

GREEN DENTISTRY: ECO-FRIENDLY AND SUSTAINABLE DENTISTRY

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ABSTRACT

Dentistry is committed to preserving oral health and improving function. Unfortunately, it has a significant negative influence on the environment since it produces heaps of waste, especially metallic waste, and uses a lot of water and power. In order to practice green dentistry, one must use water and power wisely, produce less waste, and reduce pollution by utilizing cutting-edge technology and set protocols and recommendations by Eco Dentistry Association (EDA) and multiple other studies and organizations. Oral health professionals need to understand how important it is to contribute to sustainability. They both have a moral obligation to the community to provide the best possible oral health care, to uphold patient safety, and to minimize their influence on the environment. This study examines some doable recommendations for greening dentistry practices through increased use of more recent technologies, less usage of paper and disposables, and eco-friendly waste management.

Keywords: Eco-friendly dentistry, pollution, sustainable development, waste disposal

INTRODUCTION

Green dentistry, also known as eco-friendly dentistry, is defined 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 [30]. The term "green" has attracted seriousness in recent times as industries are identifying means to generate eco-friendly products and practices. There is a lot of gravitational pull from the media emphasizing the growing environmental concerns regarding rising global temperatures, increase in carbon emissions, generating vast amount of waste etc. As any profession, dentistry is also a field that should share the responsibility of reducing the environmental impact from dental offices. It is an unsaid obligation to the dental professionals to engage in practices that will decrease the environmental impact and carbon footprint by adapting to a more environmentally friendly practices. [1,2, 38]

The terms "eco-friendly" and "green" are frequently used interchangeably and denote a number of characteristics, including renewability, sustainability, and energy efficiency. These also denote the absence of toxicity, and a decrease in carbon footprint. Sustainable and environmentally friendly methods, dental office/hospitals and workplace design, and waste management are all part of the health care business. [3] Integrate sustainability in dentistry by a dentist's commitment to both society and the environment. [4]

Green dentistry is the practice of dentistry using methods, supplies, and equipment that don't affect the environment and are sustainable for development, i.e., meets the needs of current times without jeopardizing the ability for future generations to utilize the available resources to meet their own needs for practice. [4] [5] Saving limited natural resources like water and energy, reduce the use of nonhazardous products, waste reduction, elimination of dangerous substances that could have a harmful impact on patients and the environment, and encouraging use of eco-friendly products, are a few ways that a dental office can be eco-friendly. Rethink, Reduce, Reuse, and Recycle are the four R's that can be used to describe all of these characteristics. [6,7]

The management of hazardous waste, particularly dental waste, which poses a dilemma for both public safety and the environment, is one of the major difficulties facing emerging nations. [8] The current research concentrates on environmental consideration in dental facilities and offers useful recommendations to limit waste production and lessen the carbon footprint of the industry. [9] The purpose of this review is to increase awareness amongst dental practitioners about the current environmental impact of a dental practice and suggests means and measures to incorporate green dentistry in order to pursue that goal.

EDA, which was co-founded by Dr. Fred Pockrass and his wife Ina Pockrass in 2008, defines green dentistry as "A high-tech strategy that reduces the environmental impact of dental practices and

encompasses a service model for dentistry that supports and maintains wellness

The term "eco-friendly dentistry" was coined by Drs. Steven Koos and Goran Kralj. Dr. Steven Koos then trademarked eco-friendly dentistry on December 22, 2009. They described it as a freshly developing field of dentistry that incorporates a commitment to sustainability, prevention, and prudence as well as a minimally invasive patient- and world-centered dental treatment philosophy. The EDA connects patients and dentists who practice green dentistry by offering education, standards, and networking opportunities. The EDA intends to assist dentists by offering some secure, reusable options that reduce their operating costs, such as wherever practical, switching from paper to digital media. [12] Eco-friendly dentistry involves using environmentally friendly operations and design principles in all dental disciplines. This will safeguard the immediate health of patients and treating dental team staff, safeguard the overall health of the community at large, and safeguard the sustainability of natural resources. [10]

BACKGROUND

With the concept of green dentistry first emerging in Europe, the principles surrounded around increased environmental sensitivity among dental practitioners by promoting actions, rules, policies consistent with European Union's sustainable development strategy and creation of an international network on the same concepts..[10]

The word "eco-dentistry" has been modified in the modern day to refer to a branch of dentistry that goes beyond pollution prevention to also advocate for sustainability.

