This shows that the generation rate of dental waste in Iran is very low. Although the amount of dental waste is small in comparison with municipal waste, the treatment and disposal management of dental waste due to its hazardous characteristics is necessary. Findings indicate that there was no effective activity for waste minimization, separation, reuse and recycling in the dental centers in Iran. Management of sharps, potentially infectious and other hazardous waste was also not proper and these items were collected and disposed along with domestic waste. Other findings indicate that improper disposal of sharps and amalgam was widespread among the clinics as these items were discarded with general garbage. Due to the absence of silver recycling companies or silver recovery unit in Iran, x-ray fixer solution was disposed in the drain.

6.2 Dental Waste Management in Palestine

(Issam *et al*, 2009) during their study in Palestine stated that large majority of dentists revealed their incorrect disposal methods of newly placed and old removed amalgam fillings in the Nablus district. The study further highlights the potential threat caused by mercury pollution; 65.6% of the dentists disposed of newly placed amalgam in the trash whilst 23.6% flushed it down the drain. Additionally, 17.3% of the dentists flushed old removed amalgam down the drain through a coarse filter, 21.6% catch in the filter and then throw it in the trash, 52.2% distribute between the filter, drain and trash, and 4.5% throw it in the trash while only 4.4% catch it in a vacuum filter. Used fixer is discarded down the drain or into the garbage, which is also done by dentists in the Nablus district; this poses a serious threat to the environment and human health. As such, the dental waste should be collected in a clearly marked container and should subsequently be recycled or treated as hazardous waste. The WHO recommendations require a silver recovery unit to be installed at the end of the X-ray processing unit. In the Nablus district, all the dental clinics surveyed disposed of blood-soaked dressings, including gauze, cotton and extracted teeth, in the trash with the regular waste. Sharps were segregated according to the WHO segregation color code. Following the collection of the solid dental waste from dental clinics, most of them are disposed of in nearby containers alongside domestic solid waste. Transportation also becomes an issue as no extra safety measures are taken in view of the mixed hazardous and non-hazardous waste. These wastes eventually end up in open unsanitary dumping sites. The villages within the Nablus district disposed of the solid waste randomly; some may dispose of it in the Nablus Municipality open dumping site while others in haphazard locations. Open air burning of the waste, as a common practice, normally causes smoke nuisance (Plate 3). The waste also gives rise to an offensive smell, littering and pollution potential. Another issue requiring attention is scavengers collecting metals from public containers in roads where dental waste is usually disposed. This exposes the scavengers to the risk from sharps, mercury and other hazardous waste. Unfortunately, all these practices are seen in the whole country as well as in many other developing countries.

Plate 3: Open Burning in Mozambique



Source: (Batterman, 2014)

6.3 Dental Waste Management in Osun State, Nigeria

(Michael *et al*, 2010) during their study in Obafemi Awolowo University Teaching complex Ile-Ife, Nigeria they established that majority of the cleaners 71.4% reported that they were not happy or satisfied with their jobs. The main reason offered for this was the very low income received as a monthly remuneration, all the respondents claimed that adequate material for cleaning such as eye/head wear, face masks, heavy duty gloves, apron and foot wear and other waste disposal materials were not available, implying that there were no measures

to prevent cross infection when disposing of waste of this nature. The study also indicates that dental wastes were collected on a daily basis and no sorting from the source of generation. 78.6% of the respondents claimed that no provision had been made for dumping the waste in an environmentally friendly manner. Thus, a location was designated for dumping the waste generated by dental treatment. This dump site or depot, although started as an illegal open dump site, has grown to become an official disposal site for OAU dental teaching hospital.

