Hg-rid Life

Layman´s Report

Mercury Decontamination of Dental Care Facilities

Reducing the environmental impact of dental amalgam use, examples from Sweden

Praktikertjänst ivl SWEDEN RECYCLING Life

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HG-RID-LIFE LIFE15 ENV/SE/000465

Hg-rid-LIFE in brief

Project title
Mercury Decontamination of Dental Care Facilities

Project acronym
Hg-rid-LIFE

Project location
Sweden

Sector
Water

Duration
September 2016 - August 2019

Website
www.praktikertjanst.se/life

LIFE Reference
LIFE15 ENV/SE/000465

Web-based tool
www.hg-rid.eu

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Partners

Praktikertjänst ivl SWEDEN RECYCLING

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Year of Publication: 2019

Project organization

COORDINATING BENEFICIARY

PRAKTIKERTJÄNST AB

Praktikertjänst is the largest private dental and health care group in Sweden, with 80 health care centres, 1,000 dental clinics and approx. 600 dental facilities. The company is owned and operated by the doctors, dentists, dental technicians and hygienists, physiotherapists, nurses, midwives, chiropractors, psychologists and therapists that are also responsible for managing the clinics all over Sweden. The business´s model is unique and combines the small business´ individual freedom and vicinity with the large group's efficiency and economic strength. Praktikertjänst's shareholders are responsible for a dental clinic or a health care centre and are at the same time employed by Praktikertjänst. Company shareholders are responsible for the day-to-day running of the business and this model ensures a high level of quality and continuity. With central functions for administration, Praktikertjänst's clinics can focus on their core business – dental and health care.

www.praktikertjanst.se

ASSOCIATED BENEFICIARIES

IVL SVENSKA MILJÖINSTITUTET AB

IVL Swedish Environmental Research Institute is an independent research institute in the field of the environment and sustainability, owned by a foundation jointly established by the Swedish Government and Swedish industry. IVL Swedish Environmental Research Institute was established in 1966 and has since then been involved in the development of solutions to environmental problems, at national and international level. The institute employs around 300 experts, which makes IVL a leading institute for applied environmental research and consultancy services. Common to all assignments is the interaction between ecological, economic and social perspectives. With four thematic areas: Natural resources, climate and environment, Resource-efficient cycles and consumption, Sustainable production and environmental technology, and Sustainable urban development and transport.

www.ivl.se

SWEDEN RECYCLING AB

Sweden Recycling has more than 30 years of experience and are experts on taking care of mercury decontaminated sludge and other dangerous waste from dental clinics in Sweden. The vision is to help reducing environmental pollution in Sweden by developing and selling services that ensure secure and effective handling of dangerous waste from dental clinics. Sweden Recycling takes care of everything from decontaminations of clinics, waste handling and transportation to paperwork and reporting to authorities. The final disposal of waste and sludge is handled by the mother company in Germany, Medentex, that also has a laboratory for mercury analysis.

www.swedenrecycling.se

Mercury and dental amalgam

Mercury

Mercury is a metallic element that is liquid at normal room temperature. It easily forms alloys with other metals, and these are called amalgams. Mercury is relatively rare, and is extracted from the mineral cinnabar. It is a strong poison, both for humans and animals and also for the environment.

Mercury is classified as one of the most dangerous environmental hazards. The toxic effects of mercury depends on its chemical form. When the mercury is released into the environment it can be converted to methylmercury with help from micro bacteria. Methylmercury is the most dangerous form of mercury that can be aborbed by living organisms and bioaccumulate in the food chain. It is extremely toxic and affects the central nervous system, muscles, kidneys, immune system and fetal development.

Mercury and dental amalgam

Dental amalgam

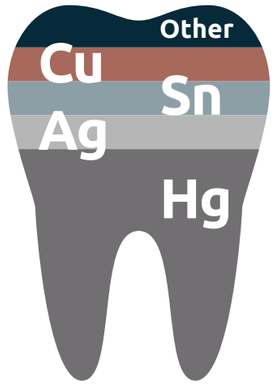
Dental amalgam, also known as “silver fillings”, commonly consists of mercury (50%), silver, tin, copper and traces of other metals. This material has been used for dental care in the teeth of hundreds of millions of patients around the world. It is still used in many countries and in the EU. In dental amalgam, mercury is very dense, to enable it to be used as filling for most patients.[1]

Example of dental amalgam

Dental amalgam is the largest use of mercury in the European Union and a significant source of pollution.[2] Improperly managed dental amalgam waste can pose a risk for the environment. If it ends up in a landfill, mercury may be released into the groundwater or air; if it is incinerated, mercury may be released into the atmosphere. Despite its decline in the last few years, dental use of mercury remains a significant contributor to overall mercury releases into water in the EU.[3] Approximately 41% of all water bodies in the EU exceed mercury concentration levels that were set to protect fish-eating birds and mammals. In some countries, mercury levels measured in biota were above safe limits in almost all bodies of surface water.[2]

The EC estimated in 2016 that only 69% of waste produced from dental amalgam was managed as hazardous waste.[2]

With around 75 % of the 500 million EU inhabitants having fillings, it is estimated that 1 500 tonnes of mercury is held in human bodies.[4]