In 2007, Dr. Ali Farahani and Mittale Suchak, published the results from a survey study conducted in 5 dental offices in Ontario, Canada. Results from the environmental assessment questionnaire and interviews were analyzed quantitatively and qualitatively. , This was the first international reference to environmentally friendly dentistry. In this study, the authors defined eco-friendly dentistry as a method of practicing dentistry that adopts sustainable practices by maintaining resource consumption in line with nature's economy, by protecting the environment through methods that will help in eliminating or reducing outgoing wastes, and by promoting the health of all individuals in the clinical environment by consciously reducing the amount of chemicals in the air that can be inhaled. [11]

THE PROBLEM: MASSIVE PRODUCTION OF WASTE

There are 4 main types of ways that waste is generated in a dental office: Infection control protocols, placement and removal of mercury containing dental material, conventional x-ray systems and water waste from conventional vacuum systems. In the United States itself, dental practices generate annually [approximately](#):

- 1.7 billion sterilization pouches
- 680 million chair barriers, light handle covers, and patient bibs
- 3.7 tons of mercury waste
- 48 million lead foils (conventional x-rays are still used by 40% of dental offices)
- 28 million liters of toxic x-ray fixer (conventional x-rays) [35]

Apart from the medical wastes that are generally categorized in 4 categories of hazardous, infectious, radioactive, and sharps; in a dental office there is also chemical waste generating from disinfectants, radiographic developer and fixer solutions. Disposable items like disposable autoclave wraps, sundries such as plastic suction tips, irrigation syringes, cups, paper towels, patient bibs, etc., make a heavy amount of regular waste which could be substituted with biodegradable disposable products. Therefore, all these waste materials, need special handling and disposal measures.

The waste produced in a dental set up is volumetric, i.e., the waste produced depends on the foot traffic of patients treated per day. For every patient there is an approximate usage of about 40 products. Digitization has helped reduced the paper usage per dental patient. In a digital dental office, the charting is typically reduced to 6-page paper chart as compared to the conventional 12 page chart [32]. Office garbage is also produced, including nonhazardous materials like paper, cardboard, aluminum, and plastics, which increases the overall volume.

One of the most controversial concerns in a dental office is "silver" amalgam fillings. The amalgam fillings are made of equal parts of elemental mercury and other metals, like tin, silver and copper. Mercury is used throughout dental treatments to install, remove, and polish dental amalgam. [9,13,14] Potentially dangerous waste is created both when a tooth is restored with dental amalgam and after it is removed, including release of mercury vapor over time, even after they are cured; amalgam sludge

that can be present in the wastewater system of the dental office including filters; amalgam scrap which is residual amalgam left post restoration and also other kind of amalgam waste left. [9,15,16] Not only there is exposure concern in all patients, but there is also considerable adverse effects on special population of pregnant women and children due high toxicity of elemental mercury.

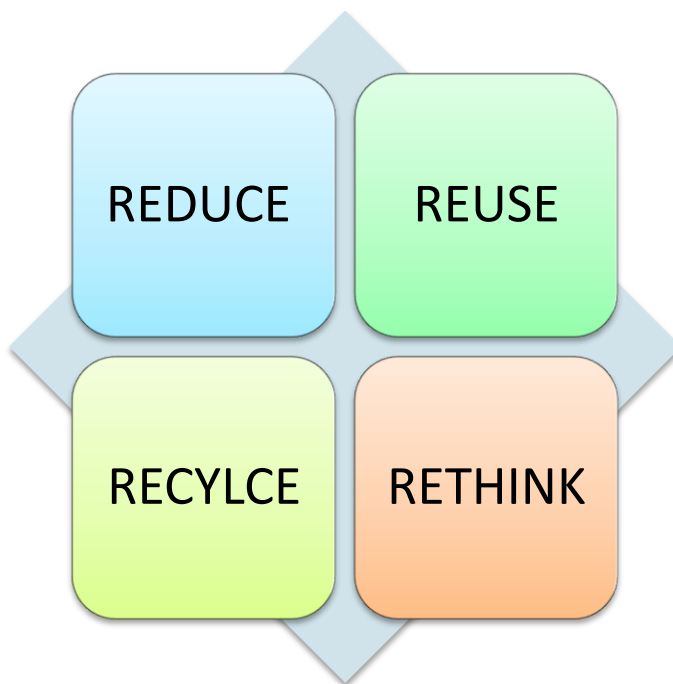
It is an apparent question that why do dentists still use amalgam fillings given it is less aesthetically appealing, potential mercury exposure, and waste production? Amalgam is an inexpensive material and has been used in dentistry since olden days. Some of the dentists believe there is no risk of mercury exposure because the mercury is chemically “fixed” in the amalgam. [33]

According to estimates, between 3% and 70% of the entire mercury concentration in wastewater treatment plants comes from dentists. [17]

