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Review Article

Eco-dentistry: Sustainable practices for healthier life and a greener planet

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ABSTRACT

Background: Eco-friendly dentistry, or "Green Dentistry," is a concept aimed at minimizing the environmental impact of dental practices by reducing waste, conserving energy, and preventing pollution. The idea first emerged during the 5th European Dental Students' Association Congress in Belgrade, Serbia, in March 2003. It was proposed as a new and evolving practice to address the environmental harm caused by conventional dental methods.

Objective: This review aims to present a series of "green" recommendations for dental professionals, patients, and dental industries, providing practical, sustainable alternatives to promote eco-friendly practices within the field of dentistry.

Methods: An electronic search was conducted using the PubMed database, focusing on peer-reviewed articles up to February 2024 using the keywords "green dentistry," "eco-friendly dentistry," and "dental waste," resulting in 45297, 1186, and 9372 items, respectively. After a thorough review, relevant data from other electronic sources were also included for additional information.

Results: The adoption of green dentistry practices encourages the integration of sustainable technologies and methods by dental professionals. It promotes the use of eco-friendly materials, digital tools to reduce paper waste, energy-efficient equipment, and recycling programs, all of which contribute to reducing the ecological footprint of dental practices.

Conclusion: Green dentistry offers a viable approach to making dental care more sustainable by reducing waste, conserving resources, and preventing pollution. By embracing sustainable practices, dental professionals, patients, and industries can collectively help minimize the environmental impact of dental care, ultimately promoting a greener wellness lifestyle.

Keywords: Eco-dentistry, Hazardous material, Green dentistry, Green recommendation, Dental professionals

INTRODUCTION

"The greatest threat to our planet is the belief that someone else will save it."

— Robert Swan

Eco-friendly dentistry is a concept that aims to minimize harm to the environment caused by conventional dental practices. The traditional methods have already caused a considerable amount of damage to the environment, and it is necessary to take certain measures to control the situation. The idea of green dentistry is based on preventing pollution, saving energy, and minimizing waste. The medical and dental industries are adopting new technologies to reduce

environmental impact and decrease waste production. Green dentistry encourages dentists to use sustainable approaches, such as implementing new technologies and strategies, to reduce the burden on the environment. Many practical and easy alternatives can help in the practice of green dentistry. This review provides a series of "green" recommendations for dental professionals, dental patients, and dental industries to make this idea work.[1-3]

MATERIALS AND METHODS

An electronic search was conducted using the PubMed database, focusing on peer-reviewed articles up to February 2024 using the keywords "green dentistry," "eco-friendly dentistry," and "dental waste," resulting in 45297, 1186, and 9372 items, respectively. Articles with significant findings, recent advancements, and practical implications were prioritized, while redundant or low-relevance studies were excluded. After a thorough review, relevant data from other electronic sources were also included for additional information. A table of selected articles included in this review is given below [Table 1].

HISTORY

The concept of "green dentistry" originated in the 5th European Dental Students' Association Congress held in Belgrade, Serbia, in March 2003. During the meeting, the Greek delegation proposed the outline of the project and suggested its adoption by the assembly.[4] On April 3, 2007, Dr. Ali Farahani and Mittale Suchak published a study that introduced the concept of eco-friendly dentistry to the international community.[5] Eco-friendly dentistry refers to an approach that promotes sustainable practices in dentistry. This means reducing resource consumption, minimizing waste, and safeguarding the environment. In addition, eco-friendly dentistry aims to promote the well-being of everyone in the clinical environment by minimizing the chemicals in the air we breathe.[4]

In 2008, Dr. Fred Pockrass and his wife, Ina Pockrass, co-founded the Eco-Dentistry Association (EDA). The EDA's main goal is to provide education, standards, and connections to patients and dentists who practice green dentistry. The EDA also aims to help dentists reduce their operating costs by suggesting safe and reusable alternatives, such as replacing paper with digital media whenever possible.[4]

The term "eco-friendly dentistry" was coined by Dr. Gorankralj and Dr. Steven Koos. They define it as a new practice in dentistry that combines a commitment to sustainability, prevention, precaution, and a minimally invasive approach focused on both the patient and the environment. Dr. Steven Koos trademarked and established the definition of eco-friendly dentistry on December 22, 2009.[1]

WHAT IS ECO-DENTISTRY?

