



*Minamata Initial
Assessment*

Health component in West Africa

A summary of the health impact assessment undertaken in six West African countries as part of the Minamata Convention pre-ratification process.



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ISBN: 978-929023414-2

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1. Introduction

Mercury is one of the top ten chemicals endangering human health and the environment worldwide. The poor handling and disposal of such products can damage ecological systems and human health. People are exposed to mercury through touch, ingestion and inhalation. When mercury is released into the environment as a gas or solid, it can travel long distances by wind and water and enter the food cycle. Mercury does not degrade and there is no cure for mercury poisoning. Different forms of mercury are toxic to the brain, kidneys, heart, lungs and immune system.

Mercury does not degrade and there is no cure for mercury poisoning

Mercury is used in a wide range of products and applications. The primary sources of anthropogenic mercury emissions are artisanal and small-scale gold mining (727 tonnes), coal combustion (474 tonnes), primary production of non-ferrous metals (193 tonnes), cement production (173 tonnes), large-scale gold production (97.3 tonnes) and consumer product waste (95.6 tonnes).¹ Mercury-containing materials such as thermometers and sphygmomanometers are used in many health facilities and present a potentially harmful health risk. Dental amalgam is still widely in use in dentistry. Poorly managed disposal of such mercury-containing materials and other mercury wastes poses additional health risks.

Dental amalgam

In 2010, mercury in dental use accounted globally for 340 metric tonnes, which represents under 20% of the global mercury emissions overall.² The WHO report, 'Future Use of Materials for Dental Restoration' (2010) reported that the use of dental amalgam results in 180-240 tonnes of mercury being discharged into the atmosphere, soil, and water every year, while only 80-100 tonnes are recycled, sequestered or disposed of securely.³

Most dental fillings are made of amalgam, which is a mixture of mercury, silver, tin and copper. Researchers have been warning for years that amalgam can increase mercury levels in blood. Recent reports discovered that people with more than eight amalgam fillings have twice as much mercury in their blood, compared to people with no fillings.⁴ The safety of dental

amalgam has been considered by many countries around the world, with some European countries restricting its use for health reasons.

Medical instruments containing mercury

The World Medical Association passed a resolution⁵ in 2008 calling for the substitution of mercury-based medical devices with safer alternatives. Due to the health effects of mercury exposure, industrial and commercial uses are regulated in a number of countries. However, Low and Middle Income Countries have been slow to phase out the use of mercury-based medical devices, largely due to the cost of replacing equipment.

Mercury waste management

The Basel Convention Technical Guidelines⁶ assert that mercury must be disposed of in a stabilized and solidified state in a specially engineered landfill or must be permanently stored in secure underground storage facilities that use storage vessels specifically designed for the purpose. Globally, only a few countries have the technology and equipment for the solidification and stabilization of mercury, and only a limited number of appropriate final disposal facilities are available around the world. Of the total amount of waste generated by healthcare facilities, about 85% is general, non-hazardous waste. The remaining 15% is considered hazardous material that may include mercury as chemical waste. Open burning and incineration of healthcare wastes can result in gaseous mercury emission, which then acts as a neurotoxin.

The Minamata Convention and Minamata Initial Assessments

The Minamata Convention, entered into force in August 2017, is a global treaty that aims to protect human health and the environment from anthropogenic emissions and releases of mercury and mercury compounds. Leading roles for the health sector in the Minamata Convention are:

- Article 4 and Annex A (Mercury-added products): Phase out manufacture, import and export by 2020 of thermometers, blood pressure monitors, antiseptics and skin-lightening

¹ United Nations Environment Plan. Global Mercury Assessment 2013: Sources, Emissions, Releases and Environmental Transport. UNEP Chemicals Branch, Geneva, Switzerland; 2013 (<http://wedocs.unep.org/handle/20.500.11822/7984>, accessed 16 April 2018)

² *ibid*

³ World Health Organization. Future use of materials for dental restoration: Report of the meeting convened at WHO HQ, Geneva, Switzerland 16th to 17th November 2009. Geneva, Switzerland; 2009 (http://www.who.int/oral_health/publications/dental_material_2011.pdf Accessed on 16 April 2018)

⁴ Yin L, Yu K, Lin S, Song X, Yu X. Associations of blood mercury, inorganic mercury, methyl mercury and bisphenol A with dental surface restorations in the U.S. population, NHANES 2003 - 2004 and 2010 - 2012. *Ecotoxicology and Environmental Safety*. 2016; 134:213. doi: 10.1016/j.ecoenv.2016.09.001