The United Nations Environment Program estimated in 2006 that every square mile of ocean is home to 46,000 pieces of floating plastic. In the North Pacific Ocean, two slow moving spirals of currents have collected enormous amounts of plastic trash, chemical sludge and debris. They form two large islands of floating trash that are connected by more trash, collectively forming what is known as the Great Pacific Garbage Gyre, or The Pacific Garbage Patch. Estimates of its size vary to as large as twice the size of Texas. It is known as the largest landfill in the world, and is considered to be the largest problem facing our ocean today because of the chemicals it leaches into the ocean, and the destruction of valuable marine life. [34]

4 “R’s” remedy

By reducing, reusing, recycling, and rethinking, dentistry can decrease its environmental impact. [6, 38]



RETHINK

Rethinking the use of resources in dental practices can make a significant difference in reducing the environmental impact. Practices can consider the following actions [36]:

- Adopting LED lights with motion sensors can save up to 80% of energy used by traditional light bulbs. [37]
- Promoting indoor plantation in the office can help reduce indoor pollution and enhance the aesthetic appeal of the practice.
- Using office furniture made from recycled or reclaimed wood and with the usage of low volatile paint reduces the environmental impact of the practice.
- Switching to eco-friendly office cleaning products, such as those made from natural and organic ingredients, can help reduce exposure to harmful chemicals and decrease the amount of waste generated by the practice.
- Proper sun illumination helps to decrease the usage of energy

- The use of natural materials is frequently emphasized in eco-friendly building design. This is also referred to as "green architecture" and "sustainable design," among other terms. From the planning stage through construction, operation, maintenance, refurbishment, and demolition, it is environmentally friendly and resource-efficient
- Making the office solar powered can help to obtain a limitless amount of renewable energy.
- Lone standing offices can also have an inclined roof for water harvesting in regions of high/adequate rain.

REDUCE

According to the Keep America Beautiful website, Americans generate 250 million tons of garbage per year, and since 1960, the amount of waste generated in the US has nearly tripled. In the landfill, items we throw away slowly decompose and mix with what others have tossed. Toxic chemical cocktails can form and leach into the soil, eventually reaching our water stream. Sometimes trash is burned, polluting the air we breathe. When we transport our trash to landfills or incinerators, we consume even more energy, making the garbage problem an environmental double-whammy. Green dentistry entails minimizing pollution and waste. Reduce the usage of paper, plastic, chemical, water consumption and energy consumption. Disposables should be used less frequently. Reducing waste of consumable goods and raw resources is vital, as is reducing air and water pollution due to landfills and incinerators, respectively. Water should be used more efficiently. Going paperless can help you use less paper. For this reason, it should be encouraged whenever possible to create, use, and save office records using computers and other digital technology. [19,20]

- Modern high-tech developments have improved the efficiency, dependability, and cost-effectiveness of dental practices. Nearly all high-tech advancements in dentistry, such as computer-aided design and computer-aided manufacturing systems (CAD-CAM), also have some positive effects on the environment. As impression material is no longer necessary, there is less waste to dispose of. Because fewer patients must travel to their visits, there are fewer greenhouse gas emissions.
- Using digital X-ray instead of a traditional system helps to reduce waste. Traditional x-ray fixers contain chemicals such as Ammonium Thiocyanate and Boric anhydride. These chemicals are known to be skin, eye and respiratory tract irritants, and hazardous if ingested or inhaled. They also may be toxic to the blood, thyroid, kidneys and liver, and repeated or prolonged exposure can produce target organ damage. This will also help to reduce the estimated 48 million lead foils waste generated every year in the United States. [30]
- Substituting autoclave wraps with sterilizable cassettes and plastic syringes with glass syringes can reduce waste by up to 90% [36]
- Bulk ordering to reduce packaging waste
- Using nontoxic, biodegradable, approved surface cleaners and disinfectants
- Using reusable stainless steel or compostable impression trays are all examples of ways to reduce waste.
- Prefer steam sterilization and reduce the use of harmful chemicals for chemical sterilization, such as those that include glutaraldehyde, a potent lung and skin irritant. Eliminate toxic chemicals.
- Biodegradable disposable cups
- Hospital-grade fabric operating rooms and sterilization techniques. Reusable metal suction tips and saliva ejectors.
- Regular cleaning of water lines with enzymatic or biodegradable cleansers is recommended. However, as chlorine bleach has the potential to disperse mercury into the clinic's air, it should not be used for cleaning. Filtering the water used throughout the practice will reduce calcium and other deposits, extending the life of the instruments and lowering maintenance costs.
- Proper disposal of amalgam can help reduce mercury pollution, which can have harmful effects on aquatic life and human health
- Wastewater treatment facilities use a lot of resources, including electricity and materials. Thus, it is imperative to limit both water use and wastewater production. **Consider that one in eight people in the world lack access to safe water.** Over 3 million people die each year from water-

related disease. And more people in the world own cell phones than have access to a toilet. **In the US, thirty-six states will face water shortages in the next five years**, and places like Arizona and California are already facing limited supply. It's estimated that in the next 30 years, the US water crisis could cost the country as much as \$300 billion.