The waste disposal knowledge of the cleaners on the associated danger of operating open disposal site was remarkable, 78.6% knew that there was a high possibility of contacting infections from such site. Furthermore 42.9% had on some occasion reported seeing scavengers picking victuals from the disposal site. This shows that there are no proper minimization, reuse, segregation and recycling program for the proper management of dental waste in Osun state

6.4 *Dental Waste Management in Ibadan, Nigeria*

Olajumoke, (2010) reported that the responses from the dentists indicates major issues to be addressed in the management of waste materials in and from the dental clinics in Ibadan, Nigeria. The attitude and practice of dentists in this study leave opportunities for cross-infection within and outside the dental surgeries. The majority of those sampled stated that there were no special disposal facilities for the different kinds of waste generated. It has also been confirmed that the dentists, after attending to patients they leave the clearing of waste to the cleaners who put them in domestic rubbish bins. The dentists were not aware or bothered about what happened to waste they generated and especially how such waste materials were finally disposed of, they stated that there were no hospital recommendations for dealing with waste in their surgeries. 62.0% of the dentists sampled confirmed that there are no proper methods of segregating sharps, infectious, hazardous, radioactive and other general wastes. However they are mixed together at the source of generation which eventually lead to environmental pollution when incinerated. Bells (2004) proposed that waste materials should be disposed of in appropriate containers and bags. All such items should be packed to the required level and labeled with the practiced name and duty of care number. They should then be stored in a special designated area of the practice awaiting collection. The temporary storage of dental waste is important before and after transportation, storing the waste affords an opportunity to pre-treat the waste before finally disposing it (Coker et al, 1998).

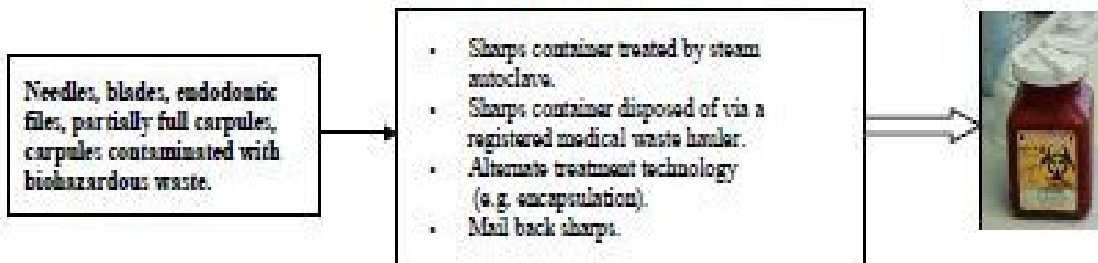
7. RECOMMENDATION

Medical waste management strategy includes all activities involved in waste generation, segregation, transportation, storage, treatment and final disposal of all types of wastes generated in the healthcare institution, stages of which require special attention. This will ensure that inputs (funds, equipment and facilities), activities and options (healthy environment, safe workplaces, and healthy workers) for the handling and disposal of health care waste are in place (Manyelele and Lyasenga, 2010). It is recommended that the dental waste disposal guide as proposed by Kern County be adopted and used in Nigeria and other third world countries. The diagram below is intended as a disposal guide for some types of regulated waste. It is intended to serve as a comprehensive list of all regulated waste. As proposed by (Kern County Environmental Health Services Department Medical Waste Program, 2014 USA). This can be adopted and used in all Dental Clinics in Nigeria and other developing nations.

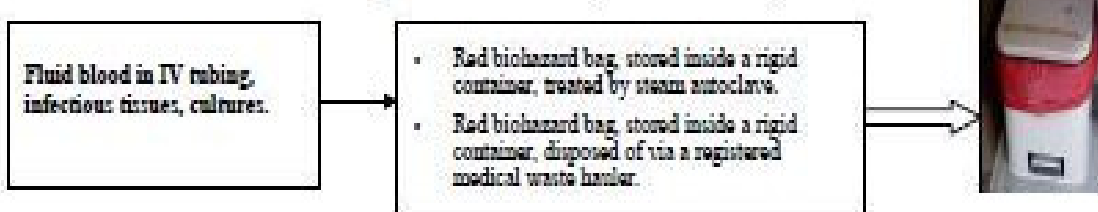
DENTAL WASTE DISPOSAL GUIDE

*This diagram is intended as a disposal guide for some types of regulated waste.
 It is not intended to serve as a comprehensive list of all regulated wastes.*