⁵ World Medical Association statement on reducing the global burden of mercury. 59th WMA General Assembly, Seoul, Korea; 2008 (<https://www.wma.net/policies-post/wma-statement-on-reducing-the-global-burden-of-mercury/> Accessed on 16 April 2018)

⁶ Basel Convention. Technical guidelines for the environmentally sound management of wastes consisting of elemental mercury and wastes containing or contaminated with mercury. Twelfth Meeting of the Conference of the Parties to the Basel Convention, Geneva, Switzerland; 2015 (<http://www.basel.int/Implementation/Publications/LatestTechnicalGuidelines/tabid/5875/Default.aspx> Accessed on 16 April 2018).

cosmetics; Phase down use of dental amalgam.

- Article 7 and Annex C: Artisanal and small-scale gold mining: Develop public health strategies to address the health impacts of mercury use in artisanal and small-scale gold mining.
- Article 12: Contaminated sites: Undertake human health risk assessments.
- Article 16: Health Aspects: Develop and implement strategies and programmes to identify and protect populations at risk.
- Article 17: Information exchange.
- Article 18: Public information, awareness and education.
- Article 19: Research, development and monitoring: Undertake health assessments and monitor levels of mercury and mercury compounds in vulnerable populations.

To ratify the Minamata Convention, countries need to undertake assessments that provide baseline information of their current situation. Undertaking these Minamata Initial Assessments (MIAs) will help countries complete pre-ratification preparations and define national priorities for implementation of the Convention. WHO Regional Office for Africa (WHO-AFRO) submitted a proposal for a small-scale project on the health component of the MIA to the United Nations Industrial Development Organization (UNIDO). This

health impact assessment is part of a comprehensive MIA of the health and environmental impact of mercury within Africa. The Ministries of Public Health in six West African countries, Benin, Guinea, Mali, Niger, Senegal and Togo, with the support of WHO, collected data and information on the use and disposal of medical equipment and materials containing mercury in the health system. This report summarizes the findings obtained.

The findings in this report will be useful to professionals working in the health and environment sectors, including planners and programmers in national governments, NGOs, research agencies, and regional and international development partners.

This health impact assessment is part of a comprehensive MIA of the health and environmental impact of mercury within Africa.

