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Sustainable Dentistry: Redefining Oral Care For A Better Planet

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Abstract

Aim *- To identify the environmental challenges in modern dental practice and propose sustainable strategies that minimize ecological harm without compromising clinical care.*

Background *- Although dentistry emphasizes prevention and minimally invasive treatments, it significantly contributes to environmental degradation through high consumption of single-use items, energy, and transportation. Sustainable dentistry supports WHO's vision of environmentally responsible healthcare and is guided by four core principles: disease prevention, patient self-care, lean service delivery, and adoption of low-carbon technologies.*

Result *- Key sustainability opportunities in dentistry include:- • Preventive care, which reduces disease burden and the need for resource-intensive treatments., • Travel-related emissions, accounting for 65% of dental clinic carbon footprints, can be mitigated through tele-dentistry and promoting active travel., • Energy-efficient infrastructure, including LED lighting and optimized HVAC systems, can reduce emissions by up to 15%., • Single-use plastics, particularly from dental consumables and toothbrushes, contribute significantly to landfill waste and should be replaced with recyclable or reusable options., • Nitrous oxide, with high global warming potential, requires improved delivery and emission control systems., • Enhanced waste management through proper segregation and adherence to the 4Rs (Rethink, Reuse, Recycle, Recover) can significantly reduce the environmental load.*

Conclusion *- Eco-conscious changes in dental practice can meaningfully reduce its environmental footprint. Sustainable approaches offer both environmental and economic advantages.*

Clinical significance *- Integrating sustainability into routine dental care enhances efficiency, reduces operating costs, and aligns with ethical responsibilities toward community health and environmental stewardship.*

Keywords: *Sustainable dentistry, Environmental, Eco-friendly dental practices, Dental waste management.*

INTRODUCTION

The World Health Organization (WHO) defines sustainable healthcare as practices that minimize environmental harm while promoting social responsibility (World Health Organization, 2022).[(1)] In dentistry, adopting this approach is essential to not only reduce environmental damage but also to enhance patient care and community health. Dentists, who specialize in providing compassionate oral care to individuals of all ages, have a unique opportunity to lead this shift by integrating sustainable practices into their work.

Dentistry focuses on preventive care, early detection, and minimally invasive treatments, which in turn are key to fostering long-term oral health. However, these practices often come with an environmental cost, including significant waste and resource use. Modern dentistry, particularly in dental settings, heavily relies on disposable items during procedures. For example, consider common household dental products

such as toothpaste tubes, floss containers, toothbrush packaging, and whitening strips, which contribute to waste when discarded. In a dental clinic, a single procedure might involve more than 30 disposable items, such as plastic barriers, single-use materials, personal protective equipment, and sterilization pouches, all of which are discarded immediately after use. This waste is multiplied across dental practices, hospitals, and households, raising important questions for dentists committed to maintaining individual's oral health: What is the environmental toll of this care?

Research indicates that healthcare waste is a significant contributor to greenhouse gas emissions, climate change, air pollution, water and food insecurity, and other environmental issues, all of which have direct health consequences. These findings highlight the critical need for sustainable practices in dentistry.[2] Given the known health risks associated with environmental waste, dental professionals have an ethical obligation to implement sustainable measures. This responsibility calls for a balanced approach in dentistry that ensures both patient well-being and environmental protection, encouraging the profession to evolve toward sustainability in both clinical practice and public health advocacy.

Principles Of Sustainable Healthcare[3]

The Centre for Sustainable Healthcare has developed four principles of sustainable clinical practice (Figure 1).

