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Study on Usage and Waste Management of Amalgam Dental Fillings and Mercury-free Alternatives

Authors: Martina Hayes, Aileen Callanan, Mairead Harding, Christopher Lynch and Francis Burke

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Rialtas na hÉireann
Government of Ireland

ENVIRONMENTAL PROTECTION AGENCY

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- Office of Environmental Enforcement
- Office of Evidence and Assessment
- Office of Radiation Protection and Environmental Monitoring
- Office of Communications and Corporate Services

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EPA RESEARCH PROGRAMME 2014–2020

Study on Usage and Waste Management of Amalgam Dental Fillings and Mercury-free Alternatives

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EPA Research Report

Prepared for the Environmental Protection Agency

by

University College Cork

Authors:

Martina Hayes, Aileen Callanan, Mairead Harding, Christopher Lynch and Francis Burke

ENVIRONMENTAL PROTECTION AGENCY
An Ghníomhaireacht um Chaomhnú Comhshaoil
PO Box 3000, Johnstown Castle, Co. Wexford, Ireland

Telephone: +353 53 916 0600 Fax: +353 53 916 0699
Email: info@epa.ie Website: www.epa.ie

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This report is based on research carried out/data from April to December 2018. More recent data may have become available since the research was completed.

The EPA Research Programme addresses the need for research in Ireland to inform policymakers and other stakeholders on a range of questions in relation to environmental protection. These reports are intended as contributions to the necessary debate on the protection of the environment.

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Project Partners

Dr Martina Hayes
Cork University Dental School and Hospital
Wilton
Cork
Ireland
Tel.: +353 21 490 1100
Email: martina.hayes@ucc.ie

Professor Christopher Lynch
Cork University Dental School and Hospital
Wilton
Cork
Ireland
Tel.: +353 21 490 1100
Email: chris.lynch@ucc.ie

Dr Mairead Harding
Oral Health Services Research Centre
Cork University Dental School and Hospital
Wilton
Cork
Ireland
Tel.: +353 21 490 1210
Email: m.harding@ucc.ie

Ms Aileen Callanan
Cork University Dental School and Hospital
Wilton
Cork
Ireland
Tel.: +353 21 490 1100
Email: aileen.callanan@ucc.ie

Dr Francis Burke
Cork University Dental School and Hospital
Wilton
Cork
Ireland
Tel.: +353 21 490 1100
Email: f.burke@ucc.ie

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Executive Summary

The filling of teeth is one of the most routine and common tasks undertaken by dentists. Because of the availability of community fluoridation and improved dental care, Irish adults have fewer missing teeth; however, they have more teeth with fillings. This trend has been observed in national oral health surveys from 1982 to the most recent survey in 2002. When filling teeth, dentists rely on two main materials: amalgam (a metallic compound containing mercury) and resin composite (a plastic, tooth-coloured material). Historically, amalgam was the only direct filling material for restoring posterior teeth. Although resin composites have been placed in anterior (front) teeth for over 40 years, the evidence to support their placement in posterior teeth has developed in the past 10–15 years.

The European Union introduced Regulation 2017/852 to implement the Minamata Convention on Mercury. Article 10 of the regulation sets out the parameters for the use of dental amalgam. Of note, dental practitioners should not place amalgam in deciduous (baby) teeth, in children aged under 15 years or in pregnant/breastfeeding women (EU, 2017). The regulation also requires dentists to have an "amalgam separator" fitted to their chair to minimise the levels of dental amalgam entering wastewater.

There is a lack of information in relation to the placement of filling materials (amalgam and composite) by dentists in Ireland. There are no "national surveys" available on the selection and use of restorative materials. The aim of this study was to determine, using a structured questionnaire and focus groups, the selection and use of restorative materials by dentists in Ireland using a sample of 2400 dentists obtained from the Dental Register. We attempted to identify any barriers that may exist to the "phase down" of dental amalgam and to ascertain how dentists manage waste from dental amalgam and other filling materials.

The response rate to the survey was 11.9% ($n = 286$) and, accordingly, results should be interpreted with caution. Based on the survey responses, resin composite is the most commonly placed dental filling material in Ireland. On average, dentists reported placing 14 resin composite fillings per week. Dental amalgam was the next most commonly used material, with each dentist placing an average of eight amalgam fillings per week.

When asked about deciduous teeth, 15% of dentists ($n = 43$) reported that they would "commonly" use dental amalgam. The proportion of dentists who indicated that they would "commonly" place amalgam in permanent teeth in children aged under 15 years was 33%. When asked what circumstances would prompt them to select dental amalgam as the filling material to place in a child, dentists frequently referred to "challenges in isolation", i.e. keeping the tooth dry enough to place an alternative to amalgam. They also cited the scenario in which the child is "uncooperative" or has "poor oral hygiene".

There was a discrepancy between the type of filling material used to fill posterior (back) teeth when the adult patient paid the full economic cost of the treatment (private) and the type of filling material used when the cost of the treatment was reimbursed by the state (Dental Treatment Services Scheme, DTSS). In total, 17% of dentists who responded would "often/always" place amalgam in a back tooth in a private adult patient whereas 46% of dentists "often/always" place amalgam in a back tooth in a DTSS adult patient.

The majority of dentists (94%) who responded had a waste management policy in relation to waste amalgam and only 8% reported that they did not have an amalgam separator fitted to their dental chair. The use of pre-dosed capsules of amalgam was reported by 93% of dentists. A total of 72% of dentists did not have a waste management policy for waste resin composite and there was significant variation in the disposal practices described by respondents.

The phase down of dental amalgam was welcomed by 61% of dentists who responded; 75% of dentists did not believe that it would cause any major disruption to their practice of dentistry. In total, 60% of dentists were supportive of a complete phase out of dental amalgam within the next 10 years.

1 Introduction

1.1 The Minamata Convention: Phase Down of Dental Amalgam

The use of dental amalgam has been a contentious issue for many years and concern has been expressed regarding the potential risk to health and the environment arising from poor waste management. The United Nations Minamata Convention on Mercury is an internationally binding treaty that opened for signature in October 2013. The Convention got its name from the city of Minamata in Japan after severe mercury poisoning of seafood occurred, causing a neurological syndrome called Minamata disease (UNEP, 2017). The aim of the Convention is the protection of human health and the environment from sources of emissions and releases of mercury and mercury compounds (Mackey *et al*., 2014). The use of dental amalgam is one of the areas the Convention seeks to address, with a proposed voluntary phase down and commitment to other measures pertaining to the use of dental amalgam (UNEP, 2017). Annex A of the Minamata Convention includes measures relating to minimising the use of amalgam in dental restorations through national objectives such as caries prevention; promotion of mercury-free alternatives; health promotion; encouraging research into and the development of mercury-free alternatives; and educating and training dental professionals in mercury-free alternatives. Measures also include discouraging insurance policies and programmes from favouring dental amalgam use and, finally, restriction on the use of dental amalgam to only its encapsulated form and promoting best practice in dental facilities in relation to dental amalgam (UNEP, 2017). Parties to the Convention are required to commit to two or more of the measures outlined in the treaty. The European Parliament and Council adopted Regulation (EU) 2017/852 on mercury in May 2017 to enable the European Union (EU) and its Member States to ratify the Minamata Convention on Mercury. The EU is to assess the feasibility of an EU phase out and work on this has commenced (EU, 2017). Ireland signed the Convention in October 2013 and ratified it in March 2019 (UNEP, 2018).

Once released, mercury persists in the environment and can travel long distances and bioaccumulate up the food chain to large fish, where it can be consumed by humans. Mercury can cause serious damage to the central nervous system, thyroid, kidneys, lungs, immune system, eyes, gums and skin of humans. Mercury contamination can also have serious impacts on ecosystems, such as reproductive effects on birds and mammals (Nilsson and Dynesius, 1994). Biomagnification of up to 100,000 times has been reported from algae to the top of the food chain (Campbell *et al*., 2003).

Although the relationship between dental amalgam and human health is still a subject of much debate, there is no evidence to suggest a negative impact on human health from dental amalgam restorations *in situ* (Brownawell *et al*., 2005). The environmental impact, however, is not disputed – the waste created from the extraction, disposal and incineration of dental amalgam is known to contaminate the environment (UNEP, 2016). There are many ways in which dental amalgam waste is generated. It can be generated from the removal of amalgam restorations from a patient's tooth or when placing an amalgam restoration; it can also be generated in the form of excess or unused amalgam. This amalgam waste has the potential to enter the water system when there is no amalgam separator in the suction unit or the spittoon. Once it enters the water table it can be converted into mercury or methyl mercury by microorganisms. This can then remain in the water or enter the food chain, where it can bioaccumulate. Contamination also occurs from the cremation of human remains, with mercury being released into the atmosphere, onto land and into water (Chin *et al*., 2000).

1.2 Phase Down of Amalgam in Ireland

In line with the Minamata Convention requirements and EU regulations, Ireland ratified the Convention in March 2019. Ireland has already begun to implement some of the measures pertaining to the restrictions

placed on the import, export and manufacture of mercury relating to dentistry. The Dental Council of Ireland has provided guidelines for dentists in line with the EU regulations as follows:

- From 1 July 2018, amalgam will not be permitted for use in deciduous teeth, pregnant or breastfeeding women or children under the age of 15 years unless it is deemed medically necessary by the dentist. Prior consent must be obtained from the patient before any dental amalgam can be placed and the reasons outlined to the patient and recorded in the patient's clinical notes.
- From 1 January 2019, dental facilities must be equipped with amalgam separators. Dentists must maintain records in relation to the installation, commissioning and retention levels of separators and separators must provide at least a 95% retention level.
- From 1 January 2019, use of bulk mercury will be prohibited and dentists will be permitted to use amalgam only in a pre-encapsulated form.
- By 1 July 2019, a national plan in relation to the phase down of mercury must be set out and communicated publicly by each Member State.
- Dentists must ensure the collection of all amalgam waste by a registered authorised waste management company as per existing waste legislation, as mentioned in section 1.4.

Any requirements laid out in the new code relating to amalgam usage and disposal are in addition to all existing obligations pertaining to infection prevention and control and waste management, as legislation was already in place in Ireland pertaining to waste collection and amalgam separators.

1.3 Phase Down of Amalgam Internationally

Many other countries have already successfully phased down or phased out dental amalgam for various reasons. In Europe, some of the countries that have successfully phased out dental amalgam include the Netherlands, Finland, Norway and Denmark. Globally, many other countries have also opted to phase out dental amalgam, such as Japan and Singapore. In the Netherlands, the dental sector embraced the use of mercury alternatives during the 1990s, which saw the use of amalgam plummet to less than 1% by 2011. Norway introduced a general ban on mercury products in 2008, with an exemption period for amalgam. This followed the introduction of guidelines to limit mercury products in 1991 and stronger guidelines in relation to dental amalgam in 2003. Japan, on the other hand, made the change from dental amalgam during the 1980s for aesthetic and environmental reasons (UNEP, 2016). Following ratification of the Minamata Convention, all EU Member States are now obliged to follow measures in line with the phasing down of dental amalgam, with the ultimate objective of phase out. These measures were to be adopted from 1 July 2018 and will be introduced over a fixed period (UNEP, 2017).