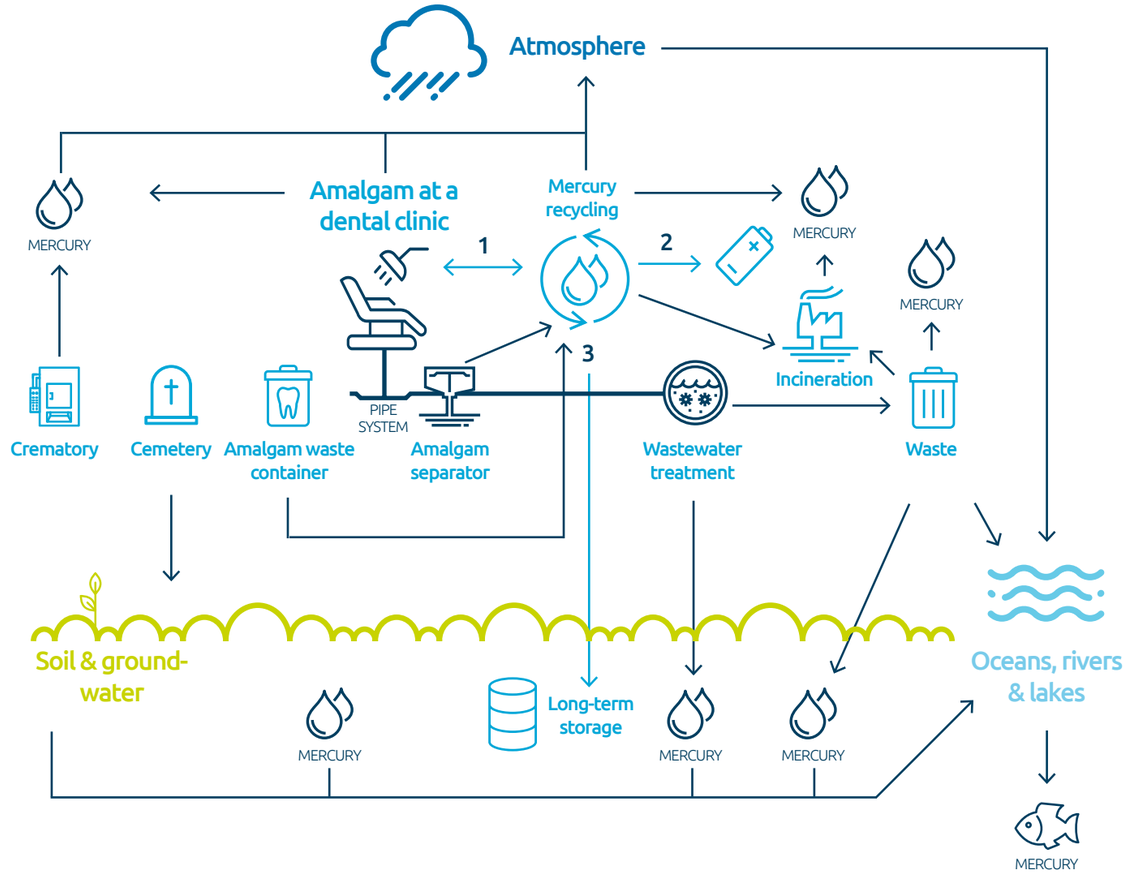


Even in countries where amalgam is prohibited there are still emissions of mercury from dental practices. In Sweden the emissions have decreased since amalgam was banned as a dental filling material in 2009 due to the environmental impact, but the remaining emissions are still significant. Despite demands for amalgam separators since the late 80s there are very few dental clinics that have zero emissions of mercury. The finest particles from removed amalgam fillings are not captured by separators. Also, if the separator is not adequately maintained it can significantly reduce the mercury capture efficiency.

Mercury and dental amalgam

Life cycle of dental amalgam

The life cycle of mercury in dental amalgam presented below shows the many pathways mercury could take within a dental clinic, industrial cleaning processes and in the environment. Most of the mercury collected from dental clinics (from amalgam separators, amalgam waste containers and pipe systems) is either 1) recycled into new dental amalgam, 2) recycled into other mercury products or 3) safely stored in long-term storage facilities underground (Sweden, Norway and Netherlands), which all reduce the environmental impact of mercury.



"In the EU, it is estimated that 1,500 tonnes of mercury is held in human bodies"

Mercury and dental amalgam

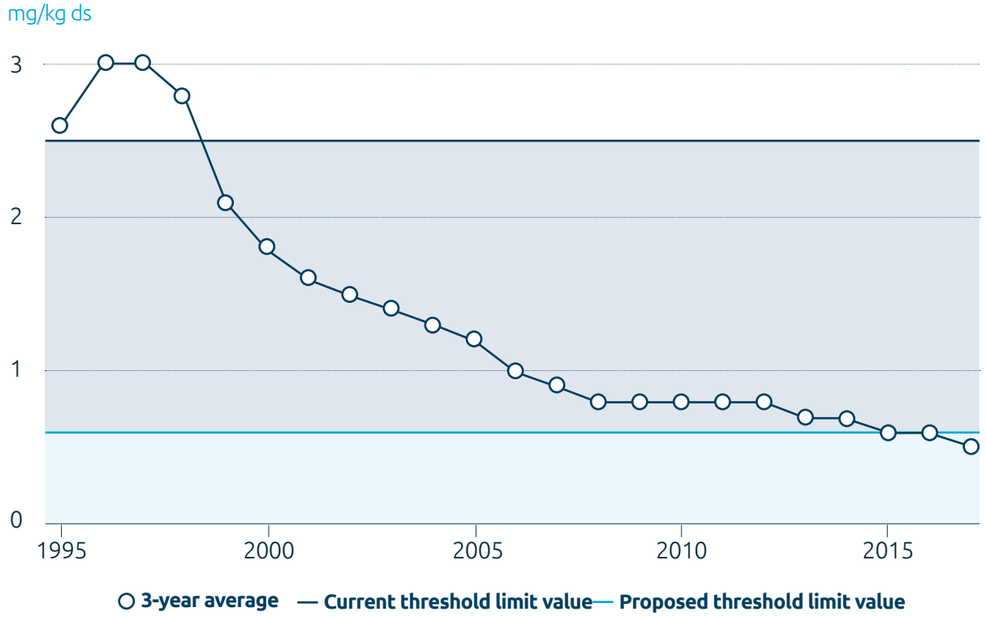
Mercury levels in sewage sludge

The past accumulation of mercury in the piping system of dental clinics over many years may constitute a source of continuous release into wastewater. For several years, the pipeline network of the dental clinics in Stockholm has been decontaminated.