Figure 1. The Minamata Convention in Africa

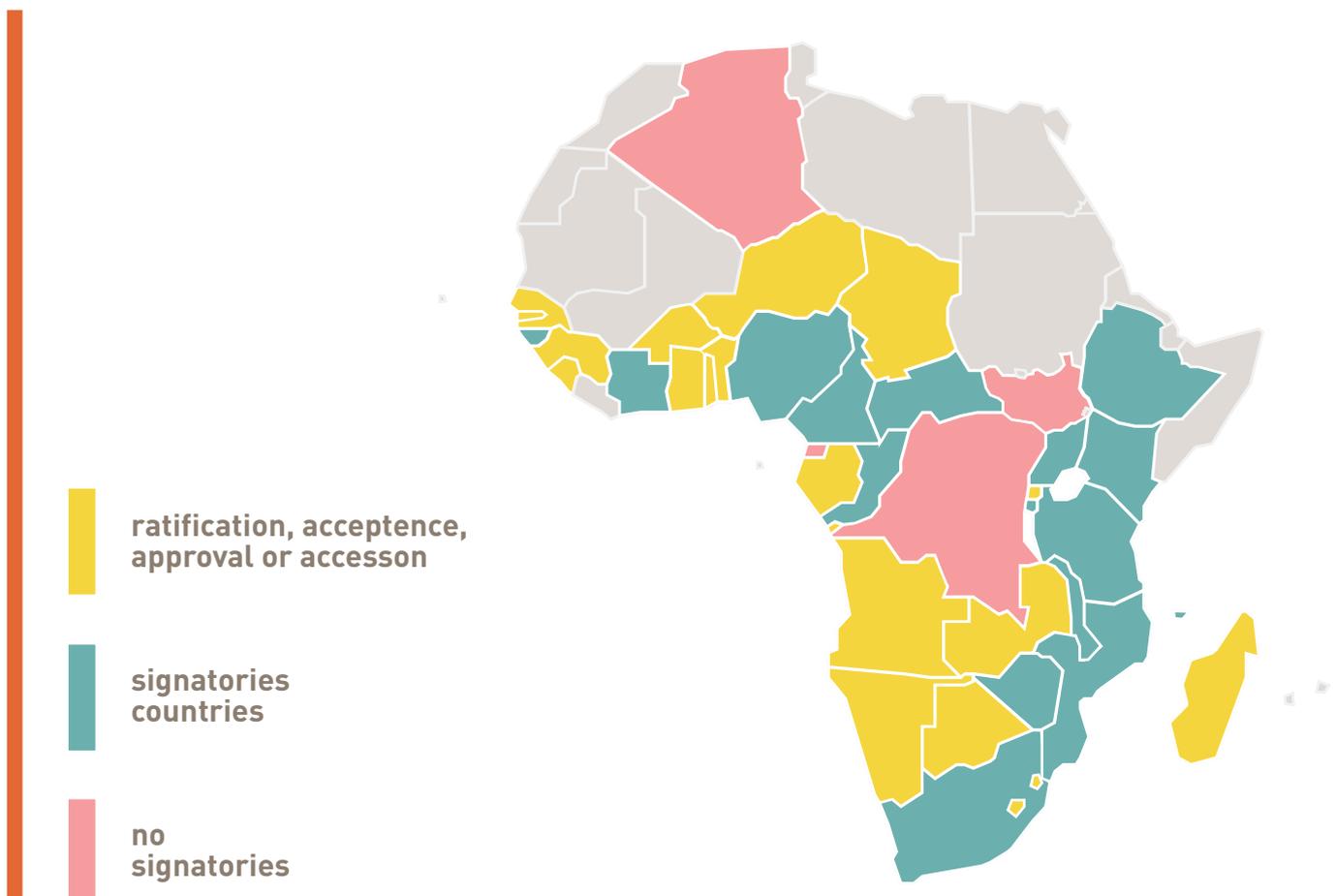
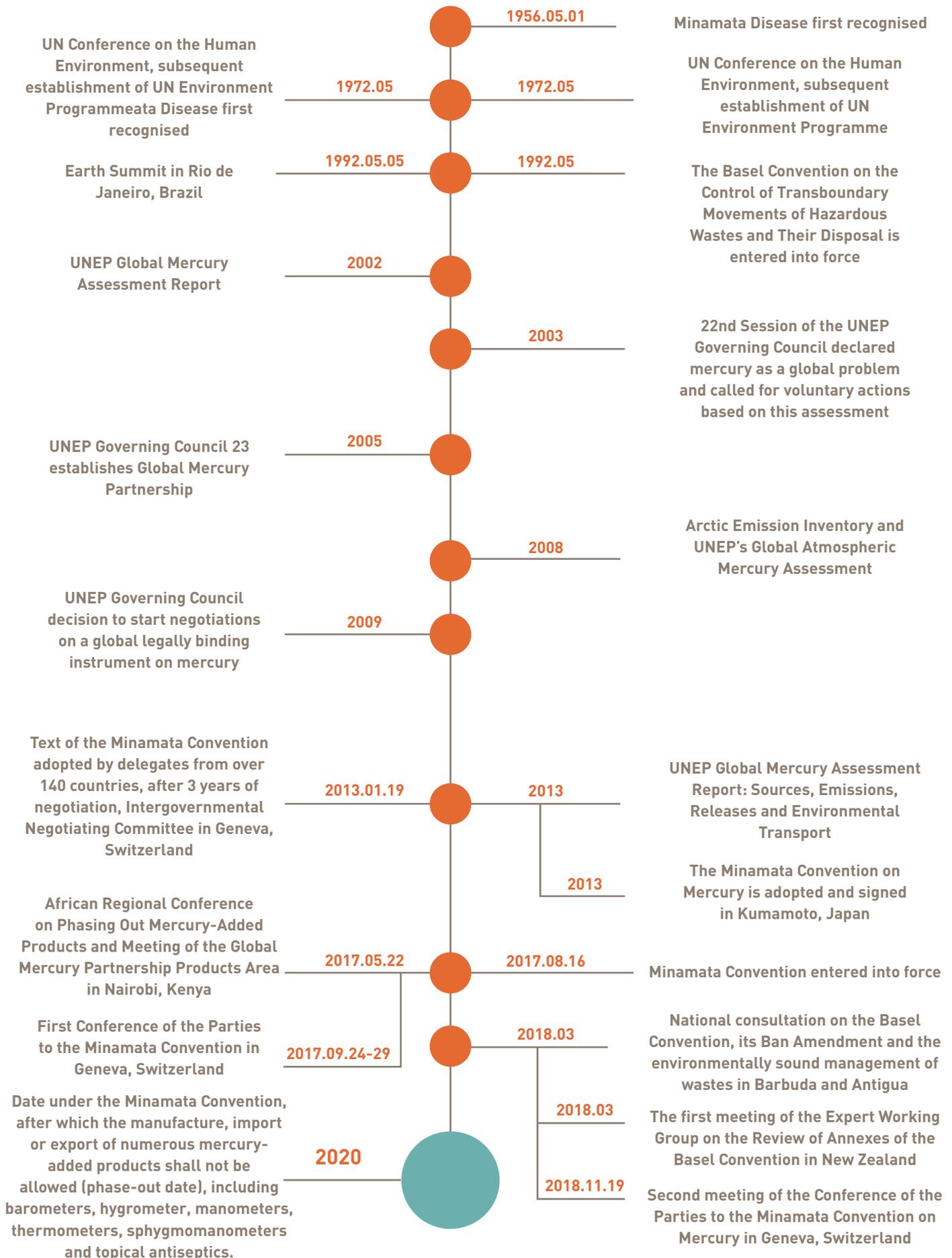