1.4 Existing Legislation Regarding Dental Amalgam

Under the existing EU Waste Directive 2008/98/EC there is a legal requirement to ensure that hazardous waste (such as dental amalgam waste) is handled in an environmentally sound manner, including having provisions on proper handling, storage, record keeping and treatment. This is contained in Statutory Instrument (S.I.) No. 126 of 2011 – European Communities (Waste Directive) Regulations 2011. Amalgam separators are devices that are fitted to suction systems in dental clinics (Figure 1.1). Their role is to filter dental amalgam from suction units in dental practices so that all wastewater going into the main wastewater system has at least 95% of the waste dental amalgam particles removed. Various systems are available to achieve amalgam separation but, to comply with regulations, a system must remove at least 95% of the waste amalgam particles. An amalgam separator can be fitted to an outlet from any dental chair unit and can be fitted retrospectively, if required. Used amalgam capsules must also be stored in an approved container and all amalgam waste from suction units must be stored in a dedicated container with a sponge impregnated with a mercury vapour suppressant (see Figures 1.2–1.4). Dental practices, as generators of the waste, are charged with the disposal of amalgam waste and are required to keep records of disposal; Waste Transfer Forms (WTFs), formerly C1 forms, must be retained for 3 years. All measures adopted under the Convention will be in addition to any existing legislation and directives.

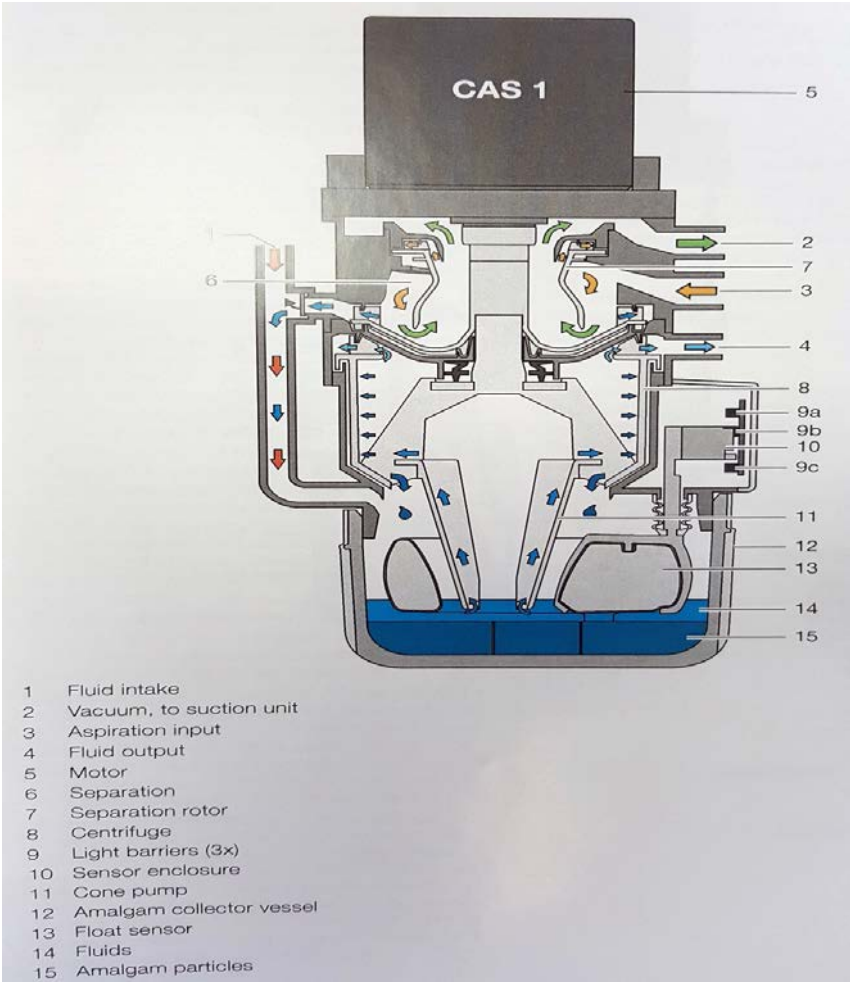

Figure 1.1. Amalgam separator device and parts.

Figure 1.2. Amalgam triturator (left), amalgam capsules and amalgam capsule disposal drum (middle) and waste amalgam disposal tub (right).

Figure 1.3. Dental amalgam in a Dappen dish and triturated amalgam capsule.

Figure 1.4. An amalgam restoration *in situ* in a posterior tooth.

Under new regulations, namely the EU (Mercury) Regulations 2018, local authorities are responsible for monitoring compliance requirements for dental facilities and handling of amalgam waste. Local authorities will be authorised to conduct inspections of dental premises and to assess compliance, including waste management practices (DCCAE, 2018).

1.5 Restorative Materials

Various materials are used by dental practitioners in the restoration of dentition damaged by dental caries. These materials include, but are not limited to, dental amalgam, resin composites, glass ionomer cements (GICs) and resin-modified glass ionomer cements (RMGICs).

Dental amalgam, which is the amalgamation of mercury and a metal alloy of silver, tin, copper and other elements, has been used successfully for many years. Amalgamation occurs when the mercury reacts with the outer layer of the silver–tin alloy, with the bulk of the particle remaining unreacted. This then sits within a matrix of silver–mercury and silver–tin phases. Because of its strength in withstanding the high loads generated in mastication, it is indicated for class I and class II restorations and core build-ups. Its unaesthetic appearance means that it is generally used in the posterior sextants of the mouth (Banerjee and Watson, 2011; Bonsor *et al*., 2013).

There are currently three types of alloy available: lathe cut, spherical and admixed. Correct manipulation in clinic is essential for optimal performance as the handling characteristics of the alloys are very different (Bonsor *et al*., 2013).

Cavity design is an important element in the successful placement of an amalgam restoration. A minimum cavity depth of 2 mm is required to prevent fracture; no sharp internal line angles must remain within the cavity; attention must be paid to the cavo-surface

angles; and, if the cavity is not retentive following caries removal, mechanical retention should be provided (Bonsor *et al*., 2013).

Resin composites are tooth-coloured restorative materials that are now widely used in dentistry, particularly when aesthetics is important. Resin composites are just one of the many types of dental composites available and are composed of a chemically active resin and a filler that is usually glass or ceramic. The chemical reaction of two resins, bisphenol A and methacrylate, which form bisphenol A-glycidyl methacrylate (bis-GMA), make up the main resin component. Other monomers are added to permit clinical handling. Filler is added to increase strength and wear resistance, reduce shrinkage, improve colour, fluorescence and translucency and reduce thermal expansion (Bonsor *et al*., 2013).

In the past, resin composites were set chemically but, since the 1970s, light curing has become more common. Resin composites are divided according to their setting status: chemically cured (self-cured), light cured and dual cured (activated by both) (Peutzfeldt, 1997). Figure 1.5 displays composite syringes, a composite compule gun, composite compules and a compule dispenser and Figure 1.6 shows a composite restoration *in situ* in a posterior tooth.

Glass ionomer cements are a group of materials whose setting involves an acid-based chemical reaction of an acidic liquid with a basic glass, requiring the presence of water, which results in the formation

Figure 1.5. Clockwise from top left: composite syringes, composite compule gun, composite compules and composite compule dispenser.

Figure 1.6. Composite *in situ* in the oral cavity.

of a matrix. GICs were the material of choice from the early 1930s to the 1950s for the anterior segments of the mouth for aesthetic reasons. The two primary forms of GIC are encapsulated and hand mixed (Bonsor *et al*., 2013).

Resin-modified glass ionomer cements are an adaptation of GICs; they maintain the benefits of fluoride release and adhesion with the addition of the benefits of resin-based composites. RMGICs contain glass, polyacid, tartaric acid and water, similar to GICs, with the addition of water-soluble resin and modified polyacrylic acids, called co-polymers. Chemicals allowing light activation are also incorporated. The setting reaction of RMGICs is complex and can be divided into dual cured (chemical and light cured) and tri-cured (including an additional acid–base reaction) (Bonsor *et al*., 2013).

1.6 Dental Amalgam in Ireland

Dental amalgam, the amalgamation of mercury and a metal alloy of silver, tin copper and other elements, as outlined previously, has been used successfully for many years. Amalgam for use in dentistry is available in two main forms: pre-dosed and bulk. Bulk amalgam has been prohibited for use in dentistry in the EU since January 2019. Pre-dosed amalgam is found in capsules, with a pre-measured amount of mercury and alloy mix in two separate compartments; when activated by depressing the capsule the two elements come together and the capsule is placed in a triturator for mixing. In bulk amalgam, the two elements, mercury and the alloy mix, are purchased separately and each element is poured into an amalgamator where it is mixed to produce the dental amalgam. In the Irish context, there is a lack of information relating to the placement of restorations, with no national surveys on the selection and use of restorative materials. Data are available in relation to the public service Dental Treatment Services Scheme (DTSS), outlined below, but no data are available in relation to out-of-pocket (private) expenditure on dental treatment, which makes up a significant proportion of the expenditure on oral healthcare in Ireland, accounting for approximately 83% of expenditure in 2014 (Woods *et al*., 2017).

Provision of dental services within the Irish dental service is complex, with them operating under a public–private mix. There are currently three publicly funded systems in Ireland: the Public Dental Service (PDS), the DTSS and the Dental Treatment Benefit Scheme (DTBS). The PDS, run by the Health Service Executive (HSE), provides salaried dentists in local health centres to provide dental treatment to eligible groups, which may include children aged under 16 years, including those with special needs, people with emergency dental needs and adults with special needs. The DTSS, operated by the HSE, provides items of dental treatment to adult medical card holders through contracted independent general dental practitioners (GDPs) (Woods *et al*., 2017; DEASP, 2019). The DTBS, operated by the Department of Employment Affairs and Social Protection (DEASP), provides insured persons with specific items of dental treatment through contracted independent GDPs. Under the DTSS, GDPs are reimbursed for amalgam restorations (using code A3A) in posterior teeth and remuneration is based on a fee per item basis (HSE, nd). The data available in relation to the placement of posterior restorations under the DTSS are likely to be very different from data available for private patients as, at present, there is not a code in this scheme under which to claim remuneration for a composite filling on a posterior (or back) tooth. The data available in relation to the DTSS are not transferable to the situation in private patients, who pay out-of-pocket for their oral healthcare.

A new national oral health policy was launched by the Department of Health in 2019. This policy (Smile agus Sláinte) outlines a number of different oral care packages. The new oral health plan supports a preventive approach and will provide packages of care to all children aged under 16 years, who total 1.1 million, and all medical cardholders over the age of 16 years, who total 1.3 million.

