Use and waste management of restorative materials in the Republic of Ireland

Précis

This study found that dentists in Ireland are largely compliant with EU Waste Directive 2008/98/EC relating to dental amalgam.

Abstract

Aim: This study aimed to investigate the use and waste management of dental amalgam and mercury-free alternatives by general dental practitioners in Ireland.

Methods: A cross-sectional survey-based study was adopted. A 53-question survey was piloted and distributed to dentists working in general dentistry in Ireland. Participants were recruited from the Dental Council of Ireland Dental Register.

Results: A total of 285 dentists (12%) responded to the survey. The study found that resin composite was the most commonly placed restorative material by respondents (69%), followed by dental amalgam (20%). Compliance with waste management of dental amalgam was high, with 93% of respondents reporting having a waste management policy concerning the disposal of waste amalgam and 87% compliance with the fitting of amalgam separators.

Conclusions: The study found that dentists in Ireland are compliant with the Minamata Convention on Mercury, and identified training and remuneration as two of the main barriers to implementing a total phase-out of dental amalgam.

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Introduction

The Minamata Convention on Mercury is an internationally binding treaty, which aims to protect the environment and human health from sources of emissions and releases of mercury. The use of dental amalgam is one of the areas the Minamata Convention seeks to address.[1] The protection of the environment from emissions of mercury that may occur via dental amalgam waste contaminating the sewage system is paramount.[2] Dental amalgam has been successfully used as a restorative material for more than 165 years.[3,4] Measures have already been introduced in line with European Union (EU) guidelines to reduce the potential emissions of mercury from this source, which contributes to mercury pollution globally. Since July 1, 2018, dentists are not permitted to use dental amalgam in deciduous teeth, pregnant and breastfeeding women, and children under the age of 15 years unless it is deemed medically necessary by the dental practitioner, and informed consent has been given by the patient or their guardian. Since January 1, 2019, all dental practices are obliged to have amalgam separators fitted and the use of bulk mercury has been prohibited. In addition, from July 1, 2019, all EU member states must have a national plan in place regarding the reduction of mercury emissions, which must be communicated to the public.[1,5] Finally, dentists must ensure that all waste is collected by a registered waste management company. These new measures are in addition to any existing legislation relating to dental amalgam use and waste disposal. The Dental Council of Ireland has outlined these measures for its members in its code of practice for dental amalgam.[5] Under the European Union (Mercury) Regulations, 2018, local authorities have been given the power to

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monitor compliance of dental facilities relating to the handling of waste amalgam. An individual authorised by the local authority may enter any premises where products containing mercury are being used, handled or produced, and must be furnished with any requested documents relating to the handling of waste amalgam.[6,7]

The ratifying of the Minamata Convention on Mercury has raised questions about the placement of restorations by dentists in Ireland, and the proportion of these restorations that are dental amalgam or mercury-free alternatives. The main mercury-free alternatives are resin composite (RC), glass-ionomer cement (GIC) and resin-modified glass-ionomer cement (RMGIC). There is also a gap in the knowledge relating to compliance with existing and new legislation in the area of dental waste, particularly dental amalgam waste. In the Irish context, there is a lack of data pertaining to the placement of restorations and key waste management practices adopted by dental practices, with no national studies on the topic. Without baseline data quantifying the numbers of restorations placed by dentists in Ireland, it is difficult to quantify any change that may occur as a result of the Minamata Convention.

Restorative dentistry accounts for a sizeable proportion of the day-to-day work carried out by general dental practitioners. The provision of dental care in Ireland is complex, operating under a public-private mix. The predominant expenditure on dental care is private out-of-pocket expenses, alone or in conjunction with one of the publicly funded schemes.[8] The three publicly funded schemes that provide dental treatment for the population of Ireland are the Dental Treatment Services Scheme (DTSS) and Public Dental Service operated by the Health Service Executive (HSE), and the Dental Treatment Benefit Scheme (DTBS) operated by the Department of Employment Affairs and Social Protection (DEASP). The DTSS provides dental treatment to low-income adults over 16 years in possession of a medical card, which is based on means testing and medical need. The DTSS provides treatment through contracted independent dental practitioners on a fee per treatment basis.[9] The Public Dental Service currently provides treatment to school-going children and adults, children with special needs and those in possession of European Health Insurance cards through salaried dentists in the HSE local clinics. The DTBS provides insured persons, based on their pay-related social insurance (PRSI) contributions, with very limited subsidised dental treatment, currently consisting of a free yearly examination, and a scale and polish at a €15 fee to the patient.[10] While data is available in relation to the publicly funded dental schemes such as the DTSS dating back as far as 1994,[11] because of the restrictions on treatment type it may not apply to the general practice of dentistry in Ireland.

