THAILAND NATIONAL SITUATION ASSESSMENT 2024

under project titled "Accelerating implementation of dental amalgam provisions and strengthen country capacities in the environmental sound management of associated wastes under the Minamata Convention"

AMALGAM
PHASE DOWN

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

SUMMARY

Mercury (Hg) is a toxic substance and a global pollutant that poses adverse effects to human health and environment, especially affecting vulnerable populations such as children and pregnant women. Mercury can travel long distances through the atmosphere, persist in environment for extended periods, and accumulate in living organisms throughout food chain ecosystem. Therefore, Department of Health, Ministry of Public Health and Department of Pollution Control, Ministry of Environment have initiated a project to minimize the use of dental amalgam and enhance Thailand's capacity for environmentally management under the Minamata Convention on Mercury. These efforts are part of the Global Environment Facility funded project "Accelerate implementation of dental amalgam provisions and strengthen country capacities in the environmental sound management of associated wastes under the Minamata Convention" which is implemented by the United Nations Environment Programme and executed by the World Health Organization with targeted technical assistance from the UNEP Global Mercury Partnership. The project aims to develop dental restorative guidelines of alternative materials and reduce the use of dental amalgam. It also aims to develop measurable, equitable, sustainable, and environmentally friendly models for managing mercury and hazardous mercury waste from dental procedures. One of the key activities of this project is the preparation of a situation report in Thailand to present to the World Health Organization, summarized according to the following topics:

1. Policy and regulatory framework

Thailand has ratified the Minamata Convention on Mercury since 20 September 2017. The convention requires parties to implement at least two measures from Annex A Part II to phase down the use of dental amalgam. The measures to be taken must take into account the situation within the member countries and relevant international guidelines. Additional considerations, according to the decision of the fourth meeting of the Conference of the Parties to the Minamata Convention on Mercury (COP4), it was not agreed to phase out but agreed to phase down the use of dental amalgam in Thailand by adding two more measures. And from the COP5, it was determined that there would be a report on the implementation results every 4 years. Regarding the actions of other countries, it was found that some countries have discontinued use, for example, Norway and Sweden phased out the use of dental amalgam even before the Convention was established. Countries that have reduced the use of dental amalgam include the United States, Australia, etc. Furthermore, in case where dental amalgam waste is transported across borders, it is necessary to proceed in accordance with the Basel Convention. World Health Organization has a policy and several resolutions to support member countries to act in accordance with the provisions of the Convention, such as the Global Strategy and Action Plan on Oral Health 2023 - 2030 (https://iris.who.int/handle/10665/376623), which provides a framework for operations that member countries can choose to be consistent with the context of country. At present, Thailand has implemented 5 measures to reduce the use of dental amalgam. Given that Thailand has not yet ratified the amendments adopted at COP4 and COP5, it can be considered that Thailand has already achieved the original provisions of the Convention. Once the amendments are ratified, there will be a 90-day period before they enter into force in the country.

Therefore, as part this project, efforts will be made to start implementing these additional COP4 and COP5 measures in order to accelerate their ratification. The measures that have been implemented are as follows.

No	Provisions	Start date
1	Setting national objectives aiming at dental caries prevention and health promotion, thereby minimizing the need for dental restoration.	Since 1977
3	Promoting use of cost-effective and clinically effective mercury-free alternatives for dental restoration.	Since 2012
5	Encouraging representative professional organizations and dental schools to educate and train dental professionals and students on the use of mercury-free dental restoration alternatives and promoting best management practices.	Since 2021
8	Restricting use of dental amalgam to its encapsulated form.	Since 2024
9	Promoting the use of best environmental practices in dental facilities to reduce releases of mercury and mercury compounds to water and land	Since 2021

Policies and regulations under the Ministry of Public Health and other main ministries are sufficient to carry out the measures specified in the Convention. Current regulatory measures of the Ministry of Public Health are adequate to protect public health. However, regulations for management of amalgam waste are complex and ability of local authorities under the Public Health Act are limited. This requires development of practical guidelines for amalgam waste management under relevant regulations.

2. Insurance policies and programmes

Thai citizens have the legal right to receive healthcare services under one of the state health insurance schemes, which include Social Security Scheme (SSS), Civil Servant Medical Benefit Scheme (CSMBS), and Universal Coverage Scheme (UCS). However, each scheme has different basic characteristics and covers different dental service benefits. The SSS and CSMBS cover medical treatment benefits. Beneficiaries are required to make co-payments if the medical expenses exceed the price set by the fund. The UCS provides medical treatment benefits to citizens who are not covered by the schemes. UCS also manages health promotion and prevention benefits for all citizens. Apart from state health insurance, citizens can purchase further voluntary health insurance from private companies that provide additional coverage. This serves as an option for those who want more comprehensive or specialized care.

Health insurance policies aimed at addressing tooth decay problems consist of oral health promotion and disease prevention, and dental restoration. The details are as follows:

<u>Oral Health Promotion and Disease Prevention</u>

Oral health promotion and disease prevention services are also considered a fundamental right for all Thai citizens, benefits include oral health examination, dental sealant application, topical

fluoride application. These services aim to prevent tooth decay and promote overall oral health. When receiving oral health promotion services at service units in the National Health Security Office (NHSO) network, people will not have to pay any costs. NHSO will be responsible for all costs of these services to ensure that all citizens have access to equal preventative oral care. However, if citizens choose to receive oral health promotion services from healthcare providers outside the NHSO network, costs may be incurred. This depends on the fee structure of that particular service provider.

Dental Restoration Services

This coverage encompasses the use of both dental amalgam and alternative dental restorative materials such as glass ionomer cement, resin composite, compomer. Dental professionals carefully assess individual needs and select the most appropriate restorative material to restore function, aesthetics, and overall oral health. Thai citizens who are covered under the National Health Security system can receive dental filling services free of charge at service units contracted with the NHSO. The Social Security Office sets a capitation reimbursement rate for scaling, filling, extraction, and extraction/surgical removal of impacted teeth at 24.32 USD/year. Additionally, they are entitled to denture benefits beyond the specified allowance. If there are additional service fees, beneficiaries need to pay the difference. However, the insured person can access services from a wider variety of service providers, such as private dental clinics, private hospitals that are contracted service units with the Social Security Office. Similarly, the Comptroller General's Department reimburses services on a fee-for-service basis, with a set price. If the service fee exceeds the set price, beneficiaries need to pay the difference. However, they are entitled to receive dental services only at public service units.

Although 68.2 million Thai people have health care coverage as high as 99.3% per year, utilization of dental services remains low. The data from the Health and Welfare Survey in 2021 shows that the lowest utilization rate was 8.3% for NHSO beneficiaries. When classified by age group receiving dental services, it was found that the pregnant women group had the highest rate of using dental services (87.4%), followed by children aged 3 - 5 years (63.7 %), children aged 0 - 2 years (55.2 %), and the working age group (12.8 %).

3. (Oral) Health workforce education and training

The Thailand Oral Health Strategic Plan 2023-2037 addresses the management of human resources in oral health as part of strategy 3, which are 1) Improvement of workforce management in the oral health system to increase access to services, increasing the number of dental professions that can develop policies and managing public health. 2) Retaining the oral health workforce, and 3) Enhancing the capabilities of the oral health workforce to strengthen policy administration and dental public health management. Data from the Human Resources Management Division, Office of the Permanent Secretary, Ministry of Public Health, as of August 1, 2023, found that the oral health workforce in public health service units consists of 6,177 dentists out of 21,019 dentists who have received professional licenses, 7,196 dental hygienists out of a total of 7,300 dental hygienists, 1,382 dental assistants, 38 dental technicians, and 2,654 others healthcare worker. From the analysis of projected statistics regarding dentists and dental hygienists in Thailand by 2026, it shows that there will be a need for approximately 15,742 to 16,764 dentists (with dentist to population ratios ranging from 1: 4,217 to 1: 3,960 respectively) and between 8,669 to 12,140 dental hygienists (with dental

hygienist to population ratios ranging from 1: 7,657 to 1: 5,468 respectively). This estimation is based on the assumption that dentists are responsible for all dental treatments, while dental hygienists primarily focus on health promotion and preventive measures. Therefore, the current information indicates that there is adequacy in the total number of dentists and dental hygienists. Instead, dental hygienists' career paths should be supported and pursued to retain oral health professionals in the health care system. Additionally, the distribution of dentists in different regions should be monitored to maintain the proportion of dentists and the population ratio at the desired level.

Currently, all faculties of dentistry in Thailand provide instruction on dental restoration using alternative materials and reduce practical training on actual patients with dental amalgam. Instruction on dental restoration using dental amalgam is still provided in theory to ensure understanding and proficient in managing the treatment for those with specific need. For dental hygienist training institutes, there are also classes primarily on dental restorations using dental amalgam materials, which is in the process of restructuring the curriculum to elevate the teaching standards of the institution to be equivalent to those of faculties of dentistry. Therefore, it is recommended to monitor the curriculum and support continuing education that focuses on dental restoration using alternative dental restorative materials, in order to reduce amalgam materials among dental hygienists.

Although all faculties of dentistry provide instruction on the use and management of dental amalgam, alternative materials, and related waste, it is found that some learning topics are not taught in some universities such as 1) Mercury and risks to human health and the environment 2) Environmentally friendly amalgam waste management practices 3) The Minamata Convention and the role of dental health professionals and 4) Toxicology for health and the environment, safety of amalgams and alternative materials.

4. Management of mercury waste and amalgam waste.

The mechanisms for managing mercury waste and amalgam waste in the public health sector in Thailand involve the operations and authorities of the Ministry of Public Health, the Ministry of Natural Resources and Environment, the Ministry of Interior, and the Ministry of Industry. The management of medical waste in hospitals are under the Public Health Act 1992, which categorizes medical waste into non-hazardous waste and hazardous waste. Amalgam or mercury waste are classified as hazardous waste due to the toxicity of mercury. There are regulations that establish criteria and standards for waste management, covering the entire process from segregation according to waste type at the source, collection in containers and waste receptacles, transportation and proper disposal according to specified guidelines, for example, Ministerial Regulation on Management of Toxic or Hazardous Waste from Communities 2020, Pollution Control Department Announcement on Guidelines for Management of Toxic or Hazardous Waste from Communities for Local Administrative Organizations 2022, Ministry of Industry Announcement on Disposal of Waste or Unused Materials 2023, Industrial Factory Announcement on Determining Methods for Collection, Deactivation, Disposal, Burial, Relocation, and Transportation of Waste or Unused Materials (No. 1) 1988. Regarding the management of amalgam waste, the Bureau of Dental Health, Department of Health, has published Guidelines for the Use of Dental Amalgam in 2019 and Manual for Managing Infectious Waste and Mercury-Contaminated Waste from Dental Clinics in 2021 to ensure that dental

personnel understand and are able to implement measures in accordance with the Minamata Convention on Mercury.

However, most public and private health service sectors still face limitations in managing mercury waste and amalgam waste. Especially the proper collection and transportation from public health service units and appropriate management processes.

5. Import, stockpiles, and export of dental amalgam and alternative materials

Data from the Customs Department from 2016 to 2023 shows that import data from 2016-2023 shows higher volumes of alternative dental restorative materials, 34,695-61,242 kg/year, compared to dental amalgam, 3,550-10,385 kg/year. This data corresponds to data from Health Data Center of the Ministry of Public Health showing increased use of alternative dental restorative materials, from 59.1% in 2016 to 72.9% in 2020, and decreased dental amalgam use, from 40.9% to 26.1%.

Amalgam waste releases into environment in 2023 by using the UNEP Mercury inventory toolkit was found that the amount of mercury release from dental amalgam was 19.4 kilograms. Various release into the air 0.4 kilograms, released into the water 9.0 kilograms. released into soil 1.48 kilograms, escaping through products 1.11 kilograms, and from specific treatment and escaping with general waste 3.7 kilograms each. In 2023, the amount of mercury released into the environment from cremation and burial was 26.81 kilograms of mercury released into the air through cremators without mercury vapor capture equipment and 1.74 kilograms of mercury released into the ground from burial.

CHAPTER 1
INTRODUCTION

Mercury (Hg) is a toxic substance and a global pollutant that poses adverse effects to human health and the environment. Mercury pollution exposes populations, regardless of proximity to source, to the harmful effects of the chemical. It is important to recognize that mercury exists in various forms: elemental (or metallic) and inorganic (to which people may be exposed through their occupation); and organic (e.g., methylmercury, to which people may be exposed through their diet). These forms of mercury differ in their degree of toxicity and in their effects on the nervous, digestive and immune systems, and on lungs, kidneys, skin and eyes. The inorganic form is the silver liquid metal that is mixed with silver and copper alloy in order to form dental amalgam. Approximately 50% of dental amalgam is elemental mercury by weight.

The Minamata Convention on Mercury is a global treaty that aims to protect human health and the environment from emissions and releases of mercury and mercury compounds. The treaty addresses mercury-added products, including dental amalgam. Annex A Part II of the Convention, which was recently amended in 2022 by the fourth meeting of the Conference of the Parties to the Minamata Convention on Mercury (COP4), outlines the provisions to phase down the use of dental amalgam.

The Article 4: Mercury added products specified in paragraph 3 *"Each party shall take measures for the mercury-added products listed in the Part II of Annex A in accordance with the provisions set out therein."* There are two requirements under Annex A Part II, as follows:
Measures to be taken by a Party to phase down the use of dental amalgam shall take into account the Party's domestic circumstances and relevant international guidance and shall include two or more of the measures from the following list:

1. Setting national objectives aiming at dental caries prevention and health promotion, thereby minimizing the need for dental restoration;
2. Setting national objectives aiming at minimizing its use;
3. Promoting the use of cost-effective and clinically effective mercury-free alternatives for dental restoration;
4. Promoting research and development of quality mercury-free materials for dental restoration;
5. Encouraging representative professional organizations and dental schools to educate and train dental professionals and students on the use of mercury-free dental restoration alternatives and on promoting best management practices;
6. Discouraging insurance policies and programmes that favour dental amalgam use over mercury-free dental restoration;
7. Encouraging insurance policies and programmes that favour the use of quality alternatives to dental amalgam for dental restoration;
8. Restricting the use of dental amalgam to its encapsulated form;

9. Promoting the use of best environmental practices in dental facilities to reduce releases of mercury and mercury compounds to water and land.

Annex A Part II, Second requirement of the dental amalgam provisions:

In addition, Parties shall:

1. Exclude or not allow, by taking measures as appropriate, the use of mercury in bulk form by dental practitioners;
2. Exclude or not allow, by taking measures as appropriate, or recommend against the use of dental amalgam for the dental treatment of deciduous teeth, of patients under 15 years and of pregnant and breastfeeding women, except when considered necessary by the dental practitioner based on the needs of the patient.

Article 11 Mercury Wastes (relevant to dental amalgam waste)

Article requirement: Each Party shall take appropriate measures to ensure that mercury wastes are managed in an environmentally sound manner, taking into account the guidelines developed under the Basel Convention and in accordance with the requirements that the COP* may adopt in the future.

Thailand has ratified the Minamata Convention on Mercury since 20 September 2017. Thailand has adopted the first requirement by applying five measures from the list. While the second requirement will be effective after Thailand redeposit the ratification. Five measures under Annex A Part II, first requirement include measures 1, 3, 5, 8, and 9. However, there is still a lack of implementation of other measures and the implementation of some measures has not yet achieved its goals.

Therefore, Thailand has established the project to accelerate implementation of dental amalgam provisions and strengthen country capacities in the environmental sound management of associated wastes under the Minamata Convention. The expected outcome of the project is to improve understanding and capacity in project countries to effectively manage the phase down of dental amalgam use and sound management of associated mercury and hazardous wastes. One of the important activities is the national situation assessments regrading dental filling usage and amalgam waste management. The information will be utilized to make recommendations and implement appropriate strategic interventions considering the local situations in the context of the Minamata Convention on Mercury. Moreover, it will support establishing baseline data for subsequent evaluation.

CHAPTER 2
MAINSTREAMING GENDER ISSUE INTO THE NATIONAL SITUATION ASSESSMENT

Thailand recognizes the importance of gender equality. This gender issue into the national situation assessment contributes to the World Health Organization (WHO) & United Nations Environment Programme (UNEP) implementation of the Global Environment Facility 7 (GEF-7) project titled "Accelerate implementation of dental amalgam provisions and strengthen country capacities in the environmentally sound management of associated wastes under the Minamata Convention". The purpose of this gender issue is to explain how gender has been integrated during the national assessment to ensure the distinct need of women and men will receive equal consideration during national assessment, including:

1. Establish a technical working group to work on national assessment that includes equal and meaningful representation of women and men, of different ages and backgrounds.
2. Identify stakeholders in relevant fields of national situation assessments and participation as appropriate with gender balance.
3. Develop tools to collect data that are designed to reach men and women equally, that collect sex-disaggregated data, and that raise awareness about gender differences that may affect information on the exposures and management of dental amalgam.
4. Collect data in all process (using questionnaires, interviews, focus groups, other direct contact to data owner, review documents and national literature) without gender discrimination.
5. Ensure that women and men are equally engaged with the development of improved policies and technical capacity to phase down the use of dental amalgam.

CHAPTER 3
METHODOLOGY

This national situation assessment was developed during March - August 2024, with the main participating organizations including Bureau of Dental Health and Bureau of Environmental Health, Department of Health, Department of Pollution Control, Dental Faculty Consortium of Thailand and National Metal and Materials Technology Center. The objective of the assessments was to provide an information for making recommendations and implement appropriate strategic interventions considering the local situations in the context of the Minamata Convention on Mercury. Moreover, it will support establishing baseline data for subsequent evaluation. The content in this document covers 1) Existing policy and regulatory framework 2) Existing insurance policies and programmes both public and private 3) State of health workforce education and training to phase down the use of dental amalgam 4) Existing waste management scheme and capacity and 5) Inventory of dental amalgam and mercury-free alternatives (including use, trade, supply, stockpiles, stock in use in society, and mercury releases and emissions). Key steps for the national situation assessment including:

1. Define the scope of assessment.
2. Identify stakeholders in the relevant fields that could support the national situation assessment and engage in consultations, as appropriate.
3. Design tools to collect data including questionnaire, interview form, spreadsheet, etc.
4. Collect data for each section through questionnaires, interviews, focus groups, other direct contact to data owner, and review documents (including Minamata Initial Assessment) and national literature.
5. Review existing measures/activities to conduct a gap analysis (assessing measures/ activities against the dental amalgam provisions listed in the Minamata Convention on Mercury) and identify improvement opportunities.
6. Conduct inception workshop for brainstorm on national situation assessment.
7. Make recommendations to improve or establish measures that will accelerate phasing down the use of dental amalgam in the country, including an implementation plan and priorities for action.

CHAPTER4
RESULTS

1. POLICY AND REGULATORY FRAMEWORK

1.1 Thailand activities after ratifying the Minamata Convention on Mercury

Thailand has ratified the Minamata Convention on Mercury since 20 September 2017 and adopted the first requirement by applying five measures from the list, while the second requirement will be effective after Thailand redeposit the ratification. Five measures under Annex A Part II, first requirement include measures 1, 3, 5, 8, and 9. Roles, responsibilities and organization activities under each measure will be described.

Measure 1: Setting national objectives aiming at dental caries prevention and health promotion, thereby minimizing the need for dental restoration

Organization Roles and Responsibilities:

Bureau of Dental Health, Department of Health has a role in developing dental public health policy, strategy and plan. Three national plans were reviewed. Even though these plans did not clearly specify their objectives for preventive dental health, activities are mainly for prevention of dental health.

Moreover, the National Health Security Office (NHSO) is responsible for health insurance set up fixed cost dental health preventive and curative programs. This organization has continuously conducted these activities for more than ten years.

Measure 3: Promoting the use of cost-effective and clinically effective mercury-free alternatives for dental restoration

Organization Roles and Responsibilities:

Bureau of Dental Health, Department of Health has applied dental health knowledge, technology and innovation and promote the use of mercury-free alternative for dental restoration. For example: dental restoration by SMART technique for all aged group, guideline for amalgam phase down in dental clinic.

The Dental Association of Thailand under the Patronage of H.M. the King organized technical meeting related to impact of amalgam on human health and alternative restoration materials, and disseminate technical knowledge via organization's website. This aims to help ensure safe dental practices.

Measure 5: Encouraging representative professional organizations and dental schools to educate and train dental professionals and students on the use of mercury-free dental restoration alternatives and on promoting best management practices

Organization Roles and Responsibilities:

Dental Faculty Consortium of Thailand, combined of 18 dental health faculties, is responsible for promoting curriculum and training dental professionals and students on the use of mercury-free dental restoration alternatives and on promoting best management practices. In addition, the Consortium disseminates dental curriculum developed by World Health Organization to build social responsibility and reduce mercury release from dental practice to the environment to dental health personnel. Moreover, the Dental Faculty Consortium of Thailand has worked with the Dental

Association of Thailand on cancelling practices on restoration of dental amalgam for general dentist professional as well as for pediatric dentist.

Measure 8: Restricting the use of dental amalgam to its encapsulated form

Organization Roles and Responsibilities:

For the purpose of controlling medical devices and protecting safety of consumers, the Minister of Public Health Ministry with recommendation of Medical Device Committee issued ministerial notification under the Medical Device Act to control dental amalgam form. It is specified that alloy and mercury to form dental amalgam as well as dental amalgam to be manufactured, imported and sold, shall be in capsulated or sachet. Moreover, it is prohibited to manufacture, import or sell alloy and mercury to form dental amalgam in tablet or powder forms.

Measure 9: Promoting the use of best environmental practices in dental facilities to reduce releases of mercury and mercury compounds to water and land

Organization Roles and Responsibilities:

Healthcare Facility Act, which is responsible by Health Service Support Department, recommend dental health facility that may apply and remove amalgam for dental restoration may set up chairside trap or separator.

Under the Public Health Act, 1992, it is specified that waste from household activities including health care facilities is controlled by the Act. It is responsible by local authority within their jurisdiction. However, almost all local authorities are not able to dispose within their vicinity. The Minister of Health, with the recommendation of Public Health Committee, issued regulation and notifications regarding hazardous waste management from healthcare facilities specifying how to collect, transport and dispose hazardous waste. Domestic waste management is responsible by local authorities, according to the Public Health Act. However, there are some limitations on amalgam waste management. Even though there is technical guideline for dental amalgam use and management of waste within healthcare facilities, it should be reviewed to ensure safe mercury management. To manage hazardous waste from healthcare facilities is mainly responsible by the Public Health Act, however, Factory Act allows licensed company for mercury recycling, and secured landfill. For collecting, transferring, and disposing of domestic waste is responsible by each local authorities, almost all of them have limitation in managing hazardous domestic waste like mercury.

1.2 Opportunities for Thailand to conduct more measure regarding dental amalgam and amalgam waste management

According to the provisions under the Part II, Annex A of both first and second requirements, four groups of activities were proposed. These are group 1 measures related to policy and plan development, group 2 Measures related to limit amalgam forms, group 3 Measures related to curriculum and dental health professional control and last group measures related to management of dental amalgam waste as summarized on Table 1.1

Table 1.1 Summarized policy in Thailand.

Groups	Measures	Implemented
Group 1 Measures related to policy and plan development		
1.1 Setting national objectives and develop national plan	Measure (i) Setting national objectives aiming at dental caries prevention and health promotion, thereby minimizing the need for dental restoration	Y (since 1977)
	Measure (ii) Setting national objectives aiming at minimizing its use	N
1.2 Setting national collaborative objectives	Measure 2 Exclude or not allow, by taking measures as appropriate, or recommend against the use of dental amalgam for the dental treatment of deciduous teeth, of patients under 15 years and of pregnant and breastfeeding women, except when considered necessary by the dental practitioner based on the needs of the patient	N
1.3 Health insurance	Measure (vi) Discouraging insurance policies and programmes that favor dental amalgam use over mercury-free dental restoration	N
	Measure (vii) Encouraging insurance policies and programmes that favor the use of quality alternatives to dental amalgam for dental restoration	N
1.4 Conducting research and promote alternative material for restoration	Measure (iii) Promoting the use of cost-effective and clinically effective mercury-free alternatives for dental restoration;	Y (since 2012)
	Measure (iv) Promoting research and development of quality mercury-free materials for dental restoration	N
Group 2 Measures related to limit amalgam forms		
2.1 Setting national objectives and develop national plan	Part of Measure 1 Exclude or not allow, by taking measures as appropriate, the use of mercury in bulk form by dental practitioners	Partly Y
	Measure (viii) Restricting the use of dental amalgam to its encapsulated form	Y (since 2024)
Group 3 Measures related to curriculum and dental health		
3.Educate dental professionals and revise curriculum	Measure (v) Encouraging representative professional organizations and dental schools to educate and train dental professionals and students on the use of mercury-free dental restoration alternatives and on promoting best management practices	Y (since 2021)
	Part of Measure 1 Exclude or not allow, by taking measures as appropriate, the use of mercury in bulk form by dental practitioners	

Groups	Measures	Implemented
Group 4 Measures related to management of dental amalgam waste		
4. Amalgam waste management	Measure (ix) Promoting the use of best environmental practices in dental facilities to reduce releases of mercury and mercury compounds to water and land	Y (since 2021)

1.3 Adequacy of existing policies and regulations analysis

In term of policies and regulations under the Ministry of Public Health and other main ministries are adequate to meet these two requirements. The Ministry of Public Health's current regulatory measures are sufficient to protect public health. However, regulations for management of amalgam waste are complex and ability of local authorities under the Public Health Act are limited. This requires development of practical guidelines for amalgam waste management under relevant regulations.

1.4 Proposed action plan

Measure 1: Preparation for Declaration of Intent of collective measures regarding exclude or not allow or recommend against the use of dental amalgam for the dental treatment of deciduous teeth, of patients under 15 years and of pregnant and breastfeeding women.

Scope of activities:

Department of Health in corporation with dental health associations prepare for declaration of intent on excluding or not allowing or recommending against the use of dental amalgam for the dental treatment of deciduous teeth, of patients under 15 years and of pregnant and breastfeeding women. This announcement will be done and disseminate publicly through appropriate channels. Moreover, the declaration of intent shall communicate directly to dental health personnels and dental health care facilities.

Responsible organization:

Department of Health, with other related organizations

Measure 2: Draft National Dental Health Action Plan to be proposed to the Office of the Economic and Social Development Council prior to Cabinet approval.

Scope of activities:

Strategic oral health plan will be revised and will propose to the Cabinet for approval. This revision will cover various measures which were not clearly stated e.g. dental health promotion and prevention, research and development measures. In addition, setting up national committee for monitoring and evaluation will also be proposed.

Responsible organization:

Department of Health, with other related organizations

Measure 3: Development of dental amalgam waste management align with existing regulations

Scope of activities:

Existing regulations regarding dental amalgam management will be explored; developing technical guidelines specific for within dental health facilities, storage, transfer, recovery or disposal

of dental amalgam; finally, regulation under the Public Health Act regarding healthcare hazardous waste may be revised.

Responsible organization:

Department of Health, with other related organizations

To implement these three proposals, it is recommended that Department of Health will be focal point to work with relevant organizations. Results from these proposals will be shown by the end of next fiscal year, 2025. Thailand will be able to utilize knowledge to conduct all measures according to accelerate phasing down dental amalgam. In addition, these may be resource for reporting country's progress to the Secretary of the Minamata Convention in 2026 as well as to prepare for the next negotiation in COP 6.

2. INSURANCE POLICIES AND PROGRAMMES

2.1 Health insurance in Thailand: a system in transition

The history of healthcare benefits Thailand can be traced back to the establishment of various public health insurance schemes, including the Civil Servant Medical Benefit Scheme (CSMBS), the Social Security Scheme (SSS), and the Universal Coverage Scheme (UCS). These schemes were introduced to provide comprehensive healthcare coverage to different segments of the population, ensuring that civil servants, private sector employees, and the general public have access to essential medical services.

