# Future Use of Materials for Dental Restoration







# **Future Use of Materials for Dental Restoration**

Report of the meeting convened at WHO HQ, Geneva, Switzerland

16th to 17th November 2009

Report prepared by Dr. Poul Erik Petersen, Professor Ramon Baez, Dr. Stella Kwan, and Dr Hiroshi Ogawa



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#### Content

Prefa	ce	V
Execu	ative summary	Vii
1.	Introduction	1
1.1	The global burden of dental caries	1
1.2	Oral health promotion and disease prevention	2
1.3	Dental restoration	3
1.4	WHO Consultation 1997	3
1.4.1	Dental amalgam and alternative direct restorative materials	3
1.4.2	Research agenda to improve health	3
1.5	WHO policy on the use of dental amalgam for restoration	4
1.6	Recent major international statements on dental restorative materials	5
1.7	UNEP initiatives on mercury	6
2.	Objectives of the WHO meeting in 2009	7
3.	Outline of the structure of the meeting	8
4.	Types of dental restorative materials	8
4.1	Strengths and weaknesses of different materials	9
4.2	Restoration longevity	11
4.3	Biological considerations	12
5.	Effects on health and the environment	12
6.	Best Management Practices (BMP)	13
7.	Implications for training of dental health professionals	16
8.	Implications for future research	16
9.	Country experience	17
9.1	African Region	17
9.2	Region of the Americas	17
9.3	South-East Asia Region	20
9.4	European Region	21
9.5	Eastern Mediterranean Region	22
9.6	Western Pacific Region	23
10.	Partners in relation to use of dental restorative materials	24
10.1	The role of the dental profession	24
10.2	The role of the International Association for Dental Research (IADR)	25
10.3	The role of UNEP	25
10.4	The role of WHO	26

11.	Summary of discussions	27
12.	Recommendations	29
12.1	Strengthening the prevention of dental caries	29
12.2	Evidence available on materials for dental restoration	29
12.3	Indicators of success of restoration	30
12.4	Challenges to research	30
12.5	Cost of dental care	31
12.6	Health service facilities	31
12.7	The providers of dental care	31
12.8	Dental care provider-patient interaction	32
12.9	Responsibility of the dental industry	32
12.10	The dental profession	32
12.11	Responsibility of UNEP	33
12.12	Responsibility of WHO	33
13.	Conclusions	34
14.	References	37
Annex	x 1 Consensus Statement on Dental Amalgam 1997	43
Annex	x 2 List of participants	45
Annex	x 3 Meeting agenda	51
Annex	x 4 Bibliography - other useful publications	55

#### **Preface**

Dental caries remains a major public health problem to most countries of the world.

Despite much effort in health promotion and disease prevention, dental restorations are still needed.

Globally, dental caries affects 60-90% of school-aged children and the vast majority of adults.

At present, the distribution and severity of dental caries vary in different parts of the world and within the same region or country.

In most low and middle income countries, dental caries levels among children were low until recent years; meanwhile dental caries prevalence rates and caries severity tend to increase rapidly with changing lifestyles and growing consumption of sugars, inadequate exposures to fluoride, and lack of national programmes for prevention of oral disease. In contrast, a dental caries decline has been observed in the majority of high income countries over the past 20 years or so. This pattern is seen as the result of a number of public health measures, including effective use of fluoride, coupled with changing living conditions, healthy lifestyles and improved self-care practices, establishment of school oral health programmes, and improved access to dental care.

Despite these efforts, the burden of dental caries is high among adult people in most high income countries. At present, the disease level is lower in the low income countries of Africa and Asia, meanwhile, reports are now available on a growing burden of dental caries among adults living in middle income countries.

At the global level, inequities are found in use of oral health services. Restorative dental care is accessible to people in high income countries. However, many countries of Africa, Asia and Latin America have a shortage of oral health personnel and generally the capacity of the services is limited to pain relief or emergency care. For people suffering from severe tooth decay, teeth are often left untreated or are extracted to relieve pain or discomfort.

Dental amalgam has been widely used over decades as a dental restorative material.

During the past 10 years or so, the awareness and recognition of the environmental implications of mercury has increased and dentistry being a source to contamination of the environment has gained further attention.

In response to initiatives on mercury reduction and the request from Member States for guidance on dental care, the World Health Organization (WHO), in cooperation with United Nations Environment Programme, organized a Consultation to discuss the implications of use of dental restorative materials. The overall aim of the meeting was to assess the scientific evidence available on use of dental restorative materials, particularly the potential for use of materials alternative to dental amalgam in restorative care. The dental care and cost implications were discussed with special reference to the situation in low and middle income countries.

It is a hope that this report, as a result of the Consultation, will be of practical value and interest to the dental profession, the oral health research community, and the public health authorities worldwide.

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#### **Executive summary**

Dental caries is a major public health problem globally. Despite much effort in health promotion and disease prevention, dental restorations are still needed. Dental amalgam, a restorative material that contains mercury, has been widely used for some 150 years. In the past decades, the awareness and recognition of the environmental implications of mercury has increased and alternative tooth-coloured filling materials have become increasingly more popular.

Jointly with the World Health Organization (WHO), the United Nations Environment Programme (UNEP) has strengthened the work for reduction of the mercury releases and usage. Work of the intergovernmental negotiating committee that is mandated to elaborate legally binding instrument mercury commenced in 2010 with the goal of completing it prior to the UNEP Governing Council/Global Ministerial Environment Forum in 2013.

Given the diversity of countries worldwide and the availability of alternatives, UNEP recognizes that there is a need for consultation with different groups including the oral health sector. A number of expert consultations have already begun, with a view to finalizing a legally binding treaty in 2013 that may contain both legally binding and voluntary measures. The treaty would have a significant impact on delivering oral healthcare worldwide.

On this background, the WHO Global Oral Health Programme - in cooperation with UNEP Chemicals - organized a two-day meeting to discuss the implications and the way forward. The aim of the meeting was to assess the scientific evidence available on dental restorative materials alternative to dental amalgam and the implications to countries of using alternatives to amalgam for dental restorative care.

Twenty-nine participants from 15 countries of all 6 WHO regions attended the meeting, representing international oral health researchers, scientists, university academics, WHOCCs, ministries of health, NGOs, dental professionals, UNEP, and anti-mercury pressure groups. Following an opening address from Dr Ala Alwan, Assistant Director General, Non-communicable Diseases and Mental Health and Mr Per Bakken, UNEP, Dr Poul Erik Petersen outlined the scope, purpose, objectives and structure of the meeting, followed by a number of presentations and discussions. Day One discussed the availability of different restorative materials, their advantages and potential adverse effects on health and the environment. Experiences from both developed and developing countries of all WHO regions was shared in Day Two, which highlighted the implications for oral healthcare.

Following a review of existing evidence and much deliberation, the huge challenges to the dental profession and the research community were noted. In general, dental

amalgam remains a dental restorative material of choice, in the absence of an ideal alternative and the lack of evidence of alternatives as a better practice. If dental amalgam were to be banned, a better and more long-lasting replacement would be needed than the materials available to date. The choice of materials may depend on the tooth, site and size of cavity, as well as healthcare financing, patient preference, health care provider preference, technology, cost and environmental factors. While the harmful effects of mercury on health and the environment are recognized, the possible adverse effects of alternative materials require further research and monitoring. Providing the best care possible to meet patients' needs should be of paramount importance. Variations between countries and challenges faced by middle- and low-income countries are critical. Implications for training of dental personnel and costs to society as well as the individual are significant and need to be taken into consideration.

The meeting concluded that complete ban may not be realistic, practical and achievable. It may be prudent to consider 'phasing down' instead of 'phasing out' of dental amalgam at this stage. A multi-pronged approach with short-, medium-and long-term strategies should be considered. Elements of strategies can be put in place while waiting for the new materials to be developed. The role of WHO, UNEP, NGOs (such as IADR and FDI) and the industry is critical. A further meeting must be convened to discuss the way forward and to develop strategies to address issues in both developed and developing countries.

#### 1. Introduction

#### 1.1 The global burden of dental caries

Dental caries (tooth decay) has historically been considered the most important component of the global oral disease burden. Dental caries is still a major public health problem in most high income countries as the disease affects 60-90% of school-aged children and the vast majority of adults. At present, the distribution and severity of dental caries vary in different parts of the world and within the same region or country<sup>1-4</sup>. For the permanent dentition, the severity of dental caries is measured by the Decayed, Missing and Filled Teeth index (DMFT). According to the WHO Global Oral Health Data Bank<sup>5</sup>, the global dental caries index among children aged 12 years is 1.6 teeth on average, however, there are marked differences in severity amongst regions. The disease level in children of this age is relatively high in the Americas (DMFT = 2.8) and in the European region (DMFT = 2.6); the index is somewhat lower among children of the Eastern Mediterranean (DMFT=1.6) and Western Pacific (DMFT=1.5) regions, while at the moment dental caries is less severe in South East Asia (DMFT=1.1) and in the African region (DMFT=1.2). The WHO Global Oral Health Data Bank also provides information on the time trends in dental caries experience of children. In most low and middle income countries, dental caries levels were low until recent years while dental caries prevalence rates and dental caries experience have tended to increase rapidly with changing lifestyles and growing consumption of sugars, inadequate exposures to fluoride, and lack of national programmes for prevention of oral disease<sup>1,3</sup>. In contrast, a caries decline has been observed in most high income countries over the past 20 years or so. This pattern is seen as the result of a number of public health measures, including effective use of fluoride, coupled with changing living conditions, lifestyles and improved self-care practices, and establishment of school oral health programmes<sup>1,3</sup>.

Worldwide, dental caries prevalence is high among adults as the disease affects nearly 100% of the population in the majority of countries<sup>1,3</sup>. Most high income countries and some countries of Latin America show high DMFT values (i.e. 14 teeth affected by caries or more at the age of 35-44 years) while dental caries experience levels at present are lower in the low income countries of Africa and Asia. Meanwhile, reports are now available on a growing burden of dental caries among adults living in low and middle income countries. In several high income countries older people often have had their teeth extracted early in life because of pain or discomfort, leading to reduced quality of life. The proportion of edentulous adults aged 65 years or more is still high in some countries; meanwhile, in several industrialized countries there has been a positive trend of reduction in tooth loss among older adults in recent years. In parallel, an increase in the proportion of adult people with functional dentition (i.e. 20 teeth or more) reflects the growing use of preventive oral health services available<sup>1,3</sup>.