1.7 Dental Amalgam Alternatives

Resin composite is the most commonly used alternative to dental amalgam for the restoration of posterior teeth. A plastic tooth-coloured material, it has been used in anterior teeth for more than 40 years but has been increasingly used to restore posterior teeth in the last 10–15 years. Despite its increasing popularity among dental practitioners, a UK-based study of GDPs (providing both NHS and private dental care) suggested that amalgam restorations are still used in 59–70% of restorations placed in posterior teeth

(Lynch and Wilson, 2013). The use of resin composites in the restoration of posterior teeth has occurred for many reasons, including significant improvements in materials, patients requesting more aesthetically pleasing materials and concerns around the potential effects of the mercury content of amalgam coupled with the environmental effects of mercury released from dental amalgam. Resin composites are also a more conservative material to place in terms of the preservation of tooth tissue (Lynch and Wilson, 2013).

The teaching of posterior composite techniques in Ireland has become more established, with surveys suggesting that the ratio of composite fillings placed in posterior teeth to the proportion of amalgam fillings placed in posterior teeth is now approximately 55%:45% among dental students studying in Ireland (Lynch and McConnell, 2006). Posterior composite techniques have become the first pre-clinical skills taught to dental students in the restoration of posterior teeth, rather than amalgam techniques, as was the case previously in Ireland. In the last 20 years, dental students have gained increased experience in placing posterior resin composites compared with amalgam. There are many benefits of posterior resin composites, including their good aesthetic appearance, especially from the patient point of view, better preservation of tooth tissue and good adhesion to the tooth structure (Lynch and Wilson, 2013).

Following composites, the two other most used amalgam alternatives are GICs and RMGICs. GICs mainly come in two forms, encapsulated and hand mixed, and their setting involves an acid-based reaction. RMGICs are an adaptation of GICs that incorporate constituents allowing light activation.

2 Objectives

The aim of this project was to determine the current levels of usage of, and the waste management practices with regard to, dental amalgam and mercury-free alternatives in Ireland among GDPs and HSE-salaried dental practitioners.

Specific objectives were to:

- determine the approximate number of direct restorations (i.e. fillings) placed by dentists in Ireland;
- quantify the proportion of these fillings that are dental amalgam compared with mercury-free alternatives (composite, GIC and RMGIC);
- quantify the amounts of dental amalgam and mercury-free alternatives imported by the main dental suppliers in Ireland;
- identify the key waste management practices and policies for amalgam and mercury-free alternatives;
- assess the current knowledge among registered dental practitioners regarding national and international legislation for the disposal of both dental amalgam and mercury-free alternatives.

3 Methods

3.1 Study Design

The study adopted a mixed-methods descriptive cross-sectional survey design. This involved conducting qualitative (one-to-one) interviews with identified key experts on the topic; qualitative focus groups; and face-to-face interviews with dental nurses. A nationally representative sample of dentists was selected and surveyed as part of this study. Ethics approval was provided by the Social Research Ethics Committee (SREC) at University College Cork (Log 2018–108). Informed consent was obtained from each participant by means of a consent form. Completion of the form was considered as informed consent to participate in the study.

Qualitative interviews were conducted with key experts in person or by telephone prior to the design of the survey to guide survey content. A snowballing technique was adopted in the recruitment of the key experts. This technique involves a referral-type process from one individual to the next and has been used very successfully in contacting hard-to-reach or hidden populations, particularly in the research field (Streeton *et al*., 2004). The experts were identified and invited to participate in one-to-one interviews in person or by telephone from April to June 2018. A topic guide was designed and used for conducting the interviews.

Qualitative interviews and focus groups were also conducted in person with dental nurses, who play a key role in dental practice waste management. A convenience sample of dental nurses was taken from a conference attended by dentists and dental nurses at University College Cork in January 2019. Dental nurses were approached at the conference and invited to participate in one-to-one interviews and/or focus groups in person. Again, a topic guide was designed and used for the purpose of the dental nurse interviews. Qualitative data gathered from these interviews are presented in Chapter 4 to complement the quantitative data from the questionnaire, primarily in areas that were identified by dentists as being within the role of the dental nurse.

In order to quantify the amounts of dental amalgam and mercury-free alternatives imported in Ireland, dentists working at Cork University Dental School and Hospital (CUDSH) were asked where they source their restorative dental materials (i.e. filling materials). These suppliers were then contacted by email and telephone.

3.2 Survey Instrument

The survey instrument was modelled on a previous survey, “No More Amalgam”, of alternatives to dental amalgam, designed by Professor Christopher Lynch and used in a similar study in Wales (Lynch *et al*., 2018). This questionnaire was amended where it made reference to the NHS remuneration system and was adapted to the Irish oral healthcare setting. Following interviews with key experts in restorative dentistry, it became apparent that there was no consensus on the ideal replacement to dental amalgam and that there was no gold standard internationally for the waste management of restorative materials other than amalgam. Key barriers to the complete phase down of amalgam identified included cost, time management issues, operator skill and awareness of alternatives. Questions relating to these potential barriers were incorporated into the final survey instrument.

The survey was adapted for use in the Irish context and, prior to distribution, it was piloted locally by dentists in independent practice and dental hospital staff. There was also engagement with the Environmental Protection Agency steering committee in terms of consultation in relation to the content of the survey. The survey instrument had a total of 53 questions, with most of the questions adopting a tick box response. The survey instrument consisted of both fixed-choice and open-ended questions and was laid out over six distinct sections: current practice, waste management, knowledge of phase down, attitudes, training and demographics:

- Section 1 was designed to capture data relating to dentists’ current practice in the placement of restorations and to quantify the number and type of restorations placed.
- Section 2 questioned the key waste management practices of dentists in relation to both amalgam

and amalgam alternatives, namely composites, GICs and RMGICs.
- Section 3 captured data relating to knowledge of the Minamata Convention on Mercury.
- Section 4 questioned dentists on their attitudes to and experiences of placement of the various restorative materials available and material selection.
- Section 5 was designed to capture data relating to previous and potential future training of the participants.
- Section 6 asked key questions regarding demographics of the participants and their practices.

3.3 Survey Instrument Distribution

In total, 2400 copies of the survey were distributed by post from September to December 2018 across three phases, with 750 surveys distributed in wave 1 in September, 600 surveys distributed in wave 2 in November and 1050 surveys distributed in wave 3 in December. Convenience sampling was also adopted at several key events, including dental conferences, meetings and study groups, to maximise participation levels. At events, dentists in attendance were asked to fill in the questionnaire and place the completed questionnaire in a box before leaving.

3.4 Sampling Frame

The Dental Register was used for the recruitment of participants into the study. All dentists practising dentistry in Ireland must be registered with the Dental Council and listed on the Dental Register. In September 2018 the register listed 3124 dentists and this list was requested from the Dental Council. All specialist dentists (e.g. orthodontists, oral surgeons) were removed from the sample population as the study related to placement of restorations and key waste management practices associated with this and these specialities are not concerned with the placement of restorations. Others removed from the register were those with a registered address outside Ireland. The 2400 remaining dentists on the register were used as the sampling population and, ultimately, all were invited to participate during the three waves.

Unique identifiers were assigned to each potential participant to enable follow-up of non-responders and preserve anonymity. A mailing company was used for distribution of the surveys and returns were forwarded to investigators at CUDSH. A stamped addressed envelope was provided in the mailing to increase participation, along with an information leaflet describing the nature of the study, a consent form and the contact information of the investigators. Non-responders were contacted and an offer made to resend the survey to them. Follow-up was carried out by telephone for those participants whose details could be found online; the Dental Register includes either the practice or the home address of dentists but not telephone numbers or email addresses.

3.5 Data Entry and Analysis

Data entry was performed by a data management company, Seefin Data Management, and uploaded in Excel format. The Excel file was cleaned by investigators at CUDSH and uploaded to IBM SPSS (Statistical Package for the Social Sciences) for data analysis. The data was analysed using SPSS version 24 for Windows. Quantitative analysis of survey data using frequencies was performed. Tables and graphs were used to display the results where appropriate.

4 Results

The response rate to the survey was 11.9% ($n = 286$). This response rate is discussed further in section 5.4. Despite the low response rate, the study had a similar number of participants as a study in the UK ($n = 270$) that had a 40% response rate (Lynch *et al*., 2018), with another study conducting similar research in Australia having a response rate of just over 3% (Alexander *et al*., 2016). However, as a result of the low response rate, the sample may not be nationally representative. The sampling frame, the Dental Register, also had some inherent flaws for use as a sampling frame for a survey-based study. The authors emphasise that, given the low response rate, the main limitation of the study, the results should be interpreted with caution.

4.1 Demographics of Respondents

In total, 41.5% of respondents were female. The age distribution of participants is shown in Table 4.1.

Table 4.2 displays the number of dentists from each province in Ireland within the sample.

In total, 56% of dentists identified themselves as the principal dentist in the practice and 44% were associates. On average, 38% of patients treated were private patients, 28% were DTSS patients and 34% had Pay Related Social Insurance (PRSI) entitlements. This varied considerably between practices, however, with some respondents treating no DTSS patients and others treating only DTSS patients. A total of 221 participants had completed their dental training in Ireland, 31 in the UK, 18 in other EU countries, two in countries outside the EU and two “abroad”.

Table 4.3 displays the distribution of the decade of graduation for dentists in the sample.

Table 4.1. Age distribution in sample

Age (years)	Number	%
25–34	58	20.5
35–44	83	29.3
45–54	74	26.1
55–64	54	19.1
65+	14	4.9
Total	283[a]	100.0

[a]Not all participants completed the demographics questions at the end of the questionnaire.

Table 4.2. Numbers of dentists per province

Province	Number
Munster	73
Leinster	125
Connaught	28
Ulster	11

Not all participants completed the demographics questions at the end of the questionnaire.

Table 4.3. Distribution of decade of graduation

Decade	Number
1970s and earlier	22
1980s	65
1990s	78
2000s	67
2010s	47

Not all participants completed the demographics questions at the end of the questionnaire.

4.2 Usage of Amalgam and Alternative Filling Materials

4.2.1 Total number of restorations placed

A total of 8455 restorations were placed by dental practitioners who responded to the survey in the week prior to filling out the survey. The minimum number of restorations placed was zero and the maximum was 180; the average number of restorations placed was 30. Resin composite was the most commonly placed dental material, with 6047 (71%) resin composite restorations placed by respondents in the week prior to filling out the survey, with an average number of composite restorations placed by each dentist per week of 14 (min. 1, max. 85).

There were 1675 (20%) amalgam restorations placed by dental practitioners in the week prior to completing the survey, making it the second most commonly used restorative material. The minimum number of amalgam

restorations placed was zero and the maximum was 80; the average number of amalgam restorations placed was eight.