In 1998 the treatment plants in Stockholm, Sweden, received contribution for decontamination of dental clinics. During the project the concentration of mercury in sludge gradually decreased, partly because of the decontaminations.[5]

The figure below shows how the average concentration of mercury in sludge from waste water treatment plants in Stockholm, Sweden from 1995 to 2017 has decreased. The concentration is presented in mg/kg dry substance. The current limit for mercury in sludge to be spread on agricultural land is 2.5 mg/kg dry substance. This limit is proposed to be changed to 0.6 mg/kg dry substance. Approximately 90 % of the mercury is estimated to originate from dental amalgam.[6]

AVERAGE CONCENTRATION OF MERCURY IN SLUDGE FROM WASTE WATER TREATMENT[3]



In two large scale sewage treatment plants in Stockholm, Sweden, mercury levels have been halved in sewage sludge the last decade.[4]

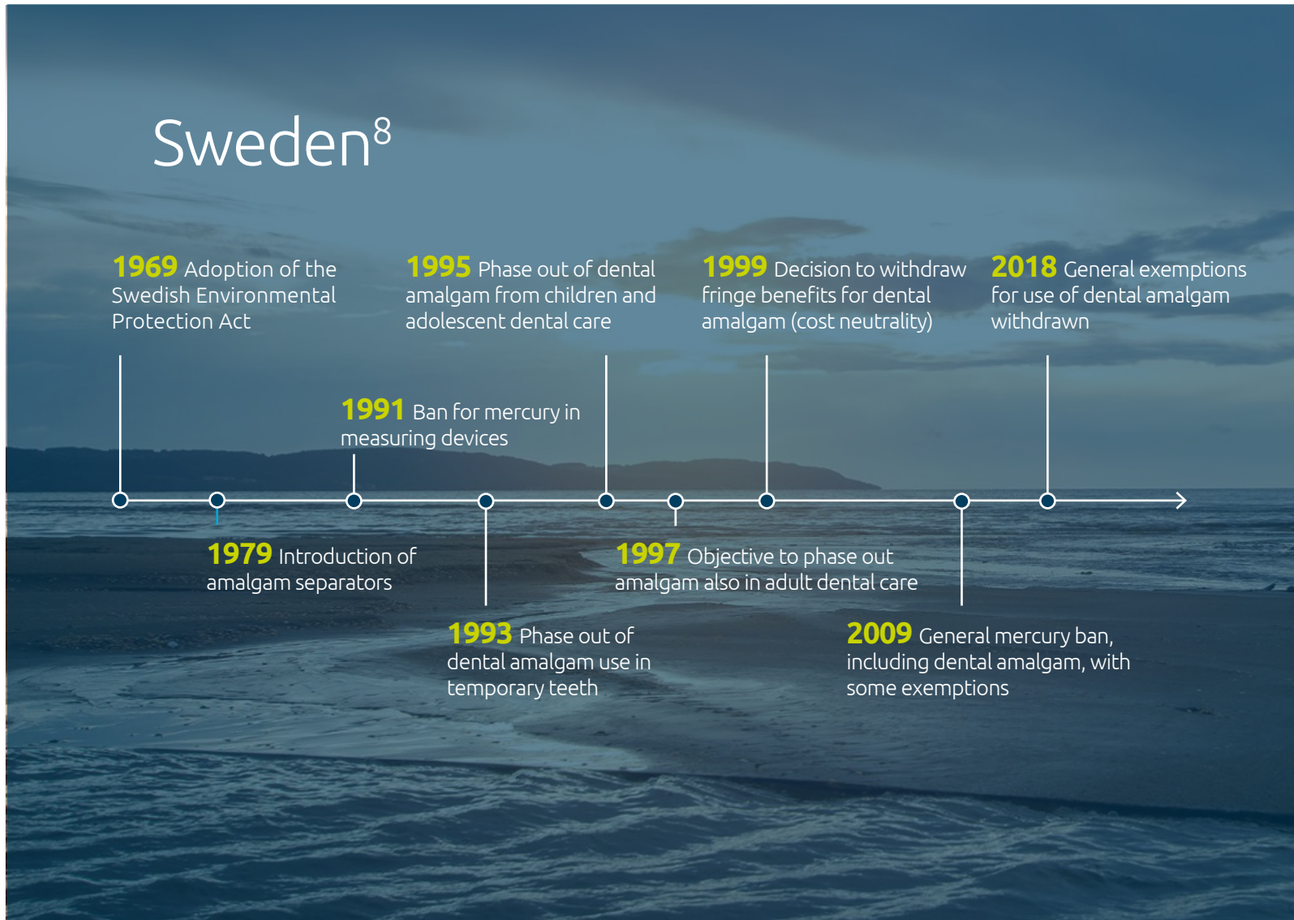
Mercury and dental amalgam

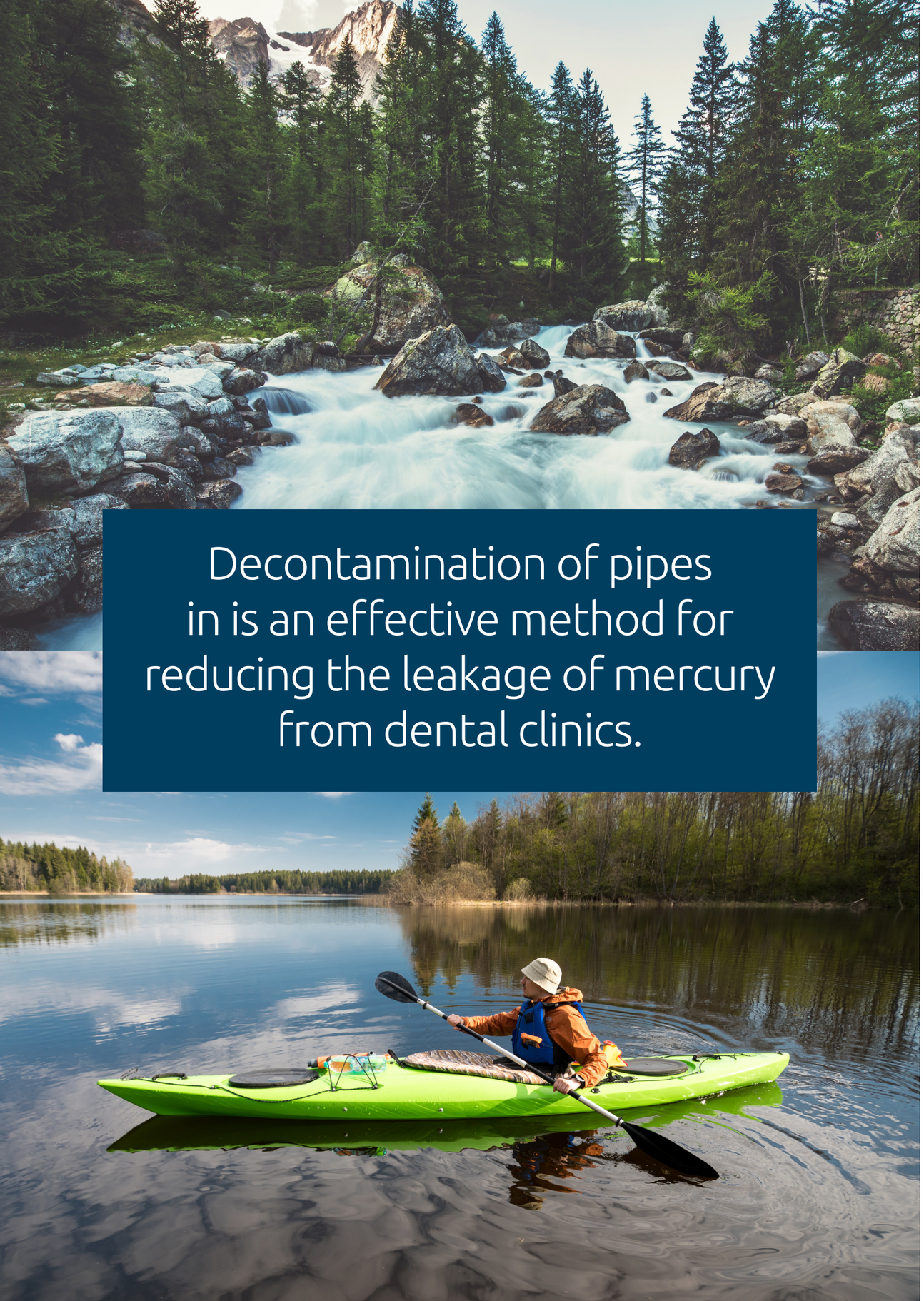
Important years for reducing the environmental impact of dental amalgam

The Minamata Convention on Mercury, which will restrict the use of mercury in the world, was adopted in October 2013 and entered into force in August 2017. The Convention requires a phase down of amalgam use. The Minamata Convention has been named after the environmental disaster in Minamata, Japan, in the 1950s.

EU decided on a regulation concerning mercury and dental amalgam which entered into force 1st of January 2018. EU Member States shall establish national plans with the measures intended to implement to phase down the use of dental amalgam by 1st of July 2019. The Member States shall publish their national plans on the Internet.[7]

Sweden has already phased out dental amalgam and therefore the national plan does not include new measures but sets out the approach for the phase out.[8]





