“There’s plenty of room at the bottom”: The biomedical waste management in dentistry

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ABSTRACT

Inappropriate and inadequate handling of biomedical waste may have serious public health consequences and a significant impact on the environment. It is necessary to manage infectious materials to prevent or reduce exposure of persons and the environment to potentially harmful bio-waste. Dental clinics generate a number of biomedical wastes, including the materials such as scrap amalgam, photochemical waste (developer and fixer), lead foil from traditional X-ray packets, blood-soaked materials, human tissue, and disinfectants, which are challenging to the environment. Wise handling and disposing them is critical. Sound management of biomedical waste is thus a crucial component of environmental health protection. The purpose of this article is to discuss about various types of biomedical waste produced in the dentistry, different waste management practices, the hazards of indiscriminate disposal of biomedical waste and to create awareness among the dental profession, regarding minimizing the production of biomedical waste and dentists are encouraged to follow the best management practices, while disposing hazardous wastes.

Key words: Bio-hazard symbol, biomedical waste management, grit, photographic fixer, regulated waste, universal waste

INTRODUCTION

The term biomedical waste has been defined as “any waste that is generated during the diagnosis, treatment, or immunization of human beings or animals, or in the research activities pertaining to or in the production or testing of biological and includes categories mentioned in Schedule I of the Biomedical Waste (Management and Handling) rules 1998.[1] Hospital waste management has been brought into focus in India recently, particularly with the notification of the Biomedical Waste (Management and Handling) rules, 1998, in which the rule makes it mandatory for the health care establishments to segregate, disinfect, and dispose of their waste in an eco-friendly manner.² American Dental Association (ADA) and Center for Disease Control recommend that medical waste disposal must be carried out in accordance with regulations.³⁻⁴ There may be increased risk of nosocomial infections in patients due to poor waste management. Improper waste management can lead to change in microbial ecology and spread of antibiotic resistance.⁵ The best disposal options are prevention or minimize the toxic substances from dental clinics to the environment.⁶

OBJECTIVES OF BIOMEDICAL WASTE MANAGEMENT

1. To prevent transmission of disease from patient to patient, from patient to health workers and to prevent injury to the health care workers in support services, while handling biomedical waste.
2. To prevent general public exposure to the harmful effects of the cytotoxic, genotoxic, and chemical biomedical waste.
**CATEGORIES OF BIOMEDICAL WASTE**[1]

There are ten categories notified in The Government of India, “Biomedical Waste (Management and Handling) rules” 1998. They are: Category No. 1: Human Anatomic Waste; Category No. 2: Animal Waste; Category No. 3: Microbiology and Biotechnology Waste; Category No. 4: Waste Sharps; Category No. 5: Discarded Medicines and Cytotoxic drugs; Category No. 6: Soiled Waste; Category No. 7: Solid Waste; Category No. 8: Liquid Waste; Category No. 9: Incineration Ash; and Category No. 10: Chemical Waste.

Classification of dental waste: According to Nancy Godwin:[7]
1. General waste (nonregulated)
2. Contaminated waste:
   a. Regulated and
   b. Infectious waste
3. Hazardous waste:
   a. Regulated and
   b. Toxic waste.

Any waste container that holds “potentially infectious” waste materials, whether regulated or nonregulated must be labeled with a biohazard symbol [Figure 1].

According to US Centers for Disease Control and Prevention Guidelines wastes are classified in the following ways.[3,4]

**Anatomic biomedical waste**
2. Infectious waste: Culture infectious agents, associated biological (e.g., culture flasks, petri plates, specimens, vaccines, wastes from the production of biological, chemicals, disinfectants, sterilizing agents.

Infectious waste is that part of medical/dental waste that has been shown through controlled studies capable of transmitting an infectious disease. Infectious medical/dental waste is also known as regulated waste.[3,8-10]

**Nonanatomic biomedical waste**
Waste from dental materials/equipment/disposables that appear to be medical waste:
3. Lead-containing: Lead foils packets, lead aprons, broken thermometers, and blood pressure gauges.
4. Chemical or pharmaceutical waste: chemicals, disinfectants, sterilizing agents, expired drugs, waste-bearing cytotoxic/genotoxic properties.
5. Contaminated/uncontaminated sharps: syringes (with/without needles), broken glass, scalpels, specimen tubes, and slides.

**Regulated waste**
Includes all “sharps” such as disposable needles, scalpel blades, broken glass, burs, endodontic files and reamers, blood, and blood-soaked or blood-caked items, human tissue, extracted teeth, and waste from pathological procedures. Regulated waste requires special disposal in biohazard containers or bags. Since extracted teeth are potentially infectious, they are considered regulated waste. Only teeth without amalgam may be heat sterilized. Teeth containing amalgams can be placed in biohazard containers for pickup.

