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An Eco-Conscious Dental Care: A Review of Green Dentistry, Approaches, Importance, Applications and Waste Reduction in Dentistry

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Abstract

Environmental degradation has become a critical global concern. All healthcare systems, along with dentistry, contribute to a large volume of pollution through waste generation and resource over-consumption. The waste arising from dental practices is although low in volume, but is definitely has a great impact on the environment. The majority of waste are radiographic waste, single-use plastics, amalgam particles, biomedical waste, chemicals, and disinfectants. Green dentistry, or eco-friendly dentistry, offers a comprehensive approach that focuses on waste reduction, resource conservation, minimisation of hazardous emissions, and adoption of energy-efficient technologies. This review focuses on current evidence on the principles and applications of green dentistry. It also includes the waste management strategies, digital radiography, eco-friendly sterilisation techniques, waterless vacuum systems, and the emerging use of herbal endodontic medicaments. Factors like high initial cost of setup, limited awareness, infrastructure constraints and inadequate literature makes it difficult for adoption of green dentistry practices. This review highlights the need for dental professionals, policymakers, and educators to integrate sustainability into clinical protocols. By consolidating available research, it provides a foundation for future policy development and clinical guidelines to safeguard public health and the environment.

Keywords: Biomedical waste, Green Dentistry, Herbal Dentistry, Dental waste, sustainability, eco-friendly, Recycle.

Introduction

In the twenty-first century, the overall concern of environmental degradation has emerged as one of the most emphasised global challenges. The combined effects of air intensification, water pollution and soil pollution are threatening the ecological balance and human well-being. Even in the health sector, the combined contribution to environmental pollution is increasing day by day. The reason being the clinical activities that generate substantial waste. They also consume significant amounts of energy and water, and

they all together rely on materials with long-term ecological impacts. Although the waste arising from dental clinics and practices is comparatively small as compared to other medical disciplines, it does contribute to a major everyday growing environmental burden. The different kinds of waste that come out of a dental practice include amalgam particles, disinfectants, biomedical waste, single-use plastics, radiographic chemicals, and plenty of other surplus materials. All of these waste products can be extremely hazardous to our ecosystems if not properly managed. There is a rise in concern regarding pollution of water systems, soil contamination, and increased carbon emissions because of the use of mercury-containing amalgam, aerosol-producing procedures, and high volumes of disposable materials. As the demand for oral healthcare is expanding globally, the environmental footprints of dental services are also expected to grow in equal proportions. This itself states the need for a sustainable approach to dental practices in everyday life. The concept of green dentistry, also referred to as eco-friendly or sustainable dentistry, has gained popularity. Green dentistry promotes minimisation of waste generation, conservation of resources, reduction of hazardous emissions and also adoption of environment-friendly technologies. The approach of green dentistry is to encourage the adoption of these eco-friendly technologies without compromising on the quality of patient care. The concept of green dentistry encourages the integration of preventive dentistry, digital innovations and the use of environmentally preferable products. It highly promotes incorporating energy-efficient clinical designs and rigorous waste management protocols. Apart from just benefiting the environment, green dentistry also aligns with global health priorities. It promotes long-term public health, occupational safety, and economic efficiency. It is crucial for the dental professionals, policymakers, educators, and researchers to identify and acknowledge the growing need for sustainability in healthcare. It is equally important to recognise the environmental implications of dental practices and the constant need to look for opportunities to improve them. An in-depth knowledge of current evidence is vital to guide the adoption of such practices. Evidence-based strategies are required to reduce the ecological harms while Parallelly maintaining the quality standards of clinical care. The present literature review aims to focus on existing research on green dentistry, analysing its principles, implementation practices and advancements in technologies. It gives a clear knowledge of its environmental benefits and the limitations when it comes to its adoption in day-to-day practice. By merging the present knowledge, this review highlights the significance of adopting an eco-conscious approach towards dental practices for increasing sustainability. It ultimately provides a structured foundation for future research, policy development and establishing clinical guidelines. Understanding green dentistry is not solely an option but an ethical approach to safeguard public health and our environment.