Decontamination of pipes in is an effective method for reducing the leakage of mercury from dental clinics.

The project

The project's main purpose is to minimise emissions of mercury from dental clinics in Sweden and hopefully in other EU countries.

Objectives

- Further developing existing methods for decontamination
- Increase awareness and knowledge of how to minimise mercury leakage from dental facilities
- Support the development of national and international guidelines for management of dental mercury by providing a draft proposal of guidelines

The project has been concentrated on the environmental impact of mercury from dental amalgam.

Key phases

Collection of data

- Screening of 530 dental facilities: Collection of data about the amalgam separators, suction systems, pipe system and levels of mercury in wastewater.
- Questionnaires to dental clinics & municipalities about mercury management.

Implementation

- Guidelines for dental care in Sweden about minimising the emissions of mercury from dental amalgam.
- Dialogue meetings with dental clinics, service technicians and municipalities responsible for environmental supervision discussing the guidelines.
- Web-based tool aimed to provide guidance towards minimising emissions of mercury.
- About 90 decontaminations of dental clinics in order to improve methods.

Dissemination and communication

- National fairs and conferences.
- Fairs and conferences in the EU.
- Seminars for students (dental nurses) and municipalities.
- Webinar.
- Digital notice boards.
- Other communication channels and networks.

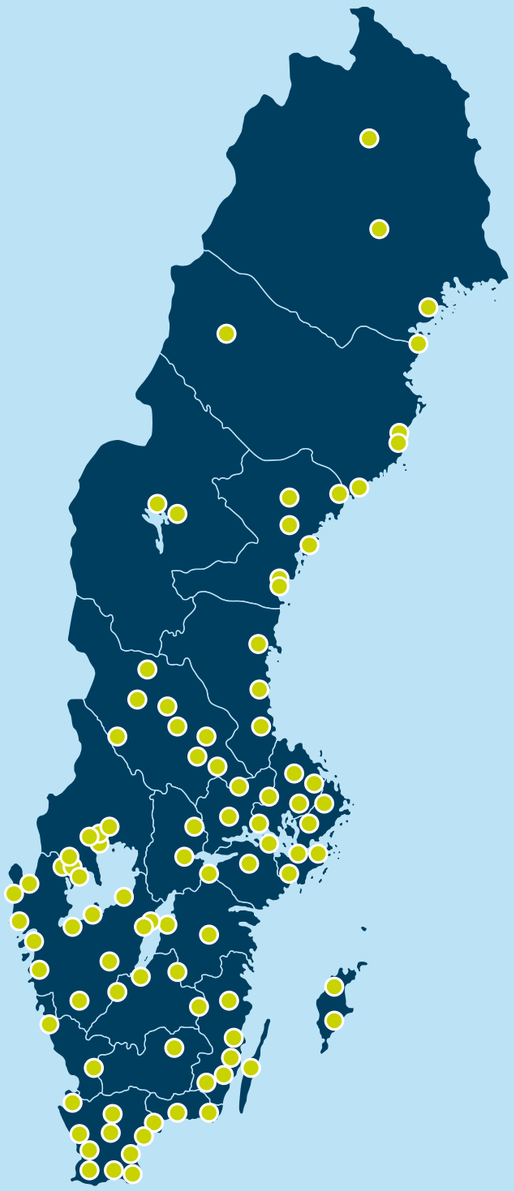
The project

The project area

The project was conducted in Sweden, located in the northern part of Europe. Sweden has a population of about 9.9 million people (2017). 85% of the inhabitants live in the southern half of the country. About 7,500 dentists are in active practice and 3,600 of them in private sector.