**Nonregulated waste**
includes items such as used patient bibs, barriers used during treatment, and saliva soaked gauze. If this waste contains potentially infectious materials, even if it is considered nonregulated, it should be labeled with a biohazard label. Any waste container that holds “potentially infectious” waste materials, whether regulated or nonregulated must be labeled with the biohazard symbol [Figure 1].

**Hazardous waste**
This could pose a risk to human beings or to the environment. Examples: Scrap amalgam,
photochemical waste (developer and fixer), lead foil from traditional X-ray packets, some disinfectants.

The World Bank’s health care waste management guidance, note lists four steps to healthcare waste management:
1. Segregation of waste products into various components that include reusable and disposable materials in appropriate containers for safe storage;
2. Transportation to waste treatment and disposal sites;
3. Treatment; and
4. Final disposal.[11]

**Segregation**
The “key for waste management” is waste segregation. Only a segregation system can ensure that the waste will be treated according to the hazards of the waste and that the correct disposal routes are taken, and the correct transportation equipment will be used. Recycling can be only carried out if recyclable materials are separated from the hazardous waste. Contaminated materials are excluded from any recycling activity, and they must be treated as mixed hazardous waste. Without effective segregation system, a complete waste stream must be considered as hazardous.

The correct segregation is the clear responsibility of every waste generator. If the waste is unclear or not recognizable, then that waste must be classified in the highest to be expected risk group. Segregated waste should not be mixed during transport and storage. If hazardous and nonhazardous wastes are mixed, the entire mixture must be considered and treated as hazardous waste. Only a segregation system can ensure that the waste will be treated according to the hazards of the waste and that the disposal routes are taken.[12,13]

**Color coding of the segregated waste**
Color coding means to combine different waste groups with “similar hazards in one main group” in a fast and easy way by a fixed color.

The different waste groups have different colors for the containers/bags for the identification according to the hazards and applied throughout the complete disposal chain, that is, segregation, collection, storage, transport, and disposal.

Warning colors are red, yellow, and orange used for hazardous waste; positive colors are blue, and green used for recycling; and neutral color is black for normal waste.

Yellow color container/bag should go for incineration/deep burial, that is, for categories - 1, 2, 3, and 6; red for categories - 3, 6, and 7 should be sent for autoclaving/chemical treatment; blue/white with categories - 4 and 7 to autoclaving/chemical treatment and destruction/shredding; and black with categories - 5, 9, and 10 for disposal in secured landfill.

Impression compound, agar, dental waxes, green stick compound, impression pastes, shellac base plates should be kept in a “yellow plastic bag” then sent for either incineration or deep burial. Rubber base impression material, investment material, pumice, acrylic, metal dust, alginate, old models, and casts, old acrylic dentures and teeth kept in a “black plastic bag” and dispose of in municipal dump.[13]

**Collection of biomedical waste**
Collection of biomedical waste should be done as per biomedical waste (management and handling) rules, at ordinary room temperature the collected waste should not be stored for >24 h.

**Handling and storage**
Safe handling of regulated waste is essential. Involved personnel must be informed of the possible health hazards present and be trained in appropriate handling, storage, and disposal methods. In response to a continuing concern about exposure, and the development of technological advances that increase employee protection, the US congress passed the Needlestick Safety and Prevention Act in 2000.[14]
Generally, waste should not be stored for >30 days.

**Disposal**
The various disposal methods are available for proper disposal of biomedical waste which includes incineration, autoclaving, chemical methods, thermal methods (low and high), ionizing radiation process, and deep burial and microwaving. “The medical waste should be completely free of pathogenic bacteria before disposal”. Incineration and autoclaving are considered traditional methods. Chitnis et al.[15] have devised a solar heating system for disinfecting infectious waste in economically less developed countries. They stated that considerable reduction
in the amount of viable bacteria by this method. Untreated medical waste can be disposed off in sanitary landfills. Disposal without treatment is not recommended for human tissues, sharps and culture from clinical laboratories. Practically all infectious waste must first be treated, whereas ordinary solid or liquid waste requires no treatment before disposal.

