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*RESEARCH ARTICLE*

# BIOMEDICAL WASTE: CURRENT MANAGEMENT OPTIONS AND RECOMMENDATION FOR PROSTHODONTIST, ENDODONTIST AND RADIOLOGIST

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## *Abstract*

**Aim:** Our aim was to come forward and provide recommendations to Prosthodontist, Endodontist and Radiologist on the issue of biomedical waste management i.e. management of waste generated by them.

**Material & Method:** A thorough computer search using PubMed, Google Scholar, Wikipedia and Yahoo search engine, search through cross-references and hand search in the libraries was performed.With this agroup of practitioner, academic scholars and other prominent persons of the field were consulted and a questioneare was designed. Their after, the recommendations were drafted into salient points.

**Results:** Biomedical waste likeImpression materials waste, Titanium based waste, Metal based waste, Zinc based waste, Gypsum based waste, Resin based waste and Ceramic waste, need a very precise and specific management.

**Conclusion:** Mishandling of biomedical waste (both infected and non-infected) is a growing problem for our self and society. Lack of awareness is adding a big amount of fuel to this fire. If proper segregation, collection, transportation and final disposal protocols are followed from the point of generation (keeping in mind the harmful effects on our self and our environment), we can reduce a lot of non-infected waste turning to infected ones and contribute in the safety of generations to come.



## Introduction:-

Like in medicine/Hospitals, dentistry has a big role in safe guarding our society. In dental clinics/hospitals there are number of hazardous waste generated every day. These wastes should be properly segregated, treated (where ever required) and finally disposed of. The waste generated in dentistry can be broadly categorized as Mercury containing wastes[1-7], Silver containing wastes[8,9] Lead containing wastes[10,11], Impression materials waste[12,13], Titanium based waste[14], Metal based waste [15,16,17], Sharps, Zinc based waste[11,18,19], Gypsum based waste [20,21,22], Resin based waste[23], Ceramic waste[24, 25] Liquid wastes (chemical waste, sterilizing agents, disinfection solution), Expired/outdated contaminated Medicines, Non-hazardous wastes and Plastic waste.[26]

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**Mercury Containing Wastes**
Mercury is used in dentistry as medium for stetting of restorative material known as amalgam. Amalgam includes 40-60% silver, 27-30% tin, 13-30% copper and 1% zinc which set with mercury. From a long time amalgam has been the material of chose for restoration (filling) of teeth due to its low cost, ease of application, strength and durability. It is found in clinics/hospitals as: Extracted tooth which have amalgam restoration, Unutilized amalgam (which is a left over after restoration of tooth, can be known as scrap amalgam), Unutilized elemental mercury and in various equipment like Sphygmomanometer, thermometer etc.

**Management of scrap amalgam includes:**
Amount of amalgam mixed should not exceed the amount required for restoration of teeth. Premeasured amalgam capsules can be used. This will avoid the generation of scrap amalgam. Amalgam should be recovered from extracted tooth and stored in a separate container which can be named as scrap amalgam container. Dental suction units should have disposable suction traps and amalgam separators. Trap should be changed at regular intervals to avoid amalgam accumulation. The scrap amalgam container should be handed over to a certified biomedical waste carrier (CWC). According to ADA mercury and silver in amalgam waste should be recovered through distillation process and then sent for disposal recycling.

**Management of elemental mercury includes:**
In case of unutilized elemental mercury, it should be reacted with silver to form amalgam scrap. It should be kept in a tight container (as its vapors are also very harmful). In case of spills of mercury "mercury spill kit" should be used. It should never be placed in regular garbage and washed down the drain. A CWC person should be contacted for final disposal and recycling.

**Recommendation:**
High strength GIC cement, composites etc. should be given preference for restoration of teeth. This will help in eliminating mercury from dental office. Equipment like Sphygmomanometer, thermometer etc. should be replaced by nonmercury containing instruments i.e. its digital form.

**Silver Containing Wastes**
Silver is found in dental clinics/hospitals in the form of: Undeveloped X-ray films, Fixer solution used to develop the X-ray films and in amalgam restorations.

**Management includes:**
Silver recovery/separator unit should be used to recover silver from fixer solution (desilvering). After this, recovered silver should be kept separately in a container labeled 'recovered silver' and then the left fixer should be first mixed with developer then it should be diluted with water and then it should be disposed down the septic system or sewer. Undeveloped X-ray films contain high concentration of silver and can contaminate soil and ground water so it must be treated as hazardous waste. It should be kept separately in a container labeled as 'undeveloped X-ray films'. Both the 'Recovered silver' and 'undeveloped X-ray films' container should be handed over to CWC for final disposal and recycling.

**Recommendation:**
The X-ray technology of digital radiovisiography (RVG) should be encouraged. There are many advantages of RVG such as, it reduced up to 80% of radiation to the patient compared with classic X-ray, faster imaging and developing of images (without X-ray film) and alsoit has a digital intraoral sensor instead of X-ray film.