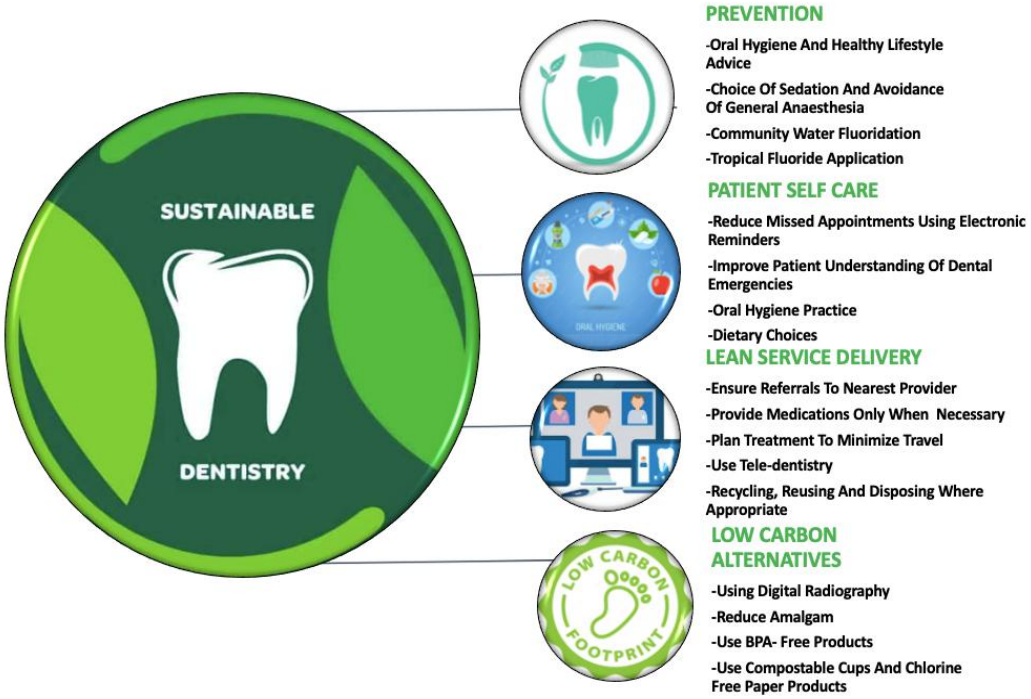

Figure 1. Four principles of sustainable dentistry

1. Disease Prevention – **The most sustainable approach in healthcare is to avert disease onset altogether, thereby eliminating the environmental impact associated with its treatment.**
2. Promoting Patient Self-Care – **Encouraging individuals to take an active role in managing their own health can decrease the dependency on healthcare resources over time.**
3. Efficient Service Delivery (Lean Services) – **Optimizing healthcare systems by eliminating non-value-adding activities conserves resources. These resources extend beyond tangible items like paper and dental supplies to include less visible factors such as staff time, facility operations, and travel. Notably, research in dentistry highlights that a significant portion of carbon emissions stems from travel to and from clinics by both patients and staff. Thus, redesigning care pathways to limit in-person visits while preserving clinical outcomes can significantly reduce environmental impact.**
4. Adoption of Low-Carbon Technologies and Treatments – **It is critical to assess the environmental claims of new technologies or procedures against reliable evidence, as terms like "eco-friendly" or "sustainable" are often used in marketing without substantiating data. Therefore, the integration of alternative treatments should be guided by robust environmental and clinical data.**

Spheres Of Influence (Figure 2)