In low income countries, oral health services are mostly offered from regional or central hospitals of urban centres and little, if any, importance is given to preventive or restorative dental care. Many countries of Africa, Asia and Latin America have a shortage of oral health personnel and generally the capacity of the systems is limited to pain relief or emergency care. In Africa, the dentist to population ratio is approx. 1:150000 against about 1:2000 in most industrialized countries. Among children and adults suffering from severe tooth decay, teeth are often left untreated or are extracted to relieve pain or discomfort. In the future, tooth loss and impaired oral function are therefore expected to increase as a public health problem in many low and middle income countries.

#### 1.2 Oral health promotion and disease prevention

Dental caries is avoidable, thus the need for dental restorative care can be reduced effectively when disease prevention programmes are established at country and community levels. Firstly, countries and communities should advocate a diet low in sugars in accordance with WHO/FAO recommendations.6,7 Among other recommendations, free (added) sugars should remain below 10% of energy intake and the consumption of foods/drinks containing free sugars should be limited to a maximum of four times per day. Secondly, fluoride is most effective in dental caries prevention when a low level of fluoride is constantly maintained in the oral cavity.8 There is clear evidence that long-term exposure to an optimal level of fluoride results in diminishing levels of caries in both child and adult populations.9-12 Fluorides can be obtained from fluoridated drinking-water, salt, milk, mouth rinse or toothpaste, as well as from professionally applied fluorides; or from combinations of toothpaste containing fluoride with any of the other fluoride sources. Thirdly, development of healthy lifestyles including proper general and oral hygiene behaviour, and healthy environments such as access to clean water and sanitation are essential to oral health.1

Several high income countries having established preventive programmes demonstrate a systematic decline in dental caries in children and improved dentate status in adult populations 3,5. In most middle and low income countries oral disease prevention programmes are not yet organized. In addition, the vast majority of people are underserved and the need for comprehensive oral health care is growing dramatically, including dental restorative care. In response to the Bangkok 6th World Conference on Health Promotion, 13 the Liverpool declaration in 2005 formulated guidelines on appropriate interventions for oral health. 14 The World Health Assembly in 2007 agreed on a resolution (WHA60.17): Oral health: action plan for promotion and integrated disease prevention. 15 The resolution gives directions to countries in identifying the opportunities for oral health and the development or adjustment of oral health systems. 16 The World Health Report 2008 on Primary Health Care 17 is a vital instrument to countries in their efforts to

ensure universal coverage and the provision of essential health care to populations. Effective primary oral health care - particularly in middle and low income countries – will focus on the unmet needs for dental care and dental restoration.

#### 1.3 Dental restoration

In spite of the success in the prevention of dental caries, teeth in need of restoration still occur. In the case of dental treatment, diseased tissue is removed and teeth restored with appropriate material(s). In high income countries, dental amalgam has been widely used over decades as a dental restorative material. Providers of oral health care in low- and middle income countries also generally consider amalgam most relevant in serving their patients. However, the limited availability of oral health manpower, service facilities and materials for dental restoration, and the high cost of dental restorative treatment induce radical treatment with the extraction of teeth among people suffering from pain and illness. Consequently, unless the access to dental restorative treatment is further improved, the growing burden of dental caries in low and middle income countries will result in even higher numbers of people becoming edentulous in the near future.

#### 1.4 WHO Consultation 1997

#### 1.4.1 Dental amalgam and alternative direct restorative materials

Dental amalgam used in restorative care is a compound of mercury and silver-based alloys. The evidence available suggests that dental amalgams are considered to be effective and safe; however, some concerns have been expressed about the possible health effects of mercury in amalgam and to contamination of the environment from mercury. In 1997, the WHO held a Consultation Meeting on the use of dental amalgam. A large amount of evidence from diverse scientific sources was evaluated, and described in a meeting report.18 In addition, WHO offered a Consensus Statement from the meeting and this has formed the basis for the WHO position on use of dental amalgam (Annex 1). The WHO consultation also expressed the need for further research related to the use of amalgam.

#### 1.4.2 Research agenda to improve health

The participants of the WHO Consultation in 1997 devoted considerable time to a discussion of a research agenda related to dental restorations. Many attempts were made to reach agreements on a prioritized list of research topics in the area of dental restorations. Since the participants had a diverse and heterogeneous background, these discussions often ended up in general, but also specific, views on operative/conservative dentistry, cariology, and preventive dentistry.

The research topics unanimously agreed on were to establish:

- Global registry of biological and adverse health effects for monitoring of dental material related symptoms/diseases in various populations (patients and professionals) including the formation of an international advisory group to establish guidelines and evaluate the collected data.
- Research to develop affordable preventive caries programmes, making any restorative material unnecessary, including studies helping to identify fractions of various populations at high risk of caries, for targeted actions.
- Studies to identify special risk groups and individuals highly sensitive to various restorative materials.
- Development of restoration methods and inexpensive biomaterials that can withstand local climatic, storage and handling limitations.
- Research to develop improved and novel materials, including development of biological materials (biomimetics/tissue engineering) for restorative purposes.
- Development of better diagnostic methods for caries and methods for clinical decision making.
- Development of criteria regarding the replacement of failed restorations.
- Improvement in methods for minimal intervention in caries management:
- Improved and affordable methods for recovering and recycling of restorative materials.
- Improved methods to make relevant dental material information available, including use of Internet.
- Development of direct filling materials with easy handling characteristics.

## 1.5 WHO policy on the use of dental amalgam for restoration

During the past 10 years or so, the awareness and recognition of the environmental implications of mercury has increased and dentistry being a source to contamination of the environment has gained further attention. In addition, within the dental profession and the oral health research community the interest of serving patients through use of alternative dental restoration materials has grown markedly. A few high-income countries have introduced a ban on use of dental amalgam in light of the higher availability and accessibility of tooth-coloured dental materials.

It is worth noting, however, that in the majority of countries third-party payment schemes do not yet recognize the use of alternative materials and one implication of this is that use of these materials for restoration of tooth structure is more expensive to consumers than dental amalgam. In the vast majority of low- and middle-income countries, the use of dental amalgam remains the only appropriate material for dental fillings or build-up material as the alternative materials are far too expensive for people and society. Even today dental restoration is expensive often leading to tooth extraction in the case of dental pain or discomfort.

The research on tooth-coloured materials for restorative dental care has grown significantly over the past 10-15 years. High quality alternatives are now available on the market in some of the wealthiest industrialized countries and some materials have been tested in clinical investigations as well as in population studies. Moreover, these studies have been conducted on both primary and permanent teeth. However, such research is mainly carried out in high-income countries and research findings from the use of alternative biomaterials may not apply directly to low-and middle income countries.

### 1.6 Recent major international statements on dental restorative materials

In May 2008, a Scientific Committee of the European Commission addressed safety concerns for patients, professionals and the use of dental amalgam and the alternative restorative materials available.23,24 The committee concluded that dental amalgams are effective and safe, both for patients and dental personnel and also noted that alternative materials are not without clinical limitations and toxicological hazards. The Scientific Committee of the European Commission recognises that dental amalgam is an effective restorative material and may be considered the material of choice for some restorations. Because dental amalgam is neither tooth-coloured or adhesive to remaining tooth tissues, its use has been decreasing in recent years and the alternative tooth-coloured filling materials have become increasingly more popular. Independent of risk management decisions, a sustained reduction in the use of dental amalgam in oral health care provision is expected across the European Union, the rate of which is dependent on trends in dental education towards the increasing use of alternative materials in place of amalgam and the possible reduced availability of mercury products in general.

The World Dental Federation (FDI) approved the 1997 WHO Consensus statement on dental amalgam.18 The FDI General Assembly 2009 reiterated and stressed the statement on amalgam that it is a safe, widely used and affordable dental filling material and currently serves the oral health needs of the majority of communities around the world, particularly those most disadvantaged and in need of dental treatment.

#### 1.7 UNEP initiatives on mercury

The United Nations Environment Programme (UNEP), established in 1972 following the UN and the Stockholm conferences on the environment, is the focus within the UN for environmental issues. Jointly with WHO, the Programme has strengthened the work for reduction of the exposure to mercury. Mercury is a naturally occurring element found in air, water, and soil. It is distributed throughout the environment by both natural and human anthropogenic processes. People are exposed to mercury mainly through their diet, especially through consumption of fresh water, fish and animals that consume fish. People may also be exposed to mercury through occupational activities, occupational exposures can occur where mercury or mercury compounds are produced, used in processes, or incorporated in products. People seeking dental care may be exposed to mercury through dental restorative materials and dental personnel can become exposed through work processes in the dental office if safety precautions are not exercised or due to improper manipulation of the material. Dental amalgam is classified as a medical device and mercury is an essential component; however in some countries mercury is acquired and used for other purposes such as artisanal gold mining, which is a source of mercury emissions.

UNEP, together with WHO, launched a guidance document entitled "Identifying Populations at Risk from Mercury Exposure". <sup>25</sup> The document is intended to assist countries concerned about the potential national impacts of mercury pollution to identify specific populations or subpopulations that may be at risk.

Following the development of the Global Strategy on Mercury in 2001, a Global Mercury Assessment was initiated in 2002. In 2003, the UNEP Governing Council decided that special attention was needed and in 2005 the Council called for mercury partnerships between governments and other stakeholders as one approach to reducing risks to human health and the environment from the release of mercury and its compounds to the environment. The partnership has the following objectives:

- Minimization and, where possible, elimination of mercury supply considering a hierarchy of sources, and retirement of mercury from the market to environmentally sound management.
- Minimization and, where feasible, elimination of unintentional mercury releases to air, water and land from anthropogenic sources.
- Continued minimization of global uses and demand for mercury.
- Promoting the development of non-mercury technologies where suitable economically feasible alternatives do not exist.