The CSMBS is a comprehensive health insurance scheme in Thailand that covers government employees, retirees, and their dependents, making up about 7% of the total population. It was established in 1980 as a fringe benefit to compensate for low public sector salaries. Prior to 2003, CSMBS beneficiaries had to pay for outpatient care upfront and then get reimbursed later. This was seen as potentially hindering access to care for cash-constrained beneficiaries. In 2003, the government implemented the Direct Billing Payment (DBP) program for the CSMBS, which allowed hospitals to bill the government directly for outpatient services instead of patients having to pay out-of-pocket. This was found to increase outpatient utilization and treatment intensity among CSMBS beneficiaries. The CSMBS is financed through general tax revenue, unlike the Social Security Scheme (SSS) which is a payroll-tax contributory scheme, and the Universal Coverage Scheme (UCS) which is also tax-financed. The CSMBS provides more comprehensive benefits compared to the other schemes.

The history of the Social Security Scheme in Thailand dates back to the early 1930s when the country transitioned from an absolute monarchy to a constitutional monarchy. Initially introduced as 'social security' in 1932, the establishment of a formal social security system faced challenges due to political instability during World War II. It wasn't until 1947, under Prime Minister Field Marshall Phibul-Songkram, that the Social Security Act, B.E. 2497 (1954) was promulgated. However, its implementation was delayed due to the absence of a Royal Decree. The Social Security Act, B.E. 2533 (1990) marked a significant milestone by starting the Social Security Scheme (SSS) for private sector employees. Over the years, this scheme has expanded to include smaller establishments and additional benefits, evolving to cover various aspects of social security for different groups in Thailand.

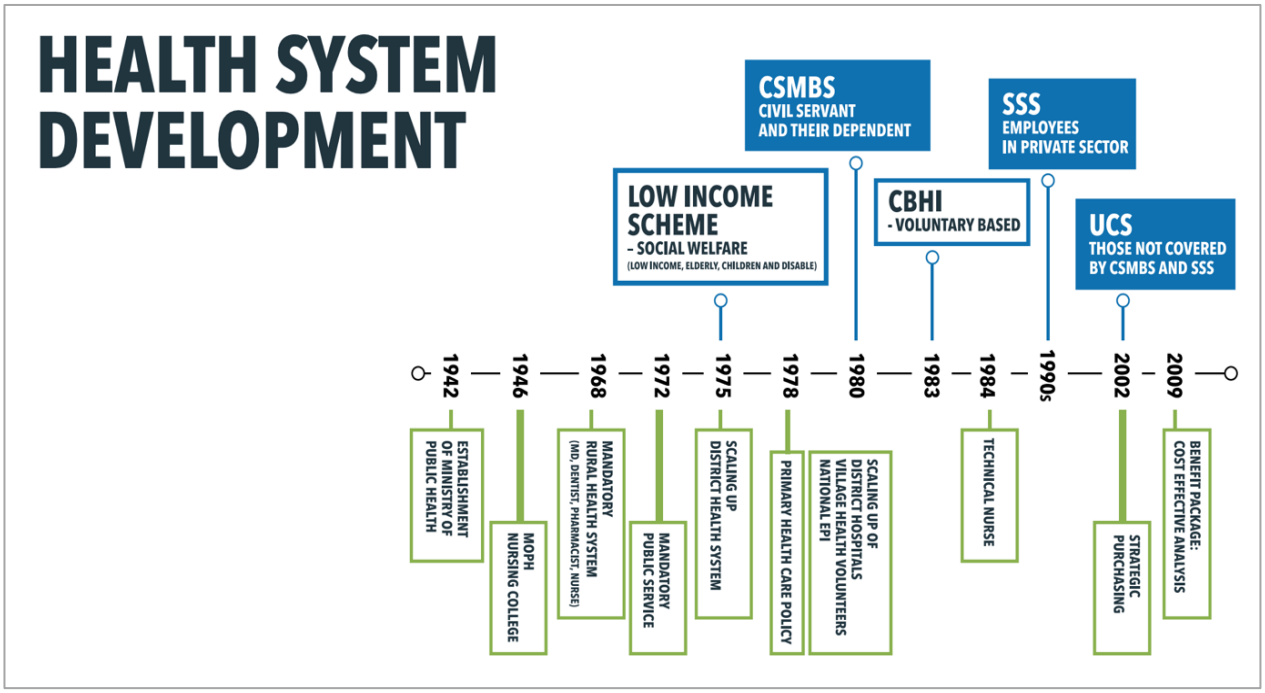
The Universal Coverage Scheme (UCS) which is widely referred to as the "30 Baht Healthcare Policy" or "Gold Card Project" in Thai culture, launched in 2001, was a significant milestone in Thailand's healthcare system. The National Health Act was established in 2002. It aimed to consolidate existing health coverage schemes into a unified system, providing equitable access to healthcare services for all citizens. The UCS covers both in-patient and out-patient care, primary and secondary healthcare services, and specialized treatments, ensuring that individuals receive necessary medical care without financial hardship.

Over the years, Thailand has made significant progress in achieving Universal Health Coverage (UHC), ensuring that the entire population has access to essential healthcare services.

The success of Thailand's healthcare system can be attributed to stable financial frameworks, a focus on preventive care, innovative healthcare delivery models, decentralization in healthcare management, and strong political commitment to improving public health (Fig 2.1).

In conclusion, the history of healthcare benefits for Thai citizens in Thailand reflects a commitment to providing accessible and quality healthcare services to all segments of the population. The introduction of the Universal Coverage Scheme and other public health insurance schemes has played a crucial role in expanding healthcare coverage and improving health outcomes for Thai citizens.

Fig 2.1 Health system development in Thailand.



2.2 National insurance schemes: public and private insurance

Thailand's healthcare system is comprised of two main types of insurance:

1. Government-Supported Health Insurance:
2. Voluntary Health Insurance:

Thailand's healthcare insurance system is a two-tiered structure that encompasses both government-sponsored and voluntary health insurance options. The vast majority of the Thai population, over 99%, is covered by government-sponsored health insurance, which serves as the foundation for their healthcare needs. Voluntary health insurance, on the other hand, provides additional coverage and choice for those seeking more comprehensive or specialized care.

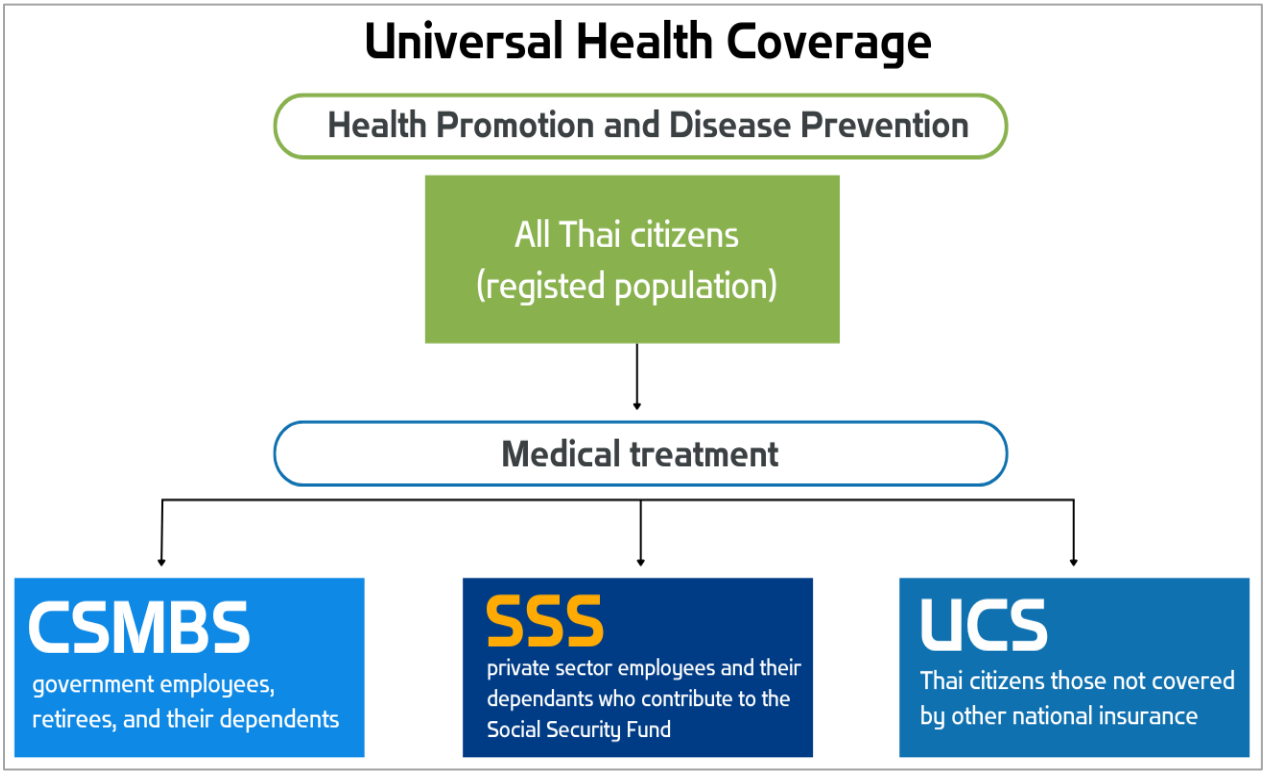
2.2.1 Government-supported health insurance: universal health coverage

Government-supported health insurance in Thailand plays a pivotal role in ensuring universal healthcare coverage and promoting equity in healthcare access. This system is further divided into three primary groups:

1. Universal Coverage Scheme (UCS): This scheme provides free healthcare services to all Thai citizens and permanent residents. It is funded by general tax revenue and covers a comprehensive range of medical services, including inpatient and outpatient care, emergency care, preventive care, and certain specialized treatments.
2. Social Security Scheme (SSS): This scheme covers private sector employees and their dependents who contribute to the Social Security Fund. It offers a similar benefit package to the UCS, but with some additional coverage, such as maternity care and occupational disease benefits.
3. Civil Servant Medical Benefit Scheme (CSMBS): This scheme provides healthcare benefits to government officials and their families. It is generally considered the most comprehensive of the three government-sponsored health insurance programs, covering a wider range of services and offering higher reimbursement rates.

Additionally, Thailand's public health insurance system encompasses two broad areas: health promotion and disease prevention, and medical treatment (Fig.2.2).

Fig.2.2 Universal Health Coverage in Thailand.



Health Promotion and Disease Prevention:

All Thai citizens have the right to health promotion and disease prevention services. These services are primarily provided by the National Health Security Office (NHSO). The NHSO implements various programs and initiatives aimed at promoting healthy lifestyles, preventing diseases, and educating the public about health issues.

Medical Treatment:

Access to medical treatment under the public health insurance system varies depending on an individual's employment status and affiliation. The three main entities responsible for medical treatment are:

1. Comptroller General's Department (CGD): The CGD administers medical benefits for civil servants under the Ministry of Finance. This group comprises around 7.0% of the population.

   The Comptroller General's Department (CGD), under the Ministry of Finance, stands as a crucial pillar of Thailand's healthcare landscape, entrusted with the responsibility of administering healthcare benefits for civil servants, state enterprise employees, permanent employees, and their families. This mandate is rooted in the Civil Service Welfare (Medical Care) Act of 2010 (BE 2553) and its subsequent amendments.
2. Social Security Office (SSO): The SSO administers medical benefits for individuals enrolled in the social security system, which typically includes private sector employees. This group accounts for approximately 18.2% of the population.

   The Social Security Office, under the Ministry of Labour is a government agency responsible for managing the social security system in Thailand by the Social Security Act of 1990. It plays a crucial role in providing financial support and protection to Thai citizens in case of illness, injury, disability, or death. The Social Security Office is responsible for handling complaints and disputes between hospitals and patients, managing the social security fund, and implementing policies and programs related to social security. The social security system in Thailand is a contributory scheme that provides financial support to workers in case of illness, injury, disability, or death. The system is funded by contributions from employers, employees, and the government. The Social Security Office is responsible for managing the social security fund, which is used to provide benefits to eligible individuals. The office also plays a role in promoting and protecting the health and well-being of Thai.
3. National Health Security Office (NHSO): The NHSO administers medical benefits to the remaining 75% of the population, primarily those who are not employed in the formal sector or are not covered by other government schemes. This coverage is mandated by the National Health Insurance Act of 2002 (BE 2545).

   The National Health Security Office (NHSO) stands as an independent public organization established under the National Health Insurance Act of 2002 (BE 2545). Its primary mission lies in administering the Universal Coverage Scheme (UCS), catering around 75% of Thailand's population who fall outside the coverage of other government agencies. Overseeing the NHSO's operations are two national committees: the National Health Security Board and the Health Standard and Quality Control Board (Fig.2.3).

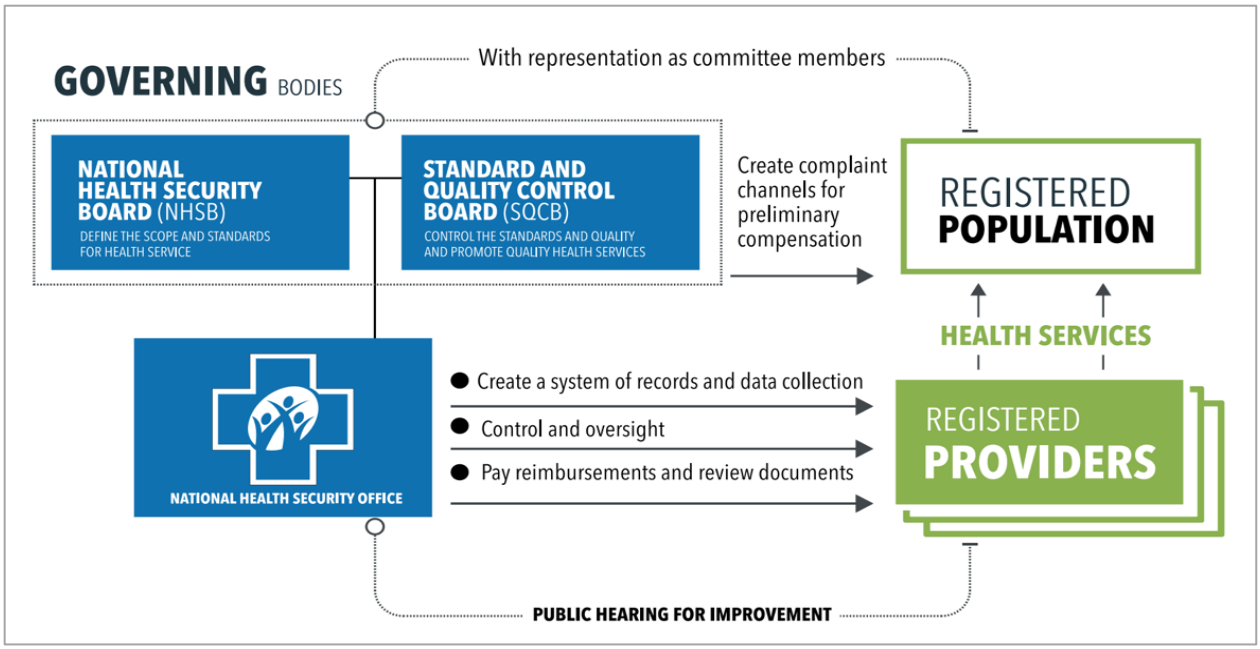
The National Health Security Board

This is a committee established under the National Health Security Act of 2002 and consists of representatives from various sectors, including government agencies, professional councils, local administrative organizations, private hospitals, non-profit organizations, and qualified individuals. The Minister of Public Health serves as the chairman, as stated in Article 18. Its responsibilities include managing the National Health Security Fund, setting the scope and standards of healthcare services, establishing conditions for providing initial financial assistance as stipulated in Article 41. It is also responsible for overseeing the operations of the NHSO. Compensation for wrongful acts: the board oversees a framework for compensating individuals who have suffered harm due to negligence or malpractice within the healthcare system.

Health Standard and Quality Control Board

This committee was established under the National Health Security Act of 2002, and consists of representatives from various sectors, including government agencies, professional councils, local administrative organizations, private hospitals, non-profit organizations, and qualified individuals. Its responsibilities are defined by the National Health Security Act of 2002 and include overseeing and regulating healthcare units, promoting quality and standards of services, protecting the rights of eligible individuals under the health security scheme, handling complaints from healthcare recipients, and providing initial financial assistance among other duties.

Fig.2.3 Governing bodies in National Health Security Office.



4. Other government agencies: local government organizations and other public entities may provide medical benefits to their employees. This group represents a small fraction of the population, less than 1%.

2.2.2 Other insurance schemes: voluntary private insurance

Private health insurance in Thailand supplements the public healthcare system (Universal Health Coverage) by offering additional benefits and coverage. It's provided by various local and international insurance companies. Typical features of private health insurance 1) expanded hospital choices: access to a wider network of private hospitals within Thailand, often with better facilities and shorter waiting times. 2) outpatient coverage: coverage for doctor's visits, diagnostic tests, and treatments. 3) additional benefits: coverage for dental, vision, maternity, critical illness, and alternative treatments which may not be covered by public healthcare. 4) international coverage: some plans offer coverage for medical treatments abroad. 5) flexibility: customize plans with varying deductibles, coverage limits, and optional benefits.

Thai citizens can opt to purchase voluntary health insurance plans to supplement their existing coverage. These plans typically offer a wider range of benefits, including coverage for a broader spectrum of medical services, such as specialized treatments and alternative therapies. Higher reimbursement rates for medical expenses, reducing the financial burden on individuals. Access to a wider network of healthcare providers, including private hospitals and clinics. Additional benefits, such as maternity coverage, dental care, and overseas medical treatment.

Employer-provided health insurance, moreover, many Thai employers offer health insurance plans as a part of their employee benefits package. These plans are typically funded by a combination of employer contributions and employee contributions. The benefits offered by employer-provided health insurance plans vary depending on the employer and the plan selected.

Voluntary health insurance and employer-provided health insurance plans can play a valuable role in complementing Thailand's universal healthcare system, providing individuals with access to a wider range of healthcare services and reducing the financial burden of medical expenses. These additional coverage options can contribute to improved health outcomes and a higher quality of life for Thai citizens.

2.3 Oral health benefits packages and service coverage

Thailand's universal healthcare policy, which encompasses health promotion, disease prevention, and medical treatment, extends its coverage to oral health as well. Specifically, it addresses the issue of dental caries (cavities) in the following ways:

Dental Restoration Services

Dental restoration services, including fillings, are considered a fundamental right for all Thai citizens. This coverage encompasses the use of both alternative dental restorative materials and amalgam fillings. The universal healthcare system's coverage of a wide range of dental restorative materials, including glass ionomer cement, resin composite, compomer, and amalgam, reflects Thailand's commitment to providing comprehensive oral healthcare services to its citizens. Dental professionals carefully assess individual needs and select the most appropriate restorative material to restore function, aesthetics, and overall oral health.

Oral Health Promotion and Disease Prevention

Oral health promotion and disease prevention services are also considered a fundamental right for all Thai citizens. However, the specific services provided vary depending on the individual's age group. Oral Health Promotion and Disease Prevention Benefits include:

- Oral health examination is considered a fundamental right for all Thai citizens, regardless of age or demographic group. This includes vulnerable populations such as pregnant women, children with special needs, inmates, and homebound patients. These examinations not only assess the individual's oral health status but also provide an opportunity for treatment planning and oral health education delivered by dental professionals. Oral health education and counseling are integral components of oral health promotion strategies. Through these sessions, individuals receive personalized guidance on proper oral hygiene practices, dietary habits, and effective use of dental care products. This knowledge empowers individuals to take proactive measures in maintaining good oral health and preventing dental caries.
- Dental sealant application is considered a fundamental oral health benefit for Thai citizens within the age group of 6 to 20 years. This coverage extends to vulnerable populations within this age range as well. The specific teeth eligible for dental sealant application include premolar and molar teeth.
- Topical fluoride application is a crucial oral health benefit available to Thai citizens of all ages, from infants to the elderly. This preventive measure encompasses a range of fluoride materials, including fluoride varnish, fluoride gel, and silver diamine fluoride (SDF). The choice of topical fluoride material depends on the individual's age, oral health status, and risk factors for dental caries. Dental professionals carefully assess these factors and select the most appropriate fluoride material for each patient. The Ministry of Public Health and the Royal College of Dental Surgeons of Thailand have established guidelines for the use of topical fluoride in Thailand. These guidelines provide detailed recommendations for the appropriate application of different fluoride materials based on age, risk factors, and individual needs.

2.4 Population coverage

Thailand's healthcare system has made significant strides in expanding coverage and improving access to healthcare services for the citizens. However, disparities in access to and utilization of healthcare services persist across different population groups.

Overall Access Rates

The data from the Health and Welfare Survey in 2021 found that healthcare coverage in Thailand reached an impressive 99.3% of the population. This widespread coverage is attributed to the nation's robust universal healthcare system, which encompasses three main schemes.

Moreover, approximately 6.7 million individuals, or 9.9% of the population, utilized dental services and found that CSMBS beneficiaries had the highest proportion of dental care utilization (16.5%). SSO beneficiaries had a utilization rate of 13.7%. The lowest utilization rate was 8.3% for NHSO beneficiaries.

Table 2.1 Dental care utilization among Thai citizens from the survey.

Health insurances	Population (person)	Number of people who received oral health services (OHS) (person)	Percentage of people received OHS (%)
All population	68,191,203	6,722,787	9.9
Health insurance schemes			
CSMBS	4,754,132	778,389	16.5
SSS	12,323,215	1,686,210	13.7
UCS	49,530,847	4,127,922	8.3
Others	1,156,205	121,818	10.5
Have no insurance	426,804	8,448	2.0

However, the data from the Health Data Center of the Ministry of Public Health, which is the data collected from the Ministry's healthcare facilities, report different results: Thai citizens (all health insurance schemes) utilized dental services about 24.80% in 2021, 23.62% in 2022, and 26.80% in 2023.

In summary, although the results of people's access to oral health services differ from different data sources, Thai people's access to oral health services is still quite low, possibly due to various barrier factors. These are some limitations:

- Uneven distribution of dental professionals: dentists and dental care facilities are often concentrated in urban areas. This leads to significantly reduced access for individuals residing in rural or remote regions.
- Financial barriers: despite government coverage, out-of-pocket expenses for certain treatments or specialized care can still be substantial, particularly for low-income individuals and those without robust coverage.
- Lack of awareness: limited understanding of the importance of oral health, effective preventive measures, and the availability of services can prevent individuals from seeking oral health care.
- Long waiting times: public dental facilities may have extensive waitlists, delaying necessary treatment and potentially leading to a worsening of oral health conditions.
- Transportation difficulties: insufficient transportation options, lack of reliable public transport, or long distances to dental facilities can create significant logistical hurdles for individuals seeking care, especially in rural areas.
- Cultural and attitudinal barriers: fear of dental procedures, negative past experiences, or a general perception of dental care as a non-essential service can discourage individuals from seeking preventive care or addressing dental issues.

Access by Population Groups

The data for this topic comes from the Health Data Center of the Ministry of Public Health between 2021 and 2023. The population that receives dental services can be divided into

age groups. It includes promoting oral health, preventing disease, and treating and restoring oral health, as follows table 2.2 show that there is a downward trend in dental service utilization among the population. This information also reports tooth restoration with amalgam and alternative filling materials, separated by population group as shown in table 2.3 It was found that people are increasingly receiving dental fillings and the proportion of choosing alternative materials is also increasing.

While universal healthcare coverage is a remarkable achievement in Thailand, the limitations in accessing oral health services highlight the need for multi-pronged and targeted approaches. Addressing these factors through expanding access, promoting awareness, and tailored solutions can ensure that good oral health becomes a reality for all Thai citizens.

Table 2.2 The percentage of people with access to oral health services.

Population groups	Percentage of people with access to oral health services		
	2021	2022	2023
Pregnant women	83.42	82.74	87.36
0-2 years	61.59	59.09	55.18
3-5 years	65.24	62.77	63.74
6-14 years	58.05	50.40	51.16
15-59 years	12.71	12.74	12.79
60 years and over	36.67	35.21	29.17
Patient with special needs	30.46	29.54	25.62

Table 2.3 The number of people who received tooth filling was divided into 3 groups.

Population groups	Number of people who received tooth filling (person)					
	2022		2023		2024 (6 months)	
	amalgam	alternative materials	amalgam	alternative materials	amalgam	alternative materials
0-5 years	3,630	30,449	6,300	52,845	4,746	46,588
6-15 years	34,204	159,050	82,019	352,631	65,501	345,155
Pregnant women	2,679	4,281	2,514	10,774	19,219	14,768

2.5 Cost coverage

The benefits that people receive depend on the conditions of each person who oversees the rights of the people. All costs related to promoting health and preventing oral diseases. This is handled by the National Health Security Office. However, those who would use their benefits must receive dental services in accordance with the National Health Security Office's conditions. For dental treatment, there will be differences according to each scheme.

For those entitled to the National Health Insurance or Gold Card, the Oral Health Benefit covers all expenses under the terms of the National Health Security Office, such as receiving services from a contracted service unit with the National Health Security Office.

However, the SSS and the CSMBS benefit may only cover some of the costs, depending on the dental costs of the service entity and the amount of dental services provided, with a percentage of the payment for the dental treatment of each type of dental material in case the benefit covers only a portion of the cost (as shown in the table 2.4).

Table 2.4 Cost and reimbursement by health insurance financing schemes.

List	**number of surfaces**	**Insurance schemes**	**Cost* (USD)**	**Reimbursement****		
Topical fluoride application (including all types of fluoride: fluoride varnishes, fluoride gel and silver diamine fluoride)		UCS (encompass all Thais)	2.70	All Thai citizens get free services at National Health Security Office-contracted service units.		
Dental sealant application (including all types of sealants: glass ionomer, resin composite)			6.75	Payment method: 1. capitation 2. fee for service (fee schedule)		
				UCS	SSS	CSMBS
Alternative dental restorative materials and including glass ionomer, resin composite and compomers)	1-surface	UCS/SSS/ CSMBS	10.81	Capitation	Limit at 24.32 USD/ year	Limit at 10.81 USD/ tooth
	2-surfaces	UCS/SSS/ CSMBS	13.51	Capitation		Limit at 13.51 USD/ tooth
	≥3-surfaces	UCS/SSS/ CSMBS	16.22	Capitation		Limit at 16.22 USD/ tooth
Amalgam fillings	1-surface	UCS/SSS/ CSMBS	7.03	Capitation		Limit at 7.03 USD/ tooth

List	number of surfaces	Insurance schemes	Cost* (USD)	Reimbursement**		
	2-surfaces	UCS/SSS/ CSMBS	9.73	Capitation		Limit at 9.73 USD/ tooth
	≥3-surfaces	UCS/SSS/ CSMBS	13.51	Capitation		Limit at 13.51 USD/ tooth

* Prices are based on government service agencies and the Comptroller General's Department, Ministry of Finance by using the exchange rate of 1 USD=37 Baht

** Reimbursement will vary according to people's benefits.

Payment method for each item:

1. Topical fluoride application

The payment of this benefit varies from the MOPH policy. If the Ministry of Public Health proposes to focus on group-specific promotional services, it will propose a payment model beyond capitation. It will propose that the National Health Security Office reimburse service fees on a fee-for-service basis. In 2020, fee-for-service payments were made for the use of topical fluoride in children aged 4-12 years. Currently, since 2023, fee-for-service payments have been made for the use of topical fluoride in the age group of 25-59 years at a rate of 2.70 USD (100 Baht) 2 times/person/year. For other age groups, service reimbursement is still paid on a capitation basis.

2. Dental sealant

Currently, the service reimbursement model for pit and fissure sealants is capitation. However, in 2020, the payment model was adjusted to a fee-for-service basis at a rate of 6.75 USD per tooth (250 Baht/tooth), specifically for the first and second molars in the age group of 6-12 years only.