Green dentistry has been defined by the EDA as "a high-tech approach that reduces the impact of dental practices and encompasses a service model for dentistry that supports and maintains wellness."[1]

The concept behind "Green dentistry" involves water and energy conservation, use of non-toxic products, reduction of waste, and elimination of hazardous toxins.[6]

NEED FOR IT

Dental practices usually generate a significant amount of waste, which can be of various types. Most of these waste materials can be hazardous, and therefore, their management and disposal require extra care. Among the different kinds of waste produced at dental offices, biological waste is a major component. The biological waste produced at dental offices may include infectious waste (blood-soaked gauze pieces, cotton, etc.), hazardous waste (mercury and lead foils), chemical waste (such as spent film developers, fixers, cleaning solutions, and disinfectants), sharps, and used disposable items.[7]

Remember to implement energy-efficient technologies and practices, such as using energy-efficient appliances and adopting renewable energy sources, to reduce the environmental impact of dental offices. Ensure that infectious waste products are disposed of properly according to the established protocol.[8]

HAZARDOUS MATERIALS

Developing solution

The developing solution used in radiology comprises of phenidone, hydroquinone, sodium or potassium hydroxide, sodium bicarbonate, sodium sulfite, and potassium bromide. Of all of these, hydroquinone poses a serious risk to human health and the environment[8,9] [Figure 1].

Disposal of developing solution

To dispose the developer solution in an environmentally friendly way, it is recommended to dilute, oxidize, and undergo photodecomposition. Remember to handle the solution in a way that makes it less harmful to the environment compared to the original strength solution. It is crucial to dispose of the solution in accordance with current local and national legislation and through a licensed waste contractor.[10,11]

Fixing solution

After an X-ray film is exposed and developed, the silver in the emulsion remains to a large extent. The fixing process removes the remaining half of the film, which is unexposed silver. However, it is important to note that a used X-ray fixer is considered hazardous waste due to its high silver content. The regulatory level for silver in wastewater is set at 5 mg/L, but used fixer typically contains between 3,000 and 8,000 mg/L of silver. Therefore, it cannot be disposed of as common solid waste or sewered.[11-13]

Disposal of fixing solution

Recycle the fixer solution by delivering it to a silver recovery unit operator, selling it, or paying for it.[11] Purchasing a silver recovery unit can be a viable option, depending on the volume of fixer that needs disposal.[14]

Lead

Lead foil used for shielding X-ray film or protective lead shields should not be thrown in the trash. These materials are considered hazardous waste and should be recycled for their scrap metal content.

Recycling of lead

Studies indicate that many dentists currently recycle lead foil. Companies that handle the recycling of dental amalgam or fixer often also accept lead waste. These devices are designed to separate fine particles produced during procedures such as restoration finishing, polishing, and removal from wastewater. This process reduces the amount of waste sent to wastewater treatment facilities and helps protect the environment.[15]

Amalgam

Dental amalgam is a widely used and durable material for permanent tooth restorations. However, it contains mercury, silver, and other metals that can be harmful to the environment. Mercury, a component of dental amalgam, is biocompatible but also poses toxic risks to plants, animals, and humans [Figure 2].

Recycling of amalgam

The most crucial environmental step for any dental office is installing an amalgam separator to stop mercury from dental fillings from contaminating the water supply. Amalgam separators are easy to find, quite affordable, and require minimal maintenance. They are a crucial piece of equipment in dental offices used to efficiently separate and collect amalgam waste[10] [Figure 3].

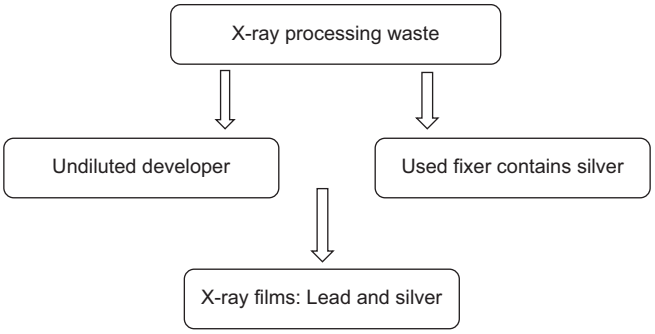

Figure 1: Waste generated through X-ray processing.