Figure 2. Sustainable Dentistry-Spheres of Influence

- **Prevention**: Oral diseases, such as caries, periodontal disease, and oral cancers, are highly preventable but affect nearly half of the global population, making them the most prevalent non-communicable diseases (NCDs).[5,6] Given that these conditions cannot always be cured, evidence-based prevention strategies are essential for improving oral health.[7] Preventing oral diseases not only reduces their prevalence but also lessens environmental impacts by decreasing the need for dental treatments, which reduces waste, energy use, and plastic consumption.[8] Studies show that dental care for individuals with high disease levels has eight times the environmental impact compared to those with minimal disease.[8,9] Key preventive measures include proper oral hygiene, fluoride use, and reducing risk factors such as excessive sugar, tobacco, and alcohol consumption. Social determinants like universal health coverage and policies on sugary drinks, tobacco, and alcohol can further reduce disease burden and environmental impact.[10] Oral health professionals can promote prevention at individual, community, and policy levels to improve health and sustainability in dentistry.
- **Travel-Related Carbon Footprint**: The term "carbon footprint" refers to the total GHG emissions directly or indirectly associated with a person, organization, event, or product.[11] To facilitate comparison, the global warming potentials of various gases are expressed in terms of carbon dioxide equivalents (CO_2e or CO_2eq), using CO_2 as the reference.[12] Not all greenhouse gases (GHGs) have the same environmental impact. Major contributors include carbon dioxide (CO_2), methane (CH_4), fluorocarbons (FCs), and nitrous oxide (N_2O), with fluorocarbons being the most powerful and enduring. Healthcare systems globally are responsible for about 4% of total GHG emissions.[13] In dental practices, transportation—the travel of patients, staff, and deliveries—constitutes the largest portion of their carbon footprint, with 65% of the total emissions being related to travel.[14] Reducing travel is therefore a key strategy to lower the sector's carbon footprint. Encouraging staff and patients to use active travel options, such as walking, cycling, or running, can cut CO_2 emissions while also promoting physical activity, which is a critical factor in preventing non-communicable diseases.[15] Strategies to encourage active travel could include providing secure bike parking, sharing public transport options on the practice's website, offering local maps for walking and biking, or organizing friendly step challenges. Additionally, scheduling appointments for families together and making the most of each visit can reduce the number of trips needed. Another effective measure is expanding the use of tele-dentistry, which has proven to be safe, cost-effective, and well-received by patients, further minimizing unnecessary travel.[4]
- Energy-Efficient Architecture: Dental clinics can significantly reduce their environmental impact by adopting energy-efficient practices, such as using LED and motion-sensitive lighting, energy-efficient

HVAC (Heating, Ventilation, and Air Conditioning) systems, and incorporating natural lighting. New constructions can benefit from sustainable designs, including solar panels, energy-efficient insulation, and green spaces, which not only enhance biodiversity but also offer psychological and physical health benefits like stress reduction and mood improvement.[17] Since energy use in buildings contributes 15% of the carbon footprint of dental care[18], retrofitting clinics with energy-efficient solutions, such as improved water and appliance use, can greatly enhance sustainability. Despite challenges like upfront costs and limited expertise, these measures provide long-term benefits for both cost savings and environmental health.

- Reducing Single-Use Plastics: The use of single-use plastics (SUPs) in dentistry has risen significantly, especially after the COVID-19 pandemic, with approximately twenty-one SUP items used per procedure.[19] While most healthcare waste (85%) is not hazardous, improper classification and disposal often result in unnecessary incineration or sterilization, leading to environmental harm.[20] Barriers such as limited recycling options, unclear guidelines, and insufficient staff education further complicate waste management. To mitigate SUP waste, clinics can adopt sterilizable instruments, classify waste accurately, and provide staff training on sustainable practices. These measures reduce environmental impact and lower the costs associated with managing biomedical waste.[18]
- **Toothbrushes**: Each year, billions of toothbrushes are discarded into landfills worldwide, where traditional plastic toothbrushes can take up to 500 years to decompose.[21] With recommendations to replace them every three months, an individual can use approximately 300 toothbrushes over a lifetime.[22] Recycling toothbrushes is particularly difficult due to the combination of plastics, metal, and other materials requiring complex separation processes.[23] While there is no universally agreed-upon sustainable toothbrush solution, life cycle analyses suggest that bamboo toothbrushes and plastic toothbrushes with replaceable heads have lower environmental impacts compared to non-replaceable plastic or electric toothbrushes.[24] Further studies, which also account for factors like biodiversity loss, ecotoxicity, and air pollution, highlight that toothbrushes made from recycled plastic have the least environmental and human health impact, making them the most sustainable choice currently available.[25]
- **Nitrous Oxide Use**: Nitrous oxide (N_2O) has been a trusted tool for managing dental pain and anxiety since the 1800s.[26] However, N_2O is a potent greenhouse gas, with a global warming potential about 270 times that of carbon dioxide.[27] Waste N_2O can be released through system leaks, unused gas, or patients' exhaled air, with the largest source of waste occurring in central piping systems. To mitigate this, portable nitrous units are recommended as they have a lower risk of leaks.[28] Exhaled N_2O can also contribute to environmental pollution, particularly if nasal hoods do not fit properly or if patients speak or cry during administration. Prolonged exposure to nitrous oxide can pose health risks, such as interfering with B_{12} metabolism, causing infertility, and leading to neurological disorders.[29] A lack of awareness about its environmental impact, combined with limited alternatives, often prevents efforts to reduce nitrous use. Strategies to minimize N_2O waste include careful case selection, efficient use of time during procedures, limiting the duration of nitrous use, and regular monitoring for system leaks. Additionally, installing catalytic processors to break down N_2O into nitrogen and oxygen has proven effective in reducing ambient levels of exhaled nitrous oxide, with a 2022 clinical trial showing a reduction of more than 70% in labour wards.[30,31]