Discussion

Green dentistry or sustainable dentistry, is an emerging approach to dental practices. It focuses on environmentally responsible methods which emphasise prevention, caution, and minimally invasive methods. It is designed to benefit the patients, dental healthcare professionals and the global community in total.[1]

The colour - Green

The colour green is mostly associated with calming and restorative effects. This makes it one of the most soothing colours for the human eye. It is believed to support visual clarity, balance and resilience. The green

colour symbolises renewal, growth and optimism. It is frequently used in the marketing of medicines and other healthcare products to express a sense of safety. Therefore, green dentistry or eco-conscious dentistry is a dental care model that merges environment friendly methods with everyday dental practice.[2]

Space designing

Even when it comes to infrastructures and space designs in a workplace, the elements of blues and greens automatically uplift the mood and creativity of a person. The well-being of employees depends upon the quality of facilities and good safety measures in a workplace. So, it is generally advised to add natural elements in the space designs using modern designing and eco-friendly materials. This helps to improve the overall well-being of working professionals.[3]

The 4 R's

But the dental clinics have to face strict rules that can limit the use of some eco-friendly practices. It can be challenging to train the staff using sustainable methods. It can also be difficult to constantly change their daily habits of dental practices. To lower the impact on the environment, dental clinics are required to adopt a new range of practical measures. One of the most effective ways to minimise waste and manage it responsibly is through Rs: 'Rethink', 'Reduce','Reuse' and 'Recycle'.[4] Here comes the role of green dentistry, which is a high-tech approach to upgrade the entire system of dental practices. It is not only beneficial for the patients and the dental practitioners but also for our planet in general.[5]

Waste generation

Any substance which degrades the natural quality of the environment is said to be a pollutant. The pollutant is known to affect the natural taste, smell, and sight of environmental substances, thus making them unfit for consumption.[6] The waste arising from dentistry can be divided into broad categories like mercury-containing waste, silver-containing waste, and lead-containing waste. The other categories include biomedical waste that is anatomic, non-anatomic waste and sharp instruments. Chemicals and disinfectants also contribute to a large amount of waste from dental practices.[7]

Dental amalgam waste and its management

Dental amalgam is one of the most conventional restorative materials used in dentistry. Amalgam is an alloy that contains mercury, silver and other heavy metals. In this way dentists are known to be the largest consumers of mercury all over the world.[8] During the dental procedures, the amalgam gets suctioned by the saliva ejectors and ultimately goes into the sewer system, affecting the quality of soil. This is one of the major contributors to soil pollution.[9] The ideal way to minimise this waste is to first replace dental amalgam with other potential restorative materials. It is highly recommended to use amalgam separators for carrying out amalgam restorations. It is also advised to use pre-capsulated dental amalgam and chairside filtration and limit the amount of amalgam trituration to reduce the volume of contamination.[10]

Chemical waste and its management

Apart from amalgam, the list of waste arising from a dental clinic is quite long. It includes x-ray waste, film-producing waste (developer, fixer solutions), waste from dental films, dental wax, dental impressions, and sharp dental instruments. The use of x-rays is an inevitable part of dentistry. The conventional radiographic techniques involve the use of a large volume of chemicals in the form of developer and fixer solution. This contributes to a significant amount of environmental pollution. Although the developer solution is not generally toxic in nature and can be easily drained into the drainage system. Whereas, the fixer solution has silver in the form of silver

thiosulphate and should be recycled in cost-effective ways.[11]

Lead waste and its management

The majority of lead-containing waste comes from lead foils used in x-ray films, lead aprons and shields. The best way to reduce the contamination caused by lead is by recycling these items. For example, the lead aprons and lead shields could be easily sent back to their manufacturers instead of just dumping them into the garbage. The lead foils that are used in the dental films can be easily collected and sent for recycling.[12] Even the unused and waste films could be easily sent back to the manufacturers for recycling.[13] Another way to reduce waste generation caused by conventional radiography is to completely switch to digital radiography. This eliminates steps like the use of x-ray films, need to develop and process the films, and dumping solutions into the drainage systems. Digital radiography not only reduces the risk to the environment, but also significantly reduces radiation exposure to the patient.[14]

Infection control

Dental office infection control and sterilisation processes can be a major source of pollution too. As reported by the Eco Dentistry Association, about 689 million plastic chair barriers and paper, along with 1.7 billion instrument and sterilisation bags, are dumped into landfills each year.[15] About 3% of the total generated waste through dentistry requires special disposal and cannot be just dumped into the general trash.[16] They can endanger the well-being of employees, degrade indoor air quality, and even contaminate local water systems. A conscious approach is to swap chemical sterilisation methods for steam-based alternatives. This shift removes the need for harmful cold-sterilising chemicals altogether.[17] An alternative way is to use reusable cloth fabric in place of single-use plastic or paper barriers for sterilisation.[18] Replacing plastic disposable suction tips with metallic ones which can be easily sterilised and using cloth pieces for transferring disinfectant chemicals instead of paper towels are great examples of reducing the amount of toxic materials.[19]