- Dental vacuum systems waste a lot of water since they use so much of it. Thus, using a dry dental vacuum system is advised as it can reduce the water usage by upto 90%. [7,9,18, 22,23,36]
- Using computers, printers, and other devices with energy stars
- Set printers to double sided printing.
- LED and high-efficiency fluorescent light installation. LED lights have a 70% reduction in electrical energy consumption potential.
- Installing motion detectors to turn out lights automatically when people leave non-medical spaces like workplaces, stores, etc.
- Adding LED "exit" signs and other emergency indicators Designating dental staff who will make sure that everything is turned off at night
- Encouraging and instructing patients to switch off the water as they wash their hands
- Installing a water distiller within the office
- Whenever possible, use eco-friendly hand sanitizer rather than washing your hands.
- Only operate sterilization equipment while it is fully loaded.
- Boiler upkeep and servicing should be done regularly.
 - Email appointment reminders, for example, save paper use and save staff time for patient communications.
- Always keep the doors to air-conditioned spaces closed. [6,19,24]

REUSE

It is important to encourage the use of recyclable and biodegradable materials, which will reduce the need for the resources and energy used to create new products.

- Using reusable glass syringes, face shields, dishes, and cutlery in the staff break room can help reduce waste.
- Switching to cloth sterilization bags and patient barriers can reduce waste by up to 90%
- Wearing cloth aprons instead of paper ones can help reduce waste and decrease exposure to harmful chemicals.
- Switching to stainless steel impression trays and suction tips can reduce waste and improve patient comfort.
- Paper goods made from recycled, chlorine-free materials should be used instead of standard ones. [19]

RECYCLE

Recycling should be our last resort, and we need to do a much better job recycling everything that we can. It's estimated that 85% of the 26,000,000,000 water bottles the US uses each year are NOT recycled and end up as garbage. Creating those bottles uses enough oil to fuel 100,000 cars. Recycling materials and resources can make a significant difference in reducing the environmental impact of dental practices. The following actions can be taken:

- The big 5 materials, which include aluminum, glass, paper, plastic, and steel, can be recycled and reused.
- Participating in an instrument recycling program can help turn old instruments into industrial metal, reducing waste.
- Using a sharps disposal service that recycles needles and syringes into building materials can help reduce waste.
- Recycling copy paper and choosing a medical shredding service that recycles shredded paper can help reduce the environmental impact of the practice
- Provide recycling bins for staff break-room waste.
- The majority of waste materials that are classified as garbage can be processed again and recycled to create new goods. [6,20]
- Several dental supplies, including paper cups, paper, magazines, common trash, and cloths for

infection prevention, can be recycled to cut back on overall cost and bulk. [7]

WASTE DISPOSAL

All types of amalgam and other waste produced in a dental office must be collected, stored, and disposed of by a dental professional alone. Several dental offices feature additional filters that catch bigger dental amalgam particles and safeguard vacuum pumps in addition to chairside filtration equipment. [5,18, 38] When used with chairside traps and vacuum pump filters, amalgam separators (International Organization for Standardization standard 11143) draw the mercury out of them and have been shown to be 98% successful at removing amalgam particles from dental clinic effluent. [19,25]

While disposing of amalgam waste, staff workers should be trained and should wear gloves, masks, gowns, etc. Separate containers should be used to send contact and noncontact amalgam debris for recycling and mercury reprocessing. [9,18] Unreacted silver can be found in unused X-ray film. Thus, it needs to be disposed of safely. In most cases, you can achieve this by giving it back to the source or a licensed garbage carrier for recycling. Lead foils, fixer, and developer solution waste all need to be recycled when using conventional X-ray systems.

BIOMEDICAL WASTE [9, 19, 38]

Materials suspected of containing harmful organisms and hence capable of spreading disease are included in the category of biomedical waste. It contains syringes, tissues, and bits of gauze stained with blood. Syringes and suture needles that contain sharps should be kept in a container that is leak-proof, puncture-resistant, and clearly labeled until they are collected and burned. Products made from anatomical waste should be kept in a yellow bag with the appropriate label. The designated color-coded waste bins have been established by the authorities [Figure 2].