The Hg-rid-LIFE-project was carried out in almost all regions of Sweden, with main focus on the southern part where most of the dental clinics of Praktikertjänst are situated.

GEOGRAPHICAL LOCATIONS OF PRAKTIKERTJÄNST DENTAL CLINICS



The project

Sweden is home to one-fifth of all water bodies in Europe.[9] The country is divided into five Swedish River Basin Districts (Bothnian Bay, Bothnian Sea, Nothern Baltic Sea, Southern Baltic Sea, Skagerrak and Kattegat), out of which three are international sharing water courses with Norway to the west and Finland to the east and north.

EU Water Policy

Adequate handling of dental amalgam waste is necessary to achieve certain goals of EU legislation on water quality. In 2000, the EU adopted the Water Framework Directive (2000/60/EC) with the goal of reaching a good status in both quality and quantity for all of Europe's waters. The Hg-rid-LIFE-project contributes to the implementation of the Water Framework Directive. The project is also addressing the Waste Framework Directive (Directive 2008/98/EC), the Mercury Directive (84/156/EEC), the EU Priority Substances Directive (2013/39/ EU) and the Community Strategy Concerning Mercury.

SWEDISH RIVER BASIN DISTRICTS WITH LAKES AND WATERCOURSES

The project

Guidelines

The project has developed guidelines for waste management of dental amalgam to reduce mercury emissions from point sources as far as possible. The guidelines are applied by Praktikertjänst and will be possible to use as a basis for the development of national and possibly EU-wide guidelines for mercury management.

In order to obtain perspectives on the proposal, 13 dialogue meetings have been arranged with representatives of dental care units, local authorities and service technicians. Submitted perspectives have been compiled and evaluated. The guidelines will be revised continuously if necessary and published on the project´s web page www.praktikertjanst.se/life and on the site for the web-based training tool www.hg-rid.eu.

The guidelines include for example installation of dental amalgam separators and suction systems, disinfection of separators, amalgam separators connected to sinks, patient treatment routines, environmental maintenance service and decontamination of pipe systems.

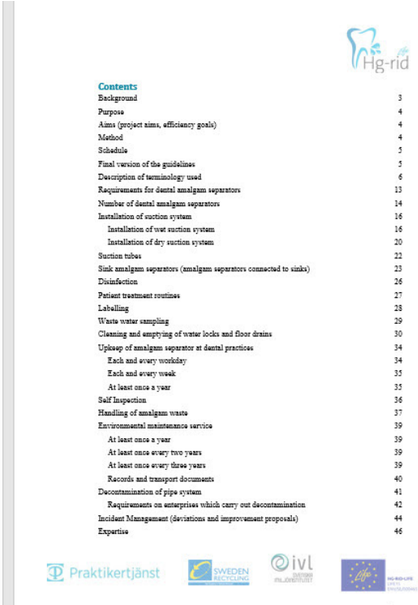
GUIDELINES FOR DENTAL CARE IN SWEDEN DEVELOPED WITHIN THE PROJECT


Hg-rid

Minimising the emission of mercury from dental amalgam – guidelines for dental care in Sweden

Praktikertjänst

1


Hg-rid

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The value of the estimated health and environmental benefits of the project, due to removed mercury, are 2 times higher than the cost of the decontaminations.

The project

Waste management

Decontamination
According to Swedish regulations the pipes in a dental clinic must be decontaminated when a dental practice is no longer to be operated at the premises. The local authorities can also require decontamination when the clinic is still in operation or it can be done voluntarily by the operator.

Decontamination of pipes, water locks and floor drains at the practice is done by high pressure washing. The decontamination method will ensure that no contaminated water reaches the public sewers. Sludge from decontamination is handled and transported as hazardous waste. Used mercury from dental care units in Sweden is stored in an approved underground storage facility.

Examples of pipes prior to decontamination

Water lock before decontamination

Mobile flushing devices are used

The project

One goal of the project has been to develop methods that will reduce mercury emissions in clinics that have high emissions, for example development of improved decontamination methods for sub-optimal pipe dimensions or pipes with poor access.

Equipment for filming pipes has been used both before the decontamination commences and after the completion of decontamination. The result of the filming shows that filming can be a useful tool partly to find clinics with a lot of sludge that are in great need of decontamination, and also for rechecking the efficiency of already decontaminated clinics. Videos before and after decontamination have been published on the project´s web page (www.praktikertjanst.se/life).

The screening of amalgam separators and suction systems showed that plastic is the most common material in the pipes (more than 90%) and that 70% of the facilities have pipes accessible from the treatment chair. These two aspects simplify cleaning of the pipes and will reduce mercury more efficiently.

A prototype/flushing nozzle that simplifies the decontamination so it can be be carried out from one and the same flush point in the pipe system has been used and improved successfully. The flush nozzle also provides advantages in spaces that may be difficult to access by another method.