To achieve these objectives the partnership areas should also:

- strengthen the capacity of developing countries and countries with economies in transition
- share and exchange information

A more formalized structure and measure was requested by the GC in 2007, addressing issues in relation to the exposure, consumption and use of mercury products globally including waste management and storage of mercury. While the GC was pleased with the progress of the Global Network Partnerships under UNEP, much work was still needed in order to reduce the emissions, supply and demand for mercury. Given the diversity of countries worldwide and the availability of alternatives, UNEP recognizes that there is a need for consultation with different groups including the oral health sector. Consultation had already begun in 2009 and formal negotiations would start in June 2010, with a view to finalizing a legally binding treaty in 2013 that may contain both legally binding and voluntary measures. The impact of this treaty would have a significant impact on delivering oral health care worldwide.

#### 2 Objectives of the WHO meeting in 2009

In response to the various initiatives on mercury and the request from Member States for guidance, the WHO Global Oral Health Programme – in cooperation with UNEP Chemicals - organized a two-day meeting to discuss the implications and the way forward. The overall aim of the meeting was:

• To assess the scientific evidence available on use of dental restorative materials, including dental amalgam, and the implications of using alternatives to amalgam for dental restorative care.

#### Specific objectives were:

- To assess the feasibility (appropriateness, efficacy, safety) of using dental restorative materials alternative to dental amalgam, particularly the potential for use in populations of countries around the world.
- To assess the potential side-effects and hazards to health of existing materials for restorative dental care.
- To highlight the cost implications of alternative dental restorative materials for oral healthcare for different populations, particularly relevant to the situation in low-and middle income countries.
- To highlight the environmental concerns of mercury pollution from the dental sector, and the effect and implications of occupational exposure from mercury for dental personnel.

 To suggest principal strategies for further reduction in contamination of the environment from mercury due to dentistry.

#### 3 Outline of the structure of the meeting

Twenty-nine participants from 15 countries of all six WHO regions attended the meeting, representing ministries of health, NGOs, dental professionals, university academics, UNEP, scientists, anti-mercury pressure groups and WHOCCs. A list of participants is appended in Annex 2 and the meeting agenda in Annex 3.

Dr Ala Alwan, Assistant Director-General, Non-communicable Diseases and Mental Health, addressed the welcome introduction and opened the meeting. He emphasized the importance of this meeting and that WHO was giving the issue of oral health care serious consideration. He looked forward to the conclusions and recommendations to be circulated to all member states. Mr Per Bakken of UNEP outlined the work of UNEP leading to this consultation meeting and the implications for future activities. Dr Poul Erik Petersen then summarized the oral health context of restorative dental care and presented the scope, purpose, objectives and structure of the meeting. Professor Ramon J. Baez was elected Chair, while Dr Stella Kwan and Dr Hiroshi Ogawa were elected rapporteurs. A number of presentations and discussion followed (Annex 3).

Day One discussed the availability of different restorative materials, their advantages and potential adverse effects on health and the environment. Experience from both developed and developing countries of all WHO regions was shared in Day Two, which implications for oral health care were highlighted. The role of WHO, UNEP, Non-Governmental Organisations such as IADR and FDI, and the industry was emphasized.

#### 4. Types of dental restorative materials

Two types of restorative materials are commonly used in dentistry; they are designated depending on whether they can be applied directly to the tooth or require fabrication of the restoration in the dental laboratory. Dental materials are used for direct restoration of a tooth in order to save its function while indirect materials include pre-formed metal crowns, dental porcelain, and cast restorations. The principal material types for direct restoration are:

- Dental amalgam (silver-tin-copper amalgams containing mercury).
- Resin-based composite materials (RBC).
- Modifications of RBCs (poly-acid modified composites); componers and giomers (glass filler modified composites).

- Glass-ionomer cements/water-based cements: Self-setting ("pure" glassionomers) or, more usually, light cured (resin modified glassionomers).
- Long-term temporary materials e.g. reinforced zinc oxide-eugenol cements.

The indications for use of restorative materials span from small cavities to extensive loss of tooth substance. Materials are employed for cavities in primary teeth; for cavities in permanent teeth, ranging from "minimal interventions" to the need for extensive replacements and/or build-procedures; replacement or repair of failed or less satisfactory restorations, or materials are used in people with compromised health and having dental caries on certain locations, e.g. root caries. The development of 'smart composites', Amorphous Calcium Phosphate Composites that respond to oral microflora by releasing chemotherapeutics or antimicrobials such as calcium and fluoride, may circumvent some of the shortcomings of composite restorations. Research into a material that is based on the technology of glass ionomers, low shrinking resins and high strength filters with simple handling and acceptable longevity is in progress.

#### 4.1 Strengths and weaknesses of different materials

While tooth-coloured restorative materials are generally more expensive than amalgam, they offer an aesthetic alternative to traditional amalgam fillings. However there are concerns about their longevity and wear particularly in areas subjected to masticatory forces. Microleakage is also a disadvantage but it can be reduced with proper manipulation and strict clinical procedures. In general, composite restorations require 7 times as many repairs as do amalgam restorations. <sup>26</sup> The advantages and disadvantages of amalgam, composites, glass ionomers and resin ionomers are presented in **Table 1**.

Table 1. Advantages and disadvantages of different types of restorative materials.

Amalgam	Composites	Glass ionomers	Resin ionomers
Principal uses			
i imorpai asos	Aesthetic dental fillings	Small non-load fillings	Small non-load fillings
Dental fillings	V	0 '. "	0 ' "
Heavily loaded posterior restorations	Veneers	Cavity liners	Cavity liners
		Cements for crowns and bridges	Cements for crowns and bridges
Leakage and recurrent of	lecay		
Moderate leakage	Low leakage if properly bonded	Low leakage generally	Low leakage if properly bonded
Recurrent decay same as other materials	Recurrent decay depends on maintenance of tooth-material bond	Recurrent decay comparable to other materials	Recurrent decay comparable to other materials
		Fluoride release may be beneficial	Fluoride release may be beneficial
Overall durability, fractu	ıre resistance & wear resista	nce	
Good to excellent durability in large load bearing restorations	Good durability in small to moderate restorations	Moderate to good durability in non load- bearing restorations; poor in load-bearing	Moderate to good durability in non load- bearing restorations; poor in load-bearing
Brittle, subject to chipping on filling edges; good bulk strength in large high- load restorations	Moderate resistance to fracture in high load restorations	Low resistance to fracture	Low to moderate resistance to fracture
High resistance to wear	Moderate resistance to wear	High wear on chewing surfaces	High wear on chewing surfaces
Cavity preparation and clinical consideration			
Require removal of tooth structure	Adhesive bonding permits removal of less tooth structure	Adhesive bonding permits removal of less tooth structure	Adhesive bonding permits removal of less tooth structure
Tolerant to wide range of clinical conditions	Requires well-controlled field of operation	Requires well-controlled field of operation	Requires well- controlled field of operation
Moderately tolerant to moisture during placement	Very little tolerance to moisture during placement	Very little tolerance to moisture during placement	Very little tolerance to moisture during placement

#### 4.2 Restoration longevity

The longevity of different materials is not easily established because the data depends on a multitude of factors, where material selection is just one. Study design, cavity selection, the operators' experience, non-standardized evaluation criteria, and the study cohorts play a role for the clinical outcome.<sup>27</sup> However, several studies indicate that amalgam tend to last longer than other materials,<sup>28,29</sup> whereas recent data suggest that RBCs perform equally well.<sup>29</sup> The most prevalent reasons for failure of fillings are secondary caries and fracture.<sup>29,30</sup>

The longevity of glass-ionomers is lower than that of amalgam or RBCs, 31-33 however, these materials have frequently been assessed in primary teeth. In fillings subjected to low chewing forces, the composite materials performs better than a glass ionomer cement. 34 The Atraumatic Restorative Treatment (ART) procedure appears to provide positive results in primary teeth. 35 Reinforced zinc-oxide-based cements are recommended for "semi-permanent" restoration lasting up to approximately one year. 36

In general, dental amalgam outlasts resin composites,<sup>37</sup> with median ages of 10-15 years for amalgam, compared with <5 to 8 years for composites.<sup>38,39</sup> Similarly, the need for replacement after 5 years is about 50% higher for composites than amalgam.<sup>40</sup> Annual failure rates of different restorative materials are given in **Table 2**, with glass ionomers having the highest failure rate of 7.6%.<sup>19,22,39,41</sup>

Espelid and colleagues compared the clinical behaviour of silver reinforced glass ionomers and resin modified glass ionomers.<sup>42</sup> After 24 months, the resin modified glass ionomers have the best overall performance with respect to retention, marginal integrity and secondary caries.

Table 2. Annual failure rates of dental restorations<sup>42</sup>

Material	Age at replacement	Annual failure rate
Resin-based composites	8 years	2.3%
Poly-acid modified composites	7 years	3.5%
Resin-modified glass ionomers	2 years	3.1%
Glass ionomers	4 years	7.6%
Amalgam	10 years	2.2.%

According to the Norwegian KVIT project, 43 95% of componer, 92% of amalgam, 85% of composite and 69% of glass ionomer restorations survive after 4 years. The high success rate of componer may be attributed to limited inter-operators

variability as only one dentist used this material. Only 4.6% of all restorations are amalgam, reflecting dentists' preference in dental restorative materials. Secondary caries is by far the most common reason for failure.

#### 4.3 Biological considerations

All artificial materials release substances into the oral environment and imply some risk of side effects and adverse reactions. <sup>44,45</sup> Amalgam has been associated with general health concerns, <sup>46</sup> while local oral effects from different restorative materials are reported. <sup>47</sup> The biocompatibility of dental restorative materials is being evaluated in different test settings. <sup>48</sup> RBCs and associated materials have been elucidated with respect to effect on cellular and sub-cellular levels related to resin constituents <sup>49-51</sup> and also filler particles. <sup>52</sup>

#### 5. Effects on health and the environment

According to UNEP, a total of 260 to 340 tonnes of mercury is released to the environment from the use of dental amalgam globally every year (**Table 3**). When released in to environment through incineration, landfill and wastewater discharges, mercury is transported and deposited globally, the major pollutant of concern. Mercury releases may then enter the food chain especially via fish consumption.

Table 3. Global annual mercury releases from the use of dental amalgam.

