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### UTJECAJ OTPADNIH DENTALNIH METALNIH MATERIJALA NA OKOLIŠ

### THE EFFECT OF WASTE DENTAL METALLIC MATERIALS ON ENVIRONMENT

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#### SAŽETAK

Dentalna medicina je struka posvećena promoviranju i unapređenju oralnog i općeg zdravlja, te zbog toga ima značajnu ulogu u zdravlju ljudi. Ordinacije dentalne medicine proizvode mnogo vrsta dentalnog otpada, kao što su: teški metali i biomedicinski otpad, a koji može naštetiti okolišu ukoliko nije odložen na odgovarajući način. Među tim otpadom živa, srebro i olovo su najštetniji za ljude ali i okoliš. Da bi se smanjio utjecaj na okoliš, stomatolozi bi trebali poduzeti sve moguće mjere za izbjegavanje proizvodnje bilo kojeg otpada ili barem pokušati smanjiti količinu otpada na minimum. U tom kontekstu je razvijena “eco-friendly” dentalna medicina kao novi pristup dentalnoj praksi. Ona se temelji na uporabi netoksičnih proizvoda, smanjenju otpada, očuvanju energije i smanjenju zagađenja. Konačno, obrazovanje o pravilnom upravljanju otpadom iz dentalnih ordinacija i njegovom odlaganju zahtjeva više pažnje.

*Ključne riječi: dentalna medicina, ljudsko zdravlje, okoliš, metalni materijali, dentalni otpad*

#### ABSTRACT

Dental medicine is a profession dedicated to promoting and enhancing oral health and well-being and therefore plays a significant role in human health. Dental practices produce many types of dental wastes, such as: heavy metals and biomedical waste, which could cause harm to the environment if it is disposed improperly. Among them, mercury, silver and lead are the most harmful for humans and the environment as well. In order to reduce the impact on the

environment dentists should take all possible activities to completely avoid the production of any waste or at least try to reduce the amount of waste to a minimum. In that context, eco-friendly dentistry as a new approach to dental practice is developed. It is based on use of non-toxic products, waste reduction, energy conservation and pollution prevention. Finally, education regarding the proper management and disposal of waste from dental offices needs more attention.

**Key words:** *dental medicine, human health, environment, metallic materials, dental waste*

## 1. INTRODUCTION

Dental medicine as a branch of medicine plays a significant role in human health. It is a profession dedicated to promoting and enhancing oral health and well-being. For that purpose, dentists use a variety of materials and equipment which present potential challenges to the environment. These materials include heavy metals and biomedical waste. Environment contamination with these materials is a worldwide concern. [1-3]

Dental practices produce many types of dental wastes which could cause harm to the environment if it is disposed improperly. Therefore, an effective management is required to minimize their environmental effect. [4]

Dental waste is classified as medical waste, which is divided into two major groups: common waste and special waste. Since the first one is similar, in terms of quality, to municipal waste it should be treated in accordance with the law regarding to municipal solid waste. Special waste include: infectious, chemical and radioactive waste. Each of them requires a certain management method. In order to prevent a spreading of the materials containing the dangerous and pathogenic agent that can cause a health and environmental risks, these two types of waste should not be mixed with the municipal waste. Namely, the most important work in the field of dental waste management is to prevent the mixing of all the components, because the components of dental wastes have different characteristics. Therefore, the management method should be performed on the basis of these characteristics. [5]

The waste products generated by dental laboratories impact on the environment as well on human health due to the components of used dental materials. Namely, chemical hazards in denture production include dental alloys (e.g. Vitallium, Wironit, Vicomp), ceramics, investment materials, dental plasters, acrylics (e.g. methyl methacrylate, MMA, ethylene glycol dimethacrylate, EGDMA), polymers, etc.. Metallic alloys used for the crowns, bridges, and dental prostheses production contain 35-65 % of cobalt, 20-30 % of chromium, 0-30 % of nickel balanced by molybdenum, silica, beryllium, boron, tantalum, cadmium. Chromium can cause liver and kidney damage and respiratory disorders as well, while cadmium can cause lung cancer and is also linked to kidney disorder. Nowadays, gold-palladium-based alloys are rarely used. Dental alloys contain silver. It is a heavy metal which could enter in water system due to inadequate disposal of wastes from dental laboratory. Biomedical waste (sharps, disposables, soiled waste) generated during the diagnosis, treatment or immunization is potentially hazardous for human health. [6-8]