This study aimed to quantify the number of restorations placed by dentists in Ireland and to quantify the proportion of these that were amalgam or mercury-free alternatives. Data on key waste management practices adopted by dental practices were also collected. This paper discusses the use of restorative materials by dentists in Ireland, the key waste management practices adopted in Irish dental practice, and training received by Irish dentists concerning the placement of restorations and waste management.

Methods

Study design

The study adopted a descriptive cross-sectional survey design. This involved distribution of a survey to target a nationally representative sample of dentists taken from the Dental Register.[12] Ethical approval was provided by the Social Research Ethics Committee (SREC) in University College Cork (Log 2018-108). Informed consent was obtained from each participant; a consent form was included in the mailing to each dentist, and completing the form was considered as the participant giving their informed consent to participate in the study.

Sampling frame

The sampling frame used for the recruitment of participants was the Dental Register. All dentists practising dentistry in Ireland must be on the Dental Register. The Register was requested from the Dental Council, and comprised the names of 3,124 dentists at the time of receipt in June 2018. All identifiable specialist dentists were removed from the sample, as were those with addresses outside of Ireland. The 2,400 remaining dentists on the Register were used as the sampling frame and were invited to participate across three waves. A mailing company was used for distribution of the surveys and returns were forwarded to investigators in Cork University Dental School and Hospital (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 contact information of investigators. Unique identifiers were assigned to each return envelope (but not the questionnaire) to enable follow-up of non-responders and preserve anonymity. Non-responders who were found via internet search and contacted via telephone were invited to have the survey posted or emailed to them.

Survey instrument

The survey instrument was modelled on a previous survey, 'No more amalgams', designed by Prof. Chris Lynch and used in a similar study in Wales.[13] A study conducted in Australia exploring restorative decision-making was also used to inform the survey content.[14] The survey was adapted for use in the Irish context, and prior to distribution it was piloted locally, by dentists in private practice and staff in CUDSH. The 53-question survey 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 concerning both amalgam and amalgam alternatives, namely composite, GIC, and RMGIC.
- **Section 3** captured data relating to knowledge of the Minamata Convention on Mercury.
- **Section 4** questioned dentists on their attitudes to and experience of placement of the various restorative materials available, and material selection.
- **Section 5** was designed to capture data relating to participants' previous and potential future training.
- **Section 6** asked key questions regarding the demographics of the participants and their practices.

Survey instrument distribution

The survey was distributed from September to December 2018 across three waves. Wave 1 was distributed in September, Wave 2 in November, and Wave 3 in December. Convenience sampling was adopted at several key events including dental conferences, meetings and study groups to maximise

Table 1: Key demographics of the sample of respondents to the questionnaire.

Demographics	Number	%*
Sex		
Female	118	41.5
Male	166	58.5
Location of practice		
City	128	45.1
Town	128	45.1
Rural	28	9.9
Principal	153	54
Associate	120	42

**Percentages do not always reflect all 285 respondents, but those who answered the question.*

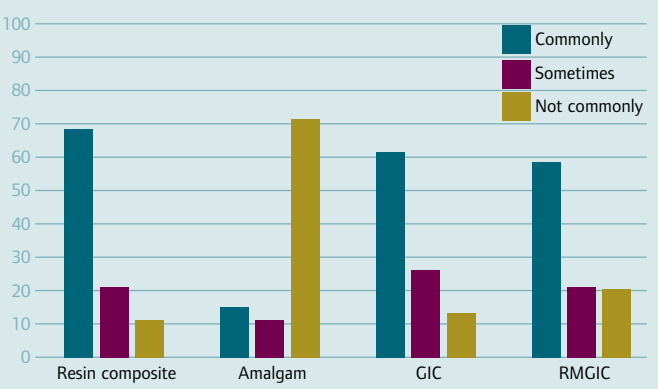

FIGURE 1: Use of various restorative materials in primary dentition.
**Percentages do not always reflect all 285 respondents, but those who answered the question.*

participation levels. At events, dentists were invited to complete the questionnaires and leave them in boxes. Follow-up was conducted following the distribution of Wave 1 of the survey to maximise participation, as outlined above.

