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Review Article

Eco-friendly dentistry: Understanding the environmental impact in dental practice

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ABSTRACT

Dental practices, akin to other branches of the healthcare industry, are vital for public health. However, they also play a part in environmental detriment via waste production, energy consumption, and the management of hazardous substances. This review endeavors to conduct a thorough analysis of the environmental impact stemming from dental facilities, precisely identifying main contributors to pollution and waste and will explore pragmatic approaches and remedies for fostering a greener, more sustainable dental sector focusing on waste reduction, energy efficiency, water conservation, and sustainable procurement. This article also underscores the significance of societal principles, community welfare, involving stakeholders, financial advantages, crafting policies, and demonstrating leadership to translate the idea of eco-friendly dentistry into tangible action. Green dentistry advocates for the utilization of biodegradable, non-toxic, and mercury-free materials and products to reduce both the quantity and harmfulness of dental waste. Concurrently, bio-dentistry embraces a holistic patient care approach while prioritizing environmentally conscious practices.

1. Introduction

Rising global apprehensions over the environmental consequences of human actions have intensified scrutiny on various sectors, including healthcare, renowned for its substantial waste output and energy usage. Dental practices, in particular, face heightened scrutiny in this regard. Green dentistry emerges as a methodology aimed at reducing the environmental footprint of dental facilities.[1] This encompasses not just the utilization of sustainable materials and techniques but also entails adopting eco-conscious approaches in waste management, energy preservation, patient care and education initiatives. It provides actionable suggestions for dental practitioners seeking to diminish their ecological footprint.[2] It additionally emphasizes the importance of united efforts and backing for endeavours aimed at promoting sustainability within the dental sector. It advocates for the adoption of waste management procedures that guarantee the correct sorting, gathering, storage, transportation, treatment, and disposal of dental

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waste, adhering to local regulations.[3] In every workplace, the endurance of human resources is closely tied to the calibre of facilities, the presence of green and blue areas, and safety protocols. Integrating natural features into work settings via innovative architectural concepts and employing sustainable building materials and energy sources substantially impacts health and general welfare, both in direct and indirect manners. Addressing the environmental footprint of dental practices involves the implementation of various strategies and solutions. The "reduce, reuse, recycle" approach is a cornerstone of sustainability. Dental establishments often face stringent regulations that may constrain the integration of certain sustainable methods. Educating staff on sustainability and motivating behavioral shifts can pose challenges.[4]Patients might hold misconceptions about sustainable practices, necessitating education and effective communication efforts. Through waste minimization, increased energy efficiency, and the utilization of environmentally friendly materials, dental practices can diminish their ecological footprint, potentially decreasing long-term expenses and appealing to environmentally aware patients.[5]The World Federation of Dentistry (FDI) endorsed sustainable methodologies in oral healthcare to guarantee sustained service delivery and advance an eco-conscious economy. Their green approach introduced environmentally friendly substitutes for conventional dental practices, replacing detrimental methods with sustainable ones.[6] Considering the prevalent use of disposable plastics, energy-intensive machinery, and hazardous waste, it is imperative to evaluate and diminish the environmental impact of dental facilities. Dental practices produce environmental impacts through various avenues, including waste production, energy consumption, and the use of hazardous substances.[7] Farahani and Suchak were pioneers in eco-friendly dentistry back in 2007.[8]Inherent factors within the profession, such as the substantial electricity requirements of electronic dental equipment, high water usage, and the environmental impact of biomaterials throughout their lifecycle, as well as the use of radiation and the generation of hazardous waste involving substances like mercury and lead, have all contributed to these concerns. The six core themes of the green dentistry model—amalgam management, radiography management, infection control management, procurement management, energy, and water conservation—were universally adopted.[9] However, the affordability, adaptability, and availability of green dental products are associated with negative perceptions. Green dental products tend to be costly and limited in availability, posing challenges to the adoption of sustainable practices. Moreover, transitioning from traditional dental practices requires a gradual shift in mindset and behavior. The predominant obstacle to integrating sustainability in all investigations is the prevailing bias within the profession that overlooks or undervalues sustainable practices.[10]

These challenges are especially prevalent in developing nations, where the main barriers include economic constraints and limited knowledge on the subject. The fundamental objective of sustainable dentistry is to enhance quality of life through preventive and operative care of high standards. However, in order to extend these benefits to underserve populations globally, increased emissions are an unavoidable consequence.[11] However, from an environmental perspective; our goal is to ensure immediate access to dental care for the population while minimizing the frequency of patient visits to the dental practice. Besides the manufacturing of dental supplies and the daily generation of dental waste, emissions from patient and staff travel represent the largest contributors of greenhouse gases within dentistry. As patients attend more dental appointments throughout their lifetime, the cumulative emissions significantly increase in comparison to those generated by other healthcare treatments. To mitigate emissions, the FDI World Dental Federation advocates for source reduction through emphasizing good oral health and preventive measures. Preventive dentistry leads to fewer appointments, reduced recall visits, decreased material usage, and consequently, less clinical waste.[12]

2. Discussion

Eco-friendly dentistry, or green dentistry, incorporates environmental sustainability into all facets of oral healthcare. This holistic approach is gaining traction in dental clinics as awareness of environmental issues grows. As eco-consciousness becomes more widespread, the dental industry is making great strides to engage in positive contributions towards a greener planet.[13] The energy-intensive operation of equipment like autoclaves, x-ray machines, compressors, and lighting systems in dental clinics significantly impacts the carbon footprint, particularly when non-renewable energy sources are used.Energy consumption extends to heating, cooling, and day-to-day operations.