Sustainable Waste Management In Dentistry

- **Waste Management:** The provision of oral healthcare generates waste beyond plastics. Many are familiar with the concept of the "4Rs" of sustainability (Rethink, Reuse, Recycle, and Recover).[32] The goal is to establish a "circular economy," where materials used throughout the dental supply chain are not disposed of through burial or incineration. Instead, this approach emphasizes applying the 4Rs to significantly minimize waste production and reduce the reliance on extracting new raw materials.
- **Dental Equipment and Materials:** Due to the complex composition of certain dental materials and the strict requirements for cross-infection control, many dental materials cannot be recycled. Items such as sharps (e.g., needles and blades), hazardous materials (e.g., dental amalgam, lead foils, and silver from X-ray processing solutions),[33] and infectious medical waste (e.g., blood-soaked gauze and visibly contaminated PPE) must be disposed of following specific protocols.[34] Since the disposal of hazardous and medical waste often involves extended transportation and carbon-intensive processes, it is essential to restrict these waste streams to only those materials classified as hazardous.[35] This requires dental teams to be well-versed in proper waste categorization and management.

- **Domestic Waste:** Dental clinics generate various forms of waste similar to household waste, though it may not always be managed as effectively in the office. Research has shown that non-infectious waste such as paper, cardboard, plastic bags, and packaging accounts for 48% of the total waste produced in dental offices, while domestic-type waste like food scraps, glass, metals, and plastics contributes another 24%.[36] Proper waste separation can significantly reduce landfill contributions, as it is estimated that 75% of landfill material consists of recyclable items like plastics, paper, glass, and metals. Additionally, food waste, which makes up 24% of landfill waste, can be diverted through composting programs, providing an effective solution for disposing of biodegradable materials.[37] Reducing paper waste is another key strategy, achievable by using electronic patient records and digital communication methods such as calls, texts, and emails. Encouraging recycling and waste reduction among the dental team can be achieved through training, motivating staff, and strategically placing accessible recycling bins.[38] Minimizing waste production in the first place is crucial and can be facilitated by conducting waste audits, which help identify sources of unnecessary waste and improper disposal.[39] This process not only highlights areas for improvement but also reduces costs associated with purchases and waste management.
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CONCLUSION

The field of sustainable dentistry is evolving, with ongoing research focusing on developing eco-friendly materials and optimizing energy-efficient technologies for clinical use. Studies on biocompatible materials, bio-based sealants, and alternative sterilization techniques are underway to further reduce the environmental impact of dental care. Collaborative efforts between dental organizations, environmental scientists, and policymakers are essential in creating guidelines that support sustainable dental practices globally. Initiatives such as the FDI World Dental Federation's "Sustainability in Dentistry Code of Practice" aim to guide the industry toward sustainable procurement and waste management strategies.[40] Efforts like incentivizing efficient treatment planning, reducing waste through better product design, and committing to eco-conscious supply chains are critical steps forward. Education and awareness are equally important, with courses like the Sustainable Dentistry Program from the Centre for Sustainable Healthcare which will help in empowering dental professionals to adopt environmentally friendly practices. By prioritizing sustainable dentistry, the profession can meet its ethical responsibility to patients, the community, and the environment, contributing to a healthier and more sustainable future.