Data entry and analysis

Data entry was performed by a data management company, Seefin Data Management (Seefin DM Head Office, Seefin House, Listowel, Co. Kerry, V31 AK27) and uploaded in an Excel format. The Excel file was cleaned by investigators at CUDSH and uploaded to SPSS Statistics for data analysis. The data was analysed using IBM SPSS Statistics version 24 for Windows (IBM House, Shelbourne Road, Ballsbridge, Dublin 4). Quantitative analysis of survey data using descriptive statistics, including frequencies, was performed by researchers at CUDSH. Frequency tables were used to calculate the minimum, maximum, and the mean for each of the variables. Tables and graphs were used to display the results where appropriate.

Results

A total of 285 dentists agreed to participate in the study, giving a response rate of 12%. **Table 1** outlines the key demographics. Dentists were asked the proportion of patients that they treat under the various dental schemes, i.e., DTSS, DTBS, and private patients. The proportion of patients that dentists reported treating privately was 47%, DTSS was 28% and DTBS was 34%. Not all of the dentists who responded to the survey completed the questionnaire in full, so the percentages do not always reflect the 285 who responded. All results are based on reported responses from participants and not observed activity.

Use of various restorative materials

Table 2 displays the numbers, proportions and averages of the various restorative materials placed by dentists in the week prior to completing the survey. Participants were asked a series of questions relating to the placement of restorative materials (amalgam, composite, GIC and RMGIC) in the primary dentition, permanent dentition in children aged 15 years and younger, permanent dentition in those aged 16-59, and permanent dentition in those aged 60 and over. **Figure 1** displays use of the various restorative materials in the primary dentition.

Participants were asked under what circumstances they would place an amalgam in a clinical situation where a child under 13 required a restoration. There were many varied reasons outlined in the responses, including: never use amalgam; moisture control; special needs; poor co-operation; allergy; severe caries rate; bleeding; poor isolation; poor oral hygiene; and, poor access. Some of the responses are displayed below:

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

Table 2: Number of restorations placed in the week prior to completing the survey.

	Dental amalgam	Resin composite	GIC	RMGIC	Total
Restorations placed*	20%*** (n=1,675)	69% (n=5,857)	5% (n=459)	3% (n=374)	8,455
Average number of restorations placed by respondents** (number of respondents)	8 (219)	14 (273)	3 (132)	3 (105)	30 (284)

* *Refers to the number of restorations placed in the week prior to completing the survey. Proportions are calculated based on the number of each restorative material out of the total number placed.*
** *Based on the number of each of the various restorative materials placed out of the total number of respondents for each material type.*
*** *Percentages do not always reflect all 285 respondents, but those who answered the question.*

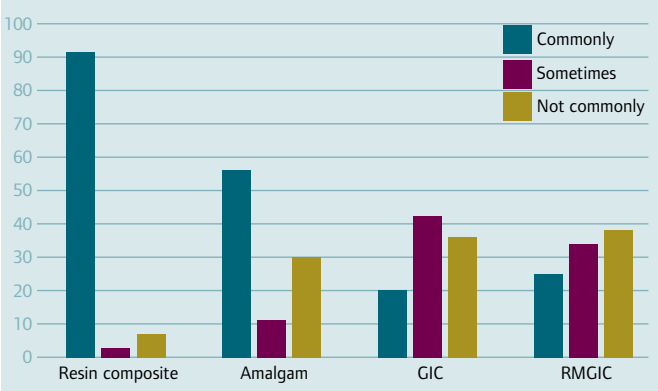

FIGURE 2: Use of various restorative materials in patients aged 16-59 years (%).
**Percentages do not always reflect all 285 respondents, but those who answered the question.*