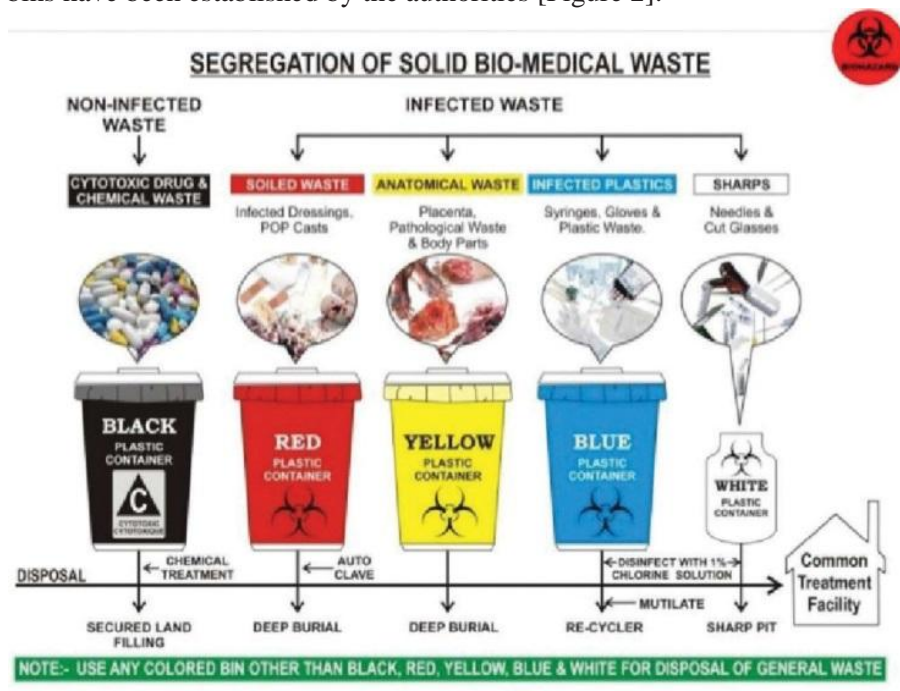


Figure 2: Disposal of biomedical waste.

GENERAL OFFICE WASTE

It contains garbage that isn't dangerous, like paper, paper towels, and cotton rolls. Dentists should take a number of actions to cut down on this waste. It is important to encourage the use of recycled-content items like paper towels and cotton or wool rolls. The amount of paper consumed in the dental office can be reduced by printing single-spaced and using both sides of the sheet. Use of recycled inkjet and toner cartridges ought to be encouraged. Flashlights and digital cameras should both be powered by rechargeable batteries. Moreover, used hand tools can be repurposed. For this, Hu-Friedy uses a tool named "Envirodent". In exchange for old instruments, a free one is offered. [19,26, 38]

FINANCIAL ASPECT

Switch to:	Annual return:
Reusable cups instead of paper cups	\$178
Cloth operatory and sterilization methods instead of disposables	\$2,337
Reusable metal instead of plastic suction tips	\$170
Tooth-colored instead of silver amalgam restorations	\$37,000
Digital billing, charting, and x-rays	\$8,769
Energy-efficient light bulbs and motion sensors	\$601

We're looking at a total of nearly \$50,000 in savings. [30]

CONCLUSION

Green dentistry offers a high-tech approach to reduce the environmental impact of dental practices and saving money for the practice in the long run which can help to provide cost-effective treatment to the patients. By adopting simple practices, such as reducing the use of disposable materials, promoting energy efficiency, and recycling, dental practices can make a significant contribution to environmental sustainability. Dental professionals have an ethical responsibility to reduce the environmental impact of their practices, and adopting green dentistry practices is a positive step towards achieving this goal.

Every employee should contribute to the work being done to put realistic, environmentally friendly improvements to outdated, unsustainable dental office routines into place. So, a dental professional can greatly contribute to improving the health of the patients, the community, and the environment by focusing more on prevention, precaution, sustainability, and raising awareness.

The dentistry community, particularly students, should be aware of the most recent writings on dental waste management and environmentally friendly dental procedures. The information and abilities needed to address this issue can be developed extremely effectively in this way. Many suggestions include:

- Environmental sustainability education is not currently required in UG curricula. The development of enough information for effective disposal and treatment of dental waste should be given adequate curriculum, time, and emphasis by dental schools during dental students' training.
- To create a website application that will let dentists track their carbon emissions in order to achieve sustainability.
- Increase public awareness of the need to reduce phantom power (the small amount of electricity that drains from certain appliances, transformers, and equipment such as surge-protected extension cords and instant-on devices such as television, monitors, and computers even when not in use).

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