Comparatively few GIC or RMGIC restorations were placed. In total, 459 GIC restorations were placed (mean 3, min. 0, max. 50) and 274 RMGIC restorations were placed (mean 3, min. 0, max. 20).

Figure 4.1 displays the proportions of restorative material placed by dentists in Ireland in the week prior to filling out the survey.

4.2.2 Filling material choice for the primary dentition

The primary dentition are the first teeth to erupt into the oral cavity. Often, these teeth are referred to as deciduous teeth or colloquially as "baby teeth". These teeth will be exfoliated (lost) as the permanent teeth erupt. These teeth usually erupt between the ages of 6 months and 3 years and are lost by the age of 12 years. Filling deciduous teeth can present challenges with compliance of young patients and difficulties in maintaining a "dry" field while placing the filling. In addition, these restorations are in teeth that will be lost and may not require the same longevity as fillings to be placed in permanent teeth. Therefore, it is reasonable to assume that dentists may make different clinical decisions when selecting a filling material for a deciduous tooth compared with a permanent tooth.

Article 10(2) of Regulation (EU) 2017/852 on mercury stipulated that, as of 1 July 2018 (2 months prior to the first mailing of this questionnaire), dental amalgam should not be used for the dental treatment of deciduous teeth.

Dentists were asked how commonly in their routine practice they would use different restorative materials when placing a filling in the primary dentition. In total, 15% of dentists ($n=43$) commonly place amalgam restorations in the primary dentition, 71% ($n=203$) do not commonly place amalgam restorations in the primary dentition and 11% ($n=32$) sometimes place amalgam restorations. A total of 68% of dentists ($n=194$) commonly place composite restorations in the primary dentition, 11% ($n=32$) do not commonly place composite restorations in the primary dentition and 21% ($n=60$) sometimes place composite restorations. For GIC restorations, 61% of dentists ($n=175$) commonly place GIC restorations in the primary dentition, 13% ($n=37$) do not commonly place GIC restorations in the primary dentition and 26% ($n=74$) sometimes place GIC restorations. For RMGIC restorations, 58% of dentists ($n=166$) commonly place RMGIC restorations in the primary dentition, 20% ($n=57$) do not commonly place RMGIC restorations in the primary dentition and 21% ($n=60$) sometimes place RMGIC restorations. A total of 10.8% ($n=31$) of dentists reported commonly placing "other" restorations in primary dentition, which were unspecified. Figure 4.2 displays the usage of different filling materials in the primary dentition by dentists in Ireland.

In a separate question in the survey, dentists were presented with the clinical scenario of needing to fill one posterior (back) tooth in a child; in total, 61% ($n=175$) of dentists reported that they would never place amalgam in this scenario.

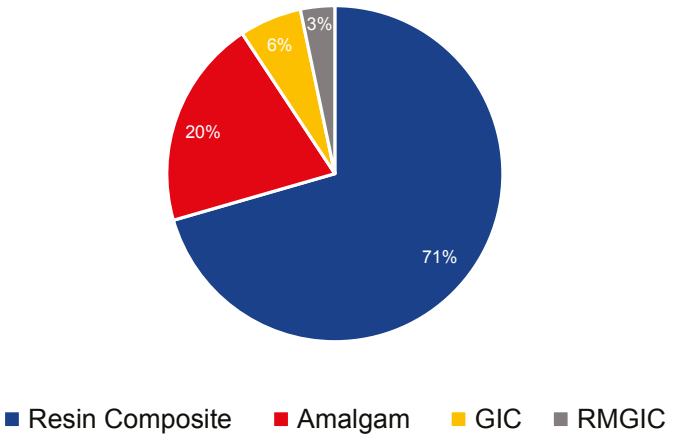

Figure 4.1. Proportions of restorative material placed by dentists in the week prior to filling out the survey.

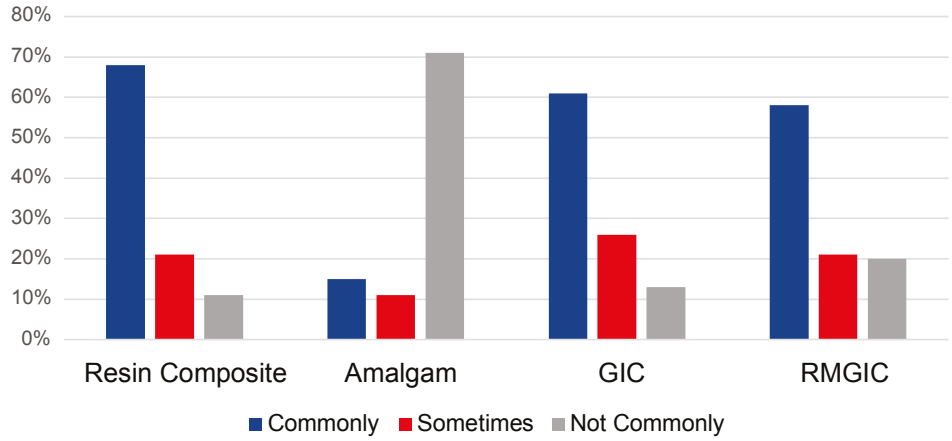

Figure 4.2. Usage of different restorative materials in the primary dentition.

4.2.3 Filling material choice for permanent teeth in children aged 15 years or younger

Article 10(2) of Regulation (EU) 2017/852 on mercury stipulated that, as of 1 July 2018, dental amalgam should not be used for the dental treatment of children aged under 15 years. In the survey, dentists were asked how commonly they used different filling materials when filling permanent teeth in children aged 15 years or younger.

In this clinical scenario, 33% of dentists ($n = 94$) reported that they commonly place amalgam restorations, 58% ($n = 166$) do not commonly place amalgam restorations and 6% ($n = 17$) sometimes place amalgam restorations; 90% ($n = 257$) commonly place composite restorations, 8% ($n = 23$) do not commonly place composite restorations and 2% ($n = 6$) sometimes place composite restorations; 35% ($n = 100$) commonly place GIC restorations, 24% ($n = 69$) do not commonly place GIC restorations and 39% ($n = 111$) sometimes place GIC restorations; and 37% ($n = 106$) commonly place RMGIC restorations, 30% ($n = 86$) do not commonly place RMGIC restorations and 32% ($n = 91$) sometimes place RMGIC restorations.

In permanent dentition in patients aged 15 years or younger, 8% of dentists ($n = 22$) commonly place other restorations, 86% ($n = 246$) do not commonly place other restorations and 5% ($n = 15$) place other restorations. Other restorations could include laboratory-made restorations such as crowns or onlays.

Regulation (EU) 2017/852 stipulates that no amalgam should be placed in deciduous teeth of children under 15 years except where deemed necessary by the practitioner on the grounds of specific medical needs of the patient. Dentists were asked under these terms in which scenarios they would place amalgam in a 13-year-old patient. This was a free-text question and responses were analysed and divided into themes. The most common response was that dentists would not use amalgam in a 13-year-old in any scenario. Scenarios in which some dentists deemed it appropriate to use amalgam were poor co-operation, poor moisture control, when the patient had special needs, when the patient had a high caries rate, in cases of poor isolation of the cavity and in cases of allergy to other restorative materials. Within the responses given, dentists often cited many of the scenarios. Some of the responses are listed below:

> Special needs patient, permanent molar (including occlusal surface) and where moisture control is not possible, limited co-operation …

> A large MO [mesio-occlusal] or DO [disto-occlusal] deep where GIC integrity very dubious with composite and/or access or co-operation leading to isolation problems.

> High cavities, no isolation, sub gingival, bleeding gums.

> Un-cooperative child, lots of caries, poor oral hygiene.

… if a patient has a history of allergy to composites or other suitable material …
… where moisture control is impossible and the alternative is extraction.
Not cooperative, wet conditions, gross caries.
Difficulty of access, difficulty of moisture control, where time or cooperation are compromised.

Figure 4.3 displays the usage of different filling materials in permanent teeth in children aged 15 years and under by dentists in Ireland.

4.2.4 Filling material choice for permanent teeth in adults (aged between 16 and 59 years)

In permanent dentition in patients aged 16–69 years, 56% of dentists ($n=160$) commonly place amalgam restorations, 30% ($n=86$) do not commonly place amalgam restorations and 11% ($n=31$) sometimes place amalgam restorations; 91% ($n=260$) commonly place composite restorations, 7% ($n=20$) do not commonly place composite restorations and 2% ($n=6$) sometimes place composite restorations; 21% ($n=60$) commonly place GIC restorations, 37% ($n=106$) do not commonly place GIC restorations and 42% ($n=120$) sometimes place GIC restorations; and 25% ($n=71$) commonly place RMGIC restorations, 38% ($n=109$) do not commonly place RMGIC restorations and 35% ($n=100$) sometimes place RMGIC restorations.

In permanent dentition in patients aged 16–69 years, 8% ($n=24$) commonly place other restorations, 86% ($n=245$) do not commonly place other restorations and 5% ($n=14$) sometimes place other restorations.

4.2.5 Filling material choice for permanent teeth in older adults (aged ≥60 years)

Dental decay in older adults can present differently from dental decay in younger age groups. Gum recession is common in older adults and this can allow the development of decay on the root of the tooth as it is a softer, more vulnerable tissue than the enamel crown of the tooth. Filling a root caries lesion is challenging as the shape of these cavities tends to be broad and shallow and the area near the root is a wetter environment for filling materials to bond to. Fillings are also frequently placed in older adults to repair or replace older fillings that have failed. Dentists may be more likely to replace "like with like", therefore replacing an old amalgam filling with a new amalgam filling. This may lead to dentists making different choices when selecting a filling material to treat older patients.

In patients aged 60 years and older, 53% of dentists ($n=152$) commonly place amalgam restorations, 33% ($n=94$) do not commonly place amalgam restorations and 12% ($n=34$) sometimes place amalgam restorations; 85% ($n=243$) commonly place composite restorations, 9% ($n=26$) do not commonly place

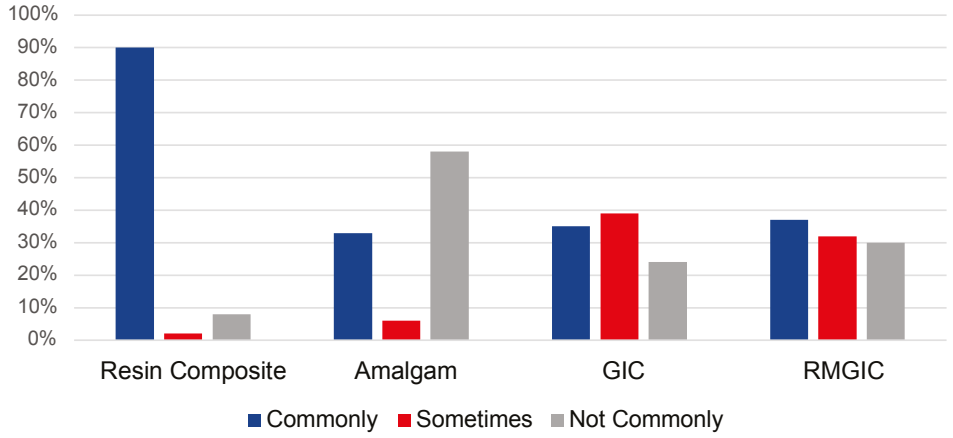

Figure 4.3. Usage of different restorative materials in permanent dentition in children aged 15 years and under.

composite restorations and 5% (*n* = 14) sometimes place composite restorations; 31% (*n* = 89) commonly place GIC restorations, 30 (*n* = 86) do not commonly place GIC restorations and 38% (*n* = 108) sometimes place GIC restorations; and 31% (*n* = 88) commonly place RMGIC restorations, 34% (*n* = 97) do not commonly place RMGIC restorations and 34% (*n* = 97) sometimes place RMGIC restorations.