Adopting sustainable measures such as creating native edible gardens, utilizing energy-efficient appliances, and installing double-glazed windows can mitigate environmental impacts.[14]Switching to electronic data storage reduces paper usage, lessening environmental impact. Eco-conscious dental practices, as stressed by Panjkov, yield substantial benefits, including decreased electricity consumption, long-term cost savings, and recognition from individuals and communities.[15] Dental practices annually discard millions of sterilization pouches, chair barriers, and light handle covers, alongside other difficult-to-breakdown disposables like gloves, masks, and suction tips. This excessive use of single-use plastics leads to environmental pollution and landfill accumulation, taking centuries to decompose. Hazardous waste, including

sharps, amalgam fillings, x-ray chemicals, and disinfectants, poses risks to human health and ecosystems and requires specialized handling and disposal. Proper management of biomedical waste, such as blood-soaked gauze, is essential to prevent infections and environmental contamination.[16] The pathways of Rotating Biological contactor (RBC) are: (i) Disposal of waste from expired composite compules or syringes as municipal waste, leading to landfill deposition. Leachate from landfills can interact with RBC, potentially releasing its components. The temperature, pH, and oxygen levels in the landfill leachate evolve over time, influencing its reactivity (ii) Generation of microparticles during the finishing or removal of RBC restorations, or from grinding CAD/CAM ingots. These microplastics not only serve as direct pollutants but also have the capacity to attract and bind to persistent organic pollutants, forming biotoxin complexes (iii) Detection of monomers in saliva and urine indicates that leached dental composite monomers are discharged into the environment through human excretion following dental procedures involving RBC (iv) End-of-life scenarios involving cremation or interment.[17]

Methacrylates found in RBC exhibit high log Kow values, indicating their potential to bioaccumulation, persist, remain stationary, and have low water solubility. Their ability to accumulate in organisms through the food chain raises concerns. Promoting the utilization of RBCs and base-plates for orthodontic appliances that are free of Bisphenol A (BPA) is advisable. Adopting a preventive approach aimed at minimizing the necessity for interventional RBC restorations should be prioritized as a best practice for improving oral health outcomes and mitigating pollution associated with this group of materials.[18] Implementing effective cleaning and sterilization protocols ensures equipment safety for reuse. Dental practices can opt for reusable alternatives for common disposable items, such as using cloth towels in lieu of paper towels, and employing metal or glass instruments instead of disposable plastic equivalents.[19] A dilemma arises between the superior environmental attributes of natural rubber latex and the less allergenic but more polluting nitrile gloves. Natural rubber latex stands out as an environmentally sustainable material, boasting innate biodegradability, thereby facilitating hospitals in fulfilling their 'green' procurement criteria. The manufacturing process for the raw materials utilized in natural rubber latex gloves consumes 16 GJ/ton, representing a significant reduction compared to nitrile gloves, which range from 108 to 174 GJ/ton, differing by an order of magnitude.[20] Certain environmentally conscious practices encompass: Decreasing aerosol products: Abandoning the utilization of aerosol products during dental procedures. Procuring organic or eco-friendly scrubs and integrating indoor plants to foster a more sustainable office ambiance. Embrace toothpaste tablets, bamboo fiber floss, or bamboo toothbrushes. Conserve water by turning off the tap while brushing and refraining from excessive mouth rinsing. Select recyclable toothpaste tube options.[21]

Dental establishments can repurpose sterilizable items such as instruments, trays, and covers. Dental clinics have the option to select suppliers with environmentally friendly practices and certifications. Give preference to products crafted from renewable resources or recycled materials, which can additionally diminish waste. Take into account the life cycle of products to guarantee their environmental sustainability.[22] Consider the life cycle of products to ensure environmental sustainability with these strategies: Invest in energy-efficient equipment and lighting, such as LED lights and Energy Star-rated devices. Utilize programmable thermostats to optimize heating and cooling systems and encourage staff to power down equipment and lights when not in use.[23] Water is vital in dental facilities for sterilization, patient care, and sanitation. Inefficient water usage, particularly in regions with limited water reserves, can stress the environment. Efficient water management is crucial for lessening the environmental impact of dental practices. Implement water conservation measures, including installing low-flow faucets, toilets, and sterilization equipment, and educate staff about responsible water use.[24] Ensure clinical waste is bio-based rather than fossil-based to reduce net emissions from incineration. Work towards minimizing single-use equipment safely and employ environmentally friendly dental materials to reduce the environmental impact of dental practices. Potential solutions entail: Substituting mercury-containing amalgam with composite resins or ceramic materials. Opt for biocompatible and biodegradable materials for dental procedures. Utilize dental materials that pose fewer hazards to the environment throughout their production and disposal processes. Amalgam usage is contentious due to mercury's bio-accumulative nature and its adverse health effects. Improper disposal poses hazards, necessitating collection and recycling of unused amalgam particles and the installation of amalgam separators.