**Lead Containing Wastes**
Lead intake can cause reproductive toxicity, neurotoxicity, hypertension etc. also it can contaminate soil and ground water (Due to its content of leachable toxins). It is found in dental office as: Lead foil in each X-ray film pack and Lead aprons

**Management includes:**
Lead foil found in X-ray film pack should be kept in a labeled separate container. Lead aprons usually last for a very long time but in case it gets damaged or is unwanted then it should be carefully kept in container. Both lead foil and lead aprons container should be handed over to CWC for its final disposal.

**Impression Materials (Used In Making Dental Impressions)**
Impressions made in dentistry can be thought to be infected (as they come in contact with the oral environment) but the thumb rule should be that as soon as you finish with making impression, it should be first disinfected (using a recommended disinfectant) then only it should be taken to pour a cast. By disinfecting impressions, we stop the possible cross infection transferring to the dental laboratory and other places of contact. Broadly used materials for this purpose are: Alginate impressions and excess (waste/left over) alginate after mixing, Rubber based impression materials, Impression compound, Zinc oxide eugenol impression paste etc.

**Management includes:**
Alginate (of alginate impressions or the left over part after mixing the material) is used to generate calcium silicate cement through high temperature calcinations, so it can be segregated. After disinfection, Rubber based impression materials are disposed in a sanitary landfill. Impression compound is disposed as a soiled waste after disinfection. Collected and handed over to CWC person. (Zinc oxide eugenol impression paste will be covered under the heading Zinc based products)

**Titanium Based Waste**
Its use in dentistry is as dental implants. In clinic they are used to rehabilitate the edentulous space.

**Management includes:**
Disinfection of dental implants, Storage of these implants in a separate container labeled as 'scrap titanium'. Handover this container to certified CWC or the company person i.e. the supplier so that it can be recycled. Titanium recycling consists in converting titanium scrap into titanium ingot with or without virgin metal by using either vacuum-arc-reduction or cold-hearth melting practices.

**Metal Based Waste**
In due course of time metal based products get corroded leading to poisoning of biological system. They are present in dentistry in the form of:Prosthodontics metal crown & bridges, Cast partial dentures, Prefabricated crowns, Orthodontic wires & brackets, Impression trays (Metal) etc.

**Management includes:**
After disinfection, base metals of crown & bridge, cast partial dentures and prefabricated crowns can kept separately and given back to the dental laboratory for recasting (recycling) as properties like hardness etc. are not affected when mixed and used with fresh alloy. Orthodontic wires & brackets and impression trays (metal) should be disinfected in the recommended manner and handed over separately to CWC for recycling. Disposable impression trays have been newly developed (composed of thermoplastic resin with reinforced fibers), can be used.

**Sharps**
Sharps are those instruments/objects that have a potential to make a cut or injury to any person, who is a generator or handler of this waste. The source of sharps in dental operatory can be: Surgical instruments, BP blades, Broken/damaged endodontic reamers and files, needles or syringes, suture needles, probes, hand scaling instruments, glass slab etc.

**Management includes:**
It should be collected in puncture proof container because if it is collected in normal polythene bag it can poke through garbage bag and cause injure as well as spread infection. After collection it should be disinfected then separated into metal sharps, glass sharps and plastic. The plastic part (of any instrument e.g. endodontic reamers and files) should be separated and treated as plastic waste. Metal should be treated with metal based waste and glass sharps separately. This can be done by the auxiliary staff or when the CWC person comes to collect the waste.
Dental clinic situated in a place having no facility of smelter; can be managed by collecting into burial pit encircled by concrete wall and place sharps layer by layer separated by lime layer. At the end this pit is covered by concrete wall.

**Zinc Based Wastes**
A study by Leirskar and Helgeland reveals that zinc based cements can be cytotoxic and damaging to the animal cells although zinc is required for the optimal growth and development of all living organisms from micro-organisms to man. Zinc exists in dentistry in the form of used/ unused (leftovers) of: Base material (Zinc

oxyphosphate, Zinc polycarboxylate, Zinc oxide eugenol), Temporary cements (Zinc oxide eugenol, Zinc polycarboxylate), Permanent restorative cement (Zinc oxide eugenol Type II, Zinc Oxyphosphate, Zinc Polycarboxylate), Impression materials etc.

**Management includes:**
The used/unused zinc based products should not be put down the drain or sewer system to avoid aquatic toxicity rather it should be treated as soiled waste and handed over to CWC for proper management.

**Gypsum Based Wastes**
Gypsum products consist of calcium sulfate dihydrate ($CaSO_4.2H_2O$). In dental clinics/hospitals it is used in fabrication of dies (casts) from the dental impressions. In dental office it is present in the form of powder which is used to pour the impressions and finally make a cast. Depending on the use, four type of gypsum products are used in the clinic for this purpose: Dental plaster (Type I), Dental Stone (Type II), Die stone (Type III) and Die stone high strength & expansion (Type IV).

**Management includes:**
Dental casts made of gypsum products are usually disposed as regular non-hazards waste and finally these casts are disposed as landfill. Regular landfill has favorable carbon-containing environment for sulfate-reducing bacteria so gypsum placed as landfill will decompose and release toxic hydrogen sulfide so it is advisable not to dispose in a regular manner rather it should be stored separately in a container and handed over to CWC person for recycling.
A study reveals that when one ton of the ordinary gypsum is recycled, it saves around 1,000 pounds of black alkali, 1 ton of lactic acid, 500 kwh of energy and when one metric ton of gypsum is recycled it saves 28 kwh of energy, 4 pounds of Aluminium.