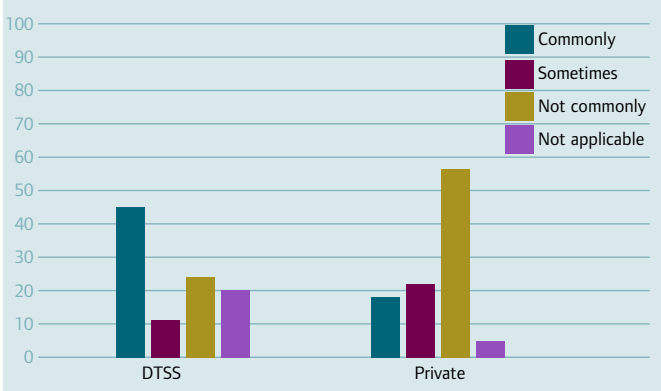

FIGURE 3: Frequency of amalgam placement in private and DTSS adult patients requiring a single restoration in a posterior tooth.
**Percentages do not always reflect all 285 respondents, but those who answered the question.*

"A large MO or DO deep where GIC integrity very dubious with composite and/or access or co-operation leading to isolation problems"

"High cavities, no isolation, subgingival, 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 co-operative, wet conditions, gross caries"

"Difficulty of access, difficulty of moisture control, where time or co-operation are compromised"

In permanent dentition in children aged 15 years and under, 32% of dentists reported commonly placing amalgam, 90% reported commonly placing composite, 35% reported commonly placing GIC, and 36% reported commonly placing RMGIC. **Figure 2** displays the use of the various materials in those aged 16-59. In patients aged over 60, 53% of dentists reported commonly placing amalgam, 85% reported commonly placing composite, 31% reported commonly placing GIC, and 31% reported commonly placing RMGIC.

Participants were asked a series of questions in relation to the frequency with which they place amalgam in adult and child patients for private treatment and DTSS treatment. **Figure 3** displays the frequency of placement of dental amalgam in adult patients requiring restoration in a single posterior tooth in private and DTSS patients. In a private adult patient requiring restorations in two or more posterior teeth, 16% of dentists reported placing amalgam often or all of the time. In medical card patients requiring restorations in two or more posterior teeth, 46% of dentists reported placing amalgam often or all of the time.

Table 3: Proportions of respondents who had waste management policies relating to waste amalgam, waste composite and extracted teeth containing amalgam, those who had amalgam separators, and those who dispose of waste amalgam in a dedicated container.

Waste management policy	Yes %* (n)	No % (n)	Don't know % (n)
Dental amalgam	92 (n=262)	1 (n=2)	6 (n=17)
Resin composite	16 (n=46)	71 (n=201)	12 (n=34)
Extracted teeth containing amalgam	70 (n=197)	21 (n=60)	8 (n=23)
Amalgam separator fitted	87 (n=246)	9 (n=24)	4 (n=12)
Dispose of waste amalgam in dedicated container with mercury vapour suppressant	78 (n=214)	11 (n=30)	11 (n=31)

* *Percentages do not always reflect all 285 respondents, but those who answered the question.*

In children under 15 years who require a single posterior restoration, 3% of dentists reported placing amalgam often or all of the time, and in children aged 15 years and under requiring two or more posterior restorations, 4% of dentists reported placing amalgam often or all of the time.

Waste management

Table 3 displays the proportion of dentists who have various waste management policies, amalgam separators fitted, and dispose of waste amalgam in a dedicated container with a mercury vapour suppressant. The number reporting emptying the amalgam separator daily was 11%, weekly was 17%, fortnightly was 3%, and monthly was 26%, with 43% not knowing the frequency with which it was emptied.

In relation to the disposal of waste chairside, most dentists reported that it was the responsibility of the dental nurse (n=167), followed by the dentist (n=84) and practice manager (n=18). When it came to keeping records of amalgam disposal, the individual who held responsibility was reported to be the dentist (n=101), the dental nurse (n=58) and the practice manager (n=89). These results are reported in frequencies, as many participants selected more than one answer. Participants were asked to specify where they dispose of waste composite. The most frequently reported disposal methods included clinical waste, general waste, and sharps bin, while many also specified that they don't have composite waste or have very little composite waste. Some participants' responses are given 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"

Dentists were asked to specify where they dispose of extracted teeth containing amalgam. The most frequently reported disposal methods were: clinical waste; sharps waste; amalgam waste; dedicated box for extracted teeth; given to patient; and, given to dental students. Some of the answers given are provided below:

"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"

Dentists were asked questions about waste transfer forms (WTFs, formerly C1 forms), with 53% reporting that they knew what a WTF was and 31% knowing how long WTFs must be retained for.