Main releases/pathways	Mercury (metric tonnes/year)
Atmosphere	50 – 70
Surface water	35 – 45
Groundwater	20 – 25
Soil	75 – 100
Recycling of dental amalgam	40 – 50
Sequestered, secure disposal	40 – 50
Total	260 – 340

Source: UNEP

Mercury is highly toxic and harmful to health. Approximately 80% of inhaled mercury vapour is absorbed in the blood through the lungs, causing damages to lungs, kidneys and the nervous, digestive, respiratory and immune systems. Health effects from excessive mercury exposure include tremors, impaired vision and hearing, paralysis, insomnia, emotional instability, developmental deficits during

fetal development, and attention deficit and developmental delays during childhood. According to the Norwegian Dental Biomaterials Adverse Reaction Unit, there is an increase in adverse reaction reports related to composites and cements following the amalgam ban in 2008. The majority of the reactions reported occurred within one week after treatment. Skin reactions and pain are the most commonly reported complaints, among a long list of general health problems and oro-facial lesions and conditions. However, the information gathered is based on voluntary reporting. There is a need to establish a more objective global registry of adverse effects for dental restorative materials. Long-term monitoring is also needed.

#### 6. Best Management Practices

The amount of mercury released to the environment from over 800,000 dental offices is estimated between 0.04 and 0.2% of total worldwide environmental mercury pollution from all sources.<sup>53</sup> While concerns about the effects of mercury on health and the environment have increased over the years, mercury in the dental amalgam is stable and, if managed properly, amalgam waste can be recycled safely. Best Management Practices (BMP) are a series of amalgam waste handling and disposal practices that include, but are not limited to, initiating bulk mercury collection programmes, using chair side traps, amalgam separators compliant with ISO 11143 and vacuum collection, inspecting and cleaning traps, and recycling or using a commercial waste disposal service to dispose of the amalgam collected. Recycling is one of the BMP for dental offices (Table 4) and a practical guide for the dental practice is given in Table 5. It may be argued that there will be no toxicologically meaningful reduction in the amount of methyl mercury in the environment if separators are universally required in dental facilities. Using amalgam separators, together with other measures of BMP, can significantly reduce mercury discharge to the environment. It may be worth noting that the annual cost to the dental industry of reducing one ton of potentially bioavailable mercury is about US 273 million to 1.2 billion dollars.

Table 4. Best Management Practices for dental offices using amalgam.

DO	DON'T
<b>Do</b> use pre-capsulated alloys and stock a variety of capsule sizes	<b>Don't</b> use bulk mercury
<b>Do</b> recycle used disposable amalgam capsules	<b>Don't</b> put used disposable amalgam capsules in biohazard containers, infectious waste containers or regular garbage
<b>Do</b> salvage, store and recycle non-contact amalgam (scrap amalgam)	<b>Don't</b> put non-contact amalgam waste in biohazard containers, infectious waste containers or regular garbage
<b>Do</b> salvage (contact) amalgam pieces from restorations after removal and recycle the amalgam waste	<b>Don't</b> put contact amalgam waste in biohazard containers, infectious waste containers or regular garbage
<b>Do</b> use chair-side traps, vacuum pump filters and amalgam separators to retain amalgam and recycle their contents	<b>Don't</b> rinse devices containing amalgam over drains or sinks
<b>Do</b> recycle teeth that contain amalgam restoration. (Note: Ask your recycler whether or not extracted teeth with amalgam restorations require disinfection)	<b>Don't</b> dispose of extracted teeth that contain amalgam restorations in biohazard containers, infectious waste containers, sharps containers or regular garbage
<b>Do</b> manage amalgam waste through recycling as much as possible	<b>Don't</b> flush amalgam waste down the drain or toilet
<b>Do</b> use line cleaners that minimize dissolution of amalgam	<b>Don't</b> use bleach or chorine-containing cleaners to flush wastewater lines

#### Table 5. Practical guide to integrating BMPs into the dental practice

#### Non-contact (scrap) amalgam

- Place non-contact, scrap amalgam in a wide-mouthed container that is marked "Non-contact Amalgam Waste for Recycling".
- Make sure the container lid is well sealed.
- When the container is full, send it to a recycler.

#### Amalgam capsules

- Stock amalgam capsules in a variety of sizes.
- After mixing amalgam, place the empty capsules in a wide-mouthed, airtight container that is marked "Amalgam Capsules Waste for Recycling".
- Capsules that cannot be emptied should likewise be placed in a wide-mouthed airtight container that is marked "Amalgam Capsules Waste for Recycling".
- Make sure the container lid is well sealed.
- When the container is full, send it to a recycler.

#### Disposal chair-side traps

- Open the chair-side unit to expose the trap.
- Remove the trap and place it directly into a wide-mouthed, airtight container that is marked "Contact Amalgam Waste for Recycling".
- Make sure the container lid is well sealed.
- When the container is full, send it to a recycler.
- Traps from dental units dedicated strictly to hygiene may be placed in with the regular garbage.

#### Reusable chair-side traps

- Open the chair-side unit to expose the trap.
- Remove the trap and empty the contents into a wide-mouthed, airtight container that is marked "Contact Amalgam Waste for Recycling".
- Make sure the container lid is well sealed.
- When the container is full, send it to a recycler.
- Replace the trap into the chair-side unit (Do not rinse the trap under running water as this could introduce dental amalgam into the waste stream.

#### Vacuum pump filters

- Change the filter according to the manufacturer's recommended schedule. Note:
   The following instructions assume that your recycler will accept whole filters; some recyclers require different handling of this material, so check with your recycler first.
- Remove the filter.
- Put the lid on the filter and place the sealed container in the box in which it was originally shipped. When the box is full, the filters should be recycled.

#### Amalgam separators

- Select an amalgam separator that complies with ISO 11143.
- Follow the manufacturer's recommendations for maintenance and recycling producers.

#### Line cleaners

 Use non-bleach, non-chlorine-containing line cleaners, which will minimize amalgam dissolution.

# 7. Implications for training of dental health professionals

Given the increasing popularity of tooth-coloured restorative materials, dental schools worldwide are revising their training and education curricula to equip students with the appropriate skills to perform the procedures. However, variations in teaching, and techniques and technologies used are observed.<sup>54-58</sup> The challenges are significant. For example, staff themselves may not have sufficient training to teach the techniques and their attitudes and the remuneration systems may influence the teaching of different techniques. While some dental schools place more emphasis on composite resins, amalgam restorations are still taught if the State only funds these materials in dental practices. Fostering the philosophy of preserving the tooth structure and improving the survival of the tooth is also imperative, as is oral health promotion. Clinical performance of posterior resin composites placed by dental students has been shown to be satisfactory.<sup>59</sup> If they are taught composite resins prior to amalgam, they may find amalgam difficult to handle. Using adhesive systems prepares them for many other procedures in restorative dentistry. In conclusion, there is a reduction in the use of amalgam in general. Adhesive resin materials allow for less tooth destruction and, as a result, a longer survival of the tooth itself. Funding agencies should take the initiative and encourage the replacement of amalgam as the material of choice for posterior teeth with adhesive systems. Staff training is a major component for success.

#### 8. Implications for future research

Amalgam has been used for about 150 years, although a declining trend is expected for the future. Following substantial reviews of evidence, 40,60-63 the US FDA issued a final regulation on dental amalgam in 2009 to confirm that dental amalgam is a safe and effective restorative material. While composites have been used for over 45 years, they require 7 times as many repairs as do amalgam. Research into the development of improved and novel alternative restorative materials remains unsatisfactory since the 1997 WHO Consultation meeting; little progress has been observed. Further research is also needed to assess the safety and adverse effects of alternative materials. Collaboration between material scientists, computer scientists, toxicologists, synthesis chemists and industry is critical.

In order to reduce the use of dental amalgam in the future, the meeting emphasizes that prevention is of paramount importance, including community interventions, proper use of fluorides, fissure sealants, and re-mineralization strategies. In the near term, alternative restorative materials including composites will need to be improved, as will the 'next generation' materials. In the longer term, tissue engineering approaches could be considered. IADR Taskforce on Dental Materials

comprising material scientists, clinicians and manufacturers has been formed to accelerate the development of improved materials, to provide clinicians with viable alternatives to greatly reduce the use of dental amalgam and, partnering with FDI, to promote BMPs until such time that amalgam use and amalgam replacement has discontinued.

#### 9. Country experience

#### 9.1 African Region

There is limited information about the use of restorative materials in the developing countries of Africa. In low resource communities oral health services are either not available or poor, especially in rural and remote areas. Oral health services are available in major urban centres but have little outreach to the underprivileged, disadvantaged population groups. Restorative dental care is extremely expensive to people living in poverty. When oral health service exists, dental amalgam is still the best choice in restorative dental care, although in certain countries the sale of composite materials has increased over the last few years. The few existing dental schools focus on the control of infectious disease transmission; issues regarding mercury from dental amalgam are not always considered as a priority. Only a few countries have a formal policy on the use of dental restorative materials. Given the high prevalence of severe and large carious lesions, the use of dental amalgam is highly indicated. For smaller lesions, composites may be more suitable. The choice of materials depends on availability and costs. Composites are more commonly used by private dental practitioners and, for aesthetic reasons, are more popular with patients. Patients' preferences, "not the science", may phase out amalgam. However, dental amalgam is considered to be a more predictable and forgiving material by dentists. In conclusion, dental amalgam has an important role to play in the provision of oral healthcare because of its affordability, ease of use and longevity. However, the implication of banning dental amalgam on the oral health of African people must not be underestimated. Under such conditions tooth extraction may be the only choice of treatment and lead to important negative impact to quality of life.

#### 9.2 Region of the Americas

Dental amalgam has been used for about 150 years; the first American Dental Association (ADA) specification was developed about 70 years ago. Amalgam has been the material of choice for restoration of posterior teeth in children and adults. Thirty years ago 80% of all restorations were amalgam. In the 1990s approximately 200 million restorations have been placed in USA and Europe combined. The use

of amalgam has decreased to some extent. Various groups have opposed the use of amalgam in dentistry based on claims of an adverse effect on patient's health and as a factor in occupational health. Nevertheless, extensive research and clinical experience have demonstrated that amalgam is safe. Earlier in 2009, the Food and Drug Administration (FDA) issued a final regulation regarding classification of amalgam as the same as other restorative materials such as gold and composites. Labelling requirements were included in the regulation. Specifically, the FDA recommended that the product labelling include a warning against the use of dental amalgam in patients with mercury allergy; a warning that dental professionals use adequate ventilation when handling dental amalgam and a statement discussing the scientific evidence on the benefits and risks of dental amalgam, including the risk of inhaled mercury vapour. This statement should help dentists and patients make informed decisions about the use of dental amalgam.

