

Sustainability in dentistry part II: Sustainability and the use of chemicals in dentistry

Learning outcomes

This article aims to assist the reader to:

- highlight the potential dangers of chemicals in the environment;
- identify toxic chemicals; and,
- identify safer chemicals to use in practice.

Introduction

The world is now in an existential ecological crisis. Our deleterious and unsustainable impact on the planet has, among other things, increased greenhouse gas emissions, with further injury from plastics and other waste in the environment. The evidence for an accelerating biodiversity crisis and serious soil degradation in many parts of the world is irrefutable.¹ The pandemic risk to our species and our planet is not if, but when. We have to change the way we organise society in order to make the future sustainable for all species.

Worldwide health systems are a significant contributor to environmental damage.²

The first article in this series discussed general aspects of sustainability in general practice, and this second article examines the use of chemicals in practice.

Chemicals in the environment

Chemicals in the environment cause many health and environmental hazards. Air pollution, for example, is responsible for about 6.7 million deaths per year worldwide, and 99% of the world's population live in places where air pollution levels exceed World Health Organisation (WHO) guidelines.³ The effect of toxins and endocrine-disrupting chemicals is becoming more apparent.⁴ These chemicals can disrupt hormones and may cause developmental and biological harm, even in extremely small amounts.

Numerous industrial chemicals are considered carcinogenic, requiring strict regulation. There are many more chemicals still used in industry, and some household products, which persist in the environment (**Table 1**). In many cases we do not understand the synergy between different chemicals and the potential for harmful chemicals to be formed by this synergy.

Endocrine-disrupting chemicals number nearly 1,000 according to the Endocrine Society (US).⁴ Water pollution may be caused by the build-up of chemicals from industry, agriculture and domestic sources. Damage may also be done in the form of accelerated, man-made eutrophication of bodies of water, including drinking water, with consequent deleterious effects on human and animal health.

Eutrophication describes the accumulation of nutrients in a body of water, which can result in an increase in the number of microorganisms and a reduction in the amount of oxygen in the water. For these reasons, health professionals, as well as others, should aim at all times to use chemicals that break down to safe end products that do not accumulate in the environment and do not damage watercourses.

Use of chemicals in dentistry

As part of the sustainability initiative, selecting the most environmentally friendly chemicals for use in dental settings is crucial. For example, while many of the products essential to decontamination contain chemicals that, at certain concentrations, are toxic to aquatic life or in some other way environmentally hazardous, much of the health and environmental damage associated with them comes from their production, the manufacture and disposal of their containers, and their transport.^{2,5,6} In this regard, the use of reusable bottles could directly reduce the amount of waste and would have a lower carbon footprint.

The most hazardous decontamination chemicals in dentistry occur in certain brands of wipes, certain brands of washer-disinfectant solutions, and in the chemicals used for prosthesis disinfection.²

Choosing the most environmentally friendly chemicals is part of the drive to sustainability. This can be difficult but safety data sheets (SDSs) are available for most chemicals used in dentistry, and no products should be bought unless there is an SDS available. The Health and Safety Authority (HSA) requires that the chemical labels and SDSs for every chemical product used in dental practices are accessible and that the associated hazards have been identified.⁷ In reality, it is often difficult to be certain of the sustainability of some chemicals, as there is not enough evidence on their environmental impact, especially for new products. Often, sections in the SDS are empty or partially completed, especially those sections on toxicological and ecological information.

For example, an SDS for a non-alcohol surface disinfectant wipe might state in section 11 (toxicological information) that no toxicological data is available, but in section 10 (stability and reactivity), it might state that the hazardous decomposition products include chlorine compounds as well as carbon monoxide, carbon dioxide and nitrogen oxides, leaving the reader to query the validity of the information. The lack of detailed information in SDSs for some hazardous chemicals makes them of limited use in risk management.

Products containing chlorine should be avoided, as the release of these products



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Table 1: The most commonly studied chemicals and where they may be found in our environment.

Chemical	Description	Products containing these chemicals
Per- and poly-fluorinated substances (PFAS)	A group of chemicals ubiquitous in the environment and used to make fluoropolymer coatings and products that resist heat, oil and water.	Non-stick cookware, water-repellent clothing, stain-resistant clothing.
Plastics – microplastics	Range of synthetic or semi-synthetic materials that use polymers to produce solid objects.	Shampoos and many other ‘flowing’ products contain microbeads, packaging.
Bisphenol A	A colourless solid, which is soluble in most common organic solvents and used in the manufacture of plastics.	Composite filling materials including fissure sealants, linings of metal cans, plastic bottles.
Dioxins	A group of chemical compounds that are persistent organic pollutants in the environment.	90% of human exposure is from food, mainly meat and dairy products, fish and shellfish.
Perchlorates	A chemical compound containing the perchlorate ion.	Disinfectants, bleaching agents and herbicides.
Phthalates	A group of chemicals used to make plastics more durable.	Plastics and small amounts found in eye shadow, moisturiser, nail polish and hair spray.
Triclosan	An antibacterial and antifungal agent. It is toxic to aquatic bacteria and can affect the structure of algae. Best avoided due to environmental effects.	Toothpastes, soaps, detergents, toys, surgical cleaning treatments.