Figure 2: Global policy context for mercury timeline



2. Methodology

2.1 Sampling

The number of facilities covered in each country varied from 45 (Niger) to 86 (Benin) (Fig. 3. Assessment regions). Each country's sample included dental facilities and general health facilities. Some of the general health facilities had dental departments. To ensure a representative sample was used, representatives from public and private facilities at different levels of healthcare (primary, secondary and tertiary), and from a range of departments, were surveyed. Survey participants included hospital directors, pharmacists, dental surgeons, interns, hygiene and sanitation technicians, store managers, volunteers and administrative staff. Although the same questionnaire was sent to each of the facilities, certain questions were more pertinent to only the dental facilities, while some applied to the general healthcare facilities.

Sampling was both random and targeted. In many cases, regions or facility type were chosen for a specific reason. In Mali, the Bamako District and Kati Cercle in the Koulikoro Region have the largest number of public and private health facilities that are the most frequented. These areas were therefore selected for the study. In Guinea, sampling factors included accessibility to facilities from main roads and proximity to mining areas. Other countries, such as Niger, also focused on specialised facilities beyond the main health structures, such as maternal health centres. In Senegal, specific private clinics were chosen based on their number of patients.

2.2 Data collection

Prior to data collection, document reviews were undertaken to understand the main issues of the subject.

In each of the six countries, data were collected using a semi-structured questionnaire developed at a workshop organized by WHO-AFRO.

The studies took place over two weeks to one month in the second half of 2017. In each of the six countries, data were collected using a semi-structured questionnaire developed at a workshop organized by WHO-AFRO. The questionnaires were

adapted to each country's local situation. The questionnaire covered the main issues relating to the usage and disposal of mercury-containing materials, and included questions to determine whether healthcare workers had adequate knowledge of the health risks of mercury. This questionnaire was sent to managers and other staff at the selected dental and general health facilities. In some of the countries, interviews based on these questionnaires were conducted in person, both individually and in groups.

In addition to this, some countries presented visual evidence of the data. Benin took photographs of the inventory items and Guinea took photographs of dental amalgam and mercury-containing materials in health structures and of storage and waste disposal facilities.

Figure 3. Assessment regions

Guinea:

Facilities across the whole country (30 dentistry and 30 hospitals/clinics)

Senegal:

Dakar region (58 health facilities and 30 dentistry)

Togo:

Lomé, Maritime and Plateaux regions (30 health facilities and 19 dentistry)

Mali:

Bamako District and Kati Cercle in the Koulikoro Region (30 hospitals, clinics and other care facilities, 30 dentistry)

Niger:

Niamey, Maradi and Zinder (45 facilities in total)

Benin:

Littoral, Atlantique, Ouémé, Plateau, Mono, Couffo, Zou, Collines, Alibori, Atacora, Donga regions: 48 facilities in total (17 dentistry, 10 general healthcare that did not do dental work, and 21 facilities that included both dental and general healthcare)