3. Dental filling

The National Health Security Office (NHSO) reimburses healthcare providers on a capitation basis, without separating dental treatment fees. Beneficiaries do not need to pay any out-of-pocket expenses. The Comptroller General's Department reimburses services on a fee-for-service basis, with a set price. If the service fee exceeds the set price, beneficiaries need to pay the difference. Similarly, the Social Security Office sets a capitation reimbursement rate for scaling, filling, and extraction at 24.32 USD/year. If there are additional service fees, beneficiaries need to pay the difference.

Thai citizens can receive oral health promotion services for free, including oral health examination, topical fluoride application, and dental sealants, from contracted healthcare facilities within the network of the National Health Security Office (NHSO). These services are aimed at preventing dental caries (cavities) and promoting overall oral health. When receiving

oral health promotion services at NHSO-affiliated facilities, Thai citizens are not required to make any out-of-pocket payments. The NHSO covers the full cost of these services, ensuring that all citizens have equitable access to preventive oral care. If Thai citizens choose to receive oral health promotion services from healthcare providers outside the NHSO network, they may be subject to charges depending on the specific provider's fee structure. It is advisable to inquire about the cost of services upfront to avoid unexpected expenses. Thus, Thailand's universal healthcare system, through the NHSO, prioritizes preventive oral care by offering free oral health promotion services to all citizens. By utilizing NHSO-networked facilities, individuals can access these services without financial burden and contribute to maintaining good oral health throughout their lives.

Thai citizens enrolled in the Universal Coverage Scheme (UCS) can receive dental restoration services free of charge at designated NHSO-affiliated healthcare facilities. This coverage is mandated by law, ensuring that NHSO beneficiaries have equitable access to essential dental care. When NHSO beneficiaries undergo dental restoration procedures at NHSO-networked facilities, they are not required to make any out-of-pocket payments. The NHSO covers the full cost of these services, including the use of filling materials that are deemed appropriate by dentists.

Thai citizens enrolled in the Social Security Scheme (SSS) are entitled to dental restoration services, but unlike National Health Security Office (NHSO) beneficiaries, they are not covered for the full cost of these services. Instead, SSS beneficiaries receive an annual dental reimbursement of 900 Thai baht (approximately 24.32 USD/year). The 900 Thai baht annual dental reimbursement covers a range of dental services, including tooth filling, scaling, tooth extractions and wisdom tooth extractions. If the total cost of dental services exceeds the annual 900 Thai baht reimbursement, SSS beneficiaries are responsible for paying the remaining out-of-pocket expenses. The cost of dental services can vary significantly depending on the complexity of the procedure, the materials used, and the dental provider's fees. However, insured individuals have access to a wider range of service providers, including private dental clinics and private hospitals with dental departments that have partnered with the Social Security Office.

Thai citizens enrolled in the Civil Servant Medical Benefit Scheme (CSMBS) are entitled to dental restoration services at government healthcare facilities. However, unlike National Health Security Office (NHSO) beneficiaries, CSMBS beneficiaries are not covered for the full cost of these services. Instead, they receive reimbursement based on a pre-determined schedule set by the Comptroller General's Department (CGD). The reimbursement rates for dental restoration services under CSMBS vary depending on the specific procedure and the materials used. For instance, if a CSMBS beneficiary undergoes a tooth filling using a tooth-colored alternative material on one surface of one tooth, and the total cost charged by the healthcare facility is 1,000 Thai baht (approximately 27.03 USD), the beneficiary would be eligible for a reimbursement of 400 Thai baht (approximately 10.81 USD) and pay the remaining difference of 600 baht (approximately 16 US dollars). The beneficiaries may have out-of-pocket expenses for dental services depending on the actual cost of the procedure and the reimbursement

rates set by the CGD. The beneficiary is responsible for paying the upfront cost of the treatment and can then submit a claim to the CSMBS for reimbursement.

Moreover, vulnerable groups with Universal Coverage Scheme can receive oral health services free of charge at designated NHSO-affiliated healthcare facilities. This ensures that financial constraints do not prevent them from accessing essential oral health care.

2.6 Recommendation-specific measures by insurance schemes to limit the use of dental amalgam

To encourage the use of alternatives to amalgam, insurance policies can be modified to favor the use of quality alternatives to dental amalgam for dental restoration This can be achieved by:

Measure 1: Phasing out financial support for amalgam

Scope of activities:

Insurance policies can be phased out to no longer provide financial support for amalgam, while phasing in financial support for mercury-free dental restorations

Considerations:

This recommendation would consideration about budget impact for shifting filling with amalgam to alternative filling materials. According to the data from the Health Data Center, Ministry of Public Health. It can be assuming the budget impact from that data as shown in the table 2.5

Hypothesis: Number of dental restorations per year: 1,000,000 - 2,500,000
Average cost per amalgam restoration: 300 baht (around 10 USD)
Average cost per alternative material restoration: 500 baht (around 13 USD)
Number of dental restorations per year (from the Health Data Center):
2021: 1,092,324
2022: 1,202,799
2023: 2,206,900
2024: 2,500,000 [predicted]

Table 2.5 The data showing the financial impact of phasing out dental amalgam in 2024.

Year	Dental fillings (times) A	Ratio Amalgam/ Alternative fillings	Amalgam fillings (times) A*Ratio (B)	Cost (B)x10 USD	Alternative fillings (times) A*Ratio (C)	Cost (C)x13 USD	Budget impact (USD)
2021	1,092,324	50:50	546,162	5,461,620	546,162	7,100,106	12,561,726
2022	1,202,799	30:70	360,840	3,608,400	841,959	10,945,467	14,553,867
2023	2,206,900	10:90	220,690	2,206,900	1,986,210	25,820,730	28,027,630
2024	2,500,000	0:100	0	0	2,500,000	32,500,000	32,500,000

According to the table, phasing out financial support for amalgam may cause financial problems for the health insurance fund, which will have to bear the increased costs from not reimbursing the services resulting from the complete transition from amalgam fillings to alternative materials by 2024. The budget will be increased due to the cost of alternative filling materials and the number people can access to dental services in the future. Furthermore, focusing solely on treatment support will lead to a continuous increase in healthcare costs within the country. It is crucial to prioritize prevention to achieve sustainable reduction in the nation's healthcare expenditures.

Thus, policy changes to promote the use of alternative materials instead of amalgam may impact the oral health budget, potentially requiring increased funding to support the higher costs of alternative materials.

Measure 2: Revising insurance company policies

Scope of activities:

Private insurance companies can revise their policies to give preference to mercury-free dental restorations, which can help reduce the use of amalgam

Considerations:

Propose insurance premium adjustments that incentivize policyholders to choose alternative filling materials over amalgam such as reduced premiums: offer lower premiums for policyholders who opt for alternative filling materials, treatment discounts: provide discounts on dental treatment costs for fillings done with alternative materials and demonstrating the insurance company's commitment to environmental sustainability and the well-being of its policyholders, which can strengthen its brand image and reputation.

Measure 3: Cost and reimbursement policies

Scope of activities:

Cost and reimbursement policies may need to be considered when amalgam alternatives are used, and the material recommendation requires the consideration of these policies.

Considerations:

This measure shifts the focus from reducing amalgam use and transitioning to alternative materials, to emphasizing caries prevention. This is achieved by adjusting the pricing and reimbursement of topical fluoride application and fissure sealants. In the past, Thailand implemented the caries prevention program for children by changing payment mechanism from capitation to fee schedule in topical fluoride application and dental sealant. The result showed the access rate was increased (table 2.6 and 2.7).

Table 2.6 The data on pit and fissure sealant application in permanent teeth of children aged 6-12 years, by year.

Year	Number of teeth	Number of children	Payment method
2019		662,092	Capitation
2020	4,360,727	1,341,037	Fee schedule

2021	1,639,950	589,163	Capitation
2022	874,093	353,586	Capitation
2023	1,585,247	629,786	Capitation

Table 2.7 The data on topical fluoride application of children aged 4-12 years, by year.

Year	Number of children	Payment method
2019	662,092	Capitation
2020	1,341,037	Fee schedule
2021	589,163	Capitation
2022	353,586	Capitation
2023	629,786	Capitation

It can be assumed that adjusting the reimbursement method for dental services results in increased utilization or access to dental services, especially in promoting and preventing oral diseases. To reduce restorative dental services, focusing on increasing compensation for promoting and preventing oral diseases would be a more sustainable option than increasing compensation for dental treatment. These are effective cavity prevention; it will help reduce the need for dental restorative materials. As a result, the likelihood of tooth decay will decrease, and tooth-colored materials can be used for restorations without significantly increasing the cost of benefits.

Measure 4: Collaboration with stakeholders

Scope of activities

The universal health coverage (UHC) policy can collaborate with various stakeholders, such as committees overseeing the UHC system, including the National Health Security Office (NHSO), the Comptroller General's Department, the Social Security Office, and private insurance companies.

Considerations:

There should be collaboration with agencies responsible for the welfare of the public or groups involved in managing health insurance funds. This collaboration aims to modify the service reimbursement structure, leading to increased access to dental services for the population, particularly in promoting and preventing tooth decay. It is also important to emphasize the significance of reducing amalgam use. If amalgam use is to continue, it is necessary to increase the cost of managing waste generated from amalgam.

3. (ORAL) HEALTH WORKFORCE EDUCATION AND TRAINING

3.1 Size, composition, and distribution of oral health workforce.

The oral health workforce in Thailand includes dentists, dental assistants, dental nurses and dental technicians, other primary health care workers, including community health workers (i.e. village health volunteers), may be trained to respond to population oral health needs.

1. Dentist

According to the Dental Council, there was approximately one dentist for every 3,400 people in Thailand in 2022. This estimation was based on the number of dentists in the private and government sectors. Until December 2023, the Council had granted licenses to 21,019 recent dental graduates, authorising them to work as dentists. Currently, 18 dental schools are accredited by the Dental Council. Approximately 800 dental graduates are registered annually to practice dentistry in Thailand (Figure 3.1).

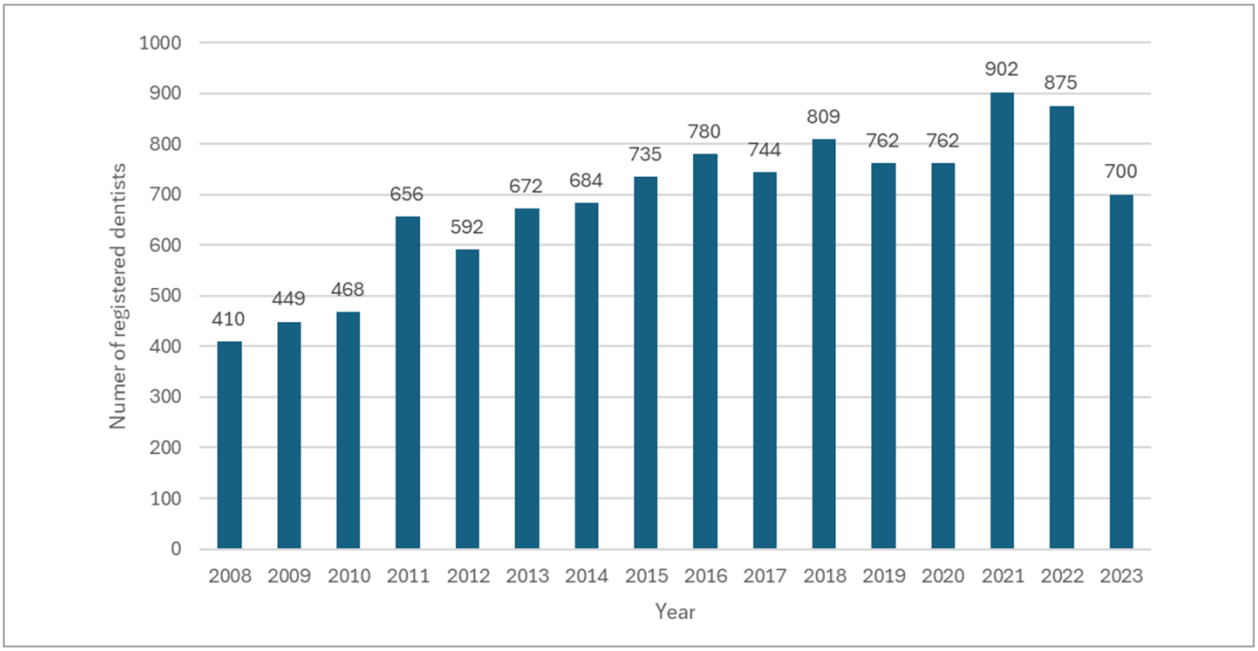
As of August 1, 2023, information from the Human Resources Management Division revealed that there were 6,177 dentists employed in government sectors across 12 health zones, excluding Bangkok (designated as health zone 13), within the Ministry of Public Health (Table 3.1). Thailand is segmented into 13 health zones, encompassing Bangkok (designated as Zone 13), emphasizing enhancing service infrastructure across primary, secondary, tertiary, and specialised medical facilities. The health zone framework is designed to establish an interconnected system known as the “Seamless Health Service Network,” leveraging principles of resource pooling and knowledge-sharing to facilitate connectivity among service systems (Appendix A).

2. Dental assistant

Many dental assistants in Thailand work in the private sector, such as in hospitals, dental hospitals, and dental clinics, and there are no official reports on the current numbers of dental assistants in Thailand in the private sector. However, from the Human Resources Management Division, Office of the Permanent Secretary, Ministry of Public Health (Table 3.1), 1,382 dental assistants work in the Ministry of Public Health in 12 health zones, excluding Bangkok (designated as health zone 13).

Dental assistants can be trained through formal education, such as the Dental Assistant Diploma Program (one year) or the Advanced Dental Assistant Diploma Program (two years). There are currently nine institutes in Thailand offering dental assistant training programs (Chulalongkorn University, Khon Kaen University, Thammasat University, Chiang Mai University, Naresuan University, Mahidol University (2-year program), Srinakharinwirot University, Prince of Songkla University, and Dental Institute, Department of Medical Services, Ministry of Public Health).

Figure 3.1 Number of dentists who have the national license to practice dentistry in Thailand from 2008 - 2023.



Source: The Dental Council of Thailand, 2023

Table 3.1 The distributions of dental personnel in Thailand divided by health zones, excluding Bangkok (zone 13), 2022.

Health Zones	Dental technicians	Dentists	Dental nurses*	Dental assistants	Supporting staff in the dental team	Total
1	4	703	711	248	230	1,454
2	4	363	436	90	139	741
3	3	372	389	57	159	715
4	5	515	591	55	251	1,033
5	3	560	649	106	258	1,123
6	4	548	651	67	242	1,122
7	2	501	661	106	151	1,036
8	3	498	714	118	242	1,111
9	5	660	598	153	367	1,483
10	2	403	556	114	201	909
11	0	522	589	110	228	1,118
12	3	532	651	158	186	1,166
Total	**38**	**6,177**	**7,196**	**1,382**	**2,654**	**13,011**

*Dental nurses = Dental public health officer/Public health academic position
Source: Human Resources Management Division, Office of the Permanent Secretary, Ministry of Public Health (as of April 20, 2025)

3. Dental nurse

As of May 2022, the Human Resources Management Division, Office of the Public Health Office, reports approximately 7,300 dental nurses. Of these, around 7,196 works within the Ministry of Public Health, with approximately 120 employed in other governmental organizations (table 3.2). https://dentalcouncil.or.th/Articles/Contents/Detail/1/A2wQeuKFIN7yboDW

Under the regulation of the Ministry of Public Health issued in 2016, the roles and responsibilities of dental nurses have the duty to provide oral disease prevention and oral health promotion at the individual, family and community levels. The dental nurses can provide dental fillings in primary teeth and fillings of uncomplicated carious permanent teeth. There are Sirindhorn College of Public Health 7 locations throughout Thailand that provide the Advanced Diploma Program in Public Health, 4 years program for dental nurses.

Table 3.2 The number of dental nurses in the Ministry of Public Health, 2022.

Agency	Number	Percentage
Sub-district hospital	4,220	58.6
District hospital	2,201	30.6
Provincial hospital	494	6.9
Other agencies in the Ministry of Public Health	280	3.9
Total	7,196	100.0

Source: Human Resources Management Division, Office of the Public Health Office, 2022

The proportion of dentists approved by the Dental Council for work in the primary health care service group is one dental nurse per 5,000 people or two dental nurses per 1 family doctor team. Therefore, Thailand's goal is to develop 6,500 family doctor teams over ten years, which means there is a total need for 13,000 dental nurses.

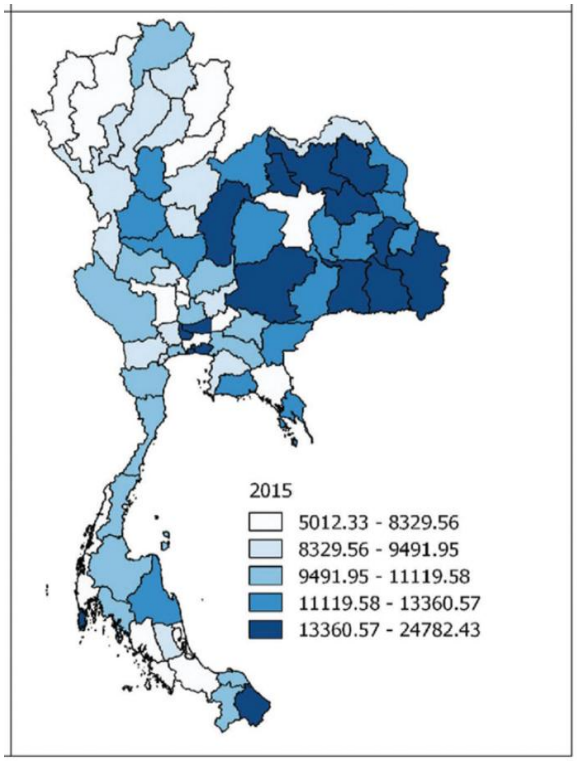
While the number of dentists in Thailand has increased continuously, a previous study demonstrated that dentist-to-population ratios were unfavorable in the Northeast region, whereas dentists were more clustered in the Central region[1]. The ratio was only 1:5,000 in some urban settings compared to 1:16,000 in rural areas.

However, the analysis of anticipated statistics concerning dentists and dental nurses in Thailand by 2026 revealed a requirement for approximately 15,742 to 16,764 dentists (with a dentist-to-population ratio ranging from 1:4,217 to 1:3,960, respectively) and between 8,669 and 12,140 dental nurses (with a dental nurse-to-population ratio ranging from 1:7,657 to 1:5,468, respectively)[2]. This forecast assumes dentists handle all dental treatment responsibilities, while dental nurses primarily concentrate on health promotion and preventive measures. Thus, the present data indicates that the productivity of the overall number of dentists and dental nurses in the current situation was not a concern; however, the career path of dental nurses should be supported and monitored to keep them in the health service sector. In addition, the distribution of dentists in the regions may need to be monitored to keep the proportion of dentists and population

ratio at the desired level.

The future direction may include coordinating with Sirindhorn College of Public Health and Praboromarajchanok Institute of Health Workforce Development, as well as the Subdistrict Administrative Organization/ Provincial Administrative Organization, in dental nurse training to reduce the use of dental amalgam. In addition, the related dental organization may provide continuing education to provide knowledge and improve the skills and techniques for alternative materials.

Figure 3.2 Distribution of Dentists in Thailand in 2015[1].



3.2 National health workforce policy, plan or strategy and whether a workforce trained to respond to population oral health needs is included in the policy/plan/strategy

The Thailand Oral Health Strategic Plan 2023-2037 addresses the management of human resources in oral health as part of strategy 3, which prioritizes the assurance of an adequate and competent oral health workforce alongside promoting their well-being (Figure 3.3). Within this objective, there are two specific aims: firstly, to strategies the production, allocation, and progression of the oral health workforce, and secondly, to enhance the capacity and skills of the oral health workforce within the system. Strategy encompasses two distinct plans: Work Plan No.1 focuses on human resource management (HRM), while Work Plan No.2 centers on human resource development (HRD). The main targets of the oral health workforce were to increase the number of personnel with competency in policy development and public health care management

and the percentage of oral health personnel who meet the criteria for primary care units with adequate quality and competency (Table 3.4).

Regarding human resource management, the primary initiatives encompass optimizing workforce management within the oral health system to enhance service accessibility, ensuring coverage and quality, sustaining the oral health workforce, and facilitating the production of oral health professionals (Table 3.4). In terms of human resource development, the initiatives involve enhancing the capabilities of the oral health workforce to bolster policy administration and the management of dental public health, cultivating oral health professionals to reinforce the primary care system, and nurturing oral health expertise to support secondary, tertiary, and specialized services (Table 3.5).

Figure 3.3 Links between strategies in Thailand's Oral Health Strategic Plan 2023-2037.

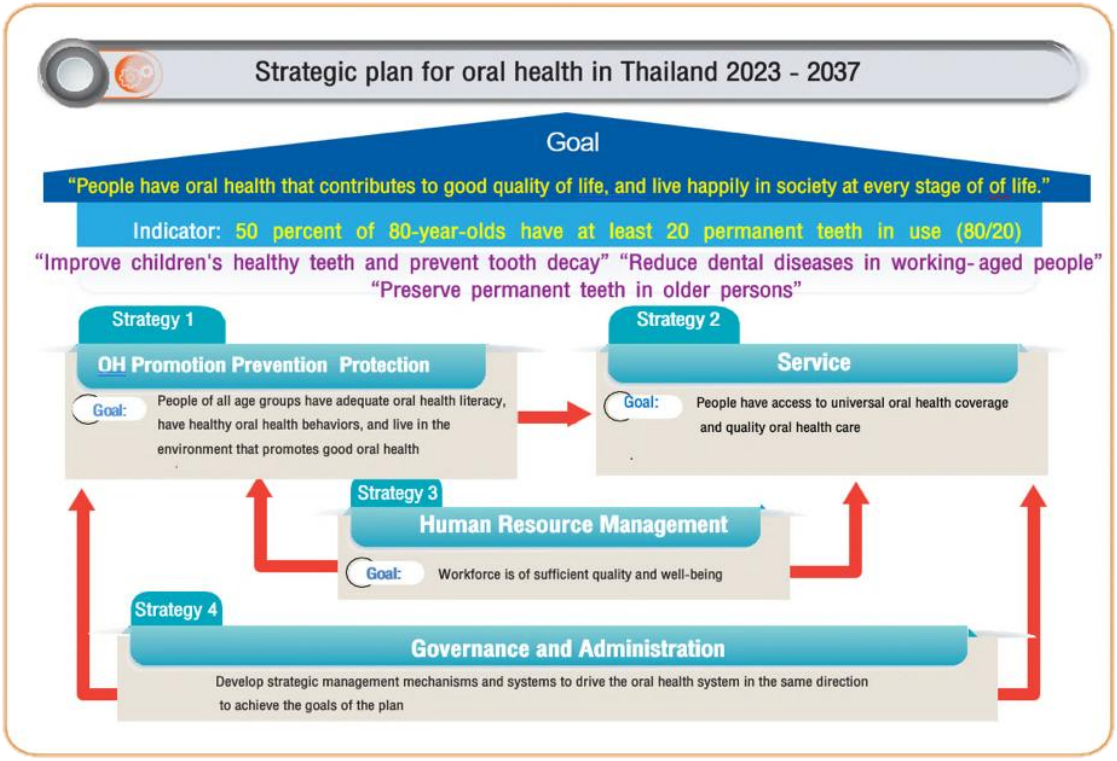


Table 3.3 Indicators and targets of managing human resources in oral health in the years 2027, 2032, and 2037.

Indicators and target values	Year		
	2027	2032	2037
Number of personnel with competency in policy development and manage public health care (persons)	750	1,500	2,500

Percentage of personnel who meet the criteria for primary care units to have adequate quality and competency	50	80	100

Source: Bureau of Dental Bureau of Dental Health, Department of Health, Ministry of Public Health

Table 3.4 Human Resource Management (HRM), planning for production, distribution, and career growth of oral health workforce (Work plan No.1).

Project Work Plan No.1	Key Measures	Agency
1. Workforce management in the oral health system to increase access to services to achieve coverage and quality	1. Establish a committee to determine and drive the national oral health workforce policy. 2. Support and strengthen the mechanism for determining and driving oral health workforce policy at the local level. 3. Plan the country's oral health workforce to align with the population's health needs, the oral health service system and the country's future changing directions.	1. Office of the Permanent Secretary, Ministry of Public Health 2. Dental Faculty Consortium of Thailand 3. Praboromarajchanok Institute of Health Workforce Development 4. Thai Dental Council /Royal College of Dental Surgeons 5. Dental Institute, Department of Medical Services 6. Department of Health, Ministry of Public Health 7. Office of the Civil Service Commission
2. Maintain the oral health workforce.	1. Develop career paths for oral health personnel in all professions, including receiving appropriate compensation for their work. 2. Develop an appropriate work incentive system	1. Office of the Permanent Secretary, Ministry of Public Health 2. Dental Institute, Department of Medical Services 3. Department of Health Office of the Civil Service Commission
3. Produce oral health workforce	1. Set a plan for producing oral health personnel that are appropriate for each professional field and have the freedom to practice their profession in accordance with the law. 2. Set an assessment of the potential and competency of oral health personnel that is consistent with the context of each period. 3. Develop curriculum proposals for teaching oral health in all professional fields.	1. Office of the Permanent Secretary, Ministry of Public Health 2. Dental Faculty Consortium of Thailand 3. Praboromarajchanok Institute of Health Workforce Development 4. Thai Dental Council /Royal College of Dental Surgeons 5. Dental Institute, Department of Medical Services

Source: Bureau of Dental Bureau of Dental Health, Department of Health, Ministry of Public Health, 2024.

Table 3.5 Human Resource Development Plan (HRD) (Work Plan No.2).

Project Work Plan No.2	Key Measures	Agency
1. Develop the oral health workforce to support policy management and management of dental public health.	1. Set a policy for workforce placement in the dental public health field. 2. Create a plan to develop workforce potential for managing dental public health work at all levels, including policy and public health administration training courses. 3. Plan successors for personnel in dental public health policy and management.	1. Office of the Permanent Secretary, Ministry of Public Health 2. Dental Faculty Consortium of Thailand 3. Praboromarajchanok Institute of Health Workforce Development 4. Thai Dental Council /Royal College of Dental Surgeons 5. Dental Institute, Department of Medical Services
2. Develop the oral health workforce to support the primary care system.	1. Develop the potential of dental hygienists to work in the primary care dental system. 1.1 Develop a curriculum. 1.2 Organize training for dentists and dental hygienists in primary care units or networks. 2. Develop a work support system for dental hygienists in the primary care dental system. 2.1. Research study to establish work support system standards. 2.2 Set work support system standards. 2.3 Evaluation.	2. Office of the Permanent Secretary, Ministry of Public Health 3. Dental Faculty Consortium of Thailand 4. Praboromarajchanok Institute of Health Workforce Development 5. Thai Dental Council /Royal College of Dental Surgeons 6. Dental Institute, Department of Medical Services
3. Develop the oral health workforce to support secondary, tertiary and highly specialized services.	1. Training specialists in specific fields by co-production between the Ministry of Public Health and the Faculty of Dentistry. 1.1 Support locations and equipment for training dentists who specialize in specific fields. a. Develop dentists who are specialists in specific fields who work in hospitals to become teachers. 1.3 Develop a curriculum that meets standards specified by	1. Office of the Permanent Secretary, Ministry of Public Health 2. Dental Faculty Consortium of Thailand 3. Praboromarajchanok Institute 4. Thai Dental Council /Royal College of Dental Surgeons 5. Dental Institute, Department of Medical Services

Project Work Plan No.2	Key Measures	Agency
	the Royal College of Dental Surgeons of Thailand. 1.4 Support budget for training operations. 2. Training of specialised dentists in a 4-month course 2.1 Develop training units 2.2 Support budget for training operations	

Source: Bureau of Dental Bureau of Dental Health, Department of Health, Ministry of Public Health, 2024.