Table 2: Chemicals that should be avoided and those which are safe to use.

Product	Safe to use	Use with caution	Avoid if possible
Surface wipes	Ammonium chloride, benzoic compound, ethylene glycol, sodium hydroxide	Phenol (toxic to aquatic life)	
Washer-disinfectant tablets	Ammonium chloride, benzoic acid, citric acid, soda ash, potassium hydroxide, ethylene glycol, ethanol, sodium cumenesulphonate		EDTA (toxic to aquatic life), 2-methyl pentane (toxic to aquatic life), benzothiadiazole (biocide)
Prosthesis disinfection	Sodium chloride	Sodium hypochlorite (toxic to aquatic life)	
Line shock treatment	Citric acid, sodium hydrogen sulphate, hydrogen peroxide		
Suction cleaner	Ammonium chloride, potassium hydroxide, sodium pyrophosphate		

can be harmful to aquatic organisms. Chlorine can damage the cell walls and proteins of living organisms. Chlorine can also, through various chemical interactions, produce carcinogens such as trihalomethane, chloramine and N-nitrosodimethylamine, although the relative health risks of such products are not yet fully quantifiable.² Oxidising disinfectant products containing chlorine can increase the mobilisation of mercury from amalgam, facilitating the entry of mercury into the environment. Mercury released into the environment can

bioaccumulate in fish and other organisms and spread throughout the food chain.⁸ The use and maintenance of amalgam separators is a legal requirement.

A HSA inspection will require confirmation that all chemicals are used, stored and disposed of in accordance with the SDS or supplier recommendation. Avoid disposing of any hazardous chemical into the municipal waste water sewage system. Always read the instructions for the use of any chemicals and avoid mixing different chemicals unless advised to by the manufacturer. There is a low

possibility of synergism or antagonism between different chemicals that are used in dentistry.⁹ Caution is required to avoid chemical accidents.

It is important to adhere to the Dental Council's Code of Practice Relating to: Infection Prevention and Control, 2015, in the decontamination of instruments and dental premises.¹⁰ This can be done using chemicals that are non-toxic to the environment (**Table 2**). A practice protocol may include:

- reducing the use of hazardous materials where possible – try to use chemicals that biodegrade readily into non-toxic chemicals with a low environmental footprint;
- always reading the SDS for any product; and,
- keeping all chemicals in a safe storage area.

Dental restoration materials

The use of amalgam for dental restorations is gradually being phased out in most of the world due to the toxicity of mercury in the environment.¹¹ In Ireland, composite filling materials are generally used instead of amalgam. Some of these materials may contain endocrine disruptors such as bisphenol A.¹² Although bisphenol A is not used in the manufacture of dental materials, it is used in the manufacture of monomers common to dental resins, such as bis-GMA, bis-EMA and bis-DMA. Residual bisphenol A may remain from the synthesis process of these monomers, and thus trace amounts may be present as a contaminant in dental resins.¹³

Currently, composite materials are considered low risk. Components of composite resins can be released during polymerisation and degradation of the material. Patient exposure to these components when placing composite material can be reduced by the use of rubber dam and by ensuring that the curing light and irradiation distance used are adequate to polymerise the particular brand of resin. Nevertheless, there are increasing concerns regarding the safe clinical application of these materials due to their biodegradation in the oral environment. The number and diversity of processes by which composite resins may be degraded in the oral cavity are many and are now recognised as a complex interplay of interactions. Biodegradation may be influenced by several factors including saliva characteristics, chewing, or thermal and chemical dietary changes.

The clinical consequences of composite restoration materials are still not fully understood.¹² There is a need for further research to better understand the risks from placement and degradation of composite materials, including potential local and systemic side effects.

The best way forward is to improve dental health generally so that fewer restorations are required.

Cleaning and household products

Domestic cleaning agents used in dental practices may contain potentially dangerous chemicals. For example, household bleach and many cleaners contain chlorine and other chemicals that can be avoided.

Most of the cleaning products on the market we refer to as detergents. Detergents occur in many forms including liquids, tablets and others, and are used for cleaning surfaces, clothes, in fabric care and in many other applications. A detergent is a mixture containing soap and often a surfactant intended for cleaning purposes.

If professional cleaners are employed, it is best if they can demonstrate that the chemicals they use are environmentally acceptable. Alternative environmentally acceptable chemicals are available from a number of companies in Ireland.

Take home messages:

- the world is in an existential ecological crisis, which affects us all;
- chemicals in the environment are contributing to this crisis – it is vital that we understand this and work to mitigate their effects;
- environmentally hazardous chemicals are used in cleaning and decontamination in dentistry, but some may be substituted with less hazardous options;
- when treating patients, chemicals such as those found in restorative materials require further research but prevention remains the most effective way to reduce environmental harms caused by healthcare;
- sustainable oral healthcare is the provision of equitable, ethical, high-quality, inclusive and safe care with appropriate, effective and efficient use of resources. The products that healthcare organisations buy and use (procurement) are essential to securing a safer environment;² and,
- the dental trade is receptive to making changes in the materials that they offer and must be part of the discussion on chemicals in dentistry.

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