Dental facilities must adhere to stringent guidelines for the safe disposal of mercury-laden materials to mitigate environmental harm. Despite guidelines, low usage of separators persists, primarily due to improper disposal practices. Nonetheless, amalgam remains popular among Indian dentists for its affordability, longevity, and ease of use.[25] Traditional radiographs involve hazardous chemicals like x-ray fixer and developer, necessitating proper disposal to prevent environmental harm. Dentists should be aware of correct disposal methods for conventional x-rays. Digital radiography is advocated in green dentistry to reduce chemical, paper, and plastic waste. A study by Amandeep et al found that 91% of dentists utilize steam sterilization for disinfection, although other research indicates limited

adoption.[26] Enzyme-based cleaners, biodegradable and chemical-free, are ideal for green practices. Yet, their usage, along with reusable items, remains low compared to disposable alternatives. Dentists in Jordan and Thailand recycle and use e-records. In contrast paper waste management was not well practiced in India, as reported by Praneetha et al and Pallavi et al.[27,28] Widely practiced waste management involves the four Rs—reduce, reuse, recycle, and rethink. The main aim is to protect human health and the environment while also saving costs, especially for clinical waste with higher disposal expenses. In surgeries, reducing waste involves minimizing disposable items like plastic liners, gauze, cotton rolls, and polishing paste in prearranged trays alongside specific instruments. After contamination, all tray contents are classified as clinical waste, prompting a need to review setup procedures to minimize unused material disposal. Dental waste mainly consists of single-use equipment to prevent cross-contamination. There's increasing interest in methods enabling sterilization and reuse of such items. However, safety for patients and staff and environmental impact assessments are essential when considering reused equipment. Recycling in dental surgeries is challenging due to the nature of clinical waste, which is typically non-recyclable.

However, protocols can be developed to separate plastic from paper in sterilization pouches using clean gloves, enabling recycling. These actions benefit the environment and offer cost-saving opportunities. Rethinking is the most crucial aspect of the four Rs.[29]When utilizing traditional wet-film radiography, research underscores the straightforwardness of lead foil recycling and advocates for community-level efforts to support this procedure by: segregating the lead foil from the remaining components of the film packet and abstaining from discarding the film in household municipal waste streams intended for landfill or incineration. Exploring alternatives to lead aprons for shielding is also under examination.Proper handling of radiographic fixer is crucial, and adhering to environmentally friendly practices is imperative. This includes: (i) refraining from mixing radiographic fixer and developer before disposal; (ii) ensuring that used radiographic fixer is not poured down the drain but instead sent for silver recovery, and neutralizing the developer before disposal; and (iii) employing certified waste carriers for waste disposal, with recycling being the preferred method whenever feasible.[30] Ceramic endosseous implant materials exhibit reduced environmental impact, emitting fewer greenhouse gases (GHGs and consuming less water and energy compared to metals. However, this assessment focuses mainly on primary production, excluding processing and finishing stages. It's recommended to explore alternatives like ultrasonic, steam, or dry heat sterilization to replace harmful cleaning agents, including monomers and associated reagents such as initiators, accelerators, and inhibitors. Certain cleaners containing hypochlorite, like sodium hypochlorite and sodium di chloroisocyanate, can increase mercury release from effluent pipes, contributing to dental amalgam pollution.[31]

3. Conclusion

Through embracing sustainable methodologies, dental practices can play a pivotal role in fostering a healthier planet while upholding their commitment to delivering top-tier patient care. As the dental industry advances, emphasizing sustainability should be of utmost importance, guaranteeing that the rendering of dental services does not jeopardize the well-being of the environment. It reiterates the potential benefits of adopting eco-friendly practices for both the planet and the dental profession, emphasizing the role of dentists as stewards of environmental health. Ultimately, it urges dental professionals to prioritize sustainability and strive towards a more environmentally conscious future for dentistry. Dental practitioners are well-acquainted with eco-conscious dental practices and hold a favorable perspective on their responsibility in environmental preservation, yet the practical application remains insufficient. While they possess sound understanding of green dentistry and harbor positive attitudes towards conserving the environment, the execution within their practices falls short of adequacy.

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5. Conflicts of interest

There are no conflicts of interest.

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