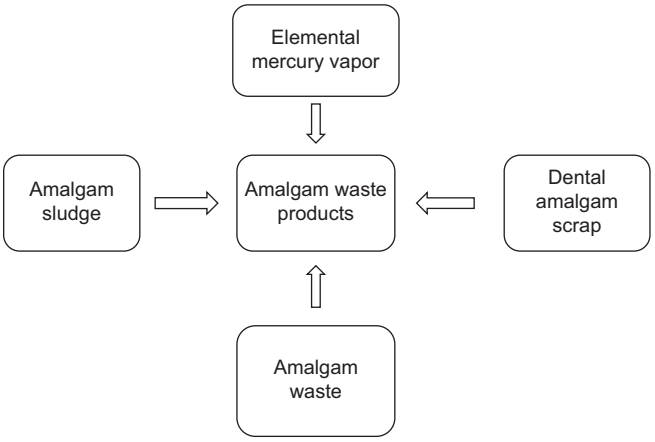

Figure 2: Amalgam containing waste product.

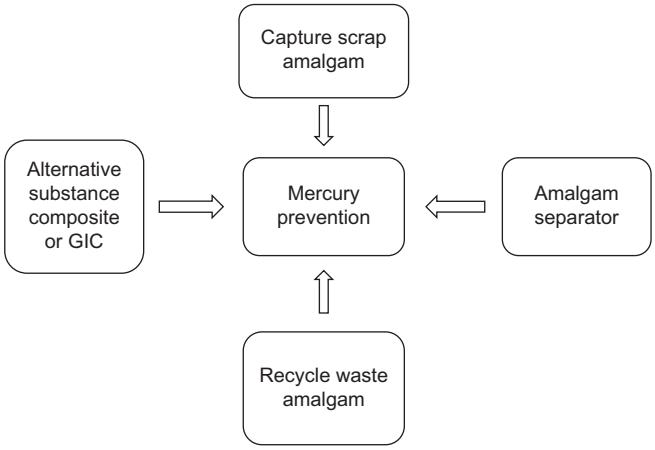

Figure 3: Prevention for mercury-containing waste. GIC: Glass ionomer cement.

Disposable items

Disposable items that are used in dental clinics should be replaced with reusable alternatives. One often overlooked source of environmental harm comes from the dental industry. Many dental practices rely heavily on disposable items, like plastic bibs, cups, and flossing tools. These single-use products, though convenient, contribute significantly to plastic waste. Since they are often made from non-biodegradable materials,

they take hundreds of years to decompose, ending up in landfills or polluting our oceans. This plastic build-up harms wildlife and ecosystems, highlighting the need for sustainable alternatives in dental care.

Items that are used in the clinics are:
1. Plastic suction tips
2. Latex gloves
3. Syringes
4. Plastic pouches
5. Plastic pouches, etc.

These single-use products shed plastic fibers and particles. Release of certain toxins, polystyrene, and bisphenol A can be released into the water.

All disposable items used in a dental clinic can be substituted with the following:
1. Cloth patient bib
2. Cloth headrest cover
3. Reusable cups
4. Reusable metal suction tips and saliva ejectors.[16-18]

ELEMENTS OF ECO-DENTISTRY

Minimizing waste is vital, and we can achieve this by prolonging the life of the items we use. Health professionals play a key role in healing our planet by embracing the four 'R's: Re-think, Reduce, Re-use, and Recycle. Although recycling is often seen as the main way to manage waste, reducing and reusing are actually more impactful. By adopting these four simple actions, dentistry and dental hygienists are leading the way in making the medical field more sustainable[19] [Figure 4].