Teeth without amalgam restorations and other tissues can be placed directly into a biohazard bag or a sharps container, which can then be sterilized. Teeth with amalgams could release mercury vapor during sterilization, thus they should be neutralized through disinfection ideally, immersion for 30 min in a fresh solution of a tuberculocidal disinfectant held within a sealed container. Treated teeth can then be rinsed with water and are ready for disposal. Teeth without amalgam restorations can be placed directly into a biohazard bag or sharps container.[7,14,16] Items heavily soiled with blood/saliva can be placed into sharps containers. However, it may be easier to store them in small biohazard bags until treated. Used anesthetic capsules should be placed into sharps containers.[4,10,11]

All the generators of biomedical waste should adopt universal precautions and appropriate safety measures while doing therapeutic and diagnostic activities and also while handling the biomedical waste. It should be ensured that, drivers, collectors, and other handlers are aware of the nature and risk of the waste. Written instructions should be provided regarding the procedures to be adopted in the event of spillage/accidents. Protective gears provided and instructions regarding their use are given. Workers are protected by vaccination against tetanus and hepatitis B.

**DISCUSSION**

With the exception of a relatively limited number of items, medical/dental waste can be disposed of using regular waste removal and disposal schemes. The majority of soiled items are not regulated waste, for example, used gloves, masks, and gowns are not considered as regulated dental waste and thus can be added to the regular trash. The US congress passed the Needlestick Safety and Prevention Act in 2000 to directs Occupational Safety and Health Administration (Organization for Safety and Asepsis Procedure Centers for Disease Control and Prevention) to revise its blood borne pathogens to establish in greater detail requirements that employees must identify and make use of effective and safer medical devices. In many countries the best biomedical waste management practices are not following meticulously by the dental profession. There are many studies available on the improper disposal of dental waste. Punchanuwat et al.[17] did a study to investigate and followed the disposal of clinical waste within dental surgeries in Bangkok and found that most wastes were disposed of into the domestic rubbish stream. Treasure and Treasure[18] conducted a national survey in New Zealand in dental practices for disposal of dental waste. It was found that the dental practices were not followed the proper disposal methods. About 56% dental practices, bloody swabs disposes into the waste paper bin; and 24.4% disposed of contaminated sharp items into general household waste. Farmer et al.,[19] in their pilot study, audited the waste collected over 1 week from 10 dental practices in Melbourne. Up to 91% of total waste was found to be cross infection control items, such as gloves, single-use cups, and protective coverings.

Nonchlorinated and incurable plastic bags can be used for the collection of waste, to avoid release of “dioxins and furans” into the environment. As per the BMW National Guidelines, 48 h is the maximum time limit for which biomedical waste can be stored before transporting to common waste treatment facility. It is required to disinfect the waste so that it is no longer a source of infection and reduces the volume of waste. Make recycled items “unusable”. As per WHO hospital waste produces 80-85% of nonhazardous waste and 15-20% of hazardous waste.[20] A dental clinic must evaluate each waste it generates to determine if it is hazardous waste or not. The waste that has not been evaluated must be assumed to be hazardous.[21]

Chin et al.[22] reviewed the environmental effects of dental amalgam, and they stated that dental mercury contamination is only a small proportion of the terrestrial mercury (3-4%), and concluded that the environmental impact of dental mercury is mainly due to the poor management of dental amalgam waste. Jokstad and Fan[23] reviewed on amalgam waste management, and stated that the discharge from dentistry is probably responsible for <1% of the total mercury discharged annually into the environment. As per WHO: SEARO, the 11 South-East Asian countries together produce some 350,000 tons of
health care waste per year, close to 1000 tons a day, which is both hazardous and nonhazardous, and it is unimaginable production from the entire world in a day and how much burden on the environment.[24]

Amalgam waste should be placed in “white rigid” receptacles with a mercury suppressant, and it should be sent to mercury recovery process prior to final disposal.[12] Amalgam particles are a source of mercury, which is known to be neurotoxic and nephrotoxic. Fetuses and newborn babies are more sensitive to mercury than adults. mercury is “bio-accumulates” in the food chain, collecting and building up in the tissues of small fish and other species and then accumulating in ever-increasing amounts as those are consumed by the other higher up the food chain. Mercury from dental amalgam can get into the environment through several ways as (a) through waste water, amalgam that is rinsed down drain or escapes from poorly maintained chair side traps and vacuum pump filters) through scrap amalgam, both contact and noncontact (this should not consider as medical waste), amalgam vapors, while removing the old amalgam fillings and if amalgam is present in the waste that is “autoclave”, the volatilized mercury will escape from the autoclave, is immediate health hazard to dental office staff and it enters into the atmosphere. (c) If amalgam scrap is discarded into ordinary trash, it will go to landfill.