Dental amalgam is a "pre-amendment device," which means that it was in use prior to 28th May 1976, when the FDA was given broad authority to regulate medical devices. That law required the FDA to issue regulations classifying pre-amendment devices according to their risk into class I, II, or III. Although the FDA previously had classified the two separate parts of amalgam – elemental mercury and the metal powder alloy - it had not issued a separate regulation classifying the combination of the two, dental amalgam. The ADA has made various statements on this and, being concerned about possible impact on the environment, issued best management practices for amalgam waste in 2007. The intention is that 99% of mercury released to the environment is captured. This may be accomplished by use of amalgam separators. The American National Standards Institute (ANSI), ADA and ISO have currently a draft international standard DIS 11143 for amalgam separators. Requirements in the standard specify that separators shall be at least 95% (mass fraction) effective, have a warning system, an alarm system and an alarm for malfunctioning. According to the US Environmental Protection Agency (EPA), 3.7 tons of mercury are discharged to the environment each year from dental practices. In 2008 a memorandum of understanding (MOU) on reducing dental amalgam discharges was jointly signed by ADA, EPA and the National Association of Clean Water Agencies (NACWA).

Factors that affect the cost as disseminated by private practitioners are related to "the dentist who performs the procedure, the location where it is performed, type of dental insurance (some insurance schemes do not cover composite restorations) and the number of tooth surfaces". Some clinicians claim that it takes twice as long to insert composite resins than amalgam. Typical cost of amalgam restoration in a pre-doctoral dental clinic ranges from \$32 to \$47 depending on complexity and from \$113 to \$207 if the procedure is conducted in a faculty practice clinic, compared with \$42 to \$62 and \$129 to \$275 respectively for composite resin restorations. In terms of longevity, amalgams are known to last 12 years as an average<sup>19</sup>; however, there are restorations that are 40-50 years old. Composite resins have been reported to last 12-15 years.

Implications for oral health are considerable if amalgam was banned. Fewer people will have access because of cost, particularly among communities in the US that are already underserved according to United States Public Health Service. Insurance coverage will need to be modified to cover alternate materials. Services in public clinics would need to be offered to all population groups. Research and development efforts would need to concentrate on developing materials that are as good as, if not better than, amalgam. All these efforts will require time. Greater emphasis needs to be placed on prevention activities.

For Canada, while medical care is provided by the government under the federal act and is administered by the provinces, 60% of Canadians receive oral health services under the fee-for-item-of-service from private dental clinics. Social and children programmes vary from province to province. Federal provides coverage for First Nations and Inuit. However, access to oral healthcare is a growing problem particularly in remote areas and among the disadvantaged. While the oral health needs of 80% of the Canadian population are met, the challenge of addressing the needs of the remaining 20% is almost intractable. In addition, the situation could be worsened by changes in the economy or increases in costs of oral healthcare.

There is no dental material industry in Canada. Although oral health services are not dictated by private insurance, dentists can only work with materials that are available. However, the use of amalgam is declining. According to the Dental Industry Association of Canada, the sale of amalgam dropped from 3000 kg in 1999 to 2500 kg in 2006. Similarly, about 5000 kg of amalgam were removed in 2003 and 4700 kg placed, and the corresponding figures of 5400 kg and 4100 kg were reported in 2007.64,65 There is no Total Daily Intake (TDI) for mercury from dental amalgam and the removable of serviceable amalgams is not warranted. The reduction of use of amalgam through diagnostic, preventive and restorative strategies aimed at tooth preservation is recommended. Nonetheless, more research and improved public information are still needed. While there are regulations on prohibition of mercurycontaining products, dental amalgam and lamps are exempted based on the need and successful management of environmental concern through the Canadian Wide Standard (CWS) for mercury. The Canadian Council of the Minister of the Environment launched an initiative in 1998 targeting a number of sectors to reduce mercury exposure. CWS for mercury from dental amalgam waste was adopted in 2001, which was followed by a MOU signed by the Canadian Dental Association (CDA) and Environment Canada (EC) in 2002. Since then, 70% of dental offices in Canada have 'voluntarily' implemented the BMPs of the CWS. In future, CDA will continue to cooperate with EC to achieve the targets of the CWS and formal monitoring of BMPs has been proposed. Ongoing public consultations have been initiated. Until there is no more demand for amalgam, a pragmatic approach has been employed to promote the use of most appropriate material, to educate dentists on the impact of mercury and to implement mitigation strategies in the meantime.

In Latin American countries, the burden of dental caries is generally high.<sup>66</sup> The caries prevalence and experience vary between countries with differing risk factors, scope of services provided, availability of community prevention programmes, economics, education and human resources available. Variations in public expenditure on health are observed between countries.<sup>67</sup> Services provided to the individuals focus on treatment of disease and prevention. Prevention activities include risk assessment, application of sealants and fluoride, professional measures to reinforce habits, elimination of inadequate retentive elements, monitoring and control. Functional or restorative services are provided using amalgam, resins, glassionomers and compomers. Endodontic and periodontal treatments are available for selected cases. Surgery is provided for simple and complicated surgical procedures and, in some countries, prosthetic rehabilitation is also available. In regards to the use of amalgam and resins, amalgam is mainly for restoration of posterior teeth and resin restorations are limited to upper and lower anterior teeth in public health services and social security clinics. This is covered under the social security services programme. In private clinics, resins are provided even in posterior teeth. For example in Colombia, for each glass ionomer restoration inserted, 6 composite resins and 14 amalgam fillings are placed. Given the high restorative treatment needs and the contrasting costs of different dental restorative materials, using composites and glass ionomers instead of dental amalgam would lead to millions of dollars of extra health spending, a budget that most developing countries in this region do not have.

Regarding impact on the environment, there is no quantification of the proportion of consumption of mercury by dental services. It is known that the main focus is in the mining operations that have led to regulatory and legislative regulation of trade and use of significant amounts of mercury. In health services, countries already have standards for bio-safety and waste management such as distribution of alloy and mercury (pre-dispensed) in capsules. Norms and regulations have been issued about the processes of production and consumption in services including registration, labelling, trade, storage, handling, collection, disposal, storage, transportation and recycling of material and spill management. When considering a restorative material, it is crucial to consider the economical cost, functional, scope and coverage of services and health public policies. If there is a need for transition, it is important to decrease the cost of the new dental material and maintain the model of Primary Health Care.

#### 9.3 South-East Asia Region

Dental caries, especially in primary dentition, is still a major public health problem. Despite the high levels of treatment needs, 90% of caries remains untreated.<sup>68</sup> The types of restorative materials used in dental schools vary between countries as do costs of materials. In general, composites are twice as expensive as amalgam. While

some countries (e.g. Indonesia) use more composites and glass ionomers, dental amalgam is still most frequent in other countries (e.g. India and Myanmar where 50% of restorations are made in amalgam). In general dental practices, dental amalgam is less popular, with the exception of Malaysia. Patients' preference and demand, site of lesions, type of dentition, cost, cost-effectiveness, training and treatment philosophy are some of the influencing factors. Glass ionomer based on Atraumatic Restorative Treatment (ART) is used in countries of this region, particularly in the primary dentition. While dental amalgam restorations are still taught in the dental curriculum, much emphasis is placed on tooth-coloured restorative materials, leading to an increasing trend in using more composite resins and glass ionomer than amalgam in the future. Manufacturers also have an important part to play in ensuring that the materials are readily accessible, easy to use and cost-effective. Local producers can help reduce costs of, and improve access to, materials (e.g. in Indonesia).

#### 9.4 European Region

The use of amalgam has been restricted in some countries in this region. For example, there is a complete ban on amalgam in Norway since January 2008. According to a study conducted 2 years after the ban, less than half (20% to 40%) of dentists would prefer dental amalgam even if it was legal. About 23% of dentists surveyed have no experience with amalgam at all. However, while composite is the most commonly used material; Norwegian dentists are not convinced that the alternatives can fully replace amalgam. Denmark has introduced a "phasing-down" practice in use of dental amalgam and in Sweden amalgam is not recommended for children under 10 years of age.

The use of dental restorative materials varies between countries. While there is a trend in the reduced use of amalgam in some European countries, many chief dental officers believe that a complete ban on amalgam would be disastrous, particularly for low resource countries. Many dentists feel that amalgam cannot be entirely replaced. The majority of Cochrane oral health reviews fail to provide sufficient quality evidence to inform the use of various materials for dental treatment. In the absence of conclusive evidence, it is agreed to continue the safe use of dental amalgam. However, the European Commission stresses that the relative risks and benefits of different restorative materials should be explained to patients for them to make an informed decision. The choice of materials is influenced by the training and education of dental professionals, policies and legislations, professionals' attitudes, costs and patient preference. The funding and remuneration also impact on the provision of restorative treatment. For example, as reported at the meeting, in Ireland the state funded dental practices insert mainly amalgam restorations for posterior teeth in children and adults, whilst semi-state funded practices use both amalgams and composites and private practices place 70% of composite and

30% amalgam restorations on posterior teeth. In Finland 5% of restorations are in amalgam and 55% Composite; in the Netherlands less than 10% restorations are amalgam and over 81% are composites. This is considerably different to Sweden where 74% of restorations are made in amalgam and 26% composites. Hence, the role of dental professionals, research communities, industry and third party payers is critical. In countries of Central and Eastern Europe, no systematic data are available on the use of dental restorative dental materials.