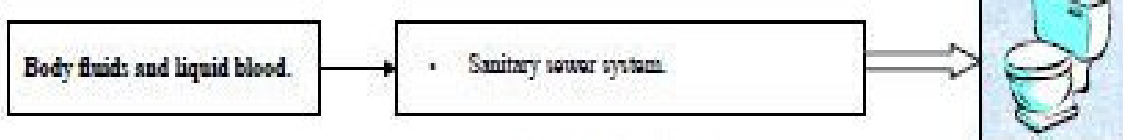
Regulated Medical (Sharps) Waste



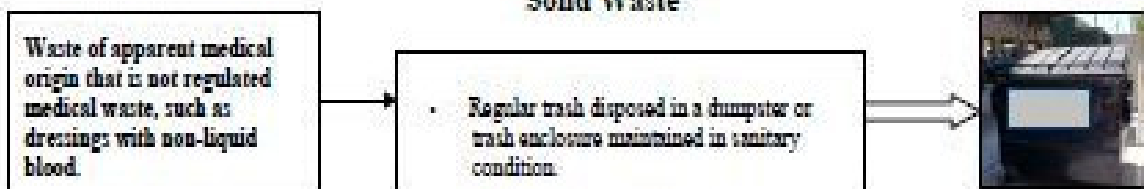
Regulated Medical (Biohazardous) Waste



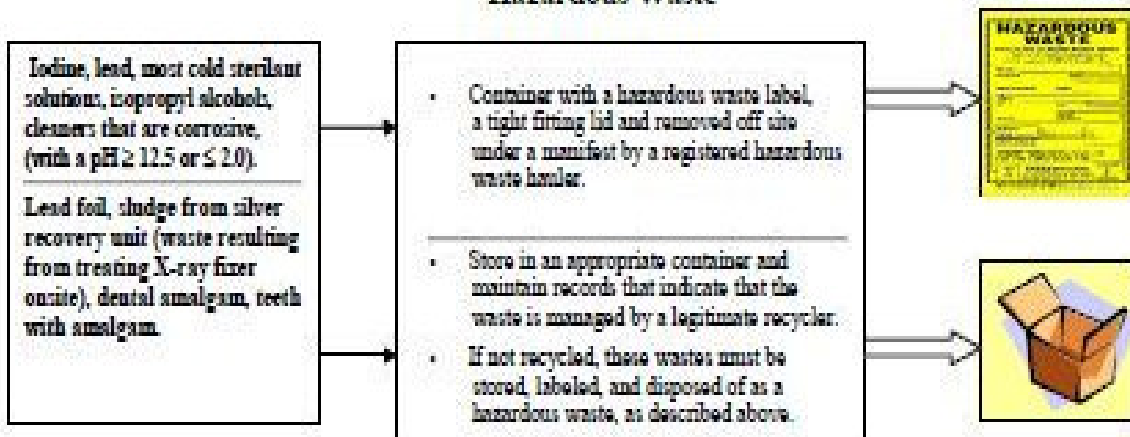
Regulated Medical (Biohazardous) Liquid Waste



Solid Waste



Hazardous Waste



8. Conclusion

Waste management is considered as undignified, unquestionably menial job, no wonder it was relegated to the group “D” staff that are headed by a sanitary supervisor. Thus the crying need of the day is to sensitize the top level managers making them aware of the various types of wastes generation, segregation, collection, transport, and final disposal. In a nut shell, waste management has two vital parts management of hazardous waste generated from different sources which involve careful segregation, collection, transport, and final disposal of various types of waste on one hand and on the other hand effective training and supervision of various categories of personnel involved in whole waste management system. With the advent of diseases like AIDS, Hepatitis B and their increasing prevalence in health care workers and other personnel working in health care institutes made it important to have proper waste management. In addition to health risks improper hospital waste management also has an impact on the environment causing pollution of water air and soil.

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