FACTS FROM THE DECONTAMINATIONS IN THE PROJECT

76 dental facilities

544 water locks

58 floor drains

132 dental clinics

472 washbasins

3 173 meter of pipes

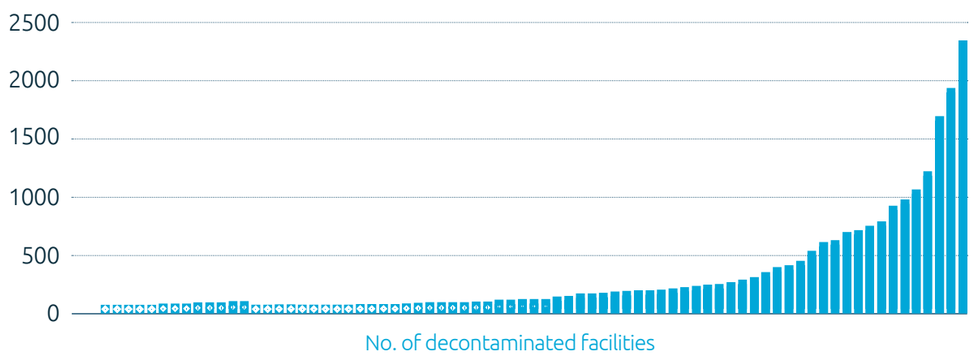
315 dental treatment rooms

79 sinks

10 550 litres of water used

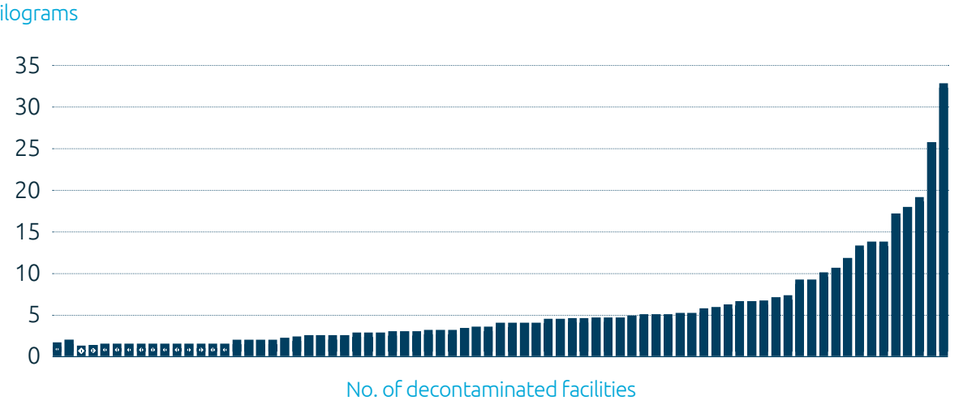
The project

MERCURY REMOVED FROM PIPE SYSTEMS (21.15 KG)



Collected mercury from 76 dental facilities, sorted from lowest to highest amount. The amount of mercury varies from 3 grams to 2.3 kilograms per facility.

SLUDGE REMOVED FROM PIPE SYSTEMS (372.25 KG)



Collected sludge from 76 dental facilities, sorted from lowest to highest amount. The amount of sludge varies from 0.3 kilograms to 31.5 kilograms per facility. In addition to mercury the sludge contains heavy metals such as silver, tin and copper.

The project

Waste from separators and containers

The project has focused on the decontamination of pipes, water locks and floor drains, but there are also some facts about the amount of mercury from the amalgam separators and from the waste containers. In Sweden the environmental maintenance service includes these three ways to remove mercury from dental facilities.

FACTS ABOUT COLLECTED AMOUNT OF MERCURY FROM AMALGAM SEPARATORS AND WASTE CONTAINERS IN PRAKTIKERTJÄNST, PER YEAR

2,200 dental chairs
(3.7 per facility in average)

1,620 amalgam separators
(2.7 separators per facility and 1.3 changes per year in average)

47.4 kg mercury
(approx. 20-25 g Hg per separator)

1,200 amalgam waste containers
(two waste containers per facility and year in average)

Through demercurisation 5.2 kg of mercury are filtered out of the sludge. (approx. 4.35 g Hg per waste container)

52.6 kg Hg/year in Praktikertjänst

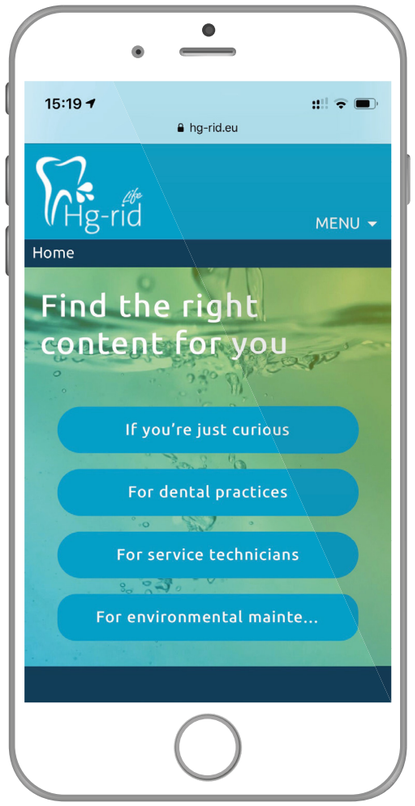
The project

Web-based training tool

One of the main results of the project is a web-based tool aimed to provide guidance towards minimising emissions of mercury from dental amalgam. Short video clips, interactive articles, check lists etc with examples from dental care in Sweden are presented. The material can give some inspiration and be a support to sustainability in Dental Practice Management.

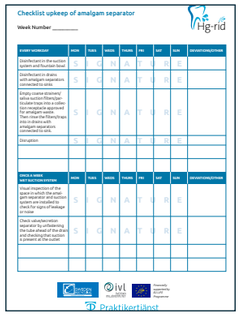
The tool is user-friendly, free of charge and provides content for dental teams, dental students, service tehnicians, local authorities and environmental maintenance service personnel.

- It is available in English, German, Spanish, French and Swedish.
- The web-based tool can be reached via www.hg-rid.eu.
- The tool will be possible to use two years after the project period, until at least 2021.



Poster for dental clinics to inform patients about lost amalgam fillings.

Guidelines for dental care in Sweden which can support and inspire other countries.



Checklists for mercury waste management at dental clinics.