#### 9.5 Eastern Mediterranean Region

The burden of dental caries is significant in this region although there are variations between countries, exacerbated by increased consumption of sugary foods and drinks. In some countries, the situation is worsening. For example, in Kuwait the proportions of children who are caries free is decreasing and the mean numbers of DMFT are increasing over time.<sup>69</sup>

In general, the use of amalgam restorations is declining. It was reported at the meeting that according to a recent impromptu survey on the use of restorative materials in the region, dental amalgam is more commonly used in government clinics than in private dental practices. The percentage varies among countries, for instance in Kuwait 50% of restorations are made in amalgam in government dental clinics, 20% in private practices and 25% in dental schools; in Jordan over 90% of restorations are amalgams made in government clinics, 60-70% in dental practices and 70-80% in dental schools. In Syria, 60% of restorations are made in government clinics and the same amount in dental schools and only 35% are performed in dental practices. However, BMPs are not observed in some countries. Allergic reactions to composite have been reported in Kuwait, while in Bahrain there are problems with local dealers. Nonetheless, the use of amalgam is considered to be declining, while tooth-coloured materials are on the increase. ART is also used in this region. Information obtained from the survey regarding how countries deal with waste and other pertinent issues on restorative materials indicates that for instance in Kuwait amalgam separators are used and practitioners recycle amalgam whereas in Jordan there are no recycling facilities and in Syria amalgam waste is disposed in the water sewer. Problems with other restorative materials identified were as follows: in Kuwait reports have been made on contact allergy with composite and no problems with composites or glass ionomers in Syria. In Bahrain, difficulty in the delivery by local dealers was reported as a problem.

Practitioners expressed different views from country to country when asked about the future of restorative materials. Those in Kuwait indicated that patients are demanding composite; in Syria, the use of amalgam is declining; in Jordan the use of aesthetic materials is increasing and in Bahrain they anticipate no change.

#### 9.6 Western Pacific Region

There is a long history of using amalgam and precious metals for dental restorations in China. Dental amalgam products are manufactured locally and are regulated by national authorities. The use of dental amalgam varies between regions and provinces in China; it is more commonly used in Hong Kong and less so in Xian and Shanxi Province. The following information summarizes use of restorative materials in various provinces/regions.

Hong Kong	The choice of restorative materials is mainly based on clinical need. Dental amalgam is the most commonly used, particularly in government clinics.
Xian and Shanxi Province	Composite resins are commonly used in large hospitals (70%), middle level hospitals (60%) and small hospitals and private dental clinics (50%). The decreasing trend of amalgam use continues.
Guangxi Province	Dental amalgam is still used in every public hospital, but only for 8-10% of dental restorations. The majority of private dental clinics (80%) still use dental amalgam based on patients' needs.
Beijing	Composite resins are used in large hospitals instead of amalgam. Dental amalgam is still in use in other hospitals and private dental clinics, although the trend is decreasing.
Shanghai	Dental amalgam is used in hospitals and private dental clinics in about 45% of dental restorations. Hospitals and dental clinics have certain measures for waste handling to reduce mercury pollution, but some of them do not have guidelines to deal with the problems.
Anhui Province	Dental amalgam is the most popular restorative material of choice for posterior teeth because it is cost-effective.
Dalian	Dental amalgam restorations are not used in children. Few are used in other hospitals and dental clinics.
Zhengzhou	Dental amalgam is commonly used for dental restorations. It costs about 50 Chinese dollars per filling; the cost is double for composite resins. There are no adverse reactions to dental amalgam reported by local experts.

In spite of being cheaper than composite restorations, the use of dental amalgam is declining in general. The declining trend could be attributed to the improved dental health of people and the increased availability of other restorative materials. In China, dental amalgam is considered to be a safe and effective filling material, and there is no reason to discontinue its use. Adverse effect on health is rare, oral lichenoid lesion is the most common allergic reaction to dental amalgam. For other countries in the region, dental amalgam is still commonly used in the Philippines, while composite resins and glass ionomers are more popular in others. The percentage of dental material use varies in countries and in practice settings.

For instance in Mongolia 10% of restorations are in amalgam, 60% composite and 30% glass ionomers whereas in the Philippines 70% are placed in amalgam, 20% in composites and 10% in glass ionomers. In private practices in Malaysia 50% of restorations are amalgams, 30% composites and 20% ionomers while in Singapore and Vietnam amalgams only amount to 20% but composites reach 60% and ionomers 20%.

## Partners in relation to use of dental restorative materials

#### 10.1 The role of the dental profession

The dental profession has an important role to play in shaping the future use of dental restorative materials. The profession has led the move from wide-scale extraction of teeth in response to pain and infection to restoration and maintenance of the dentition, resulting in a decline in tooth loss and an improvement in oral health and quality of life among people in high income countries.

Dental amalgam remains the mainstay of restorative dentistry worldwide. In lowand middle-income countries, alternative materials are rationed by price, manpower and technology. Amalgam is the principal material of choice. If amalgam is banned prior to adequate alternatives being widely available, it will have a detrimental effect on oral health, particularly for low- and middle-income countries.

The FDI World Dental Federation coordinates its members in 144 countries worldwide to promote the following strategies.

- Investigate safe affordable alternative restorative materials to dental amalgam through effective collaboration with the research communities, governments, industry, educators and practitioners.
- Employ a responsible approach to protecting the environment, in accordance with BMPs including bulk collection programmes, chair-side trap and vacuum filters, use of amalgam separators (ISO 11143) and waste disposal services.
- Adopt a Minimal Intervention Approach (MIA) to oral healthcare: modification of the oral flora, patient education, remineralisation of noncavitated lesions, minimal operative intervention of cavitated lesions and repair of defective restorations.
- 4. Promote a new paradigm among dental practitioners, shifting from a restorative to a preventive / health promotion model.

## 10.2 The role of the International Association for Dental Research (IADR)

The mission of IADR is to advance research and increase knowledge for the improvement of oral health worldwide. The role of IADR is to support and represent the oral health research community and to facilitate the communication and application of research findings. Coordination of IADR activities is undertaken through Divisions and Sections. Regions with less developed research programmes are identified for specific support and include countries of Africa and the Middle East, Asia, Europe, Latin America, and North America. A number of interest groups are established, the Dental Materials group being one of them. This group coordinates global research in restorative dental materials. This scientific group also interacts with the dental materials industry. The aim of IADR is to expand and further develop the Association's partnership with international dental associations, industry, health agencies, and scientific and educational professional organizations.

#### 10.3 The role of UNEP

UNEP has been mandated to work with governments and other stakeholders to protect human health and the environment from mercury and its compounds through the Global Mercury Partnership initiative. The goal is to minimize and, where possible, eliminate global anthropogenic mercury uses and releases. A number of areas are targeted, such as coal combustion, artisanal small scale gold mining, chlor-alkali, waste management, storage and mercury in products including dental amalgam and lamps. Organizations, agencies and individuals who support the overall goal of, and commit to contribute resources or expertise towards, the Partnership can become a partner. Between now and 2013, UNEP will facilitate expert consultations and negotiations and assist partners in the implementation of initiatives to reduce mercury use. Following consultations with stakeholders and partners, a new global legally binding instrument on mercury will be developed, taking into account the challenges faced by both developed and developing countries.

A comprehensive strategic approach to mercury has been developed to promote awareness-raising and information exchange. There are arrangements for capacity building and provisions for technical and financial assistance, where necessary. UNEP also supports country-based projects that tackle mercury risk reduction and risk management. Given the diversity of countries and the availability of alternative materials, flexibility is needed to allow countries discretion in the implementation of their commitments.

As part of this comprehensive strategic approach, UNEP believes that the dental profession has a vital role in the Partnership to reduce the demand for amalgam and

to promote mercury free alternatives. The dental profession can help increase the transparency in trade of mercury, improve better reporting on use and consumption, limit supply of mercury globally, minimize potential for diversion to other uses, reduce mercury use and encourage best management practices.

#### 10.4 The role of WHO

Mercury is one of the ten chemicals of major public health concern that WHO prioritizes. Dental amalgam is a significant source of exposure. Work for reduction of mercury is carried out by the WHO Programmes of Water, Sanitation and Health, Department of Protection of the Health Environment, and the WHO Global Oral Health Programme, Health Promotion, Department of Chronic Disease and Health Promotion. National, regional and global actions, both immediate and long-term, are needed to reduce or eliminate releases of mercury and its compounds to the environment. WHO is committed to work with the health sector and national, regional and global health partners to:

- reduce mercury exposure;
- eliminate the use of mercury wherever possible;
- promote the development of alternatives to the use of mercury.
- lead the profession in the negotiations of the development of the legally binding instrument on mercury.

The WHO Global Oral Health Programme provides advice to national and supranational health authorities in appropriate dental care. Several low and middle income countries are in process of strengthening oral health systems in response to the growing burden of dental caries and provision of restorative dental care is a matter of public health concern. Increasingly, WHO interacts with public health administrators and oral health professionals in those countries.

Elimination of mercury-related health problems requires strategic action to:

- Conduct national assessments of mercury usage and disposal and implement educational activities for the health, environment and other sectors.
- Promote the use of mercury-free alternatives and ensure that mercurycontaining devices are taken back by the manufacturer or properly disposed.
- Develop mercury clean-up and waste-handling, storage and safe-handling procedures; promote environmentally sound management of health-related waste containing mercury.
- Encourage countries to develop and implement policies and legislation on

mercury; highlight the role of the health sector in dealing with mercurycontaining material, health-care waste and emission reduction; and promote effective ways to control mercury emissions from cremation.

- Encourage international agencies to work with manufacturers, wholesalers and retailers to develop and make widely available inexpensive mercuryfree products, and facilitate their procurement.
- Assist countries in preparing advice for pregnant and lactating women and children, about the risks and benefits of fish consumption, indicating the type of fish that may be eaten and how often. WHO strongly recommends breastfeeding since the presence of methylmercury in breast milk is not sufficient to outweigh its benefits.
- Identify traditional practices, folk medicines and cosmetics involving mercury, and disseminate information on mercury hazards, exposure prevention and how to clean up spillages.
- Promote long-term monitoring (including biological measurements of exposure) and programmes to reduce occupational exposure.

#### 11. Summary of discussions

During the discussions several points related to the use of dental restorative materials were made. They were summarised as follows.

- Following a review of existing evidence and much deliberation, it was agreed that dental amalgam remains a dental restorative material of choice, in the absence of an ideal alternative. Dental amalgam is becoming more sophisticated as the technology is improving. If dental amalgam were to be banned, a better and more long-lasting replacement would be needed than the alternative materials available to date.
- While the harmful effects on health and the environment from mercury have been a major concern, the adverse effects of the alternative materials remain unclear and further research is still needed.
- Studies on adverse reactions to restorative materials lack validity as they
  rely on subjective and voluntary reporting, there is no robust mechanism
  to examine and verify reactions.
- An ideal dental restorative material should have the technology of glass ionomers, low shrinking resins and high strength fillers.
- Relying on a single universal material may be problematic. It may be necessary to investigate different materials and develop appropriate criteria for different categories.