In total, 7% (*n* = 20) commonly place other restorations, 87% (*n* = 249) do not commonly place other restorations and 5% (*n* = 14) sometimes place other restorations.

Figure 4.4 displays the usage of different filling materials in older adults by dentists in Ireland.

4.2.6 The influence of payment scheme on the choice of filling material

Under the DTSS, eligible adults (aged 16 years and over) have access to a range of dental treatments and clinical procedures. The HSE will reimburse dentists for up to two restorations per eligible person per annum. Dentists may also in certain circumstances provide further restorative treatment to patients under the scheme, subject to prior approval from the local principal dental surgeon.

The HSE operates an online checking system to enable dentists and dental nurses to determine the treatment available for a patient. Dental practices can log in to the service with their HSE panel number. A panel number is allocated to dentists on signing a contract with the HSE to provide dental treatment. Patients must provide their medical card with their medical card number and Personal Public Service (PPS) number, which is used to access the portal and provide information in relation to the treatment that is available under the scheme.

Section A3 on the claim form refers to restorations – A3A is the code for an amalgam restoration and A3C is the code for a resin composite restoration. An A3A (fee of €50.06) can be claimed for restoration of a posterior tooth (a premolar and a molar) using amalgam. An A3C (fee €51.88) for placing a composite restoration can be claimed only for an anterior or front tooth (a canine or an incisor).

Figure 4.5 displays an excerpt from a DTSS claim form showing that a code A (amalgam) can be claimed for

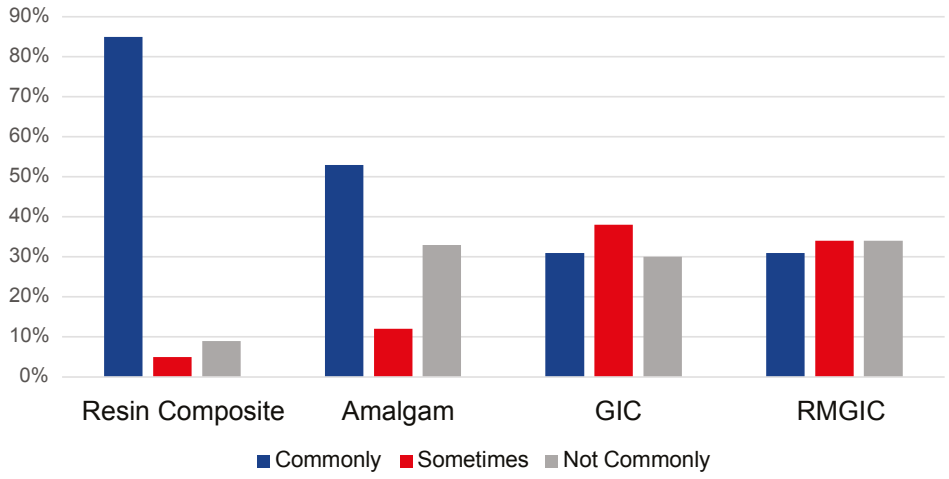

Figure 4.4. Using of different restorative materials in permanent dentition in older adults.

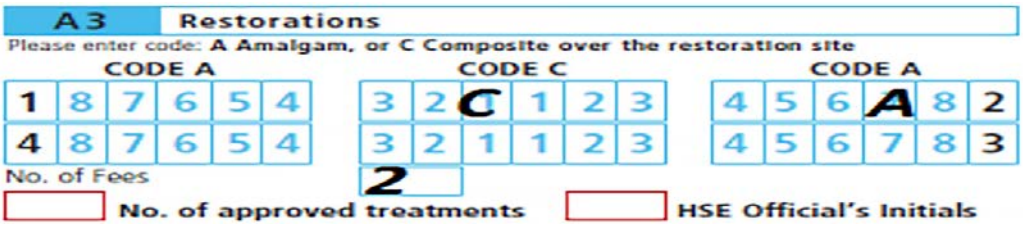

Figure 4.5. Excerpt from a DTSS claim form.

premolars and molars and a code C (composite) can be claimed for an anterior tooth.

In private practice, when adult patients need restorative work in a single posterior tooth, 26% of dentists ($n=74$) who responded never place amalgam restorations, 31% ($n=88$) rarely place amalgam restorations, 22% ($n=62$) sometimes place amalgam restorations, 15% ($n=43$) often place amalgam restorations, 2% ($n=5$) place amalgam restorations all of the time and 5% ($n=14$) responded that the question was not applicable. In DTSS patients who need restorative work in a single posterior tooth, 14% of dentists ($n=40$) who responded never place amalgam restorations, 10% ($n=28$) rarely place amalgam restorations, 10% ($n=30$) sometimes place amalgam restorations, 29% ($n=82$) often place amalgam restorations, 17% ($n=49$) place amalgam restorations all of the time and 20% ($n=57$) responded that the question was not applicable (i.e. they are not contractors for this scheme).

Figure 4.6 displays the frequency of amalgam placement by dentists in Ireland in DTSS and private patients.

4.2.7 Other specific clinical scenarios

When dentists were asked how they would manage dental decay in a pregnant woman, 72% of dentists ($n=206$) said that they would provide a composite restoration, 8% ($n=23$) said that they would place GIC and 8% ($n=23$) said that they would place RMGIC; 7% ($n=20$) would delay treatment until after the birth and 5% ($n=14$) would provide another treatment (not specified).

4.3 Waste Management of Amalgam and Alternative Filling Materials

4.3.1 Waste management of amalgam in dental practices

In total, 94% of dentists ($n=269$) reported having a waste management policy in place in relation to the disposal of waste amalgam, 1% ($n=3$) did not have a policy in place and 6% ($n=17$) did not know if their practice had a policy in place. A total of 78% ($n=223$) of dentists reported disposing of all amalgam waste in a dedicated container with a sponge impregnated with a mercury vapour suppressant, 11% ($n=31$) reported that they did not dispose of all amalgam waste in this manner and 11% ($n=31$) reported they did not know if waste was disposed of in this manner.

In total, 71% of dentists ($n=203$) reported having a waste management policy in place in relation to the disposal of extracted teeth containing amalgam, 21% ($n=60$) did not have a policy in place and 8% ($n=23$) did not know if they had a policy in place. Dentists were asked to specify where they dispose of extracted teeth containing amalgam. The most frequently reported disposal methods were in the clinical waste, in the sharps waste, in an amalgam waste-dedicated box for extracted teeth, given to the patient and given to a dental student. Some of the answers given are as follows:

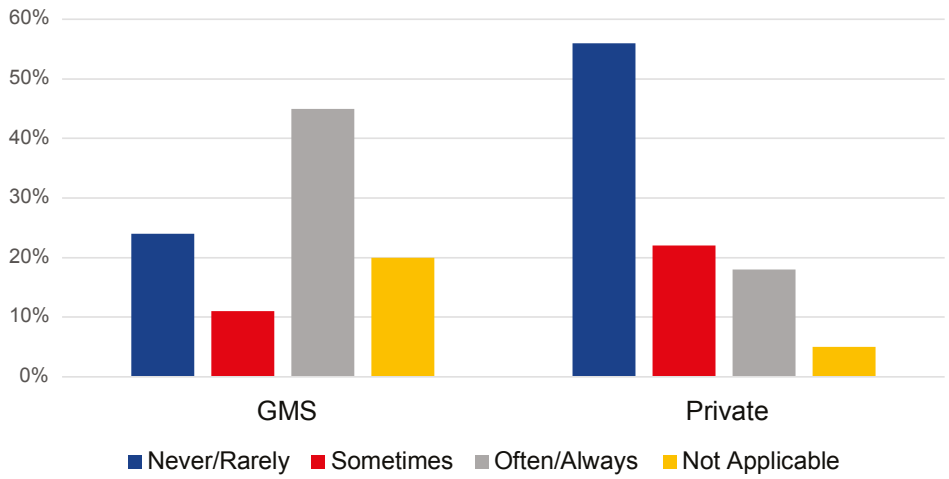

Figure 4.6. Frequency of amalgam placement in DTSS and private patients. GMS, general medical services.

> In an extracted tooth container to be collected by medical waste company.

> Yellow bags, clinical waste.

> Dental nurse disposes of it in amalgam container.

> Usually into sharps bin or give to patient to take home.

> I give all extracted teeth to patient or their parents. I consider it part of their body. I explain they must dispose of it properly.

> In a jar for third-year dental undergraduate students for clinical skills lab.

> Sharps bin for incineration.

The most common type of amalgam used in practice is pre-dosed (93% of respondents); 1% said that they use bulk amalgam, 1% use a combination of bulk and pre-dosed amalgam and 5% reported that they did not know what type of amalgam was used in their practice.

In total, 87% of dentists ($n=249$) reported having an amalgam separator fitted in their practice, 8% ($n=23$) did not and 5% ($n=14$) did not know; 13% of dentists ($n=37$) reported knowing how much amalgam the amalgam separator retains and 87% ($n=249$) did not know. When dentists were asked what percentage of amalgam they believe the amalgam separator retains, the average was 75%. The minimum was 2% and the maximum was 100%.

A total of 11% of dentists ($n=31$) reported that their amalgam separator is emptied daily, 17% ($n=49$) that it is emptied weekly, 3% ($n=9$) fortnightly and 26% ($n=74$) monthly; 43% ($n=123$) reported that they did not know how often it is emptied. When asked who was charged with the disposal of waste amalgam chairside, many respondents selected more than one answer and so the results are displayed using frequencies in Table 4.4. The most common answer selected was dental nurse.

Table 4.4. Numbers of responses relating to the person charged with waste amalgam disposal

Person charged with waste disposal	Number
Dentist	84
Dental nurse	167
Practice manager	18
Other	24
Don't know	4

Table 4.5. Numbers of responses relating to the person charged with record keeping

Person charged with record keeping	Number
Dentist	101
Dental nurse	58
Practice manager	89
Other	13
Do not know	40

In total, 53% of dentists ($n=152$) knew what a WTF (formerly C1 form) was and 47% ($n=134$) did not; 69% of dentists ($n=197$) did not know how long they were required to keep a WTF for. When asked who was responsible for keeping records of waste amalgam disposal, respondents selected more than one answer and so the results are displayed using frequencies in Table 4.5. The most common answer was dentist.