The project

5-Minute course

Mercury in nature

Basic information on what mercury is, how it affects nature and the dental industry's responsibility for mercury pollution.

Routines for handling of amalgam waste during and after treatment

A look at the routines for amalgam handling during a patient's appointment.

Video

Video

What to bear in mind for installation

Things to bear in mind for installation of amalgam separators and suction systems.

Explanation of EU regulations regarding mercury

Mercury in dental amalgam is the primary use of mercury in the EU, and represents a significant source of pollution.

5-Minute course

Try our open, free training course on how the dental industry can minimise emissions from dental amalgam on **www.hg-rid.eu**

On the site you can find interactive articles, videos, documents and more.

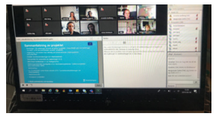
The project

Communication activities

Numerous communication and networking activities were carried out during the entire project to disseminate the project´s result and increase awareness and knowledge among stakeholders on how to minimise emissions of mercury from dental amalgam. The stakeholders are mainly dental clinics, service technicians and local authorities.

EXAMPLES OF COMMUNICATIONS ACTIVITIES

Dialogue Meetings
The guidelines developed in the project for management of dental amalgam have been discussed at dialogue meetings with dental clinics, service technicians and inspectors from the local authorities. 220 persons have participated.



Webinars for students
Webinars have been arranged for International Association of Dental Students (IADS) and for dental nurses.

Meetings with national authorities and NGO:s
Representatives from Swedish authorities; The Swedish River Basin District Authorities, Swedish Environmental Protection Agency and Swedish Chemicals Agency have been engaged in the Reference Group. The Swedish Dental Association and Stockholm International Water Institute (SIWI) have also been members.

Fairs and conferences
The project has participated in eleven national and five EU fairs and conferences. Examples of fairs where the web-based training tool has been demonstrated:

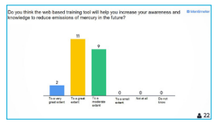
- International Dental Show (IDS) in Cologne, Germany, a fair for five days with over 160,000 trade visitors from 166 countries.
- Krakdent in Krakow, Poland, a dental fair with 16,000 visitors from Poland, the Czech Republic, Slovenia etc.
- The World Water Week in Stockholm, Sweden, with over 4,000 individuals and
- around 570 convening organizations from 138 countries participating. Experts, practitioners, decision-makers, business innovators and young professionals from a range of sectors and countries came to network, exchange ideas, foster new thinking and develop solutions to the most pressing water-related challenges.
- Swedental, the largest dental conference in the Nordic countries, with over 10,000 visitors.
- Miljöbalksdagarna, arranged by the Swedish Environmental Protection Agency with about 600 conferees, most of them inspectors from local supervisory bodies.

The project

Presentations have been made at five conferences in Sweden and two conferences in the EU. A lecture was held at Speaker´s Corner at the International Dental Show (IDS) in Cologne, Germany. During an ”Eat and learn” at a dental clinic in England, a presentation about the project was made.

Seminars for students and local authorities
Training seminars for dental nurses and inspectors at local authorities have been arranged in several cities in Sweden, with information about the project and the web-based tool.

Final Conference
The final conference was held during World Water Week, the annual focal point for the globe’s water issues organized by Stockholm International Water Institute.



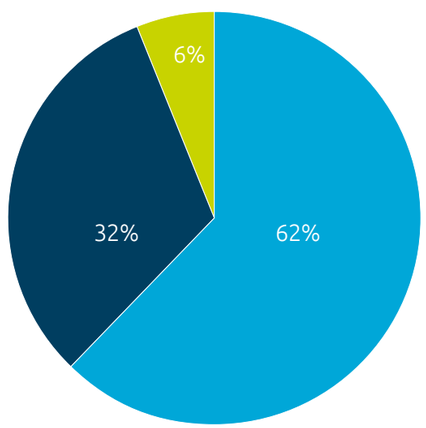
Questionnaires
Questionnaires in different forums have been carried out at fairs, conferences and at seminars for dental nurses. A survey has also been sent to dental clinics and local authorities. More than 1,000 people people have answered the different questionnaires.

Digital Notice Boards in 150 dental clinics
Information about the project has been incorporated in existing slideshows for TV screens in the waiting rooms and treatment rooms. Thousands of patients and visitors to Praktikertjänst's dental clinics have been reached.

Socio-economic impact

On a European level, building an efficient system for mercury waste handling and final disposal, which is needed for the dental clinics to comply with EU's implemented regulation 2018 on the mandatory use of amalgam separators, would not only decrease mercury discharge but also provide job opportunities enhancing the local and regional market.

In the Swedish Environmental Code it is stated that the best available technology should be used for e.g. environmentally hazardous activities. However, the cost should not be unreasonable in relation to the benefits. Hence, the societal benefits of abatement measures are important to consider.



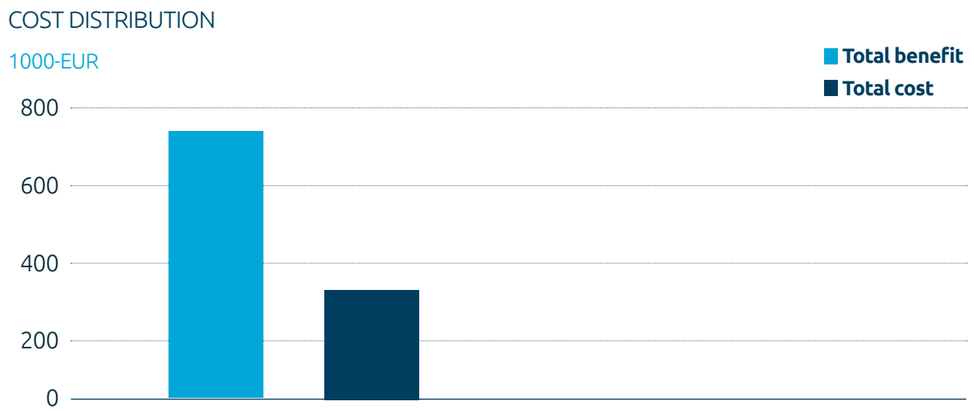
Average cost distribution per kg removed mercury

The amount of mercury removed per decontamination varies greatly. It has not been possible to find a strong correlation between for example the number of treatment chairs, how long the clinic has been in operation or length of pipes with the amount of mercury removed per clinic. Hence, this is important to bear in mind when the results are presented in average values in the socio-economic assessment.