- Amalgam restorations are more likely to be part of basic oral health care scheme that are financed by the State or third-payers, whilst it may not be the case for composites.
- The choice of materials may depend on the tooth, site and size of cavity, as well as health care financing, patient preference, technology, cost and environmental factors.
- Data on material longevity in some studies may need to be treated with some caution as different types of restorations may have been used and compared with poor standardization and consistency.
- There is a paucity of research evidence. More quality studies and systematic reviews are needed in the case of dental materials alternative to amalgam.
- It may be more important to examine tooth survival and to preserve tooth structure than filling survival. Health services will need to be reoriented to focus on disease prevention and minimize intervention.
- Implications for training are considerable. Dental teachers and students will need to be trained properly to keep up with the technology. Dental professionals will need to be made aware of the environmental impact of dental materials. Similarly, educating other stakeholders, governments, insurance companies and manufacturers is needed.
- Most of the discussion mainly focused on restorative materials; less discussion on promoting public health. It must be emphasized that providing the best care possible to patients should be of paramount importance. Patients' needs should be the top priority.
- Variations between countries must be taken into consideration. Countries with limited resources may be less likely to replace amalgam readily.
- Studies in some high income countries, whose dental disease level is low, may not be representative and findings may not be generalizable to countries worldwide. Similarly, most studies on dental restorative materials are conducted in high-income countries, whereas there is little evidence from middle- and low-income countries.
- The cost implications must not be underestimated, for example the cost of manufacturing the materials, implementing best management practices and training dental professionals.
- The challenges faced by middle- and low-income countries may be significant. Pain relief may be the most pressing need. Given the lack of infrastructure for implementation, it may not be realistic or practical to enforce on amalgam ban or BMP when there are no safe waste disposal systems.
- The proposed timeline (2013) for a complete ban may not be realistic,

practical and achievable in many countries. The needs of middle-aged and older generations who may have many amalgam fillings and those with lots of advanced caries lesions must not be ignored. It may be prudent to consider 'phasing down' instead of 'phasing out' of dental amalgam at this stage. A multi-pronged approach should be considered. Short-, medium-and long-term strategies should be developed.

 Elements of strategies can be put in place while waiting for the new quality materials to be developed.

#### 12. Recommendations

From deliberation of the meeting a number of recommendations were formulated.

### 12.1 Strengthening the prevention of dental caries

The burden of dental caries continues to be severe in high income countries while the incidence of dental caries is growing rapidly in several middle and low income countries. In most low and middle income countries dental caries often involves pain and discomfort leading to extraction of teeth. The need for dental care is still substantial in numerous countries, in particular among the poor and disadvantaged population groups.

Strengthening of disease prevention and health promotion is the most relevant approach to reduce the need for restorative care and most efficient way to phase down the use of dental amalgam. Public health intervention is needed for development of healthy lifestyles, such as healthy diet low in sugars and personal hygiene; effective use of fluoride, and development or adjustment of oral health systems that are oriented towards oral disease prevention and health promotion.

Countries are encouraged to establish population directed disease prevention programmes incorporating dental caries prevention. At the World Health Assembly, May 2007, the Member States agreed on Resolution WHA60.17 entitled "Oral health: Action plan for promotion and integrated disease prevention. The resolution 15-16 provides guidelines to countries in implementation of public health programmes including oral health.

#### 12.2 Evidence available on materials for dental restoration

Unfortunately, populations in numerous countries still show a high need for control of dental caries through restorative care whereby dental materials are used. The

characteristics of dental amalgam and the rationale for use of amalgam in restorative dental care are summarized in a previous WHO report of 1997<sup>18</sup>. Glass ionomer and composite have great potential for use as alternative to dental amalgam, but there is a need for minimizing failures. Particularly glass-ionomers appear to be relevant alternatives in dental care of children; however it remains uncertain whether such alternatives would be applicable to adults in general and older patients. The practical implications of alternative materials being used in posterior teeth are currently unsure. Longevity and failures of restorations may be affected by the extension of disease; restorations placed in small cavity lesions in occlusal surfaces have a higher life expectancy than those placed to restore severe class II lesions.

#### 12.3 Indicators of success of restoration

Indicators for evaluation of success of restorative dental care should be health outcome oriented. Preservation of the tooth in a functional state should be taken into consideration rather than retention of the material used for restoration; this is in line with goals for oral health suggested by WHO1, which focus on quality of life related measures such as dentate status. Criteria should be developed on whether dental materials alternative to amalgam successfully contribute to restore tooth function and thereby maintain dentate status.

### 12.4 Challenges to research

It is a matter of urgency that the oral health research community strengthens operational research in relation to use of dental restorative materials. Clinical research must emphasize risk assessment, criteria for use of restoration materials alternative to dental amalgam, development of standardized and reliable criteria for assessment of quality of restorations, and development and dissemination of clinical guidelines for making dental restorations. It is critical that oral health research strengthens the measurement of the evidence of using restorative materials alternative to dental amalgam through population-wide studies. In addition, it is imperative that research documents the cost-effectiveness of non-amalgam restoration in public health care.

There is a call for Dental Schools the International Association for Dental Research to encourage research on alternative materials for dental restoration and to coordinate such activity at international level.

Effective training of dental students and practitioners is based on research. In dental schools undergraduate training must better consider the safety of the environment, characteristics of dental amalgam and the existing alternatives in restorative dental care, development of skills in application of new quality materials for restoration, and the safety of dental materials to the provider of care.

#### 12.5 Cost of dental care

In the vast majority of countries around the globe the current cost of applying glass ionomer or composite is high to the patient and society compared to the cost of using dental amalgam for restoration. At present, dental care based on alternative restorative materials will have important negative implications to health status of the poor, disadvantaged people and this refers to children, adults and older people.

For low resource people in most countries, high expenses on dental care often will lead to extraction of teeth which impairs quality of life. Therefore, in countries actions are needed to ensure that dental care services are financially fair. In countries with health insurance schemes in operation would need to be adjusted to cover the relatively higher costs of dental care using alternatives to dental amalgam. In countries with third-party payment systems being introduced health authorities should give priority to balanced reimbursement schemes in restorative dental care.

#### 12.6 Health service facilities

The status of facilities for provision of oral health care must be taken into account. In high income countries health care conditions and availability of advanced equipment allow alteration of practices towards effective use of restoration materials alternative to dental amalgam. In countries where facilities for provision of oral health care are poor and where essential requirements such as water, electricity, suction and equipment are restricted or lacking, efforts should be made for improving such conditions. Best Management Practices would need to be adapted accordingly and a phase down programme for amalgam should be instituted. Availability of alternative restorative materials that do not require sophisticated for manipulation and placement must be encouraged.

### 12.7 The providers of dental care

It is important to differentiate that in high income countries the key health care provider is the dentist. In middle income countries, in addition to dentists, ancillary dental personnel and primary health workers are significant health care providers while in low income countries the primary health care worker will play a vital role in serving the population in oral health care.

In light of the high burden of dental caries around the globe it is vital that oral health care providers develop and maintain skills in dental restorative care. In many low and middle income countries there is a great need to enhance skills of ancillary personnel and primary health workers in providing essential dental health care. Efforts should be made that personnel is properly trained in minimal intervention techniques which will reduce the need for dental amalgam.

### 12.8 Dental care provider-patient interaction

The oral health care provider should be able to identify suitable material for the restorative process that is best for the patient and provide accurate information to patients about the advantages/benefits and disadvantages of dental materials available as well as information regarding safety of different dental restorative materials. It is most important that decisions on the use of dental restoration materials are made through informed interaction between patient and provider of dental care; the choice of dental materials should take cost factors to the patient and third party payment into consideration.

### 12.9 Responsibility of the industry

Industry can contribute to appropriate dental care by improving the standard of existing tooth-coloured materials and development of new materials of high-quality. In low resource communities it is needed to increase the availability of new dental materials and develop the market for alternatives to amalgam. Better supply and distribution of materials should be established.

The dental industry can also collaborate with health authorities and oral health professionals on reducing price of dental materials alternative to amalgam. Thus, the dental industry plays an important role ensuring that restorative materials, including alternatives to amalgam, are affordable to all population groups in countries.

### 12.10 The dental profession

It is highly recommended that the Federation Dentaire Internationale (FDI) strengthens its work for translation of sound knowledge about dental materials to oral health practitioners. The following activities should be given special attention:

- Promote a new paradigm among oral health professionals, shifting from a restorative to preventive and health promotion models.
- Identify safe and affordable restorative materials alternative to dental amalgam through effective collaboration with the research community, governments, industry, educators, and oral health practitioners.
- Employ a responsible approach to protecting the environment, in accordance with Best Management Practices, including bulk collection programmes, chair-side trap and vacuum filters, use of amalgam separators (ISO 11143) and waste disposal services.
- Adopt a Minimal Intervention Approach (MIA) to oral healthcare of the patient, i.e. remineralisation of non-cavitated lesions, minimal operative

intervention of cavitated lesions, and repair of defective restorations, and patient education.

### 12.11 Responsibility of UNEP

UNEP's work on mercury is mandated by the 25th session of GC in 2009 when it requested UNEP Executive Director to convene an intergovernmental negotiating committee (INC) to prepare a global legally-binding instrument on mercury. The work of the INC commenced in June 2010 with the goal of completing it prior to the Governing Council/Global Ministerial Environment Forum in 2013.

Between now and 2013, the UNEP Global Mercury Partnership will facilitate expert consultations and negotiations, and assist partners in the implementation of initiatives to reduce mercury use. Consultations with the oral health sector will focus on the promotion of dental restorative materials alternative to dental amalgam.

Following consultations with stakeholders and partners, a new global legally binding instrument on mercury will be developed, taking into account the challenges faced by both developed and developing countries. Given the diversity of countries as regards existing oral health facilities, disease levels, needs in dental care and the availability of restoration materials, flexibility is required to allow countries discretion in the implementation of their commitments in relation to reduction of mercury.