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REFERENCES

1. World Health Organization. Health in the green economy: Practices that promote social responsibility. 2022.
2. World Health Organization. Climate change and health [Internet]. 2021 Oct 30. https://www.who.int/news-room/fact-sheets/detail/climate-change-and-health.
3. Duane B, Fennell-Wells A, Bakar M. Clinical guidelines for environmental sustainability in dentistry. 2023.
4. World Health Organization. Global oral health status report: towards universal health coverage for oral health by 2030. https://www.who.int/publications-detail-redirect/9789240061484.
5. Duane B, Berners-Lee M, Stancliffe R, Steinbach I. An estimated carbon footprint of NHS primary dental care within England. How can dentistry be more environmentally sustainable? Br Dent J. 2017;223(8):589-593.
6. Benzian H, Daar A, Naidoo S. Redefining the non-communicable disease framework to a 6 × 6 approach: incorporating oral diseases and sugars. The Lancet Public Health. 2023;8(11):e899-e904. doi:10.1016/S2468-2667(23)00205-0.
7. Intergovernmental Panel on Climate Change. Sixth assessment report. 2021. https://www.ipcc.ch/assessment-report/ar6/.
8. Hayashi M, Haapasalo M, Imazato S, Lee JI, Momoi Y, Murakami S, et al. Dentistry in the 21st century: challenges of a globalising world. Int Dent J. 2014;64(6):333-342. doi:10.1111/idj.12132.
9. Martin N, Mulligan S. Environmental sustainability through good-quality oral healthcare. Int Dent J. 2021;72(1):26-30. doi:10.1016/j.identj.2021.06.005.
10. Martin N, Hunter A, Constantine Z, Mulligan S. The environmental consequences of oral healthcare provision by the dental team. J Dent. 2024;142:104842. doi:10.1016/j.jdent.2024.104842.
11. Eckelman MJ, Huang K, Lagasse R, Senay E, Dubrow R, Sherman JD. Health care pollution and public health damage in the United States: an update. Health Aff (Millwood). 2020;39(12):2071-2079. doi:10.1377/hlthaff.2020.01247.
12. Carbon Trust. A guide to carbon footprinting for businesses. Published online 2023. https://ctprodstorageaccountp.blob.core.windows.net/prod-drupal-files/documents/resource/restricted/footprint-business-guide-compressed4.pdf.
13. Lyne A, Ashley P, Johnstone M, Duane B. The environmental impact of community caries prevention - part 1: fluoride varnish application. Br Dent J. 2022;233(4):287-294. doi:10.1038/s41415-022-4901-7.