The figure above shows the average cost distribution per kg removed mercury from the decontaminations conducted within the project. The main cost is for the decontamination, followed by the revenue loss due to closure of clinic during this process, and finally the fee to the local environmental authority to receive permission for performing the decontamination. (Based on 68 decontaminations).

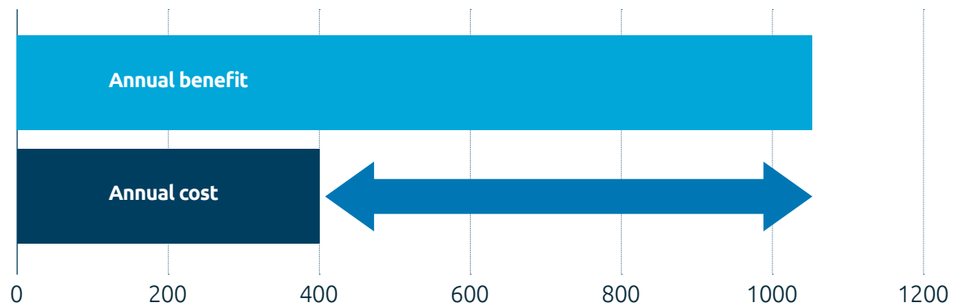
Socio-economic impact

The socio-economic analysis of the decontamination conducted within the Hg-rid-LIFE-project indicates a benefit-cost ratio of approximately 2. That is, the value of the estimated health and environmental benefits of the project due to removed mercury are 2 times higher than the cost of the decontaminations. The total estimated costs and benefits from the main analysis are presented in the figure below. (Based on 68 decontaminations).



Costs and benefits of the project's decontaminations

For amalgam separators, the annual average cost for installation and maintenance is estimated to be lower than the valued health and environmental benefits of the removed mercury from the separator. The analysis is presented per amalgam separator, and the arrow in the figure below indicates the net benefit generated by using an amalgam separator.



Annual, average cost and benefit per amalgam separator, euro.

Long term environmental benefits

Through demonstrating improved methods for decontamination of amalgam and mercury in the pipe systems of Swedish dental clinics, this project will increase possibilities to manage mercury at the source and prevent it from ending up in the nature where water bodies are a core recipient. If the calculations are based on the situation in Sweden where around 300 grams of pure mercury is expected to be removed from a clinic´s pipeline in each decontamination activity, 39-63 tonnes of mercury per year can be recovered throughout the EU in the future. The estimation is based on 130,000-210,000 dental clinics in the EU.[10]

In general, there will be a large economic gain for the EU if sludge from water treatment plants no longer needs to be sent to landfills due to high mercury concentrations. A lower mercury content of dental effluents entering wastewater treatment plants will reduce the need for municipalities to invest in expensive mercury abatement devices in sewage sludge incineration plants. It may also increase the possibilities of using sewage sludge for agricultural purposes.

Proper maintenance of the amalgam amalgam separators, capturing and treating all mercury in dental waste as hazardous waste reduces the emissions of mercury at the source. If all mercury-containing waste is treated as hazardous waste, emissions to soil, groundwater and air corresponding to approximately approximately 11 t/year to soil and groundwater, 7 t/year to air and 2t/year to water will be avoided.[10]

The project will potentially imply a widened business sector due to new services developed such as environmental maintenance service. A study for the EU Commission estimated that a full implementation of EU waste legislation would increase the annual turnover of the EU waste management sector and recycling by EUR 42 billion and create over 400,000 jobs.[10]

The project will contribute to the Global Goals for Sustainable Development, goal 6. Clean water and sanitation. It will also support one of the national environmental quality objectives in Sweden: A Non-Toxic Environment. The 16 environmental quality objectives describe the quality of the environment that Sweden wishes to achieve.

Recommendations for the future

The experiences and results of the project have highlighted some recommendations for the future:

- Decontamination of pipes in dental clinics is an effective method for reducing the leakage of mercury from dental clinics, in addition to amalgam separators and correct handling of amalgam waste. To ensure the environmental benefits, regulations must be implemented.

- According to the regulation of the European Parliament and of the Council of Mercury, dental practitioners shall ensure that their amalgam waste is handled and collected by an authorized waste management establishment or undertaking. It is problematic in countries where there are limited infrastructures. This problem has been confirmed from dentists outside Sweden during the project. Hence, waste management establishment must be ensured. A chain is only as strong as its weakest links. In many countries outside of Sweden the fundamental needs for dental waste disposal are not 100% clear now. Starting with the accurate waste number for hazardous waste and will end with the the right level of enforcement.

- Training of professionals in dental facilities in best practice for mercury management should also include dental students and schools for dental nurses. The web-based training tool www.hg-rid.eu can be useful.

- The need for more research and technological development, for example amalgam separators with zero emissions of mercury.

- Implementation of the regulation is encouraged when it is needs-driven. Cooperation and dialogue between supervising authorities, the dental practice and dental/environmental maintenance service create a common understanding of the need for measures based on know-how and improve the opportunities of working towards common goals.

- The decontaminations performed in Sweden during the project are indicated to be profitable from a socio-economic perspective. But the outcome per individual decontamination varies since the amount of mercury removed in each case varies greatly. Hence, it is difficult to predict beforehand if a decontamination will generate higher benefits than costs from a societal point of view. Another difference to take into account in the analysis when extending outside of Sweden is also that most countries do not remove the mercury from the market but instead recycle it. Since amalgam has been banned in Sweden since 2009, it can be presumed that decontaminations are more profitable in socio-economic terms in the countries where amalgam still is used and where pipe systems never have been decontaminated.

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