4.3.2 Waste management of resin composite in dental practices

In total, 16% of dentists ($n=46$) reported having a waste management policy in place in relation to the disposal of waste composite, 72% ($n=206$) did not have a waste policy in place and 12% ($n=34$) did not know if their practice had a waste policy in place. Participants were asked to specify where they dispose of waste composite; the most frequently reported disposal methods were in the clinical waste, in the general waste and in the sharps bin. Many also specified that they do not generate composite waste or that they generate very little composite waste. Some of the participant responses given are outlined below:

> Clinical waste, incineration.

> Depends if contaminated, yellow bin.

> We don't waste it, trapped bits of comp in filters, or chunks out of teeth go into yellow clinical waste bin.

> General waste.

> In sharps bin.

> Very little waste, clinical waste.

> Normal waste if not in contact with saliva.

4.3.3 *Training in waste management procedures*

In total, 55% of dentists ($n = 157$) reported that they felt that they and their staff had not received adequate training in the disposal of waste amalgam and other dental waste. Participants were asked which form of continuing professional development (CPD) they would find most appropriate to inform how to correctly dispose of waste amalgam; many selected more than one answer and so the results are displayed using frequencies in Table 4.6. The most frequently selected answer was information booklet.

When the dental nurses ($n = 8$) were asked if they felt that they had received adequate training in waste management practices, they unanimously answered "no". One nurse said that "any information gets addressed to the dentist, sometimes they give it to the practice manager who will share it with us but sometimes it probably gets binned without us ever seeing it". Another dental nurse said:

> I went to the IDA [Irish Dental Association] conference once and went to the programme for the dental team. It was great. We don't often get to attend things like that and meet other dental nurses.

After this comment, a number of the nurses commented that there were not many opportunities for dental nurses to upskill in any area, including waste management.

When asked how they would like to access further training in waste management, all nurses said that either an information book "addressed to the dental nurse, not the dentist" or a lecture would be best. Only two indicated that they would access an online resource. When the other nurses were asked why they would not favour an online lecture, they responded as follows: "I have other things to do in the evening", "I don't want to come home and face that" and "What would I gain from doing it?".

Table 4.6. Numbers of responses relating to appropriate CPD

CPD	Number
Lecture	61
Seminar	25
e-learning	77
Information booklet	160
No further training required	32

4.4 Knowledge Of and Attitudes towards the Phase Down of Dental Amalgam

4.4.1 *Knowledge of the phase down of dental amalgam*

In total, 96% of dentists ($n = 275$) were aware of the Minamata Convention relating to the phase down in the use of dental amalgam.

4.4.2 *Attitudes among Irish dentists towards the phase down of dental amalgam*

A total of 61% of dentists ($n = 175$) felt that the phase down of amalgam is a good idea, with 24% ($n = 69$) disagreeing and 15% ($n = 42$) neither agreeing nor disagreeing with this statement. In total, 25% of dentists ($n = 71$) felt that the phase down of amalgam would cause a major disruption to their practice, with 53% ($n = 152$) disagreeing and 22% ($n = 63$) neither agreeing nor disagreeing with this statement. In contrast, 44% of dentists ($n = 126$) were not concerned by the phase down of amalgam, with 35% ($n = 100$) disagreeing and 21% ($n = 60$) neither agreeing nor disagreeing with this statement. Finally, 34% of dentists ($n = 97$) felt that dental amalgam could be phased out completely in less than 5 years, 28% ($n = 80$) felt that phasing out amalgam over 5–9 years would be more appropriate, 17% ($n = 49$) thought

that amalgam could be phased out over the next 10–19 years, 4% ($n = 11$) thought that amalgam could be phased out over 20–29 years and 17% ($n = 49$) felt that dental amalgam should not be phased out completely for more than 30 years.

4.5 Potential Barriers to the Phase Down or Phase Out of Dental Amalgam

In semi-structured interviews with six dental experts (academics who are active researchers in the area of dental materials and/or dental caries) from around Europe during the questionnaire design phase of this study, a number of hypothesised barriers to the discontinuation of the use of dental amalgam were proposed. Anecdotally, it was felt that the dental profession had concerns about the ability of resin composite to adequately "seal" a cavity, with the potential for the tooth to present further problems such as postoperative sensitivity or pain. This could negatively impact on patients' experiences of dental care. It was also suggested that many dentists do not believe that alternatives to amalgam, such as composites, GIC or RMGIC, last as long as dental amalgam fillings. There were also concerns about the financial implications of phasing out dental amalgam, which is a comparatively cheap filling material. Finally, older dentists may not have been trained in the placement of resin composite, which is a very different technique from the packing and carving technique used to create an amalgam filling.

In the questionnaire part of this research, Irish dentists were presented with a series of statements to determine whether or not any of the hypothesised barriers represented real concerns of theirs.

4.5.1 Concerns about dentists' own technical abilities and training

In total, 71% of dentists ($n = 203$) who responded to the survey received didactic instruction (i.e. lectures) in posterior composite placement as part of their dental school training and 29% ($n = 83$) did not; 67% ($n = 192$) received clinical training in posterior composite placement as part of their dental school training and 33% ($n = 94$) did not. A total of 91% of dentists ($n = 260$) have attended CPD courses relating to the placement of posterior composites post graduation; 19% ($n = 49$) of the CPD courses attended were didactic (i.e. lecture based), 8% ($n = 21$) were hands-on only and 73% ($n = 190$) were both didactic and hands-on.

A total of 61% of dentists ($n = 174$) have plans to attend CPD courses relating to the placement of posterior composites in the future. When expressing a preference for course type, 92% ($n = 263$) would like to attend a hands-on course. Five would like to attend lectures or seminars, eight would like to complete an online course and 82 would like to complete a combination of the above. In total, 99% of dentists ($n = 283$) received didactic instruction in amalgam placement as part of their dental school training and 98% ($n = 280$) received clinical training in amalgam placement as part of their dental school training.

When asked if they felt more confident placing an amalgam filling than a composite filling, 25% of dentists ($n = 72$) agreed, 48% ($n = 137$) disagreed and 27% ($n = 77$) neither agreed nor disagreed. When dentists were asked if they felt more confident placing a composite filling than a GIC filling, 50% ($n = 143$) agreed, 16% ($n = 46$) disagreed and 34% ($n = 97$) neither disagreed nor agreed. Finally, when dentists were asked if they felt more confident placing a GIC filling than a RMGIC filling, 18% ($n = 51$) agreed, 29% ($n = 83$) disagreed and 53% ($n = 152$) neither agreed nor disagreed.

In total, 84% of dentists ($n = 240$) reported that they felt confident in their technical ability to use posterior composites for restoring unretentive cavities, 5% ($n = 14$) did not feel confident and 7% ($n = 20$) did not feel strongly either way. Twelve respondents did not complete this question. A total of 80% of dentists ($n = 229$) felt that they had sufficient training to allow them to place posterior composites properly whereas 11% ($n = 31$) did not feel that they had sufficient training in this area. Finally, 84% of dentists ($n = 240$) felt up to date with current techniques and practices relating to the placement of composite, 67% ($n = 192$) felt up to date with the placement of GIC and 62% ($n = 177$) felt up to date with the placement of RMGIC; 14% ($n = 40$) did not feel up to date with GIC placement and 19% ($n = 54$) did not feel up to date with RMGIC placement.

4.5.2 Concerns about the physical limitations of alternatives to dental amalgam

In total, 48% of dentists ($n = 137$) would be concerned about the prognosis of their restorations if they had

to use composite for all posterior restorations (i.e. fillings on back teeth) and 42% ($n = 116$) would not be concerned. Thirty-three respondents indicated that they were "unsure". A total of 44% of respondents ($n = 126$) said that they would not be confident placing resin composite in a cavity with a subgingival margin (i.e. one that extended down below the gum) and 38% ($n = 109$) said that they would be confident using composite in this scenario. The remainder of the respondents indicated that they were "unsure". Of the dentists, 21% ($n = 60$) would not be confident placing composite in a deep cavity that was close to the pulp (the nerve of the tooth), with 69% ($n = 197$) stating that they would be confident in placing resin composite in a deep cavity. Twenty-nine respondents indicated that they were "unsure". Finally, 65% of dentists ($n = 186$) said that they would consider GIC as a temporary filling material rather than a permanent one and 45% ($n = 129$) would consider RMGIC restorations as temporary fillings.

4.5.3 Financial implications of using resin composite in place of dental amalgam

In total, 21% of dentists ($n = 60$) believed that having to place composite in back teeth routinely instead of amalgam could have negative financial implications for their practice; 52% ($n = 149$) disagreed with this statement. The remainder of respondents were unsure.

4.5.4 Concerns about negative effects on the patient experience

When dentists were asked how long it would take to restore a moderately deep two-surface mesio-occlusal cavity in a lower first molar with amalgam, the average number of minutes estimated was 21 (min. 1 minute, max. 60 minutes). To restore the same sized cavity with a composite would take 30 minutes on average (min. 3 minutes, max. 60 minutes). When dentists were then asked if they felt that routinely placing posterior composites would cause appointment delays in the practice, 38% ($n = 109$) agreed and 50% ($n = 143$) disagreed. Respondents were not asked to explain the mechanism by which such a delay could occur.

When dentists were asked if they believed that patients have less postoperative sensitivity following an amalgam filling than following a composite filling, 36% ($n = 103$) agreed and 36% ($n = 103$) disagreed, with the remainder being unsure or expressing no difference. When asked if patients are more likely to experience food-packing following a composite restoration, 37% ($n = 106$) agreed and 38% ($n = 109$) disagreed, with the remainder being unsure or expressing no difference. Dentists were then asked if their patients experience fewer postoperative filling fractures with amalgam restorations: 15% ($n = 43$) agreed whereas 55% ($n = 157$) believed that patients with composite fillings experience fewer postoperative filling fractures. The remainder believed that there was no difference.

4.6 Dental Amalgam and Mercury-free Alternative Imports into Ireland

Three main dental material suppliers were identified by dentists working at CUDSH. These suppliers were contacted by email and by telephone and were asked to participate in this research. Despite assurances that data would be anonymised, or that quantities could be withheld (and trends in material ordering could be reported instead), all of the companies declined to participate.

5 Discussion

5.1 Discussion

The findings of this study contain limitations/ uncertainty because of the low response rate ($n = 286$), despite a significant sampling frame ($n = 2400$), and therefore the results may not be representative nationally.

The findings indicate that, although composite now appears to be the material of choice for the placement of restorations by dentists in Ireland, dental amalgam continues to be used routinely. Policies involving a reduction in the availability of components of restorative materials and restrictions in their use have the potential to have an impact on the availability and selection of restorative materials by dentists in practice. The Minamata Convention on Mercury is one such treaty that mandates parties to phase down amalgam use.