14. EPA. Carbon footprint calculator [Internet]. Available from: https://www3.epa.gov/carbon-footprint-calculator/tool/definitions/co2e.html.
15. Shehabi Z, Booth J, Revert B. Top tips for making your practice more environmentally sustainable. Br Dent J. 2022;233(4):252-254. doi:10.1038/s41415-022-4938-7.
16. Shaver J. The state of telehealth before and after the COVID-19 pandemic. Prim Care. 2022;49(4):517-530. doi:10.1016/j.pop.2022.04.002.
17. Duane B, Croasdale K, Ramasubbu D, Harford S, Steinbach I, Stancliffe R, et al. Environmental sustainability: measuring and embedding sustainable practice into the dental practice. Br Dent J. 2019;226(11):891-896. doi:10.1038/s41415-019-0355-y.
18. Martin N, Sheppard M, Gorasia G, Arora P, Cooper M, Mulligan S. Awareness and barriers to sustainability in dentistry: a scoping review. J Dent. 2021;112:103735. doi:10.1016/j.jdent.2021.103735.
19. Volgenant CMC, Bras S, Persoon IF. Facilitators and barriers to implementing sustainability in oral health care. Int Dent J. 2022;72(6):847-852. doi:10.1016/j.identj.2022.08.002.
20. Health-care waste. World Health Organization. Published February 8, 2018. https://www.who.int/news-room/fact-sheets/detail/health-care-waste.
21. How toothbrushes affect the environment: an infographic – MYSA. https://www.foreo.com/mysa/how-toothbrushes-affect-environment-infographic/.
22. Toothbrushes. American Dental Association [Internet]. Last updated October 7, 2022. https://www.ada.org/resources/ada-library/oral-health-topics/toothbrushes.
23. Lavers JL, Dicks L, Dicks MR, Finger A. Significant plastic accumulation on the Cocos (Keeling) Islands, Australia [published correction appears in Sci Rep. 2023 May 12;13(1):7722]. Sci Rep. 2019;9(1):7102. doi:10.1038/s41598-019-43375-4.
24. Lyne A, Ashley P, Saget S, Porto Costa M, Underwood B, Duane B. Combining evidence-based healthcare with environmental sustainability: using the toothbrush as a model. Br Dent J. 2020;229(5):303-309. doi:10.1038/s41415-020-1981-0.
25. Duane B, Ashley P, Saget S, Richards D, Pasdeki-Clewer E, Lyne A. Incorporating sustainability into assessment of oral health interventions. Br Dent J. 2020;229(5):310-314. doi:10.1038/s41415-020-1993-9.
26. Wilson S, Gosnell ES. Survey of American Academy of Pediatric Dentistry on nitrous oxide and sedation: 20 years later. Pediatr Dent. 2016;38:385-392.
27. O UE. Overview of greenhouse gases. Published December 23, 2015. https://www.epa.gov/ghgemissions/overview-greenhouse-gases.
28. Devlin-Hegedus JA, McGain F, Harris RD, Sherman JD. Action guidance for addressing pollution from inhalational anaesthetics. Anaesthesia. 2022;77(9):1023-1029. doi:10.1111/anae.15785.
29. American Academy of Pediatric Dentistry. Policy on minimizing occupational health hazards associated with nitrous oxide. The Reference Manual of Pediatric Dentistry. Chicago, Ill: American Academy of Pediatric Dentistry; 2023:162-165.
30. Szymańska J. Environmental health risk of chronic exposure to nitrous oxide in dental practice. Ann Agric Environ Med. 2001;8(2):119-122.
31. Khan-Perez J, MacCarrick T, Martin F. The use of nitrous oxide 'cracking' technology in the labour ward: a case report and patient account. Anaesth Rep. 2022;10(2):e12182. doi:10.1002/anr3.12182.
32. Sumich K. The 4Rs of waste management - simple steps to modern sustainability. Eco Resources. Published June 20, 2023. https://ecoresources.net.au/the-4rs-of-waste-management/.
33. Hazardous (and universal) waste management. Dentalcare.com [Internet]. Published August 1, 2016. https://assets.ctfassets.net/u2qv1tdtdbbu/5uQc6CvQFdMp7MF84tS6Y0/79d4fab63080104678eca225383ae9a1/ce499_9-24-21.pdf.
34. Guide to dental waste management and compliance. HealthFirst. https://www.healthfirst.com/blog/guide-to-dental-waste-management-and-compliance/.
35. Wilmott S, Duane B. An update on waste disposal in dentistry. Br Dent J. 2023;235(6):370-372. doi:10.1038/s41415-023-6359-7.
36. Khanna R, Konyukhov Y, Maslennikov N, Kolesnikov E, Burmistrov I. An overview of dental solid waste management and associated environmental impacts: a materials perspective. Sustainability. 2023;15(22):15953. doi:10.3390/su152215953.
37. O UE. National overview: facts and figures on materials, wastes and recycling. Published October 2, 2017. https://www.epa.gov/facts-and-figures-about-materials-waste-and-recycling/national-overview-facts-and-figures-materials.
38. Duane B, Ramasubbu D, Harford S, Steinbach I, Swan J, Croasdale K, et al. Environmental sustainability and waste within the dental practice. BDJ Team. 2019;6(6):21-29. doi:10.1038/s41407-019-0106-6.
39. Hackley D, Mu J, Papike A, Barrow J. Brief: Waste management considerations for oral health professionals – it's about equity. Harvard School of Dental Medicine; 2019.https://hsdm.harvard.edu/files/dental/files/policy_brief_dec_9_with_semantic.pdf.
40. FDI World Dental Federation. Sustainability in Dentistry initiative unites eco-conscious dental industry partners around a common aim. Published May 3, 2021. https://www.fdiworlddental.org/fdi-world-dental-federation-sustainability-dentistry-initiative-unites-eco-conscious-dental.