3.3 National guidelines for the oral health workforce on using and managing dental amalgam, alternatives and handling of their associated wastes

Dental amalgam, the commonly used filling material for dental restorations, is at the forefront of these regulatory efforts. The Minamata Convention on Mercury provides guidelines for the member countries to reduce the amount of dental amalgam use (Phase-down) at least 2 measures with nine measures. Currently, Thailand's commitment to the Minamata Convention, particularly measures 1, 2, 5, 8, and 9, underscores the importance of our national objectives. These include reducing amalgam use, promoting alternative materials, limiting amalgam use to capsule form, and implementing best environmental practices in dental clinics. These efforts are crucial in mitigating mercury exposure risks and safeguarding human health and the environment.

3.3.1 Guidelines for the use of dental amalgams and alternative materials

In 2019, the Department of Health, Bureau of Dental Public Health launched the guidelines for the use of dental amalgams. These guidelines include information about the Minamata Convention, knowledge about mercury and dental amalgams, reducing the chance of getting poisoned from amalgam, and amalgam waste management.
https://www.oic.go.th/FILEWEB/CABINFOCENTER17/DRAWER002/GENERAL/DATA0002/00002273.PDF

In February 2022, the Department of Health, Bureau of Dental Public Health launched **"Guideline for Amalgam Phase Down in Dental Clinic".** These guidelines include the Minamata Convention on Mercury, guidelines for promoting health and preventing oral disease in pregnant women, screening and monitoring for dental caries in early childhood, alternative materials and usage, SMART Technique, reducing the use of amalgam and managing amalgam waste in dental clinics, and the evaluation of operations to reduce amalgam use and amalgam waste management in dental clinics.

In addition, in 2022, the Bureau of Dental Health, the Department of Health, proposed the **Standard Operating Procedure (SOP)** for the friendly environmental management of dental amalgam in dental clinics for hospitals in the Ministry of Public Health (Appendix B). The objectives include 1.) To use it as a guideline for managing and reducing the use of amalgam and

manage amalgam waste in an environmentally friendly clinic, and 2.) To serve as a guideline for supervising, monitoring, and evaluating the results of operations to reduce the use and management of amalgam waste in dental clinics to achieve GREEN&CLEAN Hospital criteria (a good level or higher). Then, in 2022, the Bureau of Dental Public Health launched the Guideline for Amalgam Phase Down in Dental Clinic. In this guideline, reducing the use of amalgam (Amalgam phase-down) refers to using mercury-free replacement filling materials for dental restorations, according to the Minamata Convention on Mercury, which Thailand became a party to in 2017. Amalgam Waste Management in dental clinics (Amalgam Waste Management) refers to separating amalgam waste from other types of waste in dental clinics, packed in containers, and labelled as "dangerous amalgam waste" for proper transportation, which goes to the hospital's hazardous waste stop and sent for disposal according to the Ministry of Public Health regulations on the management of toxic or dangerous waste from communities, B.E. 2020.

3.3.2 Guidelines for dental amalgam fillings and alternatives in pregnant women

Mercury vapor is commonly produced during the removal and placement of dental amalgam fillings, posing a risk of inhalation and absorption into the bloodstream. This mercury can potentially cross the placenta, making it crucial to perform the removal of amalgam fillings with utmost care in all patients. Precautionary measures are essential to minimize exposure, such as utilising a saliva-proof rubber sheet and employing a water coolant system during grinding alongside a high-power suction machine. Although there is currently no evidence suggesting adverse effects on the fetus from maternal amalgam fillings predating pregnancy, it is advisable that alternative materials such as glass ionomer and composites should be considered substitutes to minimize amalgam fillings for dental restorations in pregnant women.

3.3.3 Guidelines for screening and managing for dental caries in early childhood

Dental caries in early childhood is a common oral health problem. It affects the development and health of children both during childhood and in the long term. It may have an impact on growth, development, and intelligence and could affect the emergence of permanent teeth. Severe early childhood caries also significantly affects children's quality of life. Surveillance of dental caries disease means following up, observing, and considering the nature of changes in the oral cavity and tooth surface, including factors affecting that change. Health professionals working with children, including doctors, dentists, optometrists, nurses, and public health academics, play a crucial role in implementing these guidelines and ensuring children's oral health.

The guidelines for caries risk assessment for preschool children (from the **"Guideline for Amalgam Phase Down in Dental Clinic"**) present in Table 3.6. Factors contributing to the assessment of early childhood tooth decay risk can be categorized into three main areas: host factors, behavioral factors, and oral condition.

1. Host factors:
    - Consideration of special needs children as defined by the Act on the Promotion and Development of the Quality of Life of Persons with Disabilities, B.E. 2007, including those with impairments affecting vision, hearing, movement, communication, emotions, behaviour, intelligence, learning, or other areas.

- Children with cleft lip and cleft palate.
- Children with congenital diseases requiring regular medication, as well as those experiencing poor salivation or using medications that decrease saliva flow, such as antihistamines.

2. Behavioral factors:
   - Dietary habits:
     - Children over 1 year old who still consume late-night or bottled milk.
     - Children consume sugary foods between meals more than twice a day.
   - Oral hygiene practices:
     - Children whose teeth are not brushed by their parents at least twice daily.
     - Lack of fluoride toothpaste usage during tooth brushing.
3. Oral condition:
   - The presence of visible microbial plaques.
   - Initial signs of tooth decay characterized by white lesions.
   - Presence of cavities in the teeth.

3.3.4 Alternative materials and their uses

Dental amalgam has been the primary choice for restoring posterior teeth for over a century. However, as restorative materials and adhesives have advanced and aesthetic considerations have become more significant, coupled with concerns about the safety of mercury in amalgam for both health and environmental reasons, tooth-colored alternatives such as composite resins and glass ionomer have gained popularity as substitutes for amalgam.

Composite resin

Understanding the composition and properties of composite resins helps decide on materials for tooth restoration in different clinical situations by considering the type of composite resin appropriate for the location and size of the tooth cavity. Basic guidelines and considerations for the clinical use of composite resins are in Table 3.7.

Table 3.6 Caries risk assessment, recommendations, preventive dental services and monitoring.

Caries risk assessment	Recommendations, preventive services, and monitoring
Low risk - Risk behavior - Visible plaque (have 1 or both)	- Modify risk behaviors - Hands-on tooth brushing - Fluoride toothpaste 1,000 ppm - Topical fluoride every 6 months - Follow up every 6 months
High risk - Risk from host factor (disability, special needs, medical condition, medication) - Have initial carious lesion, white spot lesions (have 1 or both)	- Modify risk behaviors - Hands-on tooth brushing - Fluoride toothpaste 1,000 - 1,500 ppm - Apply topical fluoride every 3 months. - Follow up every 3 months

Caries risk assessment	Recommendations, preventive services, and monitoring
Very high risk - Cavitated lesion	- Modify risk behaviors - Hands-on tooth brushing - Fluoride toothpaste 1,000 - 1,500 ppm - Preventive service (SDF application, glass ionomer restoration) - Apply topical fluoride every 3 months. - Follow up every 3 months

Source: Guideline for Amalgam Phase Down in Dental Clinic, 2022

Table 3.7 Considerations for clinical use of composite resins.

Tooth cavity		Recommendations/Considerations
Anterior teeth	**Small cavity**	• It may be restored with only one color of universal composite resin by using a microfilled composite resin, nanofilled or nanohybrid, which can polish to a good esthetic.
	Large cavity	• In cases where beauty similar to natural teeth is desired, a composite resin system with various colors for different parts of the tooth, such as the cervical, coronal, and incisal, should be chosen. It is recommended that it be restored using the layering technique.
Posterior teeth		• In the occlusal surfaces, the compressive strength, hardness, surface, and resistance to breaking and fracture are the priority, and esthetic properties are secondary. • Since composite resins shrink with the volume of the material, it is recommended that large cavities be restored using the incremental restoration technique. • It is recommended to use a thin layer of dental base for the tooth cavity with a flowable resin composite with a low modulus elasticity, which helps absorb the chewing force well. It also helps reduce the occurrence of microleakage, thus reducing discolouration along the edges, secondary caries, and tooth sensitivity after tooth restoration.

Source: Guideline for Amalgam Phase Down in Dental Clinic, 2022

Glass ionomer

The most commonly used types of glass ionomer as dental restorative materials include glass ionomer cement modified with resin because it has good physical properties and is easier to use than traditional glass ionomer. Both types use light-cured resin and those that cure themselves. Although resin-modified glass ionomer cements have many advantages, they often fail when placed in dental cavities where moisture is uncontrolled. Considerations for selecting glass ionomer cement for restoration in each tooth cavity are in Table 3.8.

Table 3.8 Considerations for selecting glass ionomer cement for restoration in each tooth cavity with basic guidelines.

Tooth cavity Characteristics	Recommendations/Considerations
Class I cavity	• Glass ionomer cement is quite brittle. Therefore, it is not suitable for use as a material for permanent restorations in permanent teeth in areas that receive chewing forces. However, the cavity can be restored with composite resin only or with composite resin layered on glass ionomer cement, which will have better results in strength and aesthetics.
Class II cavity	• In the case of primary teeth, restoration of small to medium tooth cavities with glass ionomer cement is considered an ideal restoration. • In the case of permanent teeth, glass ionomer cement restorations are unsuitable for permanently restoring teeth in areas that are subject to force from chewing.
Class III cavity	• In the case of primary teeth, restoring the tooth cavity with glass ionomer cement is considered ideal because the material can release fluoride. • In the case of permanent teeth, Class III permanent tooth cavity restoration should not be performed for aesthetic reasons.
Class IV cavity	• Given the high aesthetic importance of this area, it is not recommended to utilize glass ionomer cement for restoration. Instead, composite resin is preferred for Class IV cavities due to its superior aesthetic appeal and strength.
Class V cavity	• Glass ionomer cement is commonly used to restore the cavities of primary and permanent teeth. For Class V cavities, which often involve extensive decay, particularly in posterior teeth where aesthetic concerns may be less significant, glass ionomer cement is suitable. However, if aesthetics are a priority in any area, such as for visible teeth, composite resin should be used for restoration.

Source: Guideline for Amalgam Phase Down in Dental Clinic, 2022

3.3.5 Restoration of primary teeth using the SMART technique

The SMART technique (Simplified Modified Atraumatic Restorative Treatment) is a tooth restoration developed from ART (Atraumatic Restorative Treatment) using a hand instrument to remove partial caries. The tooth cavity is then restored with glass ionomer cement (glass ionomer cement), an alternative option for tooth restoration, especially in primary teeth, to reduce (Phase-down) the use of amalgam. Table 3.9 indicates the advantages and indications for using the SMART technique in dental restoration.

Table 3.9 Advantages and indications for using the SMART technique in dental restoration.

Advantages of tooth restoration SMART technique	Teeth that can be restored with SMART technique	Teeth that cannot be restored with SMART techniques
- Uses few tools - Few steps - Less pain - Patients have less fear - Preserve tooth structure - It can be used both to restore teeth and prevent dental caries.	- Vital tooth - Shallow and deep cavities - Cavities can be one surface or multiple surfaces	- Cavity exposed dental pulp - Abscess or fistula present - Tooth with a history of pain or swelling - Unrestorable or unfunctional tooth

Source: Guideline for Amalgam Phase Down in Dental Clinic, the Bureau of Dental Health, 2022

3.3.6 Guidelines for managing amalgam waste in dental clinics

The management of dental amalgam waste centers on segregating it from other waste types within the dental clinic, securely packaging it in containers labelled “Amalgam Waste, Hazardous,” ensuring proper transportation to designated waste collection points and arranging for disposal in accordance with Ministry of Public Health regulations governing the management of toxic or hazardous waste from communities in 2020.

Amalgam waste can be classified as follows:

1. Amalgam capsule
2. Contact amalgam
3. Non-contact amalgam (non-contact amalgam)

Figure 3.4 Procedures for managing amalgam waste in dental clinics (for dental personnel).

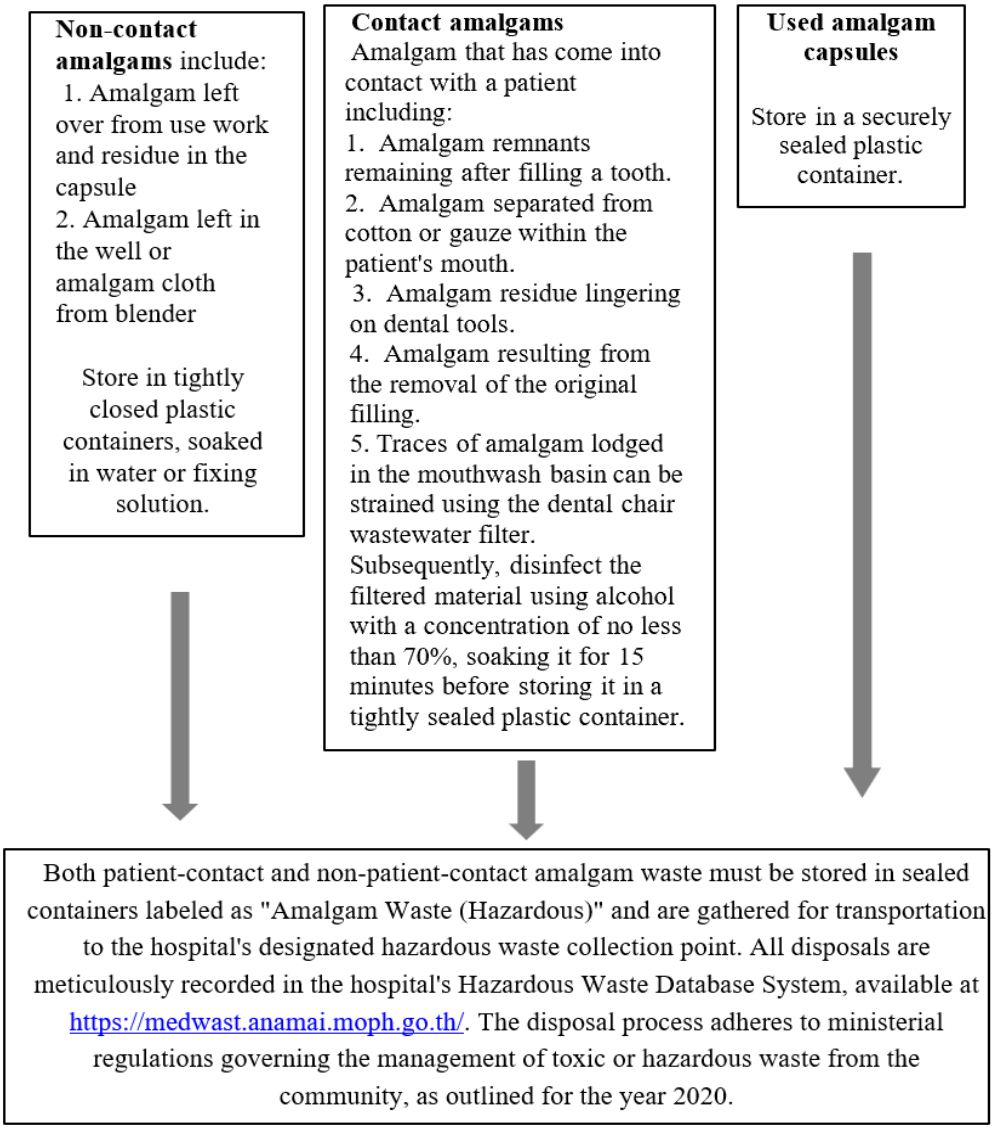
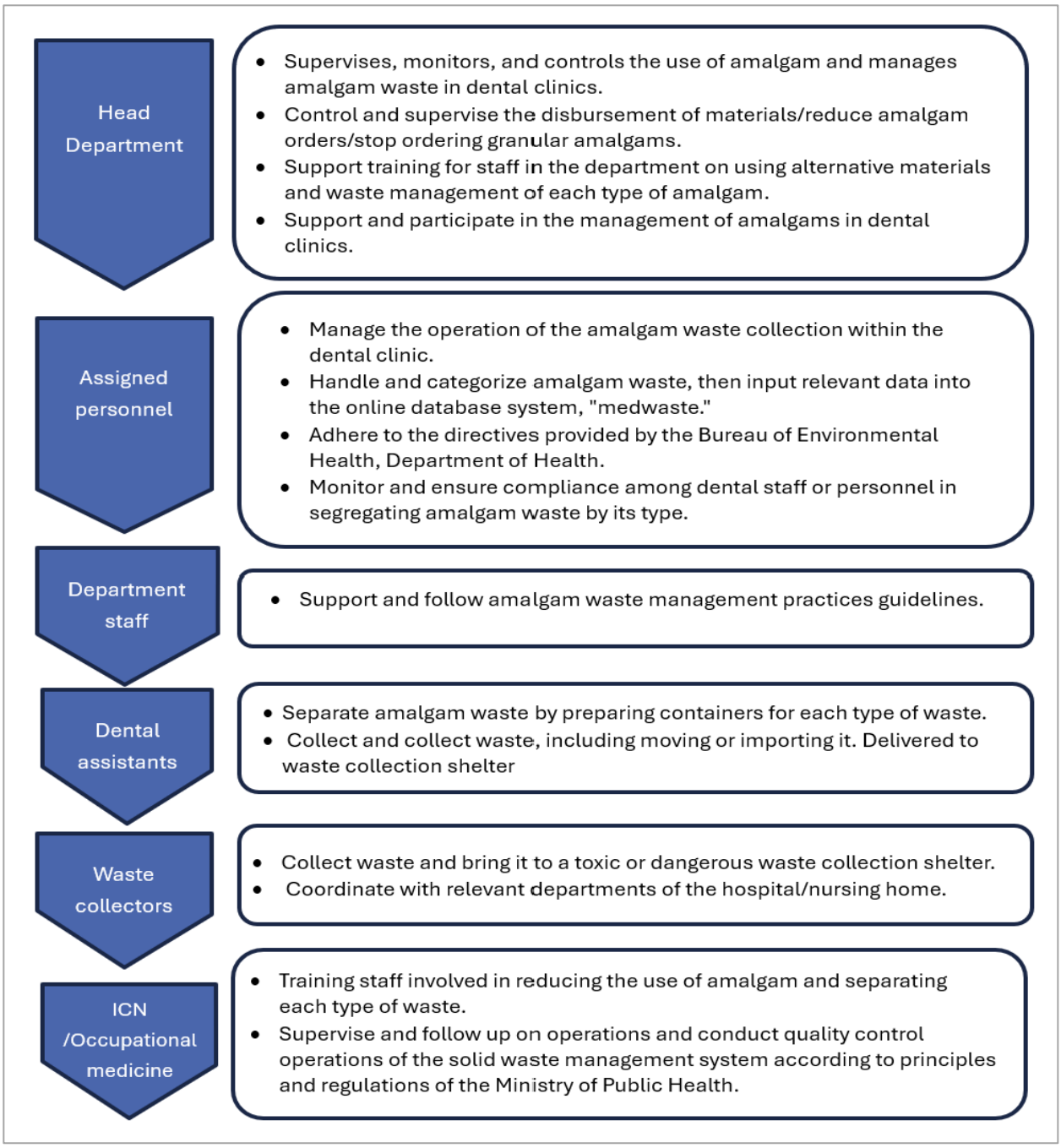


Figure 3.5 Flow work of practitioners in reducing amalgam use and managing amalgam waste in dental clinics.



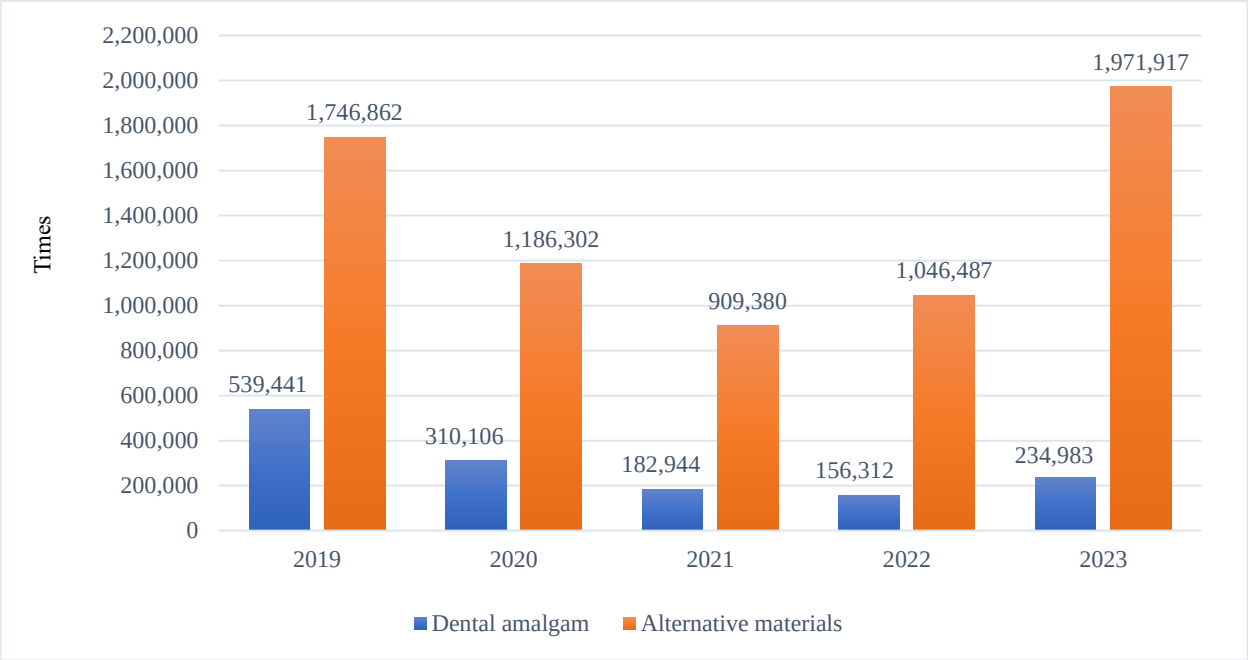
Source: Guideline for Amalgam Phase Down in Dental Clinic, the Bureau of Dental Health, 2022

3.4 Practices of the (oral) health workforce on the use and management of dental amalgam, alternatives and their associates' wastes.

The use of dental amalgam and alternative restorations

Trends in the use rate of dental amalgam and alternative materials in the government's Facilities under the Ministry of Public Health during fiscal years 2019 - 2023 is shown in Figure 3.6[3]. The number of times the population receiving dental amalgam fillings was significantly less compared to the number times of populations receiving alternative material fillings except fiscal year 2023. Each fiscal year during 2019 - 2023, the number of times the populations receiving dental amalgam fillings were 539, 310, 183, 156, and 234 per 1,000 populations, respectively. Those receiving the alternative material filling were 1,747, 1,186, 909, 1,046 and 1,972 per 1,000 populations, respectively.

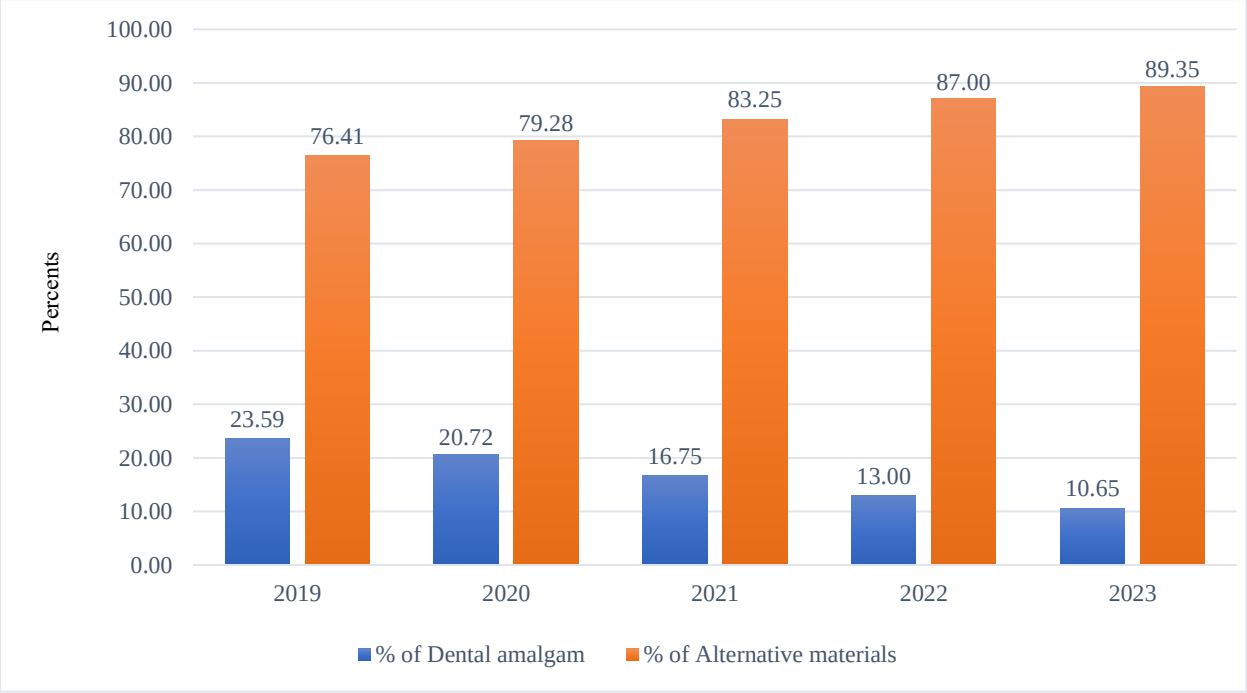
Figure 3.6 The use rate of dental amalgams fillings and alternative material fillings during fiscal year 2019-2023[3].



Remark: Alternative materials including resin composite, glass ionomer and compomer material

Figure 3.7 shows ratios of dental amalgam and alternative materials used in new fillings during fiscal year 2019 - 2023. Ratios of dental amalgam use in cavity fillings decreased every year from 23.59 percents in year 2019 to 10.65 percents in fiscal year 2023. On the other hand, the alternative materials were used more frequently, resulting 76.41 percents in fiscal year 2019 and 89.35 percents in fiscal year 2023.

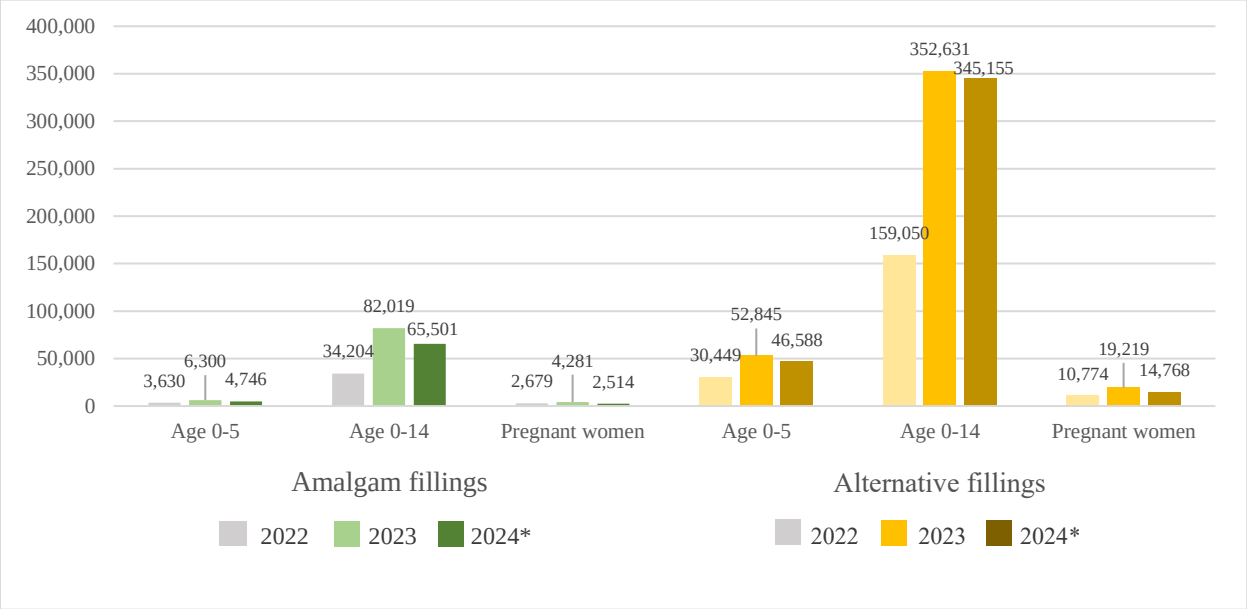
Figure 3.7 Ratios of dental amalgam and tooth-colored material (alternative material) used in new fillings during fiscal years 2019 - 2023[3].