In line with the Minamata Convention, Regulation (EU) 2017/852 legislation was introduced on 1 July 2018 to restrict amalgam use in key groups: in treating deciduous teeth in children, in treating all children under 15 years of age and in treating pregnant and breastfeeding women. The legislation also requires the fitting of amalgam separators in dental practices for the retention and collection of amalgam particles. Many dental practices in Ireland already comply with this legislation, in addition to the existing Parcom legislation, with 87% reporting compliance with the fitting of amalgam separators. There are, however, implications for practice as a result of the Convention, and barriers to its implementation may include the need for further training, clearer guidelines relating to restricted groups and amendments within the provision of state-funded dental care to reflect the principles of the Minamata Convention.

While acknowledging the low response rate to the survey, this study has provided some limited baseline data on the placement of restorative materials by dentists in Ireland, which were previously non-existent, and key waste management practices relating to restorative materials. The data may be useful to inform future CPD training for dental practitioners and training of current dental students; they may also be useful in assessing any future changes relating to the DTSS, which (at the time of the questionnaire distribution) supports the placement of amalgam restorations in posterior teeth. The study demonstrates that, although Ireland is making significant progress to date in the phase down of dental amalgam, there is still progress to be made in the implementation of a phase out of amalgam.

5.2 Implications for Practice

There are undoubtedly implications for practice of a phase out of amalgam, with amalgam continuing to be used as a restorative material in the general population, as well as in the key groups outlined in the previous section. The survey found that 15% ($n = 43$) of dentists commonly place amalgam restorations in primary dentition and 33% ($n = 94$) commonly place amalgam restorations in permanent dentition in children aged under 15 years. Although amalgam continues to be used by dentists at present, the goal of a total phase out of amalgam is achievable. Exploring why dentists continue to use amalgam, the study found that 5% ($n = 14$) reported not being confident in their technical ability to place composites and 33% ($n = 94$) did not receive clinical training in the placement of posterior composites as part of their dental school training. Providing further clinical training and supporting dentists through the transition to the phasing out of amalgam may be helpful. Unless all dentists in Ireland have received clinical training in posterior composite placement and feel competent in its use and application, it may present a barrier to achieving a phase out of dental amalgam.

There was a large difference in the proportion of dentists using amalgam often or all the time between private adult patients requiring a single posterior restoration (17%, $n = 49$) and medical card patients (46%, $n = 131$). This demonstrates the impact of the DTSS remuneration system for posterior restorations on clinical practice and the selection of restorative materials. The study found that the average proportion of patients that dentists treat under the medical card scheme is 28% (based on the limited number of respondents) and, currently, dentists operating under

the scheme may place amalgam restorations in posterior teeth at a rate of only two per calendar year (unless an exemption is granted). The recent launch of a new National Oral Health Policy may change the current system of delivery of public oral healthcare and it is important to note that the survey referred to in this report was completed prior to the introduction of Smile agus Sláinte.

5.3 Potential Barriers

A large number of the dentists surveyed, 165 out of a total of 286 (58%), received their dental school training during and prior to the 1990s. At this time, many dental students may not have received clinical training in the placement of composites for posterior teeth. Consequently, 31% of dentists ($n = 88$) surveyed reported not having received clinical training in the placement of posterior composite as part of their dental school training. In addition, 24% ($n = 69$) reported being more confident in placing amalgam than composite and 5% ($n = 14$) were not confident in their technical ability to place composites in unretentive cavities. Dentists who participated in the survey cited hands-on training or a combination of hands-on training with online training, seminars and lectures as the most appropriate form of CPD, which gives a good indication of what is required in terms of further training among those who require it.

More than half of dentists surveyed, 55% ($n = 157$), felt that they had not received adequate training in the disposal of waste amalgam and other dental waste. Despite this, 94% ($n = 269$) reported having a waste management policy in place in relation to dental amalgam. Currently, dentists must ensure the collection of waste from a waste management company. This involves the use of WTFs (formerly C1 forms); however, the study found that 47% ($n = 134$) of dentists did not know what a WTF was and 69% ($n = 197$) did not know how long WTFs must be kept for. A WTF is a document used during the transfer of controlled waste from a producer of the waste, in this case the dentist, to the contractor that disposes of the waste, the waste management company. Unless dentists and their staff have received (and engaged with) adequate training, they are unlikely to comply with the new regulations.

There were good levels of compliance in relation to amalgam separators, with 87% of dentists ($n = 249$) reporting having an amalgam separator fitted in their practice. This has been a requirement since January 2019 and is in addition to existing Parcom recommendation 93/2.

Despite this, a small proportion of dentists, 8% ($n = 22$), are in breach of this, reporting not having an amalgam separator fitted. Under the new regulations, local authorities can inspect waste management practices on dental premises. Those who are found to be in breach of the regulations are committing an offence and may be subject to a fine or imprisonment, subject to any court proceedings (S.I. No. 533/2018).

Among dentists who were surveyed, 221 (77%) received their dental school training in Ireland. This may be of interest to those involved in the training of dental students in Ireland in relation to where there may be gaps in training in the area of posterior composite placement and waste management.

5.4 Limitations

This study is not without its limitations: the response rate to the survey was lower than expected, despite follow-up. The low response rate could indicate that the sample is not nationally representative, with many dentists self-selecting to participate. As the Dental Register gives only basic information regarding the dentists on it (name, date registered, year qualified), we cannot compare the ages, genders and practice locations of responders with those of non-responders. Some non-responders were contacted by telephone in an attempt to identify their reason for choosing not to participate. Some of the reasons provided for non-participation during follow-up were as follows: only use composite; no DTSS contract; small practice; no time; and do not do surveys. The dentists who reported using only composite felt that their data were irrelevant to the study, as did those who did not have a DTSS contract.

It would be useful to identify any differences in dental amalgam usage between recently qualified dentists and those who qualified more than 20 years ago (for example). However, given the small sample size, any statistical testing is likely to be underpowered and could be misleading. The small sample size also raises concerns regarding non-response bias, as those who participated may have stronger views regarding dental amalgam than those who did not.

The sampling frame used, the Dental Register, also had limitations, but lacking a suitable alternative it was the only available sampling frame. One of the issues encountered with the sampling frame included non-conformity relating to the addresses given – the addresses consisted of both home and practice addresses and those with home addresses were more difficult to follow up. Some specialist dentists had recorded only their primary degree qualifications and this made it very difficult to filter out all of the specialists, with the questionnaire being sent to them as a result. Many were also now living and practising abroad or had moved on to complete specialist training or were working in academia, but remained on the register.

References

Alexander, G., Hopcraft, M.S., Tyas, M.J. and Wong, R.H.K., 2014. Dentists' restorative decision-making and implications for an "amalgamless" profession. Part 2: a qualitative study. *Australian Dental Journal* 59(4): 420-431.

Banerjee, A. and Watson, T., 2011. *Pickard's Manual of Operative Dentistry*. 9th edition. Oxford University Press, Oxford, UK.

Bonsor, S.J., Burke, T. and Pearson, G.J., 2013. *A Clinical Guide to Applied Dental Materials*. Elsevier/Churchill Livingstone, Amsterdam.

Brownawell, A.M., Berent, S., Brent, R.L., Bruckner, J.V., Doull, J., Gershwin, E.M., Hood, R.D., Matanoski, G.M., Rubin, R. and Weiss, B., 2005. The potential adverse health effects of dental amalgam. *Toxicological Reviews* 24: 1–10.

Campbell, L., Dixon, D. and Hecky, R., 2003. A review of mercury in Lake Victoria, East Africa: implications for human and ecosystem health. *Journal of Toxicology and Environmental Health, Part B* 6: 325–356.

Chin, G., Chong, J., Kluczewska, A., Lau, A., Gorjy, S. and Tennant, M., 2000. The environmental effects of dental amalgam. *Australian Dental Journal* 45: 246–249.

DCCAE (Department of Communications, Climate Action and Environment), 2018. *European Union (Mercury) Regulations 2018*. DCCAE, Dublin.

DEASP (Department of Employment Affairs and Social Protection), 2019. Treatment benefit. DEASP, Dublin. Available online: https://www.gov.ie/en/service/1fb655-treatment-benefit-scheme/ (accessed 20 March 2019).

EU (European Union), 2017. Regulation (EU) 2017/852 of the European Parliament and of the Council of 17 May 2017 on mercury, and repealing Regulation (EC) No 1102/2008. OJ L 137, 24.5.2017, p. 1–21.

HSE (Health Service Executive), nd. Dental services and treatment. HSE, Dublin. Available online: https://www.hse.ie/eng/services/list/2/dental/ (accessed 20 March 2019).

Lynch, C.D. and McConnell, R., 2006. Teaching of posterior composite resin restorations in undergraduate dental schools in Ireland and the United Kingdom. *European Journal of Dental Education* 10: 38–43.

Lynch, C.D. and Wilson, N.H.F., 2013. Managing the phase-down of amalgam: part I. Educational and training issues. *British Dental Journal* 215: 109–113.

Lynch, C.D., Farnell, D.J.J., Stanton, H., Chestnutt, I.G., Brunton, P.A. and Wilson, N.H.F., 2018. No more amalgams: use of amalgam and amalgam alternatives in primary dental care. *British Dental Journal* 225: 171–176.

Mackey, T.K., Contreras, J.T. and Liang, B.A., 2014. The Minamata Convention on Mercury: attempting to address the global controversy of dental amalgam use and mercury waste disposal. *Science of the Total Environment* 472: 125–129.

Nilsson, C. and Dynesius, M., 1994. Ecological effects of river regulation on mammals and birds: a review. *Regulated Rivers: Research and Management* 9: 45–53.

Peutzfeldt, A., 1997. Resin composites in dentistry: the monomer systems. *European Journal of Oral Sciences* 105: 97–116.

Streeton, R., Cooke, M. and Campbell, J., 2004. Researching the researchers: using a snowballing technique. *Nurse Researcher* 12: 35–47.

UNEP (United Nations Environment Programme), 2016. *Lessons from Countries Phasing Down Dental Amalgam Use*. UNEP, Geneva.

UNEP (United Nations Environment Programme), 2017. *Minamata Convention on Mercury*. UNEP, Geneva.

UNEP (United Nations Environment Programme), 2018. Status of signature, and ratification, acceptance, approval or accession 2018. UNEP, Geneva. Available online: http://www.mercuryconvention.org/Countries/Parties/tabid/3428/language/en-US/Default.aspx (accessed 3 March 2019).

Woods, N., Ahern, S., Burke, F., Eaton, K.A. and Widström, E., 2017. The healthcare system and the provision of oral healthcare in European Union Member States. Part 7: Republic of Ireland. *British Dental Journal* 222: 541–548.