**Resin Based Waste**
The use of resin based products has a long history. In 1901 Otto Rohm first addressed the topic 'polymers of acrylic acid' in his dissertation. Later on synthesized as poly methyl methacrylate (PMMA). Approximately after 30 years in 1962 composite material (combination of dimethacrylates i.e. epoxy resin, methacrylic acid, silanized quartz powder and recently photoinitiatoris also added) were developed. Currently Compomers are introduced which are combination of composite and glassionomer. Some of the application of resin based products include: Complete denture prosthesis (CD), Removable partial denture (RPD), Restoration of cavity, Buildup of fractured/damaged teeth etc.

**Management includes:**
For RPD's the metal part of the denture base should be removed manually and kept with 'metal based waste' container and acrylic part should be kept in the container of resin based waste. It should be handover to CWC for management.

These materials were usually send for long-term landfills after disinfection but a study revealed that in US approximately 14,000 landfills have been closed since 1978 due to being full or environmental issues. The problem with composite arises that the recycling cost is near or more than the product received after recycling.

**Ceramic Waste**
There are two types of porcelain used in dentistry, high fusing and low fusing dental porcelain, of these low fusing is commonly popular dentistry. Porcelain (ceramic) is made up of clay (kaolin-hydrated aluminosilicate), silica, feldspar (mixture of potassium & sodium alumino silicate), fluxes (eg borax) & metal oxide (for pigmentation). They are found in dental office as: Discarded/ fractured All ceramic crown and bridges which also includes latest form of ceramic i.e. zirconia. They are also known as metal free crown and bridges.

**Management includes:**
Disinfection should be done in a regular manner. Ceramics are not that hazardous to environment but of course it will utilize the landfill so instead of just discarding it as a regular waste, it can be segregated for recycling.

**Liquid Wastes/ Chemical Waste/ Disinfectants/ Sterilizing Agents**
Many chemicals, disinfectants and sterilization agents used in the dental office can have negative impact on environment if they are not disposed properly. Moreover, developer and fixer from x-ray room, vomits, pus, blood stained saliva etc. are also the source of liquid waste generated in clinics.

**Management includes:**
Infected body fluid should be collected into 10% sodium hypochlorite solution for twenty minutes and then drain into sewage. Chemical waste should be first neutralized and then can only be drain into sewage. Disinfectants and sterilization agents should be neutralized before pouring the solution in the septic system as this can significantly disturb the functioning of the system by killing the bacteria, which breakdown the waste.

**Recommendations:**
Use steam or dry heat to sterilize dental instruments. If using disposable plastic components, use non-chlorinated plastic (i.e. not PVC). Avoid halogenated products (i.e. chlorine or iodine). Never pour concentrated alcohols, ethers or peroxides down the drain as these materials are flammable and could start a fire of explosion.

**Expired/Outdated Contaminated Medicines**
Expired medicine is generally present in dental clinic/ hospitals.

**Management includes:**
It can be handed over to supplier, incinerate at high temperature. To prevent it; policy in hospital or clinic can be modified such as: purchase long expiry drug, maintain register, near expiry drugs can be handed over to department having fast consumption.

**Non-Hazardous Waste**
It includes general household waste generated from hospital including non-infected waste (Paper, Cardboard, Aluminum, Stationary waste, Plastic containers, etc.).

**Management includes:**
Its use should be minimized, where ever possible soft file i.e. electronic form should be preferred. Use of high recyclable content should be promoted. Use of refillable bottles for disinfecting or cleaning products, should be preferred. Where ever possible re-useable devices (for dental procedure) should be the first choice. It should be handed over to municipality to dispose of as household waste.

**Plastic Waste**
Plastic waste should be collected in different color coded bin depending on whether it is infected or non-infected. Infected plastic waste from dental clinic may be such as plastic part of syringe, gloves, riles tube, drip set, blood bag, plastic glucose bottles, impression trays etc. Non-infected plastic waste includes used water bottles, disposable tea cups, polythene bags, wrapper of gloves and other materials etc.

**Management includes:**
Infected plastic waste should be collected separately in different color coded bin than non-infected plastic waste which should be collected in bin of general non-infected waste. Plastic should never be burn in open or closed chamber because it produces dioxin and furans which is bio-accumulative as well as carcinogenic so, infected plastic waste should be autoclaved, shred and then can be given to local vendor to recycle. Non-infected plastic waste can be handed over to municipality and then can be separated manually and recycle.

## Conclusion:-
Mishandling of biomedical waste (both infected and non-infected) is a growing problem for our self and society. Lack of awareness is adding a big amount of fuel to this fire. If proper segregation, collection, transportation and final disposal protocols are followed from the point of generation (keeping in mind the harmful effects on our self and our environment), we can reduce a lot of non-infected waste turning to infected ones and contribute in the safety of generations to come.

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