To minimize amount of mercury vapor emitted from waste amalgam, ADA recommends that it should be stored under a small amount of “photographic fixer” in a closed container then it should be sent for re-cycling.[25] The empty amalgam capsules are - nonhazardous’ and can be disposed in the garbage, but do not dispose scrap amalgam into the garbage. [26]

When amalgam fillings are placed in or removed, people can absorb the vapors by inhaling or ingesting them. High levels of mercury vapor exposure are associated with adverse effects in the brain and the kidneys. To avoid these problems proper preventive measures should be taken along with proper disposal of mercury waste, and by opting alternative restorative materials in the place of amalgam.

Rowe et al.[27] mentioned that the mercury is a toxic and bio accumulative metal. Approximately 6% of mercury used by dental profession in the total of annual domestic consumption and is estimated to contributed significantly to the discharge of mercury into waste-water streams. Hörsted-Bindslev[16] suggested that by taking proper measurements it is possible for the dental profession to further reduce the mercury burden on the environment as well as, on the health of the dental personnel, can be kept below the normally accepted toxicological limits. Chaari et al.[28] in their cross-sectional study of 3 months compared the mercury impregnation in dentists and dental assistants in Monastir (Tunisia) to another population who are not exposed professionally, and they found that the urinary and salivary mercury levels were significantly increased in the exposed group.

According to Arenholt-Bindslev[29] the environmental impact of amalgam use in dentistry is minimal. No occupational health risks can be assumed, if we follow the normal occupational recommendations like water spray, coolant, and high vacuum suction during the removal of the amalgam restorations. Dentists should use amalgam separators to catch and hold the excess amalgam waste. If not the amalgam waste will be released into the sewers via drain. If the amalgam waste is sent to landfill, the mercury may be released into the groundwater or air. If it is incinerated, mercury may be emitted to the air mercury from dental practice contributing significantly to the overall mercury contamination in wastewater. A teaching module prepared by Environmental Protection Agency (EPA) and Marquette University’s School of Dentistry, to educate dental students on proper amalgam waste management. Aiming at environmentally responsible dentistry among dental students on amalgam recycling, principles, pathways, and practice. The module actions are called as “GRIT”. The GRIT steps highlight ADA’s best management practices for amalgam waste and encourage dental students to practice environmentally responsible dentistry. “Hour of the day” is employing the “GRIT” actions in the dental practice by the dentists and the dental students, to prevent mercury pollution. G - gray bag it, discard amalgam wastes into a gray bag, R - recycle it, select responsible recycling method/recycler, I - install it, install an amalgam separator, T - teach it, educates and trains the staff regarding the best management of dental amalgam. All the dental clinics should use some type of basic filtration system to reduce the amount of mercury passing into the sewer system. The amalgam separators can remove 95% of mercury waste that is entering into the sewer system.[25]
X-ray fixer is a hazardous material and should not be rinsed down the drain. Spent fixer solution contains approximately 4000 mg of silver/L, and should compulsorily send for recovery unit. The “de-silvered” fixer can mix with water and disposed down the sewer. Spent/used developer can be diluted with water and then poured into the drain. Unused X-ray film can be sent to a recycler. Lead containing foils sent for recycling, because there is a possibility of leaching of lead.

The needles should be destroyed by needle destroyer or by using syringe melting and disposal system. The mutilated sharps should be placed in puncture proof sharp container containing 1% NaOCl for disinfection. Once the container is three-fourth filled, it should be sent for recycling, because there is a possibility of leaching of lead.[30,31]

Sharps are regarded as highly hazardous health care waste since they can cause injuries and puncture wounds. Because of exposure of the contaminated sharps, the risk of transmission of blood borne pathogens, such as HIV, hepatitis B and C is always possible. According to WHO many cases of infection with various pathogens due to exposure to improperly managed health care waste was documented. Reports from US EPA, the dentists are exposing to viral hepatitis B infections is <1%, whereas dental assistants 5-8% resulting from exposure to sharp injuries annually.[22]

Waste glutaraldehyde and ortho-phenaldehyde which are the active ingredients of several brands of sterilizing solutions, before pouring them in the sanitary sewer, they should be neutralized with “glycine”. Electronic devices, batteries, fluorescent lamps, etc., comes under “universal wastes” and considered as hazardous wastes, and they may be managed under the universal waste management regulations.[33,34]

CONCLUSION

“Everyone wins, when the environmental health is respected and safe guarded”. In many developing countries, the proper disposal of infectious waste is a growing problem and if it is not managed in a sustained way, it will make the situation worse. Every concerned health personnel are expected to have proper knowledge, practice, and capacity to guide others for waste collection, proper handling techniques, and management. Dentists are encouraged to follow best management practices when disposing hazardous wastes. All the dental personnel as required to undergo continuing training programme on biomedical waste management.

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