Abbreviations

CPD	Continuing professional development
CUDSH	Cork University Dental School and Hospital
DTBS	Dental Treatment Benefit Scheme
DTSS	Dental Treatment Services Scheme
EU	European Union
GDP	General dental practitioner
GIC	Glass ionomer cement
HSE	Health Service Executive
PDS	Public Dental Service
RMGIC	Resin-modified glass ionomer cement
S.I.	Statutory Instrument
WTF	Waste Transfer Form

AN GHNÍOMHAIREACHT UM CHAOMHNÚ COMHSHAOIL
Tá an Ghníomhaireacht um Chaomhnú Comhshaoil (GCC) freagrach as an gcomhshaol a chaomhnú agus a fheabhsú mar shócmhainn luachmhar do mhuintir na hÉireann. Táimid tiomanta do dhaoine agus don chomhshaol a chosaint ó éifeachtaí díobhálacha na radaíochta agus an truaillithe.

Is féidir obair na Gníomhaireachta a roinnt ina trí phríomhréimse:

Rialú: *Déanaimid córais éifeachtacha rialaithe agus comhlíonta comhshaoil a chur i bhfeidhm chun torthaí maithe comhshaoil a sholáthar agus chun díriú orthu siúd nach gcloíonn leis na córais sin.*

Eolas: *Soláthraímid sonraí, faisnéis agus measúnú comhshaoil atá ar ardchaighdeán, spriocdhírithe agus tráthúil chun bonn eolais a chur faoin gcinnteoireacht ar gach leibhéal.*

Tacaíocht: *Bímid ag saothrú i gcomhar le grúpaí eile chun tacú le comhshaol atá glan, táirgiúil agus cosanta go maith, agus le hiompar a chuirfidh le comhshaol inbhuanaithe.*

Ár bhFreagrachtaí

Ceadúnú
Déanaimid na gníomhaíochtaí seo a leanas a rialú ionas nach ndéanann siad dochar do shláinte an phobail ná don chomhshaol:
- saoráidí dramhaíola *(m.sh. láithreáin líonta talún, loisceoirí, stáisiúin aistrithe dramhaíola)*;
- gníomhaíochtaí tionsclaíocha ar scála mór *(m.sh. déantúsaíocht cógaisíochta, déantúsaíocht stroighne, stáisiúin chumhachta)*;
- an diantalmhaíocht *(m.sh. muca, éanlaith)*;
- úsáid shrianta agus scaoileadh rialaithe Orgánach Géinmhodhnaithe *(OGM)*;
- foinsí radaíochta ianúcháin *(m.sh. trealamh x-gha agus radaiteiripe, foinsí tionsclaíocha)*;
- áiseanna móra stórála peitril;
- scardadh dramhuisce;
- gníomhaíochtaí dumpála ar farraige.

Forfheidhmiú Náisiúnta i leith Cúrsaí Comhshaoil
- Clár náisiúnta iniúchtaí agus cigireachtaí a dhéanamh gach bliain ar shaoráidí a bhfuil ceadúnas ón nGníomhaireacht acu.
- Maoirseacht a dhéanamh ar fhreagrachtaí cosanta comhshaoil na n-údarás áitiúil.
- Caighdeán an uisce óil, arna sholáthar ag soláthraithe uisce phoiblí, a mhaoirsiú.
- Obair le húdaráis áitiúla agus le gníomhaireachtaí eile chun dul i ngleic le coireanna comhshaoil trí chomhordú a dhéanamh ar líonra forfheidhmiúcháin náisiúnta, trí dhíriú ar chiontóirí, agus trí mhaoirsiú a dhéanamh ar leasúchán.
- Cur i bhfeidhm rialachán ar nós na Rialachán um Dhramhthrealamh Leictreach agus Leictreonach (DTLL), um Shrian ar Shubstaintí Guaiseacha agus na Rialachán um rialú ar shubstaintí a ídíonn an ciseal ózóin.
- An dlí a chur orthu siúd a bhriseann dlí an chomhshaoil agus a dhéanann dochar don chomhshaol.

Bainistíocht Uisce
- Monatóireacht agus tuairisciú a dhéanamh ar cháilíocht aibhneacha, lochanna, uiscí idirchriosacha agus cósta na hÉireann, agus screamhuiscí; leibhéil uisce agus sruthanna aibhneacha a thomhas.
- Comhordú náisiúnta agus maoirsiú a dhéanamh ar an gCreat-Treoir Uisce.
- Monatóireacht agus tuairisciú a dhéanamh ar Cháilíocht an Uisce Snámha.

Monatóireacht, Anailís agus Tuairisciú ar an gComhshaol
- Monatóireacht a dhéanamh ar cháilíocht an aeir agus Treoir an AE maidir le hAer Glan don Eoraip (CAFÉ) a chur chun feidhme.
- Tuairisciú neamhspleách le cabhrú le cinnteoireacht an rialtais náisiúnta agus na n-údarás áitiúil *(m.sh. tuairisciú tréimhsiúil ar staid Chomhshaol na hÉireann agus Tuarascálacha ar Tháscairí)*.

Rialú Astaíochtaí na nGás Ceaptha Teasa in Éirinn
- Fardail agus réamh-mheastacháin na hÉireann maidir le gáis cheaptha teasa a ullmhú.
- An Treoir maidir le Trádáil Astaíochtaí a chur chun feidhme i gcomhair breis agus 100 de na táirgeoirí dé-ocsaíde carbóin is mó in Éirinn.

Taighde agus Forbairt Comhshaoil
- Taighde comhshaoil a chistiú chun brúnna a shainaithint, bonn eolais a chur faoi bheartais, agus réitigh a sholáthar i réimsí na haeráide, an uisce agus na hinbhuanaitheachta.

Measúnacht Straitéiseach Timpeallachta
- Measúnacht a dhéanamh ar thionchar pleananna agus clár beartaithe ar an gcomhshaol in Éirinn *(m.sh. mórphleananna forbartha)*.

Cosaint Raideolaíoch
- Monatóireacht a dhéanamh ar leibhéil radaíochta, measúnacht a dhéanamh ar nochtadh mhuintir na hÉireann don radaíocht ianúcháin.
- Cabhrú le pleananna náisiúnta a fhorbairt le haghaidh éigeandálaí ag eascairt as taismí núicléacha.
- Monatóireacht a dhéanamh ar fhorbairtí thar lear a bhaineann le saoráidí núicléacha agus leis an tsábháilteacht raideolaíochta.
- Sainseirbhísí cosanta ar an radaíocht a sholáthar, nó maoirsiú a dhéanamh ar sholáthar na seirbhísí sin.

Treoir, Faisnéis Inrochtana agus Oideachas
- Comhairle agus treoir a chur ar fáil d'earnáil na tionsclaíochta agus don phobal maidir le hábhair a bhaineann le caomhnú an chomhshaoil agus leis an gcosaint raideolaíoch.
- Faisnéis thráthúil ar an gcomhshaol ar a bhfuil fáil éasca a chur ar fáil chun rannpháirtíocht an phobail a spreagadh sa chinnteoireacht i ndáil leis an gcomhshaol *(m.sh. Timpeall an Tí, léarscáileanna radóin)*.
- Comhairle a chur ar fáil don Rialtas maidir le hábhair a bhaineann leis an tsábháilteacht raideolaíoch agus le cúrsaí práinnfhreagartha.
- Plean Náisiúnta Bainistíochta Dramhaíola Guaisí a fhorbairt chun dramhaíl ghuaiseach a chosc agus a bhainistiú.

Múscailt Feasachta agus Athrú Iompraíochta
- Feasacht chomhshaoil níos fearr a ghiniúint agus dul i bhfeidhm ar athrú iompraíochta dearfach trí thacú le gnóthais, le pobail agus le teaghlaigh a bheith níos éifeachtúla ar acmhainní.
- Tástáil le haghaidh radóin a chur chun cinn i dtithe agus in ionaid oibre, agus gníomhartha leasúcháin a spreagadh nuair is gá.

Bainistíocht agus struchtúr na Gníomhaireachta um Chaomhnú Comhshaoil
Tá an ghníomhaíocht á bainistiú ag Bord lánaimseartha, ar a bhfuil Ard-Stiúrthóir agus cúigear Stiúrthóirí. Déantar an obair ar fud cúig cinn d'Oifigí:
- An Oifig um Inmharthanacht Comhshaoil
- An Oifig Forfheidhmithe i leith cúrsaí Comhshaoil
- An Oifig um Fianaise is Measúnú
- Oifig um Chosaint Radaíochta agus Monatóireachta Comhshaoil
- An Oifig Cumarsáide agus Seirbhísí Corparáideacha

Tá Coiste Comhairleach ag an nGníomhaireacht le cabhrú léi. Tá dáréag comhaltaí air agus tagann siad le chéile go rialta le plé a dhéanamh ar ábhair imní agus le comhairle a chur ar an mBord.

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Study on Usage and Waste Management of Amalgam Dental Fillings and Mercury-free Alternatives

Authors: Martina Hayes, Aileen Callanan, Mairead Harding, Christopher Lynch and Francis Burke

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Climate - Water - Sustainability
Identifying pressures • Informing policy • Developing solutions

The filling of teeth is one of the most routine and common tasks undertaken by dentists. Because of fluoridation and improved dental care, Irish adults have fewer missing teeth; however, they have more teeth with fillings as a result.

Most Irish adults have been affected by dental caries (decay) and have fillings: 82% of Irish adults with teeth have at least one filling, with each adult having, on average, 7.8 filled teeth each. When filling teeth, dentists rely on two main materials: amalgam (a metallic compound containing mercury) and resin composite (a plastic, tooth-coloured material).

Identifying Pressures

In an attempt to introduce international controls on the use of mercury, a recent international agreement has included a commitment that there should be a phase down in the use of dental amalgam (United Nations Environmental Programme 2013). More recently, European Union Regulation 2017/852 and the European Union (Mercury) Regulations 2018 will give further impetus and drive to a reduction in the use of amalgam filling materials.

Informing Policy

What is perhaps more subtle, but environmentally significant, is the waste management systems used by dentists in relation to the safe disposal of amalgam and composite materials. In 2015 and 2018, the Dental Council published codes of practice regarding dental amalgam. What is less clear is the nature and extent of the systems that dentists may have in place for the safe disposal of resin composites and their associated materials such as resin composites. The current waste management, awareness and disposal of amalgam and composite materials by dentists in Ireland requires further investigation.

Developing Solutions

This study provides some baseline data from an Irish context, which were previously unavailable. This study aimed to quantify the usage of amalgam and mercury-free alternatives in the dental service in Ireland, describe current waste management policies and practices, and identify operational variation between dental practitioners in this area. This information will determine if further research is needed in this area and if there is a need for more formal guidance for dental practitioners around waste management for mercury-free alternatives to amalgam fillings.

EPA Research: McCumiskey House,
Richiew, Clonskeagh, Dublin 14.

Phone: 01 268 0100
Twitter: @EPAResearchNews
Email: research@epa.ie