Remark: Alternative material) including resin composite, glass ionomer and compomer material

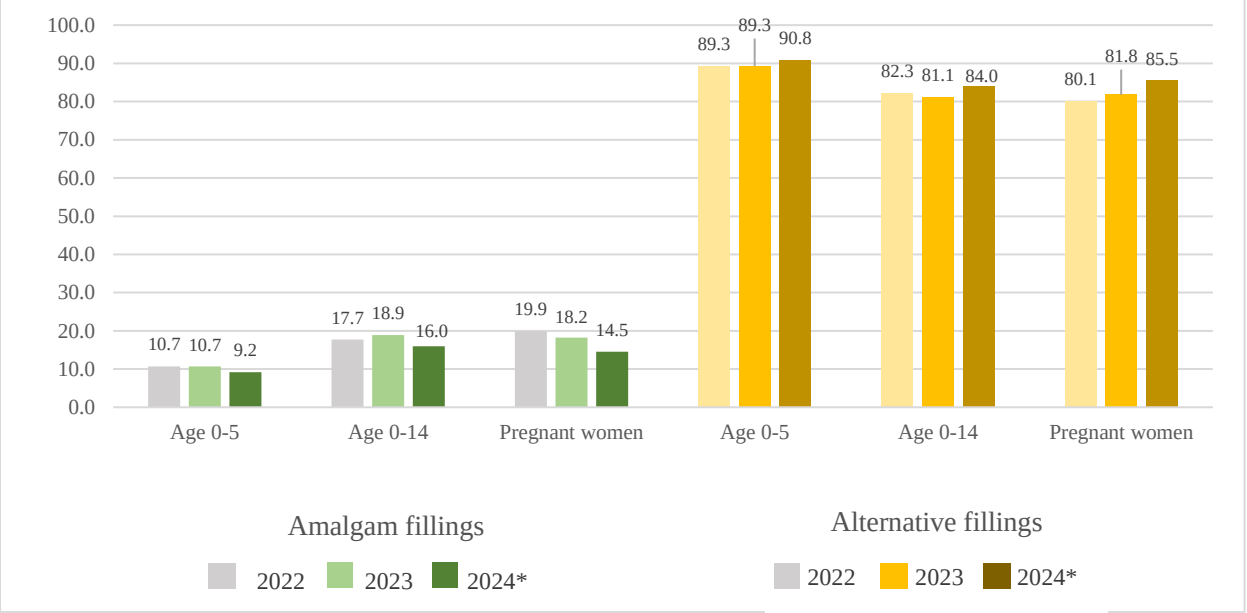
Since 2022, the Bureau of Dental Public Health has collected data on dental services and restoration of amalgam and tooth-colored filling (alternative materials) from the Health Data Center (HDC), Thailand's medical and health data warehouse system. Figures 3.8 and 3.9 show the number of restored teeth among three groups, including children aged 0-5, aged 6-14, and pregnant women. Overall, the dental restorations were increased from 2022 in all groups. The proportion of amalgam filling was lowest among the aged 0-5 group. The percentage of amalgam usage was approximately 11% to 19% of all dental fillings. In 2023, although there was an increase in the use of alternative fillings across all groups, the percentage of tooth-colored fillings remained unchanged from the previous year.

Figure 3.8 The frequency of amalgam and alternative filling uses among preschool, school children, and pregnant women during fiscal year 2022 - 2024.



Source: Health Data Center (HDC), Ministry of Public Health (as of August 1 2024)
*Data in fiscal year 2024 were collected only 10 months (October 2023 - July 2024)

Figure 3.9 Percentage of dental filling by types during fiscal years 2022 - 2024.

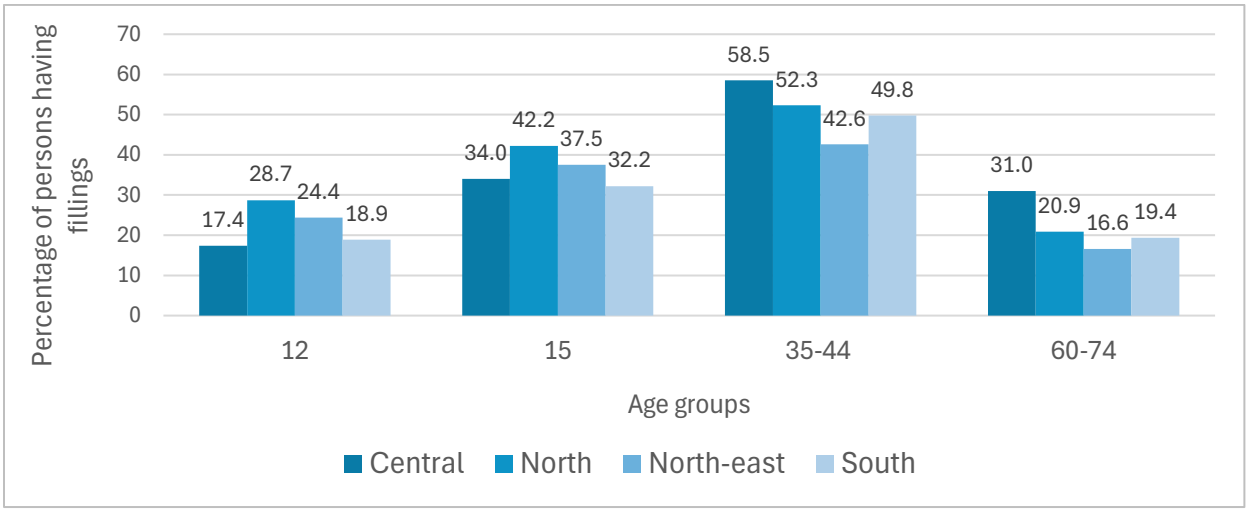


Source: Health Data Center (HDC), Ministry of Public Health (as of August 1 2024)
*Data in fiscal year 2024 were collected only 10 months (October 2023 - July 2024)

From the 9th National Oral Health Survey in 2023, the percentage of fillings was highest in the working age group (35-44 years old). The people from the central region received the most

filling, and the people from the Northeast region received the least. The trend was similar among 60-74-year-olds: the older people in the central regions received the highest filling percentage, followed by the north, the south, and the northeast. However, the proportion was different among teenager groups. The 12 and 15-year-olds from the northern region received the highest fillings, followed by north-eastern region (Fig 3.10).

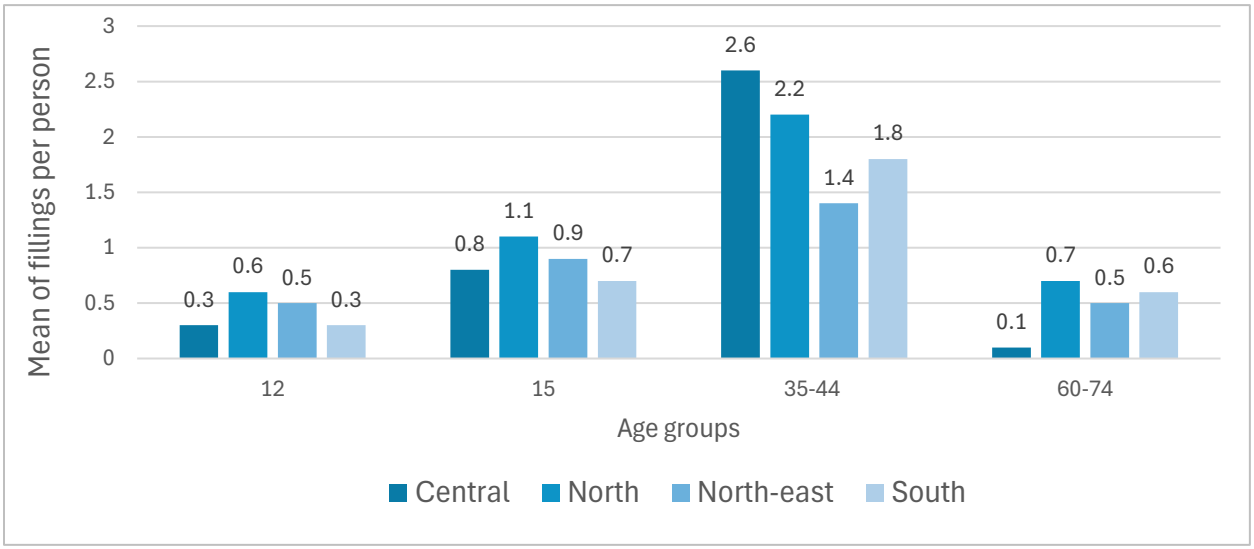
Figure 3.10 Percentage of persons who had fillings in different age groups by regions.



Source: The 9th National Oral Health Survey, 2023

The mean of fillings was highest among 35-44 years, with the highest in the central region, followed by the north, the south, and the lowest in the northeastern. However, for the 12- and 15-year-old groups, the mean fillings per person were highest in the north, followed by the northeastern and lowest in the central and southern regions. The number and percentage of fillings by region indicate the different practices of providers and behaviors of patients regarding dental service utilization, which have different patterns between children and adults (Fig 3.11).

Figure 3.11 The mean of fillings per person in different age groups by regions.



Source: The 9th National Oral Health Survey, 2023.

In the government sector, amalgam fillings were provided by both dentists and dental nurses, which may need to be further explored. Since the previous curriculum for the dental nurses was taught to restore teeth mainly by amalgam filling, the dental nurses may not be confident to provide the glass ionomer and tooth-colored fillings, which could affect the number of amalgams used, especially among children. However, the present policy to develop dental nurses in recent years has focused on prevention and promotion and has restricted the roles of dental treatment among dental nurses in Thailand. In addition, the present data indicates the increased number of restorations among these 3 groups, which may relate to the COVID-19 pandemic in which dental services were closed and were affected by the increased need for dental treatment post-COVID time. Thus, continuous monitoring of the use of amalgam filling, especially among dental nurses, and policy on providing continuing education and curriculum on alternative materials for dental nurses are recommended to reduce the use of amalgam fillings.

The dental amalgam waste management

Since the guidelines and the evaluation form to assess the amalgam waste management from the government hospitals in the Ministry of Public Health just started in 2022-2023, the data collection was in process.

3.5 Awareness-raising activities targeting the oral health workforce on the use and management of dental amalgam, alternatives and their associated wastes

Thailand has cooperated with the United Nations and implemented the measures according to the Minamata Convention on Mercury since 2017. According to regulations, it is necessary to reduce the use of amalgam in dentistry by switching to quality alternative materials with an emphasis on pregnant women and children under six years of age. In addition, following environmentally friendly guidelines, Thailand targets to reduce the use of amalgam, setting targets for amalgam waste management in pilot areas and expanding the results to all 12 health zones nationwide.

The awareness-raising activities at the national level included the presentation of academic conclusions on the impact of using amalgam on health and considering alternative materials at the 107th Thai Dental Association Academic Meeting on December 19, 2018, and at the 108th Thai Dental Association Academic Meeting on June 13, 2019. Then, the lecture on the topic Minamata Convention: Alternative Materials at an academic conference was presented at the 109th Thai Dental Association on December 20, 2019.

On December 8, 2021, the meeting to clarify the policy for reducing the use of amalgam materials in dental clinics was held at the Department of Health, Ministry of Public Health. The Deputy Director-General of the Department of Health explained the purpose of the meeting and clarified the policy to reduce the use of amalgam materials in dental clinics in the service establishment. The director of the Bureau of Dental Health described the project's purpose as accelerating operations to reduce the use of dental amalgams and strengthening countries' capabilities in environmental management under the Minamata Convention on Mercury. Thailand

has implemented five main measures: 1. Set national objectives to prevent tooth decay and promote oral health to reduce the need for dental restorations. 2. Encourage using alternative materials that contain mercury in restoration; 3. Support professional organizations in dentistry and dental educational institutions for the education and training of dentists and dental students in using mercury-free alternative materials that promote best management practices; 4. Limit the use of amalgam in capsule form. 5. Support using best environmental practices in dental facilities to reduce the release of mercury and mercury compounds into water and soil. According to the project of accelerating operations to reduce the use of dental amalgam, there are 2 main guidelines:

1. Policy on reducing the use of amalgam filling materials by promoting alternative materials among pregnant women and children under six years of age. Promote programs to prevent tooth decay in each age group by supporting prevention measures such as dental sealants and fluoride application.

2. Policy on the management of waste contaminated with amalgam by managing amalgam waste in an environmentally friendly manner according to the practice guidelines at the Dental Public Health Office. The Department of Health determines and reports results in the Dashboard Hazardous waste management database system of the Department of Health (Med waste)

The project expects countries participating in the project to adopt standards and manuals for reducing the use of dental amalgam, including the disposal of mercury waste, starting in 2022. This meeting involved relevant public and private network partners, including the Dental Institute, the Department of Medical Services, the Bureau of Dental Health, the Department of Health, the Department of Pollution Control, the head of the dental department in a large hospital in Thailand, the Association of Operative Dentistry, the Association of Pediatric Dentistry of Thailand, Private Dentist Association of Thailand. The meeting proposed enacting legislation regarding amalgam waste management to ensure standards and clear operational guidelines. In addition, there should be concern about using amalgam separators due to the high cost and the need to adjust the wastewater drainage system of the entire dental unit. Finally, the meeting concluded that the Bureau of Dental Health to follow up on the announcement of the Ministry of Public Health regarding the use of dental amalgam product containers and the designation of dental amalgam products packaged in pellet and powder form as medical devices that are prohibited from being produced, imported, or sold. The research recommendation on the reference levels of mercury-contaminated dental wastewater from the U.S. Environmental Protection Agency (USEPA) and the amount of mercury in dental wastewater in Thailand was proposed.

In 2022, the Bureau of Dental Health launched the Standard Operating Procedure (SOP) to provide guidelines to reduce the use of amalgam and environmentally friendly management guidelines for amalgam waste in dental clinics.

The workshop to develop models for using alternative materials and managing amalgam waste in dental clinics was held from 24 - 25 February 2022. The workshop comprised a series of lectures on implementing the Minamata Convention on Mercury and the effects of mercury on

health and the environment. The workshop included presenting a model for reducing the use of amalgam in dental services and a target model for amalgam waste management from pilot areas and health centers, lectures on caries management of primary teeth with alternative materials, minimal intervention approaches, and community medical waste management. Suggestions from experts at the meeting were:

1. Promoting policies to reduce tooth decay to reduce the need for tooth restoration is considered a priority that should be done, and there is a good guideline.
2. Follow current trends in amalgam use; there should be a clear pattern.
3. Manual for managing mercury-contaminated waste in a good format (Best Practice).
4. Managing amalgam waste using an amalgam separation device or amalgam separator is not considered necessary. However, it should be measured by the amount of mercury in the sewer system that is not within the specified standard, and the dental room does not release toxins into the environment.

Suggestions from advisors to the Department of Health were:

1. Dental personnel should be encouraged to use alternative materials instead of filling with amalgam. Since the price between amalgam and composite resin is hardly different, better management practices should be encouraged.
2. Proposed management of amalgam pellets with a relatively high excess of mercury by entering it in the evaluation form, collecting it, and sending it to a legal mercury disposal company.
3. Reducing amalgam can be done by preventing tooth decay in children under 6 years old and pregnant women

3.6 Health (oral) curricula (undergraduate and postgraduate) and learning activities as part of continuous professional development

Curriculum at undergraduate and postgraduate levels

The survey regarding the use of amalgam and teaching topics related to the use and management of dental amalgam, alternatives and their associated wastes was conducted in April-May 2024. The online questionnaire was distributed through the Dental Faculty Consortium of Thailand (DFCT), comprising the Dean and committee members from all faculties of dentistry in Thailand. The content in the dental curriculum was asked on the following teaching/learning topics (Appendix C):

Q1: Mercury and risks to human health and the environment

Q2: Environmentally friendly amalgam waste management practices to reduce mercury waste and pollution from dental work.

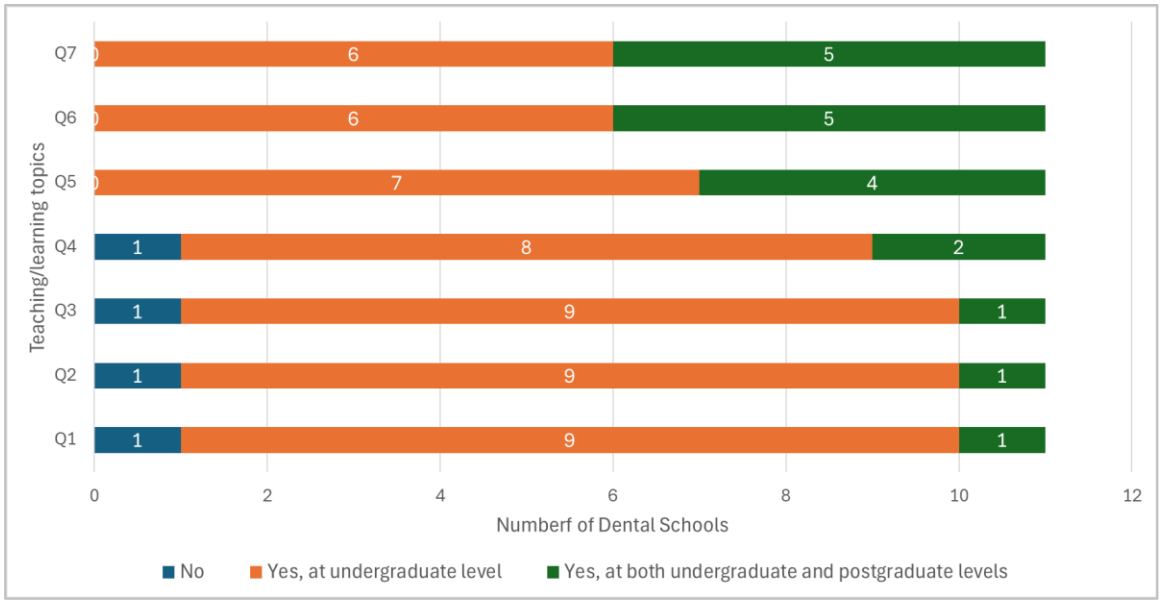
Q3: Reducing the use of amalgam in accordance with the Minamata Convention and the role of dental health professionals

Q4: Toxicology for health and the environment, safety of amalgams and alternative materials

Q5: Using alternative amalgam-free materials to prevent and treat dental caries.
Q6: Select and use dental materials for restoration based on the best evidence available, clinical judgment, and patient needs.
Q7: Guidelines for restoring teeth using alternative materials and conservative methods of restoring teeth

The survey results indicated that almost all topics, including the effect of amalgam on health and environment, the Minamata Convention on Mercury, alternative dental materials and minimally invasive restoration, and amalgam waste management, were taught at dental schools in Thailand (Figure 3.12). Among the 11 responses from the faculties, there were some learning topics related to mercury and risks to human health and the environment (Q1), environmentally friendly amalgam waste management practices (Q2), the Minamata Convention and the role of dental health professionals (Q3), and toxicology for health and the environment, safety of amalgams and alternative materials that have not been taught in only one dental school.

Figure 3.12 The number of dental schools reported teaching and learning topics (Q1-Q7) in the dental curriculum (undergraduate and postgraduate) related to the Minamata Convention on Mercury.



Requirements for dental students in response to phase-down amalgam in dental schools

During the past five years, the dental faculty adjusted the curriculum or requirements to reduce the use of amalgam materials to respond to the phase-down amalgam policy. All dental schools no longer require amalgam fillings in the patients since amalgam filling is no longer required for the national license exam since 2019. Most dental schools reduce the practice period and requirement of amalgam filling in the dental curriculum with only some amalgam filling practices in the laboratory but do not require amalgam filling in clinics. At present, every

institution is using more alternative materials. Many universities have stopped using amalgam in their clinics and expressed that some government hospitals have stopped using amalgam.

Policy and Guidelines in Dental Schools to reduce amalgam use

About 45% of the dental schools reported having the policy and guidelines to reduce amalgam use, while 36.4% reported follow-up on the amount of mercury in the waste management. Some dental schools (20%) reported training and raising awareness activities during the past five years. These activities include training in the safety handling and waste management of amalgam at the relevant department level, educating and managing staff to properly collect waste from mercury and amalgam contamination in clinics and laboratories, and some dental hospitals stopping ordering amalgam materials. Over the past five years, the dental schools reported that the Maintenance Engineering Unit and the Faculty Environmental Committee are the primary overseers of waste disposal safety. While some dental schools have no special raising awareness activities, many institutes reported that the related department instructors were responsible for teaching the proper handling of amalgams used in the lab and clinic in the bachelor's degree, postgraduate program and dental assistant courses.

3.7 Role of Faculty of Dentistry in phase down and phase out of dental amalgam use

The faculty members reported that they had significant roles in the amalgam phase-down. There are several roles suggested and have been practised as follows:

1. The institute is responsible for organizing teaching and learning to make newly graduated dentists aware of the importance of phase-down and amalgam waste management.
2. Because of its environmental impact, the dental school should be responsible for teaching dental students about the effects of amalgam on health and the environment.
3. Dental hospitals have reduced the use of amalgam and refrained from ordering amalgam materials.
4. Use alternative tooth-filling materials.
5. Reducing the use of amalgam materials for dental restorations in educational institutions and related teaching.
6. Teaching the need to reduce usage and manage amalgam waste should be an urgent.

4. WASTE MANAGEMENT SCHEME AND CAPACITY

4.1 Existing regulatory framework (link to section on policy and regulatory and framework)

The Minamata Convention on Mercury aims to protect human health and the environment from the emissions and releases of mercury and mercury compounds. It sets out a range of measures on every phase of the life cycle including the control of the supply and trade of mercury, mercury-added products and manufacturing processes in which mercury or mercury compounds are used, and their end-of-life phases. The text of the Convention also includes the articles on emissions and releases of mercury, with control directed at reducing levels of mercury while allowing flexibility to accommodate national development plans.

Mercury Waste management in the Minamata Convention on Mercury

In Article 11 of the Convention, the definitions of mercury wastes have been classified into 3 groups as the followings:

A waste consisting of mercury or mercury compounds

B waste containing mercury compounds

C waste contaminated with mercury or mercury compounds

Dental amalgam waste containing mercury, silver, copper and tin is classified into Group B (waste containing mercury compounds). Mercury-containing thermometer waste and pharmaceutical products containing thimerosal, phenyl mercuric nitrate and mercurochrome are also classified into Group B. Residues from amalgam separators are classified into Group C (waste contaminated with mercury or mercury compounds) as listed in Table 4.1.

In the text of Minamata Convention, mercury waste at all concentrations levels shall be managed in an environmentally sound manner, taking into account the guidelines developed under the Basel Convention[4,5].

Table 4.1 Types of mercury waste including amalgam waste in the public health sector[4].

Source	Categories	Examples of waste types generated	Remarks
5. Products and applications with intentional use of mercury			
5.1 Thermometers and other measuring devices with mercury	B1	Used, obsolete or broken products	Mercury
5.7 Pharmaceuticals for human and veterinary uses	B1	Stockpiles of obsolete pharmaceuticals	Thimerosal; Phenyl mercuric nitrate; Mercurochrome, etc.
5.9 Dental amalgam fillings	B2 C	Stockpiles of dental amalgam Amalgam separator residues and wastewater treatment residues from dental clinics	Alloys of mercury, silver, copper and tin

*A: Waste consisting of mercury or mercury compounds; B: Wastes containing mercury or mercury compounds; C: Wastes contaminated with mercury or mercury compounds.

4.2 Amalgam and mercury waste management in the public health sectors

Amalgam and mercury waste management in the public health sectors in Thailand is related to the authorities of the Ministry of Public Health, Ministry of Natural Resources and Environment, Ministry of of Internal Affairs and Ministry of Industry. Medical waste management is under the Public Health Act B.E. 2535 (1992). Medical waste is classified into non-hazardous and hazardous waste. Amalgam waste and/or mercury waste is classified into the hazardous waste category due to the toxicity of mercury.

Regulations, standards and guidelines for separating amalgam waste and other mercury waste from non-hazardous waste at the sources, handling, interim storage, transportation and disposal have been distributed by the following examples: Notifications of the Ministry of Public Health Regarding the Management of Toxic or Hazardous Solid Waste from the Community, B.E. 2563 (2020) (https://laws.anamai.moph.go.th/th/ministry-rule/download/?did=204268&id=71588&reload=), the Appendix to the Notification of the Department of Pollution Control on Guidelines for the Management of Toxic or Hazardous Solid Waste from the Community for Local Government Organizations, B.E. 2565 (2022) (https://www.pcd.go.th/hazards/ประกาศกรมควบคุมมลพิษ-เรื่อง-แนวทางการบริหารจัดการมูลฝอยที่เป็นพิษหรืออันตรายจากชุมชนสำหรับองค์กรปกครองส่วนท้องถิ่), and the Notification of the Ministry of Industry. Disposal of Sewage or Unused Materials B.E. 2566 (2023) (https://www.diw.go.th/webdiw/wp-content/uploads/2023/06/a12062566-02.pdf)

and Announcement of Department of Industrial Work prescribing Methods for Collecting, Destroying, Disposing, Disposing, Moving and Transporting Sewage or Unused Materials (No. 1), B.E. 2531 (1988).

Dental Health Bureau, Department of Health has published guidelines for the use of Dental amalgam in 2019[6] and for the management of infectious waste and mercury-contaminated waste from dental clinics in 2021[7] to promote the environmentally sound management of dental amalgam and the protective strategy to minimize the risk of exposure to mercury. Despite the fact that the use of dental amalgam has declined in Thailand, the dental amalgam is in need of patients under the specific circumstances.

The guidelines published procedures in segregation, collection and interim storage of dental amalgam waste as well as risk mitigation from amalgam use in dental clinics in accordance with the Dental Amalgam Waste Management published by the Australian Dental Association[8].

A. Strategy for Minimizing Mercury Exposure in Dental Clinics[7]

1. Clinic Design

   No carpet flooring. Avoid groovy structures on surfaces

2. Ventilation and Air Quality

   Place the amalgametor outside the dental room in a well-ventilated area. The lid is tightly closed during the spinning of amalgam.

   Implement safe amalgam removal techniques, such as use high power suction to minimize mercury vapor release.

3. Regular Monitoring

   Ensure proper ventilation in areas where amalgam is handled to reduce airborne mercury levels. The levels must be compliance with the World Health Organization's Threshold Limit Value in ambient air (0.05 mg/m^3). In Thailand, the notifications of Ministry of Internal Affairs B.E. 2520 (1977) prohibit workers inside buildings with mercury in the ambient air exceeding 0.05 mg/m^3.