Education and training

Most of the sample (77%, n=221) received their dental training in Ireland. Participants were asked questions relating to their dental school training in the placement of both posterior composite and amalgam. As part of their training, 71% received didactic instruction in posterior composite placement, with 67% receiving clinical training in posterior composite placement. Almost 91% of dentists surveyed had attended continuing professional development (CPD) training relating to the placement of posterior composites. When it came to amalgam, 99% of dentists received didactic instruction in amalgam placement as part of their dental school training, with 97% receiving clinical instruction. Only 44% of dentists reported that they felt both they and their staff had received adequate training in the disposal of waste amalgam and other dental waste. In relation to CPD, participants reported what type they felt would be the most suitable. Frequencies are reported for this free text answer: hands-on, n=92; lectures, n=3; seminar, n=2; online, n=8; and, a combination of all listed, n=82.

Discussion

With restorative dentistry accounting for a large proportion of the daily work undertaken by dentists, and parts of the EU Mercury Regulation already implemented, this research is timely. The gathering of baseline data pertaining to the placement of restorative materials by dentists in Ireland will allow any change in use and waste management to be quantified. Wales and Australia have recently conducted similar studies relating to the placement of restorations and the selection of restorative materials by dentists.[13,14] If Ireland is to achieve a total phase-out in the coming years, measures will need to be put in place to support dentists to achieve this. A large proportion of dentists in Ireland report commonly placing amalgam as a restorative material across all age groups, including those under the age of 15 years and in primary dentition who, under current guidelines, should only have amalgam placed when medically necessary. Dentists were not specifically questioned about their use of stainless steel crowns (e.g., the Hall technique), which is a restorative option in the management of carious deciduous molars. Exploring some of the clinical scenarios in which dentists report placing amalgam is timely, as the recommendations relating to Minamata were introduced on July 1, 2018, and the distribution of the survey instrument began in September 2018. Training and remuneration are two of the primary areas identified by this study where further support may be required for dentists towards achieving a total phase-out. In terms of remuneration, contrasting private and medical card care was identified as a barrier to placing posterior composites, with 17% of participants placing amalgam all the time in private patients compared to 46% in medical card patients.

The results of the study demonstrate that most dentists in Ireland are already selecting composite as their primary material of choice for restorations. With continuing improvements in composite materials in recent years, and better aesthetics, this is not surprising. There have been continuing improvements in composite materials and its longevity is often as good as, if not better than, amalgam in many clinical situations.[15,16] A study of posterior composite placement in the UK and Irish dental schools found that students were placing an average of twice as many resin composites compared to amalgam.[16,17] For participants in this study, 71% reported receiving didactic training and 67% clinical training in posterior composite placement, with 99% receiving didactic instruction and 97% clinical training in amalgam placement. This indicates that

some dentists have not received adequate training in the placement of posterior composite compared to amalgam. Offering accessible CPD training may be of benefit.

EU guidelines relating to the Minamata Convention came into effect in July 2018,[6] and further changes in January 2019, with more to follow in the coming months. The distribution of the survey for this study began in September 2018, two months after the changes came into effect. Although the use of amalgam in deciduous teeth and in children under the age of 15 years has not been permitted since July 1, 2018, unless it is deemed medically necessary, dentists are still placing amalgam in this cohort, with 15% commonly placing amalgam in deciduous teeth and 32% placing amalgam in permanent teeth in those aged 15 years and under. This study found that there were many and varied situations outlined by participants where they felt the placement of amalgam in this cohort was warranted. Some of the reasons outlined by dentists ranged from an allergy to mercury-free alternatives to some physical limitations in the placement of composite materials, such as moisture control and isolation of the tooth. Many participants cited poor co-operation and special needs as a reason to place amalgam; in this instance, further training in dealing with patients with special needs or poor co-operation may be beneficial. An Australian study also identified issues with moisture control in the placement of composite materials.[14] Perhaps clearer guidelines relating to the medical necessity with which dentists are permitted to place amalgam in this restricted group is warranted.