Reduce

To lessen the strain on the Earth's resources, individuals need to reduce their consumption of products that contribute to pollution. Reducing waste and promoting sustainability can be achieved through several approaches. One way is by buying products with minimal packaging and using reusable plastic containers for items such as cleansing and disinfecting solutions, which helps decrease overall waste production. In addition, adopting digital technology for tasks such as imaging impressions, cancer screening, charting, and marketing enhances efficiency, accuracy, and data accessibility, contributing to both environmental and operational improvements. To further minimize chemical use, steam sterilization can be implemented as a safer and eco-friendly alternative.[20,21]

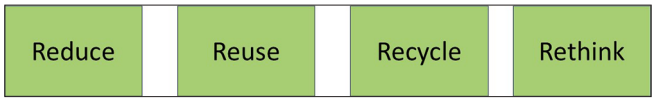

Figure 4: 4 Rs in green dentistry.

Re-use

This step is aimed at prolonging the use of items, which in turn helps to reduce waste. By re-using items, we can extend their life cycle and eliminate the need to transport them away. For example, rather than using plastic single-use items, we can choose stainless steel alternatives, like impression trays, that can be sterilized and reused for years. Using materials that conserve resources and extend their lifespan offers a more sustainable solution. For example, opting for reusable face shields reduces the need for single-use plastics, while providing glass or ceramic rinse cups minimizes waste and eliminates the constant disposal of plastic alternatives. These practices not only conserve resources but also contribute to a more environmentally friendly approach.[19]

Re-cycle

The recycle triangle, which is depicted by three green lines, represents the recycling process. Much of the waste that goes to landfills can be reprocessed and recycled into new products. Recycling is an effective method for reducing resource waste, lowering the energy required to extract raw materials, and mitigating water and air pollution from landfills and incinerators. By recycling, we can greatly reduce the environmental impact and protect the planet.[22,23]

Following are the steps that are to be conducted when a material is going to be recycled:
1. Gathering recyclable materials
2. Recycling materials to create something fresh
3. Resale of the recycled material.[24,25]

Here, these steps can be explained as first differentiating and collecting materials that can be recycled. Second, remanufacturing those materials to build something fresh and the final step is to put that product on the counters for resale.[5,26]

RE-think

Rethinking is a powerful cognitive process that invites us to reconsider and question our perspectives. Re-thinking before every step enables us to re-evaluate many practices that can be carried out in a more ecologically friendly manner. Finding new methods to reduce, reuse, and recycle may benefit from re-examining procedures and protocols.[26,27]

ALTERNATIVE PRACTICES AND SOME GREEN RECOMMENDATIONS

The tide is turning toward eco-conscious practices in dentistry. To minimize waste, dental offices can implement several changes. Here are a few of the green recommendations that can be used as an alternative option for conventional products and techniques.

Table 1: A list of selected articles included in this review.

Topic	Type of articles	Author	Publication	Year	Key words
Eco-friendly dentistry: preventing pollution to promoting sustainability	Review	Mittal, *et al.*[1]	Indian Journal of Dental Sciences	2020	Eco-friendly dentistry, pollution, sustainable development, waste disposal
Green dentistry: the art and science of sustainable practice	Review	Mulimani P.[2]	British Dental Journal	2017	Conservation of energy resources, conservation of natural resources/ methods, dental waste
Green dentistry, A metamorphosis towards an eco-friendly dentistry: a short communication	A short communication	Rastogi V., *et al.*[3]	Journal of Clinical and Diagnostic Research	2014	Dental wastes, developing country, environment, innovative dentistry
Eco-friendly dentistry: not a matter of choice	Review	Adams E.[5]	Journal of the Canadian Dental Association	2007	Conservation of natural resources, dentistry, environmental restoration and remediation
Being environmental friendly in dental radiology - "be the change"	Review	Adappa, *et al.*[14]	Balkan Military Medical Review	2015	Eco-dentistry, environment, hazardous Wastes, oral radiology, recycle, disposal considerations
Green dentistry: the new norm	Review	Velaparambi R & Gupta S.[20]	Journal of Oral Health and Community Dentistry	2023	Biomedical waste, green dentistry, herbal dentistry
Go green dentistry	Review	Passi S & Bhalla S.[30]	Journal of Education and Ethics in Dentistry	2012	Community health, eco-friendly dental association, eco-friendly environment, green dentistry
Going green with eco-friendly dentistry	Review	Avinash B., *et al.*[31]	The Journal of Contemporary Dental Practice	2013	Eco-friendly, environment, green, atmosphere
Green dentistry: the future	Review	Rathakrishnan M & Priyadarhini A.[32]	Journal of the International Clinical Dental Research Organization	2017	Biomedical, dental waste, eco-friendly, environment, green dentistry
Eco-dentistry: the environment-friendly Dentistry	Review	Chopra, *et al.*[35]	Saudi Journal for Health Sciences	2014	Energy conservation, green dentistry, pollution, waste