4. Personal Protective Equipment (PPE)

   Ensure dental staff wear appropriate PPE including gloves, masks, protective eyewear while handling amalgam waste. Use nitrile gloves instead of latex. Non-contact amalgam waste should be segregated from other waste and disposed of in a container with a tight seal

B. Sorting and separating amalgam-contaminated waste at dental clinics

Types of amalgam wastes as listed as follows:

1. Non-contact amalgam (scrap)
   - Excess mix left over at the end of a dental procedure
   - Amalgam material that remains in pre-measured capsules after dispensing
2. Contact amalgam
   - Amalgam that has been in contact with the patient
   - Carving scrap collected at chair side
   - Scrap left on instruments and matrix bands

- Amalgam captured by chair side traps
- Extracted teeth with amalgam restorations

3. Debris or residues from amalgam separators
4. Vacuum pump filters or traps contain amalgam sludge and water
5. Amalgam sludge

Mixture of liquid and solid material collected within vacuum pump filters or other amalgam capture devices

6. Empty amalgam capsules

Individually dosed containers left over after mixing pre-capsulated dental amalgam.

Amalgam-contaminated waste is disposed in three containers according to the following characteristics (Table 4.2).

Table 4.2 Amalgam-contaminated waste segregation[7,8].

Types of separated containers	Examples of Amalgam waste in the separated containers
1. Non-contact amalgam	excess mix left over amalgam remains in pre-measured capsules after dispensing
2. Contact amalgam	carving scrap collected at chair side scrap left on instruments and matrix bands and amalgam captured by chair side traps extracted teeth with amalgam restorations,
3. Empty amalgam capsules	the individually dosed containers left over after mixing pre-capsulated dental amalgam

Approaches of amalgam waste management in dental clinics[7]

1. Non-contact amalgam: scrap amalgam in airtight container, small quantities of X-Ray fixer (which contains thiosulfate) or a propylene glycol solution of sodium thiosulfate and copper sulfate can be used as vapor suppression agents[5]
2. Contact amalgam: Store in tightly closed containers, soaked in 70% ethanol for 15 minutes
3. Empty amalgam capsules: Place the empty capsules in an airtight container and make sure that the container lid is well sealed

Store amalgam waste in a covered container tightly sealed and labeled “Hazardous waste - Mercury Amalgam” Place the primary container inside a secondary container that further prevents the release of mercury vapor as a redundant safety measures. If the label on the primary container cannot be seen, a label should also be placed outside the secondary container. Do not put non-contact amalgam waste in biohazard containers or infectious waste containers (red bags)

Table 4.3 Do and Don’t in the amalgam waste management[7,8].

Do	Don’t

1. Wear appropriate personal protective equipment to minimize the exposure of mercury 2. Stock amalgam capsules in a variety of sizes to minimize the amount of amalgam waste generated 3. Well-ventilated areas in dental clinics 4. Collect amalgam waste for environmentally sound disposal	1. Do not use bulk mercury 2. Do not put non-contact amalgam waste in biohazard containers or infectious waste containers (red bags) or regular garbage 3. Do not dispose amalgam waste or do not rinse devices containing amalgam over drains or sinks

Notes:

1. Plastic capsule contaminated with amalgam are classified as waste contaminated with mercury or mercury compounds or Group C.
2. Amalgam waste submerged in water for a long period of time (up to years) may release mercury into water. Amalgam scrap is an alloy consisting of Ag_2Hg_3, Cu_6Sn_5 and Ag_3Sn[9]. A study reported droplets of liquid on the polished surface or amalgam fillings. The droplets contain mercury higher than 44%. Although this experiment was carried out in cold water to avoid formation of mercury vapor, the droplet of main mercury composition was still noticed[10].
3. Another study reported the type of alloy formed on newly prepared amalgam in comparison with amalgam fillings in removed tooth. Metallic alloys were detected in newly prepared alloy. However, for amalgam restored in tooth for 20 years, only 18% or so of amalgam were still metallic alloy, similar to what was observed in the newly prepared amalgam. The rest of 82% were metacinnabar or Mercuric Sulphide, (β-HgS), which is nearly insoluble in water. Its solubility is only $10^{-36.4}$ Molar. Metacinnabar may have been converted from mercury salts (II) that are soluble in water and precipitated with gaseous hydrogen sulphide (H_2S) from hot drink or food with sulphur-containing ingredients, e.g. hot coffee, or else H_2S get oxidised with salts of mercury (II) on the surface of dental amalgam[11].
4. Although about 80 percent of amalgam fillings presence in teeth is in the form of metacinnabar, which is chemically stable, compared to other mercury compounds. According to the technical guideline of the Basel Convention, Stabilized form needs to consist of cinnabar of nearly 100% to ensure vaporization or leaching in acceptable range. Then stabilized cinnabar will be encapsulated in solidification process prior to disposal in specially engineered landfills[4].
5. Water disinfected by chlorination generally contains hypochlorous (ClO^-). The ClO^- can oxidize mercury to mercury. (II) which is soluble in water[12], increasing risk of mercury release.

C. Handling Amalgam Waste Storage

The storage space for amalgam waste should be kept segregated from the other space where common waste, infectious waste and other waste are accumulated. The storage space should have ventilation that can eject air from the space to the outside building. The exhaust vent from the space should be far from any air intake vents. The temperature should be kept below 25 C and humidity below 40% to minimize the mercury vapor release and corrosion[8].

All personnel involved in the collection, storage, and transport of amalgam waste should receive training on mercury waste management. The interim storage space for hazardous waste in hospitals should be located in a separate room or building with ventilation, strong structures, smooth walls and floors, and ease of cleaning, as well as a roof and walls that protect from sunlight and rain. The storage space should accommodate the anticipated volume of mercury

waste to be stored. The storage space should be equipped with the fire protection system and extinguishing equipments for emergency response as well as available first aid kit. The front door of the storage space should be marked with warning signs, “Danger: Hazardous Mercury Waste”.

The guideline indicates that amalgam waste can be transported from hospitals for environmentally sound disposal by using either one of the followings:

1. Coordinate with local government authority to pick up and manage the amalgam waste in accordance with the Public Health Act B.E. 2535 (1992) and its amendments B.E. 2550 (2007), including the Ministerial Regulation on the Management of Toxic or Hazardous Solid Waste from the Community, B.E. 2563 (2020), and the manual on Safe handling of Toxic or Hazardous Municipal Solid Waste Training Manual published by Department of Health, 2021[13], Staff involved in the handling, transport, and disposal of municipal hazardous waste must receive specialized training on the safe management of toxic or hazardous municipal solid waste. Staff must wear appropriate personal protective equipment (PPE), including masks, gloves, rubber aprons, and safety boots
2. Coordinate with other hospitals to consolidate the amalgam waste at a central facility, and subsequently arrange for a private company to collect and dispose of the waste.
3. Coordinate directly with companies authorized for hazardous waste transport and disposal. In the case of coordinating with a private company, such private company must meet the following qualifications and conditions:
   (1) The companies who are involved with handling, transport and disposal must be authorized under the Factory Act B.E. 2535 (1992) (Factory Registration No. 101, 105 and 106)
   (2) The companies must be authorized by the local government organization where the hospital is located, and where the disposal facility is located.
   (3) Staff involved in handling, transport and disposal must wear PPE as well as carrying contingency plan documents
   (4) Staff involved in handling, transport and disposal are authorized in accordance with the Notification of the Ministry of Industry Hazardous Waste Transportation Documentation System B.E. 2547 (2004) and the Requirements for interim storage of hazardous waste and regular monitoring.

The qualifications of a specially registered vehicle for transporting mercury waste are as the followings:

1. Closed vehicle
2. The amount of loaded hazardous waste should be appropriate for the size and carrying capacity of the vehicles.
3. The driver cabin and the loading section need to be separated.
4. In case of road accidents during transport, the loading section should be able to keep the hazardous waste intact.
5. Appropriate safety measures are applied in the transport of mercury waste

6. The vehicles should be equipped with PPE, fire extinguishers, the labelling for the types of hazardous waste and secondary containers for the hazardous waste
7. The vehicles certified as carriers of hazardous waste should be labelled with names and address of the transport companies who own the vehicles in accordance with international or national regulations. Prior to transportation, contingency plans and emergency response number should be prepared
8. Use manifests with 3 copies, which will be kept by a waste generator, a transporter and an authority, to keep track of hazardous waste transport by the following steps:
    - 8.1 Record the weight of each type of hazardous waste at a generator's facilities
    - 8.2 Waste generators give properly prepared manifests to transporters. The transporters must sign and date the manifests when receiving the hazardous waste. The generators must keep a copy of manifest for at least 3 years.
    - 8.3 Submit another copy of manifest to an authority within 15 days of the waste transport.
    - 8.4 Carrier vehicles must be checked for tidiness before leaving for disposal facilities such as properly covered loading section

The Department of Pollution Control, Ministry of Natural Resources, published definitions of toxic or hazardous waste from municipalities in the Notification of the Pollution Control Department on Guidelines for the Management of Toxic or Hazardous Solid Waste from the Community for Local Government Organizations B.E. 2565 (2022). Toxic or hazardous waste includes objects contaminated with substances having the following properties: toxic, flammable, oxidizing, peroxides, irritants, abrasives, easily reactive, explosive, and substances that cause genetic mutations or any other substances likely to cause harm to persons, animals, plants, property, or the environment. However, it excludes infectious waste under the Public Health Act.

The Pollution Control Department, together with Provincial Offices of Natural Resources and Environment and private sectors, cooperates to promote hazardous waste management in accordance with the National Waste Management Action Plan No. 2 (2022 - 2027), the Sustainable Development Plan under the Master Plan, the National Strategy, and international commitments based on the strategic development of the bio-circular economy-green economy (BCG Model), the 3R principles (Reduce, Reuse, Recycle), and the Pollution Pays Principle (PPP) through Public-Private Partnerships (PPP), Extended Producer Responsibility (EPR), and Extended Consumer Responsibility (ECR).

Guideline for Solid Waste Reduction and Sorting in Government Agencies[14]

This guideline aims to enable the central and local agencies to adopt the practice of waste reduction and segregating hazardous waste from common municipal waste. Each agency should assign a working group responsible for monitoring solid waste management. Hazardous waste should be segregated from municipal solid waste by using bright-colored containers labeled "Hazardous Waste" with a skull and crossbones symbol, an exemplary description and pictures of the hazardous waste. A container for hazardous waste should be placed on the first floor or basement of the building where staff can get into. Regular inspection should be carried

out every 3 months. When the hazardous waste gets accumulated, it should be transported by a certified carrier company or local government authority. Disposal facilities must be certified under the Factory Act, B.E. 2535 (1992) (Factory Registration categories, 101, 105 and 106)

Regulations on the Disposal of Mercury Waste and Amalgam Waste in Thailand

Thailand has regulations for the waste management according to the notification of the Ministry of Industry on the Waste Disposal, 2023. This notification is enforced on an industrial waste generator (WG) and a waste processor (WP). Its details are briefly listed in Table 4.4. The notification holds the disposal of the amalgam waste from dental care which is a type of hazardous waste and is identified with characters of HA (the abbreviation of Hazardous waste Absolute entry) and the code of six numbers of 18 01 10 that can be explained as the followings:

- The first two numbers are an identified waste category or type. In this subject, 18 is the waste originating from human or animal health care and/or related research.
- The central two numbers are from generating processes of waste. The code "18 01" means the waste from natal care, diagnosis, treatment, or disease prevention in humans.
- The final two numbers of 10 mean the mercury-contaminated waste.

The amalgam waste from dental care can be classified as hazardous waste in terms of waste containing the contamination of mercury and/or mercury compounds when the contamination contents are equal to or exceed the determined values of that contamination. The determined values of mercury and/or mercury compounds are the followings:

- The Total Threshold Limit Concentration (TTLC) is 20 mg/kg; wet weight for measuring the total concentration of the contamination.
- The Soluble Threshold Limit Concentration (STLC) is 0.2 mg/L for measuring the extractable concentration obtained from the Waste Extraction Test (WET).
- Waste Extraction test (WET) will be considered when the total concentration values of hazardous contaminants in the waste are lower than their TTLC values but are higher than or equal to their STLC values, or those wastes are required disposal at landfills.

(To be noted that the determined values of inorganic substances are calculated on the concentrations of elements, not the compounds. In the case of metal elements, the determined values are for use with substances in powder form only. The methods of measurement and extraction are explained in remarks of table 4.4)

Table 4.4 The brief regulations according to the notifications of the Ministry of Industry on Waste Management, 2023.

Subject	Regulation
Waste generator	(1) Must have a clear separation between hazardous waste and non-hazardous waste. • Must check that there is no leakage of containers. The container presents a label informing at least the waste generator name, the code of waste category or type, dates of packing and sealing

Subject	Regulation
	containers. • For waste management that is in a status of non-operation: Must have enough, appropriate, and clean facilities. The symbol and safe labels can be clearly seen in that area. - For storage in the building: the building must be stable. There are appropriate ventilation systems, enough space for safe storage, and prevention systems for substance leakages out of the building. - There is a flow chart showing the waste storage already for verification. (2) In the case of the waste storage in the plant area: Must manage with appropriate, safe, and corrective methods. There are no environmental effects following the determined criteria, methods, and conditions of the Department of Industrial Work. (3) Don't bring any waste out of the plant except that the waste generator receives the permit from the Director General Department of Industrial Work following the determined criteria, methods, and conditions of the Department of Industrial Work. (4) The permit for bringing waste out of the plants, permits can be mainly required by electronic media, or doing it at the Department of Industrial Work following criteria, methods, and conditions determined by the Director General of the Department of Industrial Work and announced in the gazette. (5) After receiving the permit according to (3), the waste generator must inform details of management following criteria, methods, and conditions determined by Director General of the Department of Industrial Work and announced in the gazette. (6) After receiving the permit according to (3), the Director General of the Department of Industrial Work or an assigned person can suspend the permit due to the following issues: • The waste processers are in the operation of Section 37 or 39. • The waste processors don't operate according to (3). (7) Liability to sending waste to the waste processer • For transportation, the waste generator must transport waste by vehicles those can operate following the criteria, methods, and conditions determined by the Director General of the Department

Subject	Regulation
	of Industrial Work. • For a complete bringing out but the waste is still in a status of non-operation (such as loss, accident, or stealth), the waste generator is still response to completely manage of the waste. (8) Must report the following information to the Department of Industrial Work by electronic method through the central system for reporting of the Department of Industrial Work (its name is "iSingle Form") within 1 April of the next year. • The collection is in a status of non-operation according to (1). • The collection in the plant area according to (2). (9) Must control the waste processers to operate following the criteria of the waste processer. If the waste processers cannot operate in time following (15), the waste generator must inform the Director General of the Department of Industrial Work within 5 days (starting from the date that the waste processers inform the waste generator). Then, the waste generator must require the new permit for the new waste processer following (3) within 30 days (starting from the date that the old waste processers inform the waste generator). (10) For the requirement of waste characterization analysis to bring the waste out of the plant, the waste must be characterized by registered laboratories with the Department of Industrial Work, the laboratories of the government, or the international standard laboratories accepted by the Department of Industrial Work.
Waste processer	(1) Don't receive any waste without the permit following (3). (2) Must check and keep samples for verifying the important characteristics of the waste to confirm that the waste is of the permitted waste following (3) and must send those information and documents of management to the waste generator. (3) Must inform details of management following methods that the Director General of the Department of Industrial Work announcing in the gazette. (4) The raw materials (received waste) must be operated as the following: • Clearly Separate between hazardous and non-hazardous waste. • There is no leakage of containers. The container presents a label informing at least the waste generator name, the code of waste category or type, dates of packing and sealing containers. • Must have enough, appropriate, and clean facilities. The symbol

Subject	Regulation
	and safe labels can be clearly seen in that area. - For storage in the building: the building must be stable. There are appropriate ventilation systems, enough space for safe storage, and prevention systems for substance leakages out of the building. - For storage in the open area: the open area must be stable. There are enough facilities for safe storage, and prevention systems for substance leakages out of the plant. There are systems for environmental prevention if there are leakages and storage in appropriate conditions without chemical reactions. - For mixed storage, must establish the lists of each item of raw materials containing the waste generator names, category or type codes, contents, and the starting date of storage. • Must establish the updated collection plans for verification. (5) The raw material classified as hazardous waste must be completely managed within 30 days from the receiving date. If there is extended time, the waste processer must inform the waste generator before expiration at least 5 days. To extend time, cannot extend exceeding 30 days. If the waste processer cannot operate for the extended time, the waste processer must inform the waste generator before expiration at least 5 days to meet other waste processers. If the waste generator ignores, the waste processer must inform the Department of Industrial Work. (6) Must establish plans for preventing accidents and settling emergencies which cover leakage, conflagration, explosion, or unexpected situations. (7) Must monthly establish reports for management of raw materials, and products. The report must be sent to the central system of the Department of Industrial Work within the date of 15 in next months.

Remarks:

I. Analyzation of the total concentration of a hazardous contaminant (mg/kg; wet weight) or the concentration of a hazardous contaminant (mg/L) in the extractable concentration.

A. Preparation of waste samples.

(1) Type 1 -- For waste solids that can be ground into powder: The waste solids will be ground and screened through standard sieve No. 10 (opening diameter = 2 mm). The obtained powder will be mixed with another waste that does not need to be in the powder form before analysis.

(2) Type 2 -- For mixtures of solid and liquid waste that can be filtrated, and the solid content is greater than or equal to 0.5% by weight: The sample preparation steps of this case are the following:

- Separate liquid and solid waste by filtration through a membrane filter (pores diameter = 0.45 microns).

- The liquid phase is measured in its content and kept. This phase is called Initial filtrate.
- The solid phase is ground into powder and screened with a standard mesh No. 10 (opening diameter = 2 mm) before extraction by the method of Waste Extraction Test (WET) with the ratio of 1 g solid to 10 mL extraction reagent.
- Mixing initial filtrate (2) and extractable solution (3) before analysis of the total concentration value.

(3) Type 3 – For waste in forms that cannot be filtrated or ground (such as sludge, slurry, oily/tarry, or resinous materials): Impurities will be removed before analysis.

(4) For liquid waste or liquid waste containing solids in content lower than 0.5% (by weight), these liquids can be directly analyzed without extraction with the WET method. The liquids can be defined as hazardous waste If the total concentration of a hazardous contaminant (mg/kg) is greater than the TTLC values of those contaminants. If the total concentration values are less than the TTLC but exceed the STLC, the liquids must be filtered by a membrane filter (pores diameter = 0.45 microns) before analyzation. Those liquids will be defined as hazardous waste if the total concentration values of the hazardous contaminant within their filtrates are higher than their STLC.

B. Analyzation methods

(1) For metal and compound samples, using the determined extraction method of "Test Methods for Evaluating Solid Waste", Physical/Chemical Methods, SW-846, 2nd edition, U.S. Environmental Protection Agency, 1982 with Method 3050.

(2) For other hazardous inorganics and organics except compounds, using the determined method in Chapter 2 "Choosing the Correct Procedure" in "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods," of the US EPA.

II. Extraction by Waste Extraction Test (WET).

A. This process will be considered when the total concentration values of hazardous substances in the wastes are lower than their TTLC values but are higher than or equal to their STLC values, or those wastes are required disposal at landfills.

B. The test procedure steps are the following:

(1) Using 0.2 M sodium citrate solution (pH 5.0 ± 0.1) as an extractor. This solution can be prepared from the dilution of citric acid with 4.0 N NaOH until the pH of the citric acid reaches 5.0.

(2) Solubility of 50 g sample with 500 mL extractor. (The used containers in this process should be continuously washed with a nitric acid solution prepared from the mixture of nitric acid solution and deionized water with a ratio of 1:1 by volume.).

(3) Feeding the nitrogen gas to the sample solution for 15 minutes to remove oxygen before covering and shaking the sample solution for 48 hours.

(4) Filtration of the shaken sample solution by a membrane filter (pore size of 0.45 microns) using the cleaned thick-walled suction flasks for rough solids. To be noted that can use pressure filtration instead of vacuum filtration for fine solids. Additionally, the fine solids may use high speed centrifugation (rpm reaches 10,000 x G) before filtration by the membrane filter (pore size of 0.45 microns).

(5) In the case of metal elements analysis, the obtained liquid phase in (4) is added to the nitric acid until the concentration of that liquid reaches 5.0 by volume.

(6) The test to confirm that the extractable concentration of hazardous substances (in the unit of mg/L) in the sample exceed their STLC values or not can be analyzed by the determined method in Chapter Two, "Choosing the Correct Procedure" in "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods," that is identified by the US EPA.

Thailand has regulations for the management of mercury-contaminated waste that are enforced on industrial operators according to the notification of the Department of Industrial Works of Thailand (Issue 1, 1988) on the determination of methods for collection, destruction, disposal, landfill, discarding, moving, and transportation of waste, as shown in Table 4.5.

Table 4.5 The brief regulations according to the notifications of the Department of Industrial Works of Thailand (Issue 1, 1988) on the determination of methods for collection, treatment, disposal, landfill, discarding, moving, and transportation of waste.

Subject	Regulation
Collection	The collected waste needs storage entirely in safe areas that are harmless to people or surrounding communities.
Treatment	In the case of mercury-contaminated ash, the ash must be mixed with sodium sulfide solution (Na_2S) to form mercury sulfide (HgS) before solidification by mixing with cement. Also, some additives should be mixed before solidification

Subject	Regulation
	to decrease migration rates of toxins. The characteristics of obtained solids are the following. • Water permeation rate is less than $1x10^{-6}$ cm/s. • Compression strength is not less than 14 kg/cm^3. • The density is not less than 1.4 $tons/m^3$. • The features are stiff as rocks, non-flammability, and non-smelling.
Landfill	The landfill facilities should have appropriate geologies as the following. • There are no mineral sources below that area. • There are no crack marks or cavities of the below stones. • The thickness of the soil layer sandwiched between the landfill base and the groundwater level is not less than 5 feet. • There is a low groundwater level. • There is enough space to be used for 5 years or more. • It is not a watershed area, flood area, and near or connecting with rivers or water sources. • It is far from agriculture and living areas to avoid problems of scattering, transportation, and noise during the operation. • The base and walls of landfill cells must be lined with durable barriers to prevent leachate migration to surrounding groundwater and surface water sources. The barriers can be specifically synthetic materials or natural materials (such as clay). The barrier thickness must be sufficient to load the whole of the occurred mass and pressure. The water permeability rate of the barriers should be less than $1x10^{-7}$ cm/s • There are systems of collection and treatment of wastewater or carrying the wastewater to treatment at other facilities.
Monitoring	There is an observation pond for checking the groundwater properties. This is to verify and trace throughout the landfill life. To be noted that the quantity of mercury in the groundwater must be less than 0.001 mg/L.

4.3 The feasibility of health system wide approach on mercury waste management (not only dental amalgam)

In addition to dental amalgam waste, other types of mercury waste in public health sector include mercury-containing thermometer waste, sphygmamometer and end-of-life fluorescent lamps. Mercury waste needs to be separated from other common waste and infectious waste at sources (for example, in wards). Handling and transporting mercury waste should be done carefully to avoid accidentally breaking the fragile waste containing mercury. The mercury waste is stored temporarily in a designated storage, properly packaged and labeled.

Department of Health published the report on the Development of Medical Waste Management System for hospitals in Thailand from the study spanned from 2019 to 2021. The study's initial phase aimed to investigate the practice of medical waste management in hospitals by gathering qualitative data from ten hospitals with varying sizes and quantitative data from 377 hospitals of varying sizes and levels. The data were analyzed and the digital tools for medical waste management was proposed and implemented in 535 hospitals in June 2023. The hospital's medical waste management model should consist of three key elements as the following[15]:

1. establishing policies and a designated team to be responsible for healthcare waste management.
2. practicing principles of medical waste management including waste segregation, collection, transportation, and disposal
3. employing approaches to treat each category of medical waste in an environmentally sound manner including guidelines in safe and environmental sound management of each category of medical waste - fluorescent lamps,

The report recommended that "hospitals adopt a standardized medical waste management system with a primary focus on waste reduction and segregation at source[15]."

Figure 4.1 Scheme for the Management of Dental Amalgam Waste in Thailand[15].

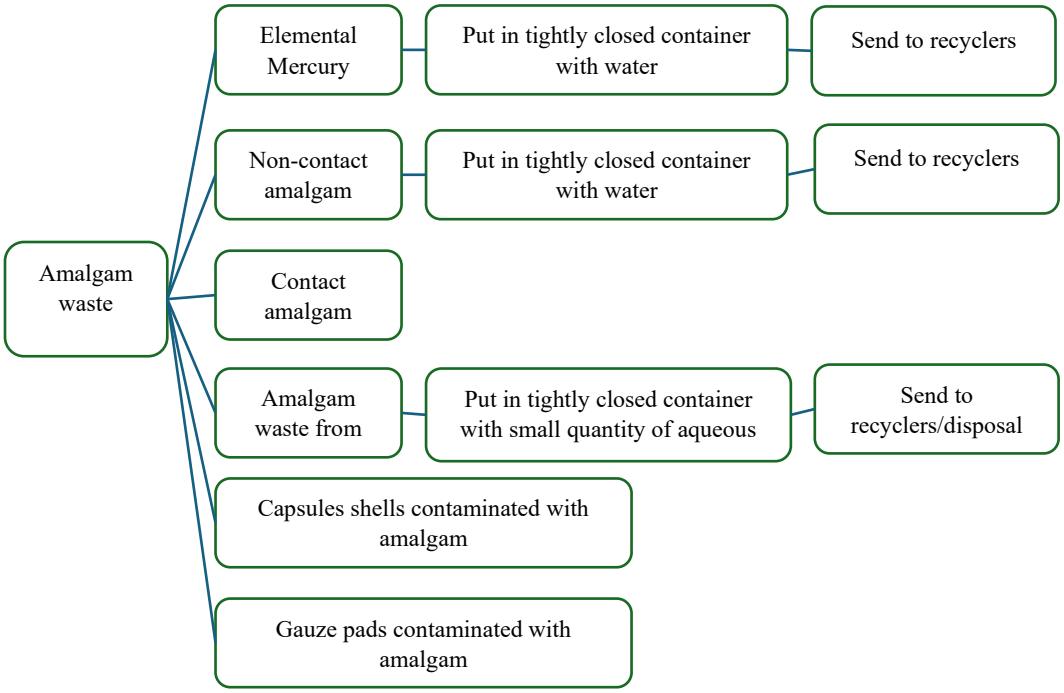
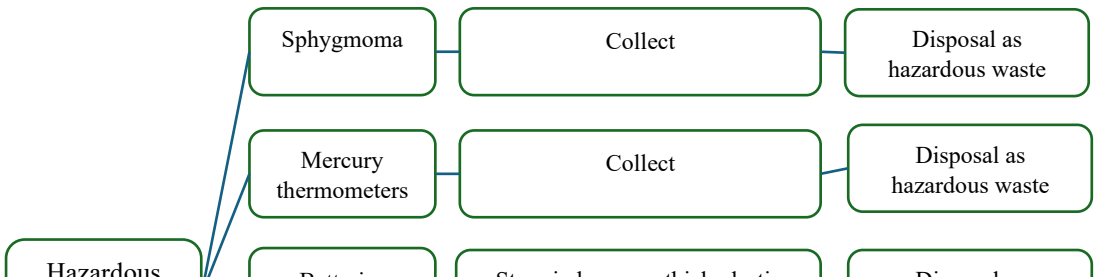


Figure 4.2 Scheme for the Management of Hazardous Waste[15].



4.4 Existing facilities, practices and technologies used in the management of mercury/dental amalgam waste (including handling, separation, packaging, labelling, collection, transportation, storage, treatment, disposal)

"The Basel Convention aims to protect human health and the environment against adverse effects resulting from the generation and, management, transboundary movement and disposal of hazardous and other wastes. The Basel Convention defies the Environmentally Sound Management (ESM) is as taking all practical steps to ensure that hazardous waste and other waste are managed in a manner that will protect human health and the environment against the adverse effects from the hazardous waste[4]".

The ESM principle in the hazardous waste management gives priority to the waste prevention, minimization, recycling, recovery and disposal, respectively.

The concept of Life cycle management of mercury serves as an approach to promote the ESM of mercury waste by reducing the mercury use in the industrial processes and the products such that reducing the amount mercury waste. When using products containing mercury or mercury compounds, special care should be taken not to emit or release mercury into the environment. Waste containing mercury or mercury compound should be treated to either recovery the mercury in them or to immobilize it in an environmentally sound manner.