### Mercury

Due to its physical and mechanical properties, durability, relatively low cost and ease of use, dental amalgam is one of the most commonly used materials in restorative dentistry for more

than a hundred years. It is an alloy made of typically 50 % mercury combined with a powder of silver, copper, tin and sometimes zinc, indium or palladium. [9-12]

A various waste products could be generated during the placement and removal of dental amalgam restorations. Such as: dental amalgam scrap, i.e. the amalgam particles that have not come into contact with the patient or amalgam waste, i.e. the particles that have come into contact with patient secretions, amalgam sludge, i.e. the fine particles present in dental office wastewater, commonly trapped in chair-side traps and vacuum filters and elemental mercury vapour can be released as well. [2]

Since the mercury is its major component, dental amalgam waste has potential harmful effects on humans (toxicity, allergenicity) and environment (bioaccumulative element) which strongly depends on its chemical form. The metallic form, which is only used in dentistry, is mainly absorbed through skin in the human body after which is converted into mercury ions which can be a toxic. In the environment, organic and inorganic mercury compounds are present as well. Hence, mercury can reach the environment through wastewater, vapors or scrap amalgam and accordingly it can be accumulated in aquatic and terrestrial food chains. [9-12]

Amalgam in dental wastewater originates from waste amalgam fillings. Namely, during the filling tooth cavity dentists always overfill it in order to carve the filling into satisfactory shape. Removed excess of dental amalgam is rinsed into a chair-side drain as well as removed restorations. Discharged mercury in dental wastewater can be present in many forms, such as: elemental, ionic and organic mercury which could be under certain conditions in water converted by microorganisms to highly toxic form of methylmercury. Since fish cannot eliminate it from their tissue, methylmercury can bioaccumulate up the food chain. Therefore, if fish with high concentrations of methylmercury is consumed regularly, it can be harmful for humans and wildlife. [9-13]

Despite the fact that dentists produce small amounts of environmentally unfriendly waste, it accumulates and presents a danger to the environment. Because of aforesaid, in recent, a concern about water contamination by heavy metals particularly by mercury from dental amalgam waste was raised. [7]

### Silver

Another heavy metal that can enter water system in the case of improperly disposed dental waste is silver. It is component of dental amalgam, but also in the form of thiosulfate in radiographic fixer solutions presents negatively affect the environment. Further, not all forms of silver are equally toxic, e.g. free silver ions are more toxic than silver thiosulfate. Fixer used for x-rays development in dental offices is a hazardous material that should not be rinsed down in the drain. Since spent fixer solution could contain up to 4000 mg of silver per liter, a silver recovery unit should be used to recapture the silver from the fixer. However, it should be on mind that many cleaners for x-ray developer systems contain another toxic substance, chromium. [1,4,7]

When dental radiographic film is processed liquid waste such as: developer, fixer and wash water is generated. This waste is stored in sealed plastic containers. Because of the presence of lead shields, packages of dental radiographic films can have adverse impact on the environment. [14]

### Lead

The lead shields inside of each x-ray packet are a byproduct of traditional radiography. Although it is a relatively small, a significant amount of waste could be produced. Like mercury and silver, lead persists in the environment. Lead is nonessential element that when is accumulated in the organism it is considered as a toxic for humans and animals. Namely,

toxic effects caused by lead can affect almost all organs and systems in the body, particularly blood and nerve system. Since it does not degrade, lead can methylate and contaminate the soil and groundwater during decades. Therefore, lead containing waste should never be disposed of in the regular garbage but should be recycled or treated as a hazardous waste. [6,14]