To promote sustainability in dental practices, several environmentally friendly initiatives can be implemented. For example, using digital X-rays instead of manual X-rays helps reduce radiation exposure and waste. Lead-free X-ray aprons and shielding can also be used to protect patients while minimizing environmental impact.[28] In terms of sterilization, adopting dry heat or steam methods instead of chemical sterilization is a safer, greener alternative. Old and damaged tools can be recycled and repurposed into other metal objects, reducing waste.[29] In addition, non-toxic, biodegradable surface cleaners and disinfectants can replace harmful chemicals, ensuring a cleaner, safer environment. Reusable stainless steel or compostable impression trays offer a more sustainable option than single-use plastic trays. Sustainable interior design materials, including wall paints made from post-industrial or post-consumer recycled materials, further contribute to a greener practice.[30]

Building design can also play a role in energy conservation by reducing the use of bricks and opting for concrete, which helps maintain a cooler indoor temperature, thereby

reducing the need for artificial lighting. Maximizing natural light and ventilation also contributes to energy savings.[9,31] Choosing Energy Star-rated equipment, such as printers and computers, ensures electricity conservation and reduces operational costs. Switching to light-emitting diode (LED) and high-efficiency fluorescent lights further reduces energy consumption. Other practical steps include encouraging patients to turn off taps while washing their hands, sterilizing equipment only when the load is complete, and transitioning to paperless systems for better efficiency. Finally, stocking all-natural oral care products, such as toothpaste and mouthwash, ensures that dental practices are fully aligned with eco-friendly principles.[32,33]

Biomedical waste management (BMW) in India

India's regulations for managing biomedical waste are aimed at protecting public health and the environment from the harmful effects of improperly disposed waste. The BMW rules, 2016 govern the handling, segregation, collection, transportation, treatment, and disposal of biomedical waste. These rules were notified under the Environment Protection Act, 1986, and are periodically updated to reflect the changing nature of medical practices and waste generation.

BMW rules, 2016

Biomedical waste is classified under four categories, namely Yellow, Red, Blue, and White, which are separated and treated as per specified practices. The BMW rules, 2016, require healthcare facilities to segregate waste at the point of generation to ensure it is disposed in an appropriate category. Waste must be transferred in leak-proof containers, and healthcare facilities are supposed to use technologies that are authorized for disposal, including autoclaving, incineration, and shredding, depending on the category of waste. Finally, the rules recommend that personnel handling biomedical waste should be trained recurrently to ensure practice safety. Healthcare facilities are also expected to maintain the records of generation, treatment, and disposal of wastes and submit an annual report to the competent authorities concerned for compliance and monitoring.[34]

CONCLUSION

Dental professionals are increasingly aware of the impact their work has on the environment. As a result, they are voluntarily adopting measures to make their practices more environmentally friendly. This practice is especially crucial in today's era of increased environmental awareness and the presence of laws designed to protect the environment. In addition to their legal obligations, dental professionals have a moral and ethical duty to adopt sustainable dentistry practices. These practices benefit not only their patients and staff but also the environment. Examples of such practices include responsible handling of solid waste, recycling, and reducing energy consumption.

While progress has been made, there is still a long way to go in promoting sustainable practices in the dental industry. Meaningful change requires the involvement of every member of the dental community, including patients, staff, students, and other stakeholders. To accelerate this progress, dental students must be educated on proper dental waste disposal and environmentally responsible practices, with compulsory education integrated into undergraduate programs. Dental industrialists should be made aware of eco-friendly materials, and new dental practitioners should prioritize green recommendations. In addition, providing sufficient information on the correct disposal and handling of dental waste is crucial for fostering long-term sustainability.

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