Waterless vacuum

The fact that the world is facing a major scarcity of water cannot be denied. The vacuum system used for dental practices consumes nearly 360 gallons of water per day. So, it is very important to reduce the pressure on water resources by switching to alternatives like waterless vacuum systems. The use of high-tech dry vacuum systems gives the same results as the conventional vacuum systems by eliminating the need for water.[20]

Endodontic Herbs

In modern endodontic practice, there is an increase in interest in using plant-based, biologically sourced agents. They are the best alternatives for traditional chemical medicaments. This growing interest is due to the fact that most of the conventional products used in endodontics for irrigation and intercanal dressing have a cytotoxic effect. There are numerous herbal substances, such as ginger, tea tree oil, turmeric, neem, clove, thyme, garlic and aloe vera that are under continuous research to check their potential as an endodontic material. These products have antimicrobial activity and biocompatibility, which makes them fit for further use.[21]

Go paperless

Paper comes from natural resources. It is not only a disposable material but costly too. By transitioning the workplace into a paper-free system, we can reduce the pressure on natural resources. In the modern world, there are platforms like Dentrix, Softdent, and EagleSoft that not only manage dental practice but also allow nearly all the tasks to be completed digitally. One way to cut down on office paper is to reduce its storage and frequent

stocking. Another way is to use paper consciously. For example, using emails and electronic messaging for communication and rethinking before printing documents. It is important to pause before printing and ensure a document is correct before sending it to the printer. If a file is under process, opt for a draft print setting, which helps decrease ink consumption by 75%.[22]

Resources and energy conservation

Using other sustainable methods in dental practice is important to reduce the environmental impact of daily work. Some simple steps can help dental and healthcare professionals to cut down on everyday operation costs and help the planet as well. Some examples are choosing energy-efficient lights, using water wisely, and switching to eco-friendly equipment. To conserve a good volume of energy, we can switch to energy-saving computers, printers and LED operating lights. It is important to make sure that all the electronic devices are turned off during night time. Motor sensors can be introduced to automatically turn off lights when not in use. Another good option is to use waterless but eco-friendly hand sanitisers. A dental healthcare professional can always educate and motivate the patients to turn off water while brushing teeth in order to reduce unnecessary wastage of water. These small changes can make a big difference to our planet.[23] Practising sustainability not only helps the environment but also sets a good example for patients and the wider dental community.

Limitations and challenges

Practising eco-conscious dentistry is extremely beneficial for healthcare professionals and the planet, but its incorporation into everyday practice comes with a lot of challenges. The concept of green dentistry is still under the development stage. The main reason is its general awareness among dental professionals. Training and education play a crucial role in order to spread awareness regarding eco-friendly dentistry. The fact that the initial cost for setting up an eco-friendly dental clinic is too high.[24] Green dentistry also relies heavily on community participation and educational outreach. Organising workshops on sustainable dental practices, techniques, and their impact on the environment can be helpful to educate the entire community.[25] The availability of limited literature on green dentistry is another constraint in spreading awareness and implementation of eco-friendly strategies.[26]

Conclusion

Conventional dental practices contribute significantly to environmental degradation. Practices like excessive consumption of natural resources, generation of hazardous waste and dependence on various materials have a long-term ecological impact. Green dentistry focuses on overcoming these challenges without compromising the quality of patient care. Adopting practices like amalgam separation, digital radiography, steam-based sterilisation, waterless vacuum systems, and the use of biodegradable substances are the best alternatives to reduce the ecological footprints of dental clinics. Despite its clear benefits, the transition to sustainable dentistry is not so smooth. It is hindered by practical barriers, high initial costs, regulatory constraints, limited training and insufficient awareness. Constant efforts are required from every end, including clinicians, educators, policymakers and researchers, for well-coordinated implementations. Ultimately, incorporating environmentally responsible practices into daily dental care is not only a professional responsibility but also a necessary step toward safeguarding public health and preserving ecological integrity for future generations.

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