#### Other dental metallic waste

Dental activities generate the sharp metallic waste as well. It includes: needles, scalpels, drills, blades, orthodontic wires. For usual patient treatment dentists use sharps, lancets, needles. If these are improperly handled and disposed after use, there is a potential risk for human health as well as for the environment. Hence, in order to prevent the spread of disease, sharps and other potentially infectious waste should not be mixed with the garbage. [14,15]

Dentists should take all possible activities to completely avoid the production of any waste. Avoidance could be achieved by adhering the certain measures, such as: appropriate training programs for staff, monitoring the amounts of all waste sent for treatment and disposal etc. If that is not possible, it should be tried to reduce the amount of waste to a minimum. [16]

Traditional dentistry generates waste materials that harm the environment. A new approach that combines dental practices and environmental protection is Eco-Dentistry or Green Dentistry. Eco-dentistry association defines green dentistry as “a high-tech approach that reduces the environmental impact of dental practices and encompasses a service model for dentistry that supports and maintains wellness”. It is based on use of non-toxic products, waste reduction, energy conservation and pollution prevention. Furthermore, green dentistry uses a sustainable approach to encourage dentists to implement new strategies to reduce consumed energy and generated waste. [2,17-19]

Dental medicine has advanced in terms of materials and techniques as well in order to provide the best to the patient. But, in this context, the environment should be conserved. [19]

The green dentistry concept involves high-tech dentistry, reduction of dental waste and pollution, savings of water, energy and money. Namely, by the reduction of waste, overhead costs are reduced and impact on landfills is minimized. The major way for reducing the waste is to extend the life of things that are used. Therefore, the four “R” were introduced: Rethink, Reduce, Reuse and Recycle. [17,19]

Rethink: Environmentalism and sustainability are both considered states of the mind. [16] Implementing small, affordable changes can make a significant impact on long term environmental sustainability. Thinking about practices and protocols and discussing them with dental team may reveal ways to reduce, reuse, and recycle. [19]

Reduce: Dentists can reduce materials and water consumption by recycling the bottles, cans, batteries and paper; switching to stainless steel impression trays, using the glasses and mugs instead of disposable cups, using the steam sterilization eliminate the use of chemicals etc. [17]

Reuse: By reusing items instead of throwing them away, resources and energy necessary to manufacture new products are saved. This ensures to prolong the use of items. In that context, dentists should use a reusable face shield, wear cloth lab coats instead of paper ones, provide glass or ceramic rinse cups etc.. [19]

Recycle: Recycling is a viable way to reduce overall contamination of the environment. Hence, in dental office should be participate in an instruments recycling program that turns them into industrial metal, use sharp disposal service that recycles them into building materials etc.. [19]

In dental offices energy could be conserved by using the solar energy and fluorescent lamps, water heaters and eco-friendly dental technologies, such as CAD/CAM systems and various digital programs. [17]

## 2. CONCLUSION

Dental practitioners should promote not only the human health but the environment as well. Namely, dental activities produce waste that can be harmful for humans and the environment. Therefore the importance of the proper waste disposal should be emphasized. Dentists have to provide the professional training courses for their employees with purpose of obtaining the knowledge about the reduction ways of the environmental impact produced by wastes from dental offices. A proactive approach is a legal obligation to ensure dental services for humans benefit with minimum impact on the environment. It is a moral and ethical obligation as well. Reduction of waste and change of consumption patterns are realistic and could be achieved. [2,14,17]

Green dentistry is a high-tech approach that reduces the environmental impact of dental practice and therefore it is an environmentally friendly way of practicing dentistry. By combining the health of humans with the health of the environment, ecofriendly dentistry provides an opportunity to reduce further degradation of our planet [18-20]

Hence, education regarding the proper management and disposal of waste from dental offices needs attention. In that, academic institution could play a significant role. [11]

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