Approaches for the management of mercury waste are as follows:

1. Separation of mercury waste at the sources
2. Handling and Collection
3. Packaging, Labelling and Transportation
4. Storage
5. Disposal in environmentally sound manner, i.e., recovery, solidification, stabilization, permanent storage and disposal in specially engineered landfill

The government sectors need to make a plan for all steps including separation, handling, collection, packaging, labelling, transportation, interim storage and disposal. The Basel

Convention gives an emphasis on raising awareness, knowledge and understanding of staff who are involved in the hazardous waste management. The Ministerial Regulation on Toxic or Hazardous Solid Waste Management, B.E. 2563 (2020) emphasizes the special training to the personnel involved.

The legislative in Parties to the Convention should contain the regulation practices in accordance with the Basel Convention and Minamata Convention and the ESM principle, as the following

1. Registration of waste generators, including hospitals, dental clinics, research institutes, etc.
2. Phasing down or phasing out the mercury-containing products
3. National Regulations and practices in the country to be compliant with the Basel Conventions
4. Certifications and regular monitoring on the disposal facilities of mercury waste

Parties to the Convention should identify sources of mercury waste in the national inventory as well as assess the quantity of generated mercury waste. Dental amalgam is intentionally mercury-added products and amalgam waste are classified as the group B of waste containing mercury. Dental amalgam contains silver, copper and tin. Residues from amalgam separators is classified as the group C or waste contaminated with mercury. In Thailand, mercury content in a few after-use capsules[16] was reported as well as mercury content in removed teeth[17].

4.5 List of companies in the country that are authorized and equipped to support the management of mercury/dental amalgam waste in the country

1. Domestic companies with secured landfills[14]
   - General Environmental Conservation Public Company Limited
   - Better World Green Public Company Limited
   - Professional West Technology (1999) Public Company Limited
2. Domestic companies with mercury recovery processes.
   - Begemann Mercury Technology Pacific (BMT) Co., Ltd.

4.6 List of companies that provide the management of mercury/dental amalgam waste through the international collaboration

List of the companies with the management of mercury/dental amalgam waste was included in the catalogue of Technologies and Services on Mercury Waste Management[18].

- Appelglobal, the Netherlands (http://appelglobal.com/)

  Experiences in cleaning up riverine sediments contaminated with mercury from artisanal small-scale gold mining in Honduras.
- BATREC Industries AG in Switzerland

  Extraction of mercury from mercury waste and stabilization of mercury by converting metallic mercury into an alloy of mercury or HgS and then safely disposed of in an old salt mine 2. Mercury metal purification is more than 99.9999%
- EAM Environmental, Inc. United States
- ECOCYCLE PTY LTD Australia

Provide disposal services of waste containing mercury or mercury compounds, such as wastes from mining, oil and gas sectors, dental amalgam waste, and mercury waste from residential communities. The company is specifically interested in recycling of dental amalgam waste.

- Ecologic, S.A. Panama
- econ industries services GmbH, Germany
- Mekatronika Ambiental Bolivia
- Nomura Kohsan Co., Ltd. Japan
- Remondis QR Germany
- TerraCycle Regulated Waste, LLC German

4.7 Health facilities where the separators could be installed

Dental information from hospitals that volunteered to install amalgam separators in Thailand. (Table 4.6 - 4.10)

Table 4.6 Number of dental workforces.

Hospital	1. Dental Health Bureau	2. Banphotphisai Hospital	3. Pathumthani Hospital	4. Thanyaburi Hospital	5. Banglen Hospital	6. Maelao Hospital	7. Chaophraya Yomrad Hospital	8. Provincial Public Health Office
Province	**Nonthaburi**	**Nakhonsawan**	**Pathumthani**	**Pathumthani**	**Nakhonpathom**	**Chiangrai**	**Suphanburi**	**Nakhon Ratchasima**
Dentist	16	8	16	10	5	5	18	2
Dental hygienist	4	2	2	3	3	3	10	0
Dental assistant	5	8	15	12	2	5	28	3

Table 4.7 Dental Units.

Hospital	1. Dental Health Bureau	2. Banphotphisai Hospital	3. Pathumthani Hospital	4. Thanyaburi Hospital	5. Banglen Hospital	6. Maelao Hospital	7. Chaophraya Yomrad Hospital	8. Provincial Public Health Office
Province	**Nonthaburi**	**Nakhonsawan**	**Pathumthani**	**Pathumthani**	**Nakhonpathom**	**Chiangrai**	**Suphanburi**	**Nakhon Ratchasima**
Dental chair no. 1 /year	Yoshida Eyecia /NA	BELMONT /2022	Actus 9000 /2010	Morita /2014	Knight Asepsis21s /2007	Siamdent /2013	TaiyoTaiyo /2016	Actus 9000 /2008
Dental chair no. 2 /year	Yoshida Eyecia/ NA	Thai Dental Products /2017	Actus 9000 /2011	Thai Dental Products /2017	serue GEMS PlatinumII /2014	Siamdent /2014	Thai Dental Products /1998	Yoshida Eyecia I /2008
Dental chair no. 3 /year	Yoshida Eyecia /NA	Actus 9000 /2017	Actus 9000 /2011	Thai Dental Products /2018	Thai Dental Products /2014	Siamdent /2017	Thai Dental Products /2000	Yoshida Fiala /2017
Dental chair no. 4 /year	Yoshida Eyecia /NA	Actus /2015	Actus 9000 /2011	Thai Dental Products /2018	Thai Dental Products /2014	Siamdent /2018	Thai Dental Products /2002	Yoshida Eyecia II /2017
Dental chair no. 5 /year	Yoshida Eyecia /2023	Actus /2011	Actus 9000/2011	Thai Dental Product /2020	Actus 9000XI /2013	Siamdent /2019	Thai Dental Products /2002	/
Dental chair no. 6 /year	/	/	Actus 9000 /2012	J Morita /NA	serue GEMS Platinum II /2014	/	Actus 9000 /2006	/
Dental chair no. 7 /year	/	/	Actus 9000 /2012	Thai Dental Products /2020	/	/	Actus 9000 /2006	/
Dental chair no. 8 /year	/	/	Actus 9000 XI /2013	Thai Dental Products /2022	/	/	Actus 9000 /2010	/
Dental chair no. 9 /year	/	/	Actus 9000XI /2014	Thai Dental Products /NA	/	/	Actus 9000 /2010	/
Dental chair no. 10 /year	/	/	Actus 9000XI /2014	Thai Dental Products /NA	/	/	Actus 9000 /2010	/
Dental chair no. 11 /year	/	/	Actus SX3000 /2015	/	/	/	Belmont /2012	/
Dental chair no. 12 /year	/	/	/	/	/	/	Victor /2012	/
Dental chair no. 13 /year	/	/	/	/	/	/	Actus 2000 /2012	/

Hospital	1. Dental Health Bureau	2. Banphotphisai Hospital	3. Pathumthani Hospital	4. Thanyaburi Hospital	5. Banglen Hospital	6. Maelao Hospital	7. Chaophraya Yomrad Hospital	8. Provincial Public Health Office
Province	**Nonthaburi**	**Nakhonsawan**	**Pathumthani**	**Pathumthani**	**Nakhonpathom**	**Chiangrai**	**Suphanburi**	**Nakhon Ratchasima**
Dental chair no. 14 /year	/	/	/	/	/	/	Thai Dental Products /2016	/
Dental chair no. 15 /year	/	/	/	/	/	/	Thai Dental Products /2019	/
Dental chair no. 16 /year	/	/	/	/	/	/	Thai Dental Products /2019	/
Dental chair no. 17 /year	/	/	/	/	/	/	Siamdent /2023	/
Dental chair no. 18 /year	/	/	/	/	/	/	Siamdent /2023	/
Dental chair no. 19 /year	/	/	/	/	/	/	Thai Dental Products /2019	/

/

Table 4.8 Suction system and type of amalgam use.

Hospital	1. Dental Health Bureau	2. Banphotphisai Hospital	3. Pathumthani Hospital	4. Thanyaburi Hospital	5. Banglen Hospital	6. Maelao Hospital	7.Chaophraya Yomrad Hospital	8. Provincial Public Health Office
Province	**Nonthaburi**	**Nakhonsawan**	**Pathumthani**	**Pathumthani**	**Nakhonpathom**	**Chiangrai**	**Suphanburi**	**Nakhon Ratchasima**
Suction system	Central suction system	Separated suction of each unit	Separated suction of each unit	Separated suction of each unit	Separated suction of each unit	Separated suction of each unit	Central & separated suction system	Separated suction of each unit
Filter at unit	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
Type of amalgam use	Capsule	Capsule	Capsule	Capsule	Capsule	tablet	Capsule	Capsule

Table 4.9 Number of people receiving dental filling in fiscal year 2023 (person).

Hospital	1. Dental Health Bureau				2. Banphotphisai Hospital				3. Pathumthani Hospital				4. Thanyaburi Hospital				5. Banglen Hospital				6. Maelao Hospital				7.Chaophraya Yomrad Hospital				8. Provincial Public Health Office			
Province	**Nonthaburi**				**Nakhonsawan**				**Pathumthani**				**Pathumthani**				**Nakhonpathom**				**Chiangrai**				**Suphanburi**				**Nakhon Ratchasima**			
Alternative materials	0-5 years	6-14 years	15-59 years	>60 years	0-5 years	6-14 years	15-59 years	>60 years	0-5 years	6-14 years	15-59 years	>60 years	0-5 years	6-14 years	15-59 years	>60 years	0-5 years	6-14 years	15-59 years	>60 years	0-5 years	6-14 years	15-59 years	>60 years	0-5 years	6-14 years	15-59 years	>60 years	0-5 years	6-14 years	15-59 years	>60 years
	12	10	693	298	15	96	436	125	4	20	309	64	33	298	1,669	764	4	99	553	204	140	519	878	432	106	319	1,352	537	1	10	289	238
Amalgam	0-5 years	6-14 years	15-59 years	>60 years	0-5 years	6-14 years	15-59 years	>60 years	0-5 years	6-14 years	15-59 years	>60 years	0-5 years	6-14 years	15-59 years	>60 years	0-5 years	6-14 years	15-59 years	>60 years	0-5 years	6-14 years	15-59 years	>60 years	0-5 years	6-14 years	15-59 years	>60 years	0-5 years	6-14 years	15-59 years	>60 years
	0	0	26	3	9	264	222	28	135	336	2,405	1042	6	43	162	29	3	10	68	44	4	9	21	8	2	12	70	19	0	0	8	14

Table 4.10 Filling tooth in fiscal year 2023 (person/teeth).

Hospital	1. Dental Health Bureau				2. Banphotphisai Hospital				3. Pathumthani Hospital				4. Thanyaburi Hospital				5. Banglen Hospital				6. Maelao Hospital				7.Chaophraya Yomrad Hospital				8. Provincial Public Health Office			
Province	**Nonthaburi**				**Nakhonsawan**				**Pathumthani**				**Pathumthani**				**Nakhonpathom**				**Chiangrai**				**Suphanburi**				**Nakhon Ratchasima**			
Alternative materials	1 side	2 sides	3 sides	>4 sides	1 side	2 sides	3 sides	>4 sides	1 side	2 sides	3 sides	>4 sides	1 side	2 sides	3 sides	>4 sides	1 side	2 sides	3 sides	>4 sides	1 side	2 sides	3 sides	>4 sides	1 side	2 sides	3 sides	>4 sides	1 side	2 sides	3 sides	>4 sides
	667/ 968	424/ 539	122/ 147	21/ 22	653/ 954	206/ 442	95/ 143	50/ 52	4,747 5,054	1,889/ 2,004	1,517/ 279	92/ 247	1,360/ 2,498	1,008/ 1,489	295/ 345	97/ 116	609/ 1,107	306/ 624	40/76	78/ 125	904/ 1,232	806/ 951	259/ 293	0	2,106/ 3,211	1,572/ 2,807	710/ 1,156	-	179/ 343	280/ 405	70/ 94	-
Amalgam	1 side	2 sides	3 sides	>4 sides	1 side	2 sides	3 sides	>4 sides	1 side	2 sides	3 sides	>4 sides	1 side	2 sides	3 sides	>4 sides	1 side	2 sides	3 sides	>4 sides	1 side	2 sides	3 sides	>4 sides	1 side	2 sides	3 sides	>4 sides	1 side	2 sides	3 sides	>4 sides
	6/6	17/ 18	2/2	1/1	388/ 584	230/ 400	25/30	1/1	127/ 180	245/ 262	31/45	1/2	88/99	127/ 145	22/22	2/2	35/74	56/ 117	9/10	2/3	16/ 22	25/ 29	2/2	0	44/54	66/73	18/19	-	19/ 42	3/4	-	-

5. INVENTORY OF DENTAL AMALGAM AND MERCURY-FREE ALTERNATIVES

5.1 Dental amalgam use, alternatives and trends

Is dental amalgam still widely in use in your country?

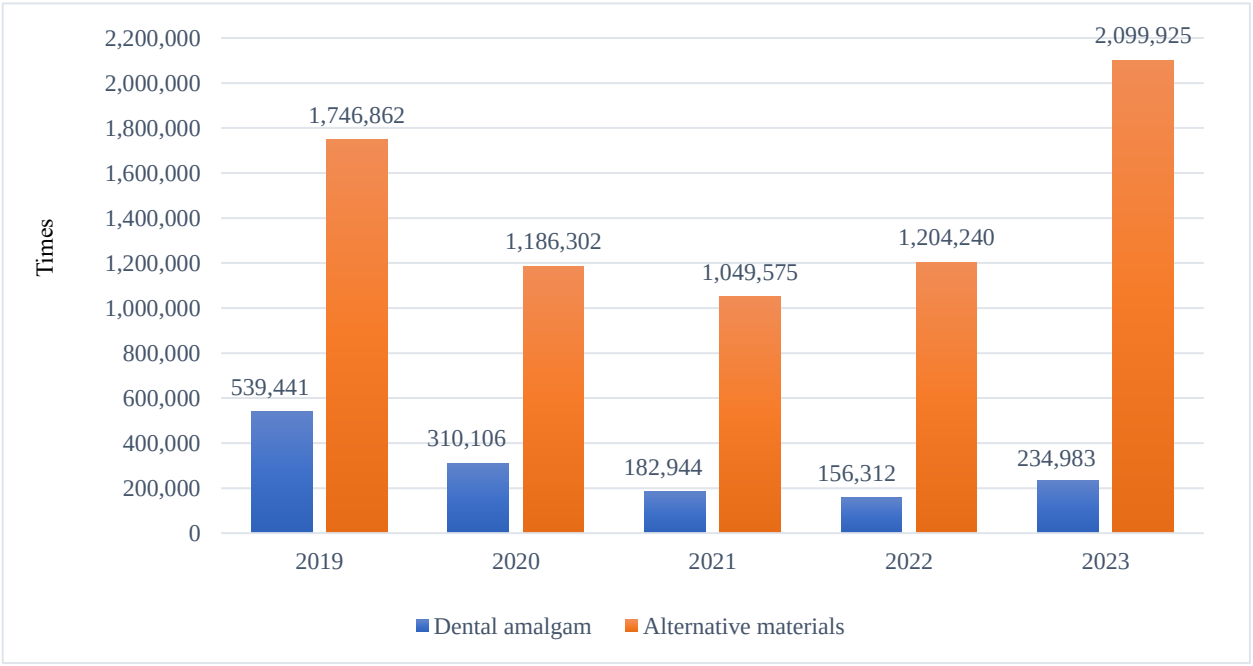
a) Yes, it is still used and there are no plans or implemented measures to phase it down

☑ b) Yes, but in process of phasing it down

c) No, dental amalgam is not used at all - complete phase out

Trends in the use rate of dental amalgam and alternative materials in the government's Facilities under the Ministry of Public Health during fiscal years 2019 - 2023 is shown in Figure 5.1[3]. The number of times the population receiving dental amalgam fillings was significantly less compared to the number times of populations receiving alternative material fillings. Each fiscal year during 2019 - 2023, the number of times the populations receiving dental amalgam fillings were 539, 310, 182, 156, and 234 per 1,000 populations, respectively. Those of receiving the alternative material filling were 1,746, 1,186, 1,049, 1,204 and 2,099 per 1,000 populations, respectively.

Figure 5.1 The use rate of dental amalgams fillings and alternative material fillings during fiscal year 2019-2023[3].

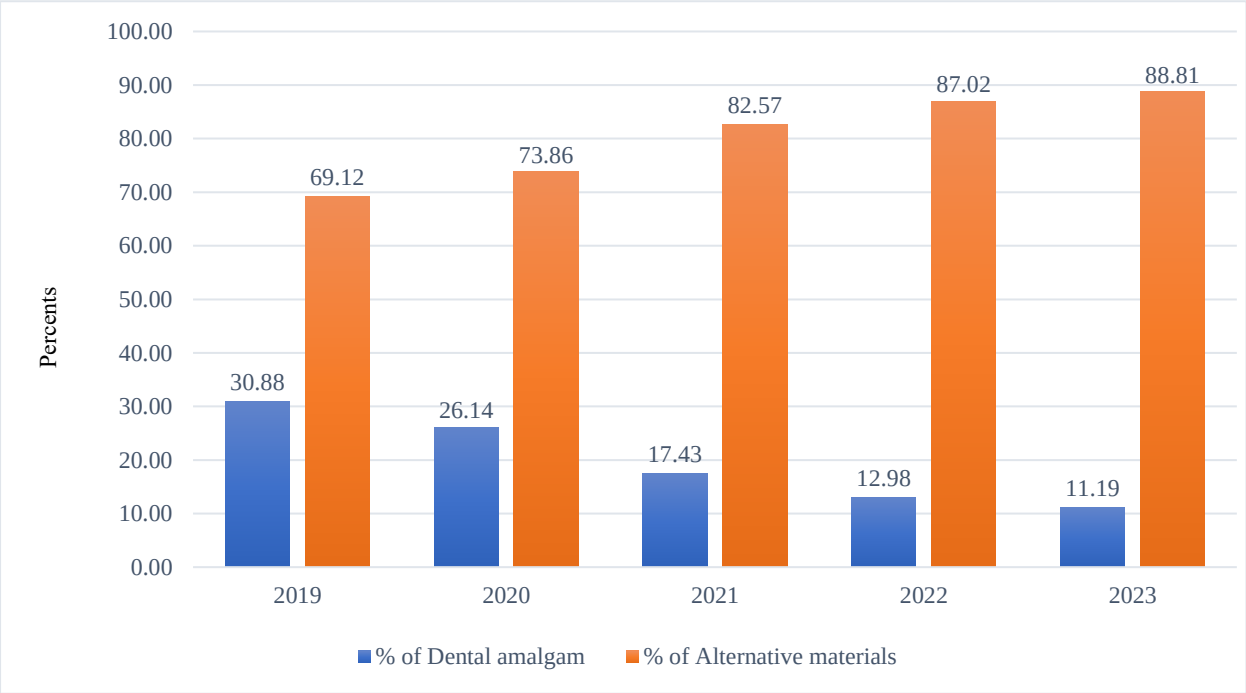


Remark: Alternative materials including resin composite, glass ionomer and compomer material

Figure 5.2 shows ratios of dental amalgam and alternative materials used in new fillings during fiscal year 2019 - 2023. Ratios of dental amalgam use in cavity fillings decreased every year from 30.88 percents in year 2019 to 11.19 percents in fiscal year 2023. On the other hand, the

alternative materials were used more frequently, resulting 69.12 percents in fiscal year 2019 and 88.81 percents in fiscal year 2023.

Figure 5.2 Ratios of dental amalgam and tooth-colored material (alternative material) used in new fillings during fiscal years 2019 - 2023[3].



Remark: Alternative material) including resin composite, glass ionomer and compomer material

From the ratios of dental amalgam and alternative material used in public health facilities during fiscal years 2019 - 2023, we estimate the total amount of dental fillings using amalgam and alternative materials in both public and private health facilities by calculating the number of dental personnel as follows (Table 5.1)

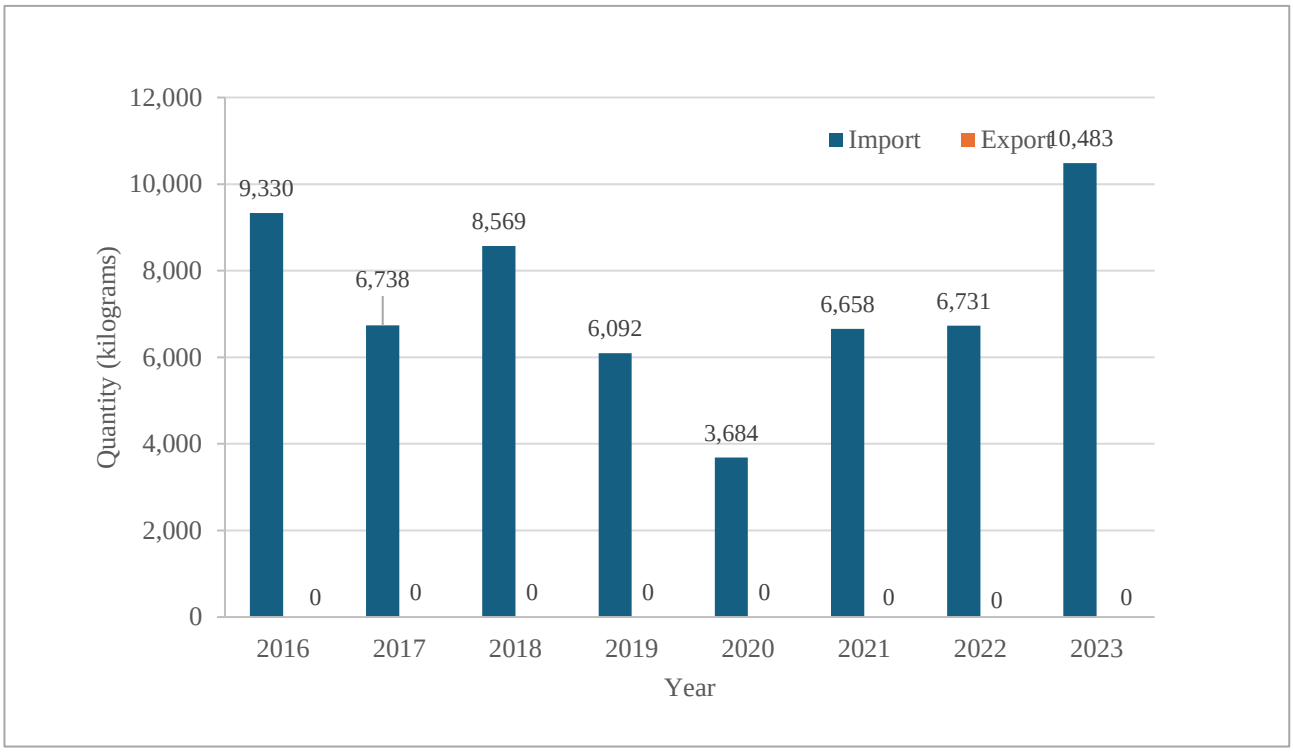
Table 5.1 The total amount of dental fillings using amalgam and alternative materials in both public and private health facilities

fiscal year	no. of total tooth filling in public health facilities (A)	percent of dental amalgam fillings in public health facilities (B)	no. of personnels in public health facilities (C)	ratio of tooth filling per dental personnels (D) = (A)/(C)	no. of personnels in public and private health facilities (E)	no. of total tooth filling in public and private health facilities (F) = (D)*(E)	no. of dental amalgam fillings in public and private health facilities (G) = (F)*(B)/100	amount of mercury usage (0.4 g per capsule) (H) = (G)*0.4	amount of mercury usage in term of kilogram (I) = (H)/1,000
2019	1,746,893	30.88	8,347	209.28	19,911	4,167,052	1,286,786	514,714.31	514.71
2020	1,186,328	26.14	8,482	139.86	20,170	2,821,061	737,425	294,970.09	294.97
2021	1,049,592	17.43	8,633	121.58	20,514	2,494,073	434,717	173,886.75	173.89
2022	1,204,253	12.98	8,937	134.75	20,927	2,819,895	366,022	146,408.95	146.41
2023	2,099,936	11.19	9,079	231.30	21,096	4,879,420	546,007	218,402.82	218.40

5.2 Import and export of dental amalgam and alternative materials

Amalgam and other compounds have been assigned under the HS code 28439000, including both for the dental and other purposes[19]. Thailand only imports amalgam material (no export). The import of goods under the HS code 28439000 during the year 2016 - 2023 is shown in Figure 5.3.

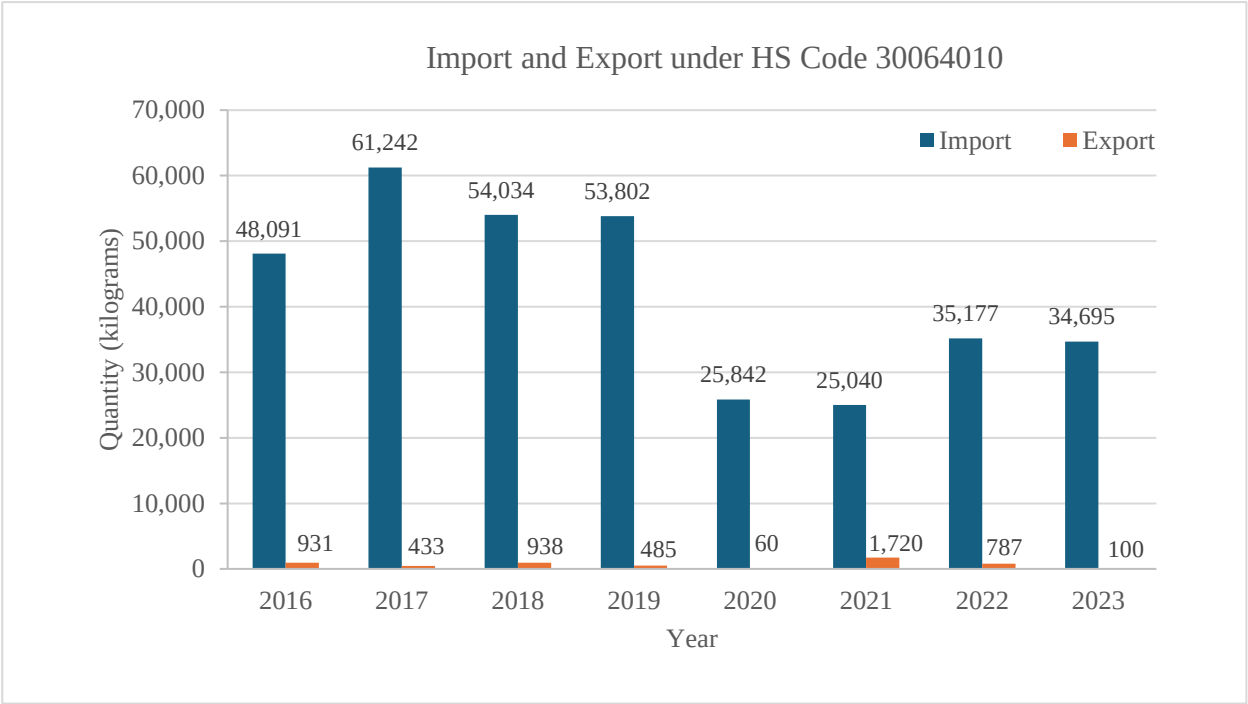
Figure 5.3 Import of Amalgam and other compounds assigned under the HS code 2843900[19].



There are no specific customs codes for the dental amalgam. Thus, the import in Figure 5.3 covers the amalgam volume of all applications. The import volume of amalgams between 2016 - 2023 was in a range of 3,684 - 10,483 kilograms. Currently, dental amalgams are imported from Italy, Japan, the United States, Pakistan, and Turkey.