### 12.12 Responsibility of WHO

WHO is committed to work for reduction of mercury and the development of a healthy environment. Work for reduction of mercury is carried out by the WHO Programmes of Water, Sanitation and Health, Department of Protection of the Health Environment, and the WHO Global Oral Health Programme, Health Promotion, Department of Chronic Disease and Health Promotion. WHO is dedicated to work with the oral health sector and national, regional and global health partners to promote the development and use of restoration materials alternative to dental amalgam. In addition, WHO will lead the oral health profession in negotiations and development of a legally binding instrument on mercury. The WHO Global Oral Health Programme provides advice to national and supranational health authorities in appropriate dental care. The Programme will provide advice to countries in strengthening of oral health systems which will match the burden of dental caries. Advice will be given on provision of use of appropriate restorative dental materials with focus on materials alternative of dental amalgam.

Country-based information on use of dental restorative materials and their impact to health is necessary. Data systems should allow assessment of trends in use of dental restorative materials indicating nature of materials, type and site of restoration, and type patient (e.g. child, adult, and old age).

#### 13. Conclusions

In the past decades, the awareness and recognition of the environmental implications of mercury has increased. The World Health Organization (WHO) and the United Nations Environment Programme (UNEP) have strengthened the work for reduction of the mercury releases, including mercury release related to the usage of dental amalgam.

Alternative tooth-coloured filling materials have become increasingly more popular.

The aim of the actual meeting was to assess the scientific evidence available on dental restorative materials alternative to dental amalgam and to review the implications to countries of using non-amalgam materials for dental restorative care.

The review of existing evidence on alternative materials and much deliberation indicate that there are huge challenges to the global research community and the oral health profession. In general, dental amalgam remains a dental restorative material of choice, in the absence of an ideal alternative. If dental amalgam was to be banned, a better and more long-lasting replacement would be needed than the materials available to date. The quality and adverse effects of alternative materials require further research and monitoring. Improving the quality and affordability of composite resins are the social responsibilities of the dental industry.

Scientific and public health experience from restorative dental care in both developed and developing countries of all WHO regions was shared. Variations between countries and the challenges to oral healthcare faced by middle- and low-income countries must be taken into consideration. The impact on costs to the society as well as the individual is considerable and in low resource countries swift changes of practices in use of dental restorative materials may have negative consequences to health status. Also, the global implication for training of oral health personnel is huge.

A number of expert consultations on mercury have already begun, with a view to finalizing a legally binding treaty in 2013 that may contain both legally binding and voluntary measures. Such treaty will have a significant impact on delivering oral healthcare worldwide.

The current timeline (2013) for a complete ban may not be realistic, practical and achievable. It may be prudent to consider 'phasing down' instead of 'phasing out' of dental amalgam at this stage. A multi-pronged approach with short-, medium-and long-term strategies should be considered. Elements of strategies can be put in place while waiting for the new materials to be developed. The role of WHO, UNEP, NGOs such as IADR and FDI, and the industry is critical.

A further meeting including public health administrators and relevant NGOs must be convened to discuss the way forward and to develop strategies to address issues in both developed and developing countries.

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### **Annex 1. Consensus Statement on Dental Amalgam**

# This Consensus Statement was unanimously approved by the participants of the WHO Consultation, Geneva, 3-7 March 1997

#### **Preamble**

Dental caries (tooth decay) is a common oral disease and its prevention is in accord with the main mission of WHO. In spite of great success in the prevention of dental caries, caries in need of restoration still occur. In these cases, diseased tissue should be removed and teeth restored with appropriate material(s). Dental amalgam, a compound of mercury and silver-based alloys, is widely used as a dental restorative material. While the current weight of evidence suggests that dental restorative materials, including dental amalgams are considered to be safe and effective, concerns have been expressed about the health effects of mercury in amalgam. Following an evaluation of a large amount of sometimes conflicting evidence from diverse sources, the WHO offers the following consensus statements on dental amalgam:

#### The use of dental amalgam

Dental amalgam is a frequently used material for restoring decayed teeth. It has been used successfully for more than a century and its quality has improved over the years. Amalgam restorations are durable and cost-effective; they are, however, not tooth-coloured. While much research has been devoted to the development of dental restorative materials, there is currently no direct filling material that has the wide indications for use, ease of handling and good physical properties of dental amalgam. The restorative materials currently available as alternatives to dental amalgam significantly increase the cost of dental care.

### Safety of dental amalgam

Dental amalgam restorations are considered safe, but components of amalgam and other dental restorative materials may, in rare instances, cause local side-effects or allergic reactions. The small amount of mercury released from amalgam restorations, especially during placement and removal, has not been shown to cause any other adverse health effects.

Because of concerns over adverse effects of mercury, some patients with or without symptoms, may request the removal of their amalgam restorations. While there has been a number of case studies and informal reports, no controlled studies have been published demonstrating systemic adverse effects from amalgam restorations. At present, there is no scientific evidence showing that general symptoms are relieved by the removal of amalgam restorations. Therefore, after a comprehensive oral examination and appropriate dental treatment, these patients should be considered

for referral to other health care professionals for diagnosis and treatment if symptoms persist.

#### Occupational risk to oral health personnel

A potential health risk to oral health personnel from mercury exposure exists if working conditions are not properly organized. The application of proper mercury hygienic requirements together with monitoring of mercury vapours in the work environment in dental clinics will significantly reduce mercury exposure.

#### **Environmental concerns**

Mercury used in dentistry may contaminate the environment via the disposal of waste products from dental clinics. Equipment is available to collect metallic waste generated during dental amalgam placement and removal. Appropriate collection and recycling technology is also available to reduce mercury pollution of the environment, including pollution from crematoria.

#### Public opinion and mass media

Today there is considerable exchange of information on dental amalgam around the world. For environmental reasons some countries are restricting all uses of mercury, including dental amalgam. Due to publicity in the mass media, however, the situation in those countries which have undertaken restrictive action is often misinterpreted, leading to numerous enquiries about the safety of dental amalgam and a demand for the removal of amalgam fillings.

The current weight of evidence is that contemporary dental restorative materials, including dental amalgam, are considered to be safe and effective. However, adverse biological reactions to the materials do occasionally occur and they must be treated on an individual basis. The WHO recognizes the importance of the continued monitoring of the safety and effectiveness of all dental restorative materials.

### **Annex 2. List of participants**



#### **Meeting on Future Use of Materials for Dental Restoration**

#### Geneva, Switzerland - 16 to 17 November 2009

16 November 2009 - Meeting Room M205 17 November 2009 - Meeting Room G

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## Annex 3. Meeting agenda

Meeting on the future use of materials for dental restoration

В

16 to 17 November 2009, WHO/HQ, Geneva, Switzerland

15 October 2009

16 November 2009 - Meeting Room M.205

17 November 2009 - Meeting Room G

#### **AGENDA**

Monday, 16 November 2009				
09:00 - 09:30	Welcome and Introduction. Dr Ala Alwan, Assistant Director-General, Noncommunicable Diseases and Mental Health (OR)			
	Mr Per Bakken, Head, Chemical Branch, United Nations Environment Programme (UNEP)			
	Dr Poul Erik Petersen, Health Promotion/Oral Health Programme Scope and purpose Election of Chairman and Rapporteurs			
09:30 - 09:50	Feasibility of dental restorative materials Professor Jon Dahl			
09:50 - 10:10	Evidence on use of tooth-coloured restorative materials - Clinical and population based experiences Professor Ivar Espelid			
10:10 - 10:30	Restorative practices and training of oral health professionals - the case of Ireland Professor Robert McConnell			
10:30 - 11:00	Coffee			
11:00 - 11:20	Use of dental restorative materials in a global perspective Dr Daniel Meyer			
11:20-11:40	Side-effects and health hazards of dental restorative materials - information based on a national registry Professor Lars Björkman			

11:40 - 12:30	Discussion
12:30 - 14:00	Lunch
14:00 - 14:20	Research on dental restorative materials - current activities and future priorities (International Association for Dental Research IADR) Professor David Williams
14:20 - 14:40	Dental restorative materials in clinical practice - views of the dental profession (FDI World Dental Federation) Dr Roberto Vienna and Dr David Alexander
14:40 - 15:00	Best Management Practices on the use of dental amalgam separators and waste management Dr Lars Hylander
15:00 - 15.20	Mercury releases to the environment and mercury trade - global perspectives Mr Peter Maxson
15:20 - 15:50	Coffee
15:50 - 17:00	Discussion

### Tuesday, 17 November 2009 The situation of restorative dental care in countries/regions

09:00 - 09:20	USA Dr Eugenio Beltran
09:20 - 090:40	Latin America Dr Sandra Tovar Valencia /Professor Ramon Baez
09:40 - 10:00	Canada Dr B. Soucy
10:00 - 10:20	Europe and Chief Dental Officers Forum Dr Jos van den Heuvel
10:20 - 10:40	Coffee
10:40 - 11:00	People's Republic of China /Western Pacific Professor Bian Jin You

11:00 - 11:20	South-East Asia Professor Prathip Phantumvanit
11:20 - 11:40	Middle East Professor Eino Honkala
11:40 - 12:00	Africa /low-income countries Dr Febronia Kahabuka
12:00 - 12:20	Africa/middle-income countries Professor Sue Naidoo
12:20 - 13.00	Discussions
13.00- 14:00	Lunch
14:00 - 14:30	The role of the UNEP Global Mercury Global Partnership Dr Desiree M. Narvaez, UNEP and Mr Michael Bender
14:30 - 14:45	The role of the WHO Chemical Safety and Global Oral Health Programmes Dr Carolyn Vickers and Dr Poul Erik Petersen
14:45 - 15:15	Coffee
15:15 - 16:00	Discussions and recommendations
	Meeting ends

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Dental caries is a major public health problem globally. Despite much effort in health promotion and disease prevention, dental restorations are still needed to re-establish tooth function.

In the past decades, the recognition of the environmental implications of mercury has increased and alternatives to dental amalgam are desirable. The World Health Organization and the United Nations Environment Programme have strengthened the work for reduction of the mercury releases and usage.

This report from a technical meeting provides information about the current evidence on use of dental restorative materials and some major challenges in relation to future use of materials alternative to dental amalgam are discussed.

More information about oral health:



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