Funding appears to have an impact on the choice of material placed by dentists in adult patients in possession of medical cards. This is most likely because the HSE only permits dentists to place amalgam restorations in posterior teeth for this patient cohort. Composite restorations are, however, permitted in anterior teeth. Unless this is revised, dentists will have no choice but to routinely place amalgam in posterior cavities. The average proportion of patients that dentists reported treating under this scheme is 28%, and so this could have an impact on a substantial proportion of the population receiving restorations with respect to equity and best practice. This is also reflected in a study conducted in Wales where dentists were found to more frequently place amalgam in NHS-funded dentistry compared to privately funded dental care.[13]

In particular, waste management would appear to be an area where further training may be beneficial for dentists and associated dental staff, with just 44% reporting having received adequate training in the area of amalgam and other dental waste disposal. Dentists are required to have waste management policies in relation to the disposal of waste amalgam and extracted teeth containing amalgam. Some 93% of dentists reported compliance with waste amalgam and 70% with extracted teeth containing amalgam. Currently in Ireland there are no requirements for dentists to have waste management policies in relation to the disposal of mercury-free alternatives. This is reflected in the response to the survey, where 16% reported having a policy for the disposal of resin composite. Dentists have been required to have amalgam separators fitted in their practice since January 1, 2019, in addition to existing PARCOM legislation requiring mandatory amalgam separators. Dentists reported 87% compliance with this. Programmes and Measures for Reducing Mercury Discharges (PARCOM 89/3) is a European Environment Agency policy relating to disposal of mercury. It stipulates a legal requirement in Ireland to separate amalgam waste with an amalgam separator. There appears to be a lack of clarity in relation to waste disposal chairside, with many dentists reporting that their dental nurse is charged with chairside disposal of dental waste, including amalgam. It is, however, the responsibility of the practice owner, as the generator of waste, to ensure correct disposal.

Limitations

This study is not without its limitations and the results must be interpreted with caution. One of the major limitations was the low response rate often observed when surveying healthcare professionals.[18] The response rate to the study was low, despite follow-up, with many self-selecting to participate. However, surveys of dental practitioners have historically low response rates. A similar study conducted in Australia had a response rate of approximately 3%,[19] while a study conducted in Wales had a response rate of over 40%,[9] with a similar number of participants as this one (n=270).

It was discovered during follow-up that many of those who were invited decided to opt out of the study based on factors that they believed rendered them ineligible. Some of the reasons cited were: not placing amalgam; not having HSE contracts; or, small practice size. This self-selection out of the study could mean that the study sample is not nationally representative. Non-response bias could be present, and respondents to the survey may be characteristically different to those who did not respond. Respondents had high levels of CPD and good compliance; this may not be representative of the general dental population.

There were also issues with the use of the Dental Register as the sampling frame. There was a lack of uniformity regarding the addresses on the Register, some being home addresses and some practice addresses. This made postal mailing and follow-up difficult. The low response rate had an impact on the data analysis that could be performed. Many of the returned surveys had missing data, which resulted in discrepancies in the numbers and proportions reported in the results section.

Conclusion/recommendations

This study found that, generally, the members of the Irish dental profession who were sampled are highly compliant with the Minamata Convention on Mercury. The conclusions are of course based on those who responded to the survey and due to the low response rate may not be reflective of the dental profession as a whole in Ireland. Further research is warranted into the impact of waste resin composite making its way into the environment. Further clarification relating to medical necessity in the placement of dental amalgam in the restricted groups may be warranted. Conducting more qualitative research in the selection and placement of restorative materials in the cohort of those aged 15 years and under in the near future would also be beneficial.

The study identified training and remuneration as two of the main barriers to implementing a total phase-out of dental amalgam in the future. CPD opportunities should be offered to dentists and other dental staff members in relation to waste disposal of amalgam and other dental waste. More training should also be offered to dentists to upskill in the placement of posterior composite where required.

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CPD questions

To claim CPD points, go to the MEMBERS' SECTION of www.dentist.ie and answer the following questions:

IDA irish dental association

CPD

1. Under the Minamata Convention on Mercury, from July 1, 2018, dentists are no longer permitted to place amalgam restorations in:

- ○ A: Adults over 65 years old
- ○ B: Children over 16 years old
- ○ C: Deciduous teeth

2. The proportion of dentists who reported having a waste management policy relating to the disposal of waste amalgam was:

- ○ A: 70%
- ○ B: 16%
- ○ C: 93%

3. The two key barriers identified by the study that may have an impact on a total phase-out of dental amalgam in the future are:

- ○ A: Patient experience and time
- ○ B: Training and remuneration
- ○ C: Lack of suitable alternatives and poor guidance