Figure 5.4 shows the import and export of dental cements and other dental fillings under the HS code 30064010 between years 2016 and 2023. The import volume was in a range of 34,695 - 61,242 kilograms. The import volume of the dental cements and other dental fillings was higher than that of the amalgam.

Figure 5.4 The import volumes of dental cements and other dental fillings under the HS code 30064010[19].



The import volume decreased in 2023 as compared to the previous year possibly due to the COVID -19 situation. After 2021, the import continued to increase, but it was still lower compared to those before the COVID-19 situations. The export volume was in a range of 60 - 1,720 kilograms.

5.3 Mercury emissions and releases

5.3.1 Mercury release into water

Report on mercury releases into water and air and from amalgam waste by using the UNEP Mercury inventory toolkit.

1. There are no regulations for the mandatory installation of amalgam separators.
2. Estimated quantity of mercury released to water[20].

Table 5.2 Main releases and receiving media during the life cycle of dental amalgam fillings[20].

Phase of life cycle	Air	Water	Land	Products	General Waste	Sector specific treatment*
Production/supply of materials for fillings				**X**		
Dental preparations and procedures at dental offices	x	**X**			**X**	**X**
Use (while in people's mouths)		**X**				
Disposal		**X**			**X**	**X**

*Separate collection for treatment at hazardous/medical waste

X - Release pathway expected to be predominant

x - Additional release pathways to be considered, depending on specific source and national situation

Important aspects influencing the release of mercury from dental amalgams

1. The amount of dental amalgam used per person (capita) in the country
2. The presence of modern high-efficiency amalgam filters in the dental clinics wastewater system. According to the Danish studies, the amalgam filters may collect 90 - 99.9 % of the amalgam input to the wastewater in the clinic. If only the coarse mesh filters (strainers) are used, most the amalgam - perhaps 80 - 90% - is lost to the public wastewater system (or release to the environment if no such system exist[21].
3. The management of amalgam waste, e.g. S/S process and disposal in specially engineered landfills

An average annual release of mercury through each pathway X is estimated by calculation using the Equation[20].

Estimated mercury release to pathway X = Activity rate (kilogram/year) x Input factor (g mercury per kilogram of activity) x Output distribution factor for pathway X (unitless fraction) (Equation 1)

Table 5.3 Overview of activity rate data and mercury input factor types needed to estimate releases from dental mercury-amalgam fillings.

Life-cycle Phase	Activity rate data needed	Mercury input factor
Production of ingredients	Mercury purchased for the production per year	Mercury loss per Kg mercury purchased for production
Use (while in people's mouths)	Population who received dental amalgam fillings	Estimated mercury Excretion per capita per year
Disposal	Number of amalgam fillings made per year 10 - 20 years ago	Mercury used for preparation of one amalgam filling

The number of dental amalgam fillings in public and private facilities was 546,007 fillings in 2023. It was estimated by using the ratio of amalgam fillings per number of dental personnel in public facilities multiplied by the total number of dental personnel in both public and private facilities. Each filling required 0.4 gram of mercury, resulting in mercury of 218.40 kilograms in dental usage in 2023.

Table 5.4 The release of mercury from dental amalgam fillings in 2023.

Phase in life - cycle	Calculated Hg output (kg/y)					
	Air	Water	Land	Products	General Waste	Sector specific treatment*
Total	**4.37**	**48.84**	**4.87**	**3.65**	**31.08**	**31.08**
Preparations of fillings in the teeth at dentist clinics (share of current mercury supply for amalgam fillings)	4.37	30.58	0.00	0.00	26.21	26.21

Phase in life - cycle	Calculated Hg output (kg/y)					
	Air	Water	Land	Products	General Waste	Sector specific treatment*
Use - from fillings in the mouth (share of mercury supply for fillings 5 - 15 years ago)	0.00	1.22	0.00	0.00	0.00	0.00
Disposal - via clinics and households and death (share of mercury supply for fillings 10 - 20 years ago)						
In countries where most dental clinics are equipped with high efficiency amalgam filters (95% retention rate)	0.00	0.00	0.00	0.00	0.00	0.00
In countries where only dental chair filters/strainers are used in most clinics	0.00	17.05	4.87	3.65	4.87	4.87

Note: The share of mercury supply for fillings in 2019 of 515 kilograms was used to estimate the mercury release in use and disposal phases.

5.3.2 Mercury emissions to air from crematoria

Table 5.5 Mercury emissions to air from crematoria (approximately).

Category	Data to be collected
For crematoria not applying mercury removal techniques	Year of answer 2022
	Number of crematoria: 25,500 Ref: https://www.sdgmove.com/2022/06/27/crematorium-reduce-air-pollution/
	Number of cremations: 557,167
	Hg emissions (kg Hg) 100.33

The number of deaths from registration in 2022 was 595,965. The proportions of number of deaths by the ages was estimated by using the data between 2015 and 2016[21].

Table 5.6 the average number of deaths and fillings in each age group from 35 - 100 years old and above[21,22].

Age (years)	percent	Number of deaths (cases)	Average fillings (teeth/person)	Proportion of dental fillings using amalgam (%)	Mercury in the oral cavity (g/tablet)	Mercury from all the deceased. (kilograms)
35 - 44	5.7	33,970	2	25	0.4	6.79
45 - 59	16.1	95,950	2	25	0.4	19.18
60 - 69	18.2	108,466	0.9	25	0.4	9.76
70 - 74	11.5	68,536	0.9	25	0.4	6.16
75 - 79	11.5	68,536	0.9	25	0.4	6.16
80 - 100 or above	31.2	185,941	0.3	25	0.4	5.58

The average fillings of the working-age population (35 - 59 years old) is two teeth per person. However, the average fillings of the populations of 60 - 79 years old is only 0.9 tooth/person. The average amount of mercury per dental filling is 0.4 grams of mercury/tooth.

According to information on religious people in Thailand. Year 2018 Buddhists accounted for 93.49%, Muslim 5.38% and Christians 1.13% .

Table 5.7 Main releases and receiving media from crematoria and cemeteries[20].

Category	Air	Water	Land	Products	General waste	Assessment Approach
Crematoria	**X**				x	OW
Cemeteries			**X**			OW

OW = National/overview approach

Table 5.8 Preliminary default mercury output distribution factors from crematoria and cemeteries[20].

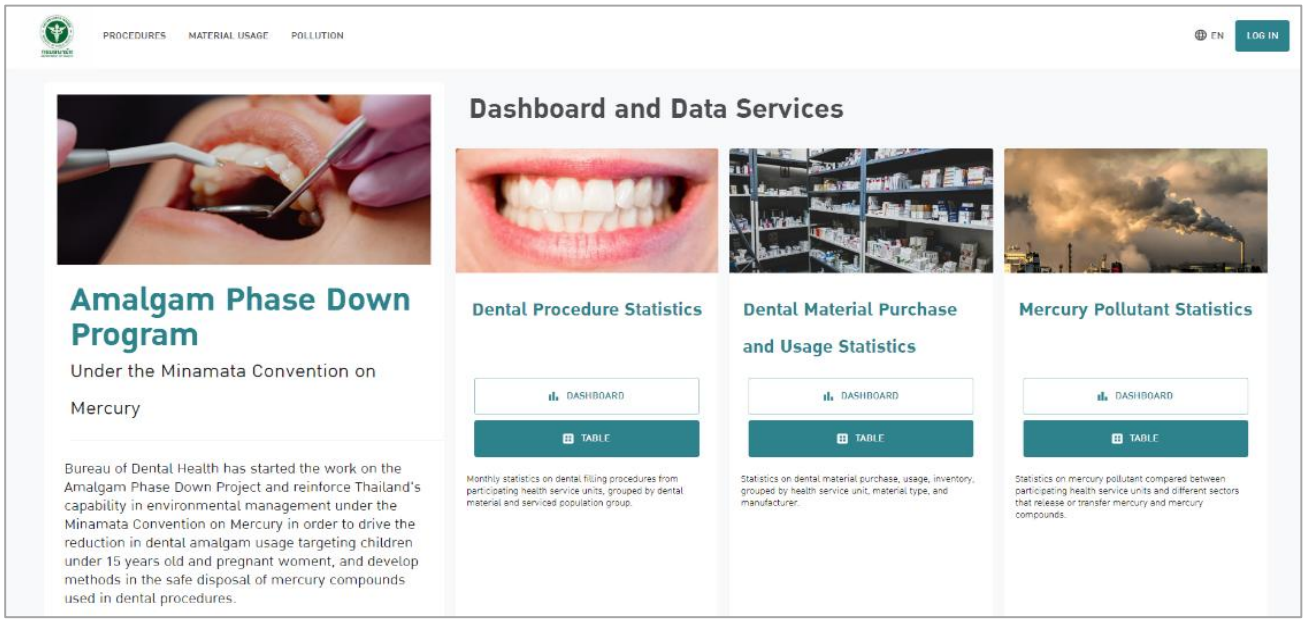
Category	Default output distribution factors, share of Hg input					
	Air	Water	Land	Products	General Waste	Specific treatment
Cremation without mercury filter	1					
Cremation with mercury filter	0.05					0.95

Table 5.9 The release of mercury from crematoria and cemeteries in 2022.

Category	Calculated Hg output Kg/y					
	Air	Water	Land	Products	General Waste	Specific treatment
Total	26.81	0.00	1.74	0.00	0.00	0.00
Cremation without mercury filter	26.81	0.00	0.00	0.00	0.00	0.00
Cremation with mercury filter	0.00	0.00	0.00	0.00	0.00	0.00
Cemeteries	0.00	0.00	1.74	0.00	0.00	0.00

There is no data of manufacturing of dental amalgam and alternative restorative materials, removal of restorations, Stocks of dental amalgam and alternative restorative materials in both public sector and private sector in Thailand. However Thailand has developed database program to gather information on dental procedure statistics, dental material purchase and usage statistic in dental facilities, and mercury pollutant statistics through website Amalgam Phase Down Program Department of Health (moph.go.th) which allow any public and private segments to fill out the forms (Fig 5.5).

Fig 5.5 Dashboard and data services on amalgam phase down in Thailand.



5.4 Suggestions for measures to strengthen the country's capacity and resources for the environmentally sound management of mercury waste and dental amalgam waste

1. Identifying sources and estimating the quantity of waste containing mercury or mercury compounds in public health sectors. The inventory helps with planning budgets and facilities for environmentally sound management.
2. Registering waste generators including healthcare facilities.
3. Estimating types and amount of mercury waste that will be generated in a healthcare facility such that areas of temporary storage is properly prepared.
4. Developing digital tool for medical waste management including mercury waste and dental amalgam waste which tracks the amount and types of waste from generators to disposal facilities, including contingency plans.
5. Assessing the mercury waste management technology in the country in accordance with the guidelines of the Minamata Convention and the Basel Convention.

CHAPTER 5

Recommended measures and implementation plan to reduce the use of dental amalgam, promote alternative dental restorative materials, and manage amalgam waste based on an analysis of the situation in Thailand

Operational proposal	Operational timeline (Quarterly based on calendar year)											
	2024				2025				2026			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
1. Preparation for declaration the intention of collective measurements regarding exclude or not allow or recommend against the use of dental amalgam for the dental treatment of deciduous teeth, of patients under 15 years and of pregnant and breastfeeding women. **Related organizations:** Bureau of Dental Health, The Dental Council of Thailand, Dental Faculty Consortium of Thailand, The Royal College of Dental Surgeons of Thailand, The Dental Association of Thailand, Private Dentist Association of Thailand, Thai association of pediatric dentistry, Association of Operative Dentistry (Thailand), Department of health service support, Provincial Public Health Office, Institute of Dentistry, Department of Medical Services.											
1.1 Appoint a committee to supervision and implement guideline on dental caries in early childhood and/or children to reduce the use of amalgam.												
1.2 Develop dental caries control and management guidelines in early childhood and/or children in national level to reduce the use of amalgam.												
1.3 Disseminate guidelines and announce national intentions in collaboration with relevant agencies through various media channels.												

Operational proposal	Operational timeline (Quarterly based on calendar year)											
	2024				2025				2026			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
2. Draft national dental health action plan to be proposed to the Office of the Economic and Social Development Council prior to Cabinet approval. **Related organizations:** Bureau of Dental Health.												
2.1 Action plan 1: Appoint a national oral health committee to consider the appropriateness of the national dental health action plan to be proposed to the office of the Economic and Social Development Council prior to Cabinet approval to enhance the formulation of national caries prevention policies.												
2.2 Action plan 2: Incorporate amalgam waste management measures into the national implementation plan for mercury management and present it to the Pollution Control Department, in order to comply with the obligations of the Minamata Convention on Mercury.												
3. Development of amalgam waste management align with existing regulations **Related organizations:** Bureau of Environmental Health, Bureau of Dental Health, Pollution Control Department, Department of Industrial Works, Department of Health Service Support, Provincial Public Health Office, Private Dentist Association of Thailand, Local Administrative Organizations.												
3.1 Appoint a subcommittee to develop mechanisms for managing amalgam waste from dental service facilities.												

Operational proposal	Operational timeline (Quarterly based on calendar year)											
	2024				2025				2026			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
3.2 Develop an information technology system for collecting data on amalgam removal and amalgam inventory to monitor amalgam usage data.												
3.3 Develop mechanisms for managing amalgam waste from the source until the completion of the disposal process in accordance with relevant laws.												
3.4 Announcement of amalgam waste management measures with legal effect.												
4. Promote health insurance policies and programs for dental restorations that encourage the use of alternative dental restorative materials over dental amalgam. **Related organizations:** Bureau of Dental Health, National Health Security Office,												
4.1 Emphasizing caries prevention by adjusting the pricing and reimbursement of preventive program.												
5. Support dental professional organizations and dental educational institutions for studying and training dental professions in the use of alternative materials and promote the implementation of best management practices. **Related organizations:** Praboromarajchanok Institute, Dental Faculty Consortium of Thailand, The Royal College of Dental Surgeons of Thailand, Bureau of Dental Health.												
5.1 Dental educational institutions adjust teaching curricula and training to emphasize the use of alternative dental restorative materials and raise awareness about amalgam waste management.												

Operational proposal	Operational timeline (Quarterly based on calendar year)											
	2024				2025				2026			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
6. Reduce the release of mercury into the environment from teeth restored with amalgam after cremation. **Related organizations:** Bureau of Environmental Health, Pollution Control Department, Department of Religious Affairs, Ministry of Culture, Local Administrative Organizations.												
6.1 Prepare a summary with recommendations about estimated mercury released into the environment from teeth restored with amalgam after cremation proposed to relevant organizations that shall continue to manage emissions from crematorium furnaces.												

Remark: The underlined organization is the main operating organization

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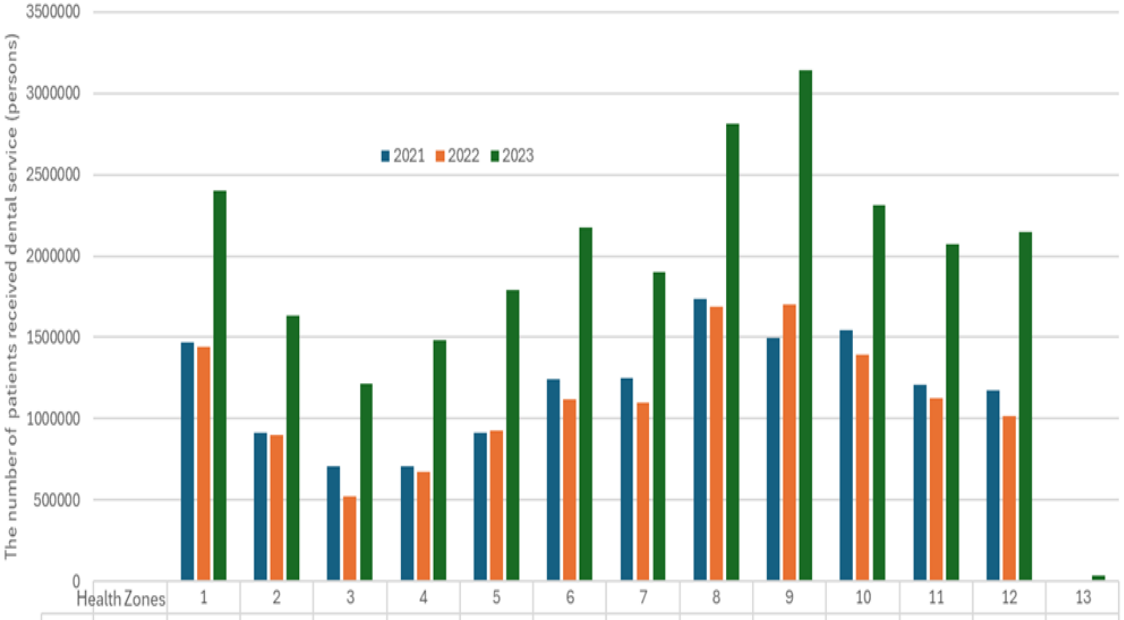
APPENDIX A

Figure A Thirteen Health Regions of Thailand.

Figure B The number of patients receiving dental services divided by health zones, 2021-2023.



Health Zones	1	2	3	4	5	6	7	8	9	10	11	12	13
2021	1,467,183	910,303	705,001	706,076	916,106	1,244,969	1,249,844	1,733,126	1,496,154	1,543,417	1,205,003	1,174,061	1,671
2022	1,441,543	896,189	520,234	673,324	926,732	1,121,608	1,101,566	1,689,851	1,699,288	1,395,229	1,128,267	1,014,554	8,614
2023	2,399,025	1,636,164	1,216,752	1,484,474	1,789,157	2,174,059	1,900,481	2,812,878	3,142,321	2,311,895	2,069,562	2,144,900	33,036

APPENDIX B

STANDARD OPERATING PROCEDURE (SOP) FORM

Organization Name Bureau of Dental Health	Operating manual for amalgam waste management procedures
	Reducing the use and environment friendly management of amalgam waste in dental clinics Indicator: 1.26 Percentage of hospitals that can develop environmental health according to the GREEN&CLEAN Hospital criteria, passing the criteria at a good level or higher.

1. Objectives

1.1 To use as a guideline for managing and reducing the use of amalgam and manage amalgam waste in Environmentally friendly clinics

1.2 To serve as a guideline for supervising, monitoring, and evaluating business performance and operations to reduce use and manage amalgam waste in dental clinics to be environmentally friendly according to the criteria of GREEN&CLEAN Hospital, passing the criteria at a good level or higher.

2. Scope

This operational manual for driving indicators Covers the contents of the process and steps to manage and reduce using amalgam and managing amalgam waste in an environmentally friendly clinic. The important measures are as follows:

2.1 Policy to reduce the use of amalgam in dental clinics in healthcare facilities

2.2 Guidelines for managing amalgam waste in dental clinics to be environmentally friendly are related to the dental department/dental public health in hospitals under the Ministry of Public Health.

3. Definition

3.1 ***Amalgam*** refers to a metal obtained from a combination of mercury and other metals. In dentistry, the metal used as a tooth restoration (or filling) is pre-mixed with mercury, an alloy of silver, and Tin is called Silver-Tin-Alloy. When mercury was mixed, a new compound is called Silver-Tin Amalgam. The principle is to mix silver alloy powder, Tin and mercury in a state of moldability (plasticity), soft and can flow. When left, it will harden. Metal ingredients were then developed to make it safer and more suitable. It is also called dental amalgam or dental amalgam material. Although nowadays, it has been found that the use of amalgam in dentistry is decreasing, it is a material of choice for restoring posterior teeth due to its durability and simple method of use.

3.2 ***Minamata Convention on Mercury*** means one of the important provisions of the Minamata Convention on Mercury. Member countries reduce the amount of dental amalgam use (Phasedown) with 9 measures:

1. Set national objectives to prevent tooth decay and promote oral health to help reduce tooth decay. Need tooth restoration
2. Set national objectives to minimize amalgam use.
3. Promote the use of alternative materials that do not contain mercury in dental restorations that are cost-effective and clinically effective.
4. Promote research and development of alternative materials that do not contain mercury.
5. Support education/training of dentists/students in using alternative materials that do not contain mercury.
6. Do not promote health insurance programs that use amalgam over mercury-free alternative materials in restorations.
7. Promote a health insurance program that promotes using quality alternative materials to amalgam in dental restorations.
8. Limit the use of dental amalgams to capsules.
9. Support using best environmental practices in dental clinics to reduce emissions. Mercury and mercury compounds enter water and soil.

3.3 ***Reducing the use of amalgam (Amalgam Phasedown)*** means reducing the use of amalgam materials in the dental clinic and promoting the use of substitute materials according to the Minamata Convention on Mercury in health care facilities.

3.4 ***Amalgam Waste Management*** refers to managing amalgam waste in dental clinics, including disposable amalgam capsules, contact amalgam, and non-contact amalgam. Management of amalgam waste includes separation, collection, and transportation, and then it is sent for disposal according to the Ministerial Regulations on the Management of Toxic or Dangerous Waste from Communities B.E. 2020.

3.5. ***Health Data Center (HDC)*** system refers to the system that every service unit under the Ministry of Public Health must operate in every province. HDC contains information that imports data files according to the Ministry of Public Health standards, totalling 43 standard files. The time for sending data includes data on individual outpatients of the service unit. Primary and regional hospitals/general hospitals/community hospitals submit the data by the 15th of the following month. By the end of the next month, the health data warehouse will receive data from 2 sources: HDC at the Cloud of the Ministry of Public Health and HDC at the Provincial Public Health Office. All service units must submit data to the HDC at the Ministry of Public Health before the system forwards the data to the HDC of the Provincial Public Health Office and records relevant procedure information and reports on time.

3.6. ***Medical Waste Management Database in Hospital*** means a solid waste management system in a hospital arising from operations. The hospital carries out various activities, such as removing waste from the treatment process, cooking, and removing waste from the wastewater treatment system. There is also waste from service recipients and relatives. The solid waste generated in hospitals can be classified into four types: general waste, hazardous waste, infectious waste, and recycled waste. The waste management system that occurs in hospitals must proceed according to the principles of sanitation and related laws.

4. Responsibility

4.1 Person directly responsible: Division of dental health risk factors

- Dr. Nonthinee Tangcharoendee, expert dentist
- Dr.Nantmanat Yambut, specialist dentist
- Dr. Wasinee Kiatadisorn, expert dentist
- Mr. Kasiwit Damkliang, expert medical scientist
- Miss Pranaya Jongmee, Public Health Practitioner
- Miss Kanya Ritim, Public Health Laboratory Specialist

4.2 Co-operators include central government agencies, including the Environmental Health Department, Pollution Control Department, Ministry of Natural Resources and Environment and government agencies from the area, including dental personnel in the provincial hospital, general hospital, community hospital, subdistrict health promotion hospitals and related professional organizations including the Association of Pediatric Dentistry of Thailand, the Association of Operative Dentistry of Thailand, Private Dentist Association of Thailand, the Royal College of Dental Surgeons of Thailand, Dental Faculty Consortium Thailand, Praboromachanok Institute and Sirindhorn College of Public Health.

5. Procedures

Order	Work flow	Details	Period	Responsible person/ Department	Documents/ related information
1	Review the situation and analyze information and knowledge to plan operations	• Review the situation and past performance results • Analyze data/knowledge. and problems and obstacles in operations • Set operational goals based on indicators.	Aug-Sept 2021	Division of Oral Health Risk factors	• Situation of using dental filling materials health risks and amalgam waste management amalgam in hospitals under the Ministry of Public Health in Thailand • Information on tracking infectious waste and waste management systems, including mercury contamination from dental clinics.
2	Set goals Set measures and prepare plans. Operation	• Set operational goals • Set measures to the operation • Create an action plan	Sep 2021	Division of Oral Health Risk factors	• Summary of the meeting of states parties • Third Minamata Convention on Mercury (COP3)
3	Propose the relevant persons	• Propose operational plans to executives and relevant people	Sep 2021	Division of Oral Health Risk factors	

Order	Work flow	Details	Period	Responsible person/ Department	Documents/ related information
		<u>If, the plan was not approved</u> • Review and adjust plans. <u>If, the plan was passed</u> • Explain plans and values Goals per operating area			
4.	Explain plans and operational goals based on indicators to co-operators and networks in the area.	• Explain the operational plan, target values and indicators to co-operators at the district level and networks in the area.	Oct 2021	Division of Oral Health Risk factors	Guidelines for dental public health operations for the fiscal year 2022
5.	Carry out activities according to the driving plan	• Develop a policy to reduce the use of amalgam materials in dental clinics in the service location • Driving operations to reduce the use of amalgam materials and manage amalgam waste in dental clinics • Develop a model for using alternative materials in place of amalgam and managing amalgam waste in dental clinics • Supervise and follow up on operations in the pilot hospital	Oct 2021-Sep 2022	Division of Oral Health Risk factors and Co-operators	• Manual for managing infectious waste and contaminated waste Mercury from dental clinics. • Essentials of dental practices for the safe use of mercury • Research testing mercury waste from used amalgam shells.
6.	Supervise, monitor, analyze data	• Follow up on operations, reducing use and manage amalgam	Jul-Sep 2022	Oral Health Risk factors	• HDC system user manual • Database system Manage hazardous

Order	Work flow	Details	Period	Responsible person/ Department	Documents/ related information
	and evaluate performance	waste in dental clinic with HDC system 2 times a year (March and August) • Evaluate the results of amalgam waste management. in the dental clinic from the database system hazardous waste management for hospitals (MEDWASTE) once a year (August)			waste for hospitals (MEDWASTE)

APPENDIX C

Curriculum information questionnaire related to guidelines for reducing the use of amalgam materials for dental restorations.

Instruction: Please type or write in the blank space. Or put a checkmark ☑ that corresponds to the curriculum at your institution.

Please specify the name of your university ……

1. Does your curriculum include teaching content on the following topics?*

	No	Yes, at undergraduate level	Yes, at post-graduate level	Yes, both at undergraduate and post-graduate levels
1.1 Mercury and risks to human health and the environment				
1.2 Environmentally friendly amalgam waste management practices to reduce mercury waste and pollution from dental work.				
1.3 Reducing the use of amalgam in accordance with the Minamata Convention and the role of dental health professionals				
1.4 Toxicology for health and the environment, safety of amalgams and alternative materials				
1.5 Using alternative amalgam-free materials to prevent and treat dental caries.				
1.6 Select and use dental materials for restoration based on the best evidence available, clinical judgment, and patient needs.				
1.7 Guidelines for restoring teeth using alternative materials and conservative methods of restoring teeth				

2. Has your institution adjusted the curriculum or requirements to reduce the use of amalgam materials? How?

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3. During the past 5 years, has the dental clinic in your institution tracked the amount of amalgam used (such as the number of capsules used per year)?.

A. No, and there is no action plan for the next 6 months. (Skip to question 3)

B. No, but there is a plan to monitor the use of amalgam over the next 6 months. (Skip to question 3.)

C. There is follow-up in some clinics, such as in teaching clinics and special clinics.

D. There is follow-up in every clinic.

3.1 If you answer yes to question 2, please specify the trends in amalgam use that you have followed over the past 5 years.

☐ Continuously decreased over the past 5 years.

☐ Tends to decrease but not consistently over the past 5 years

☐ There is still no decreasing trend. Relatively constant or more

4. Does your institution have policies and guidelines to reduce the use of amalgam materials, such as announcing work guidelines to reduce the amount of amalgam use or target to reduce amalgam purchases

☐ Yes ☐ No

5. Does your institution monitor the mercury level in wastewater every month to keep it within the standard? (0.005 mg/L)

☐ Yes ☐ No

6. Over the past 5 years, your institution has organized activities such as training for relevant personnel to increase awareness of mercury waste management. Or campaign to reduce the use of amalgam materials? If so, please explain.

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……..……..

7. The role and opinions of institutions in phase down and phase out using amalgam materials.

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8. Suggestions for reducing the use of amalgam for dental restorations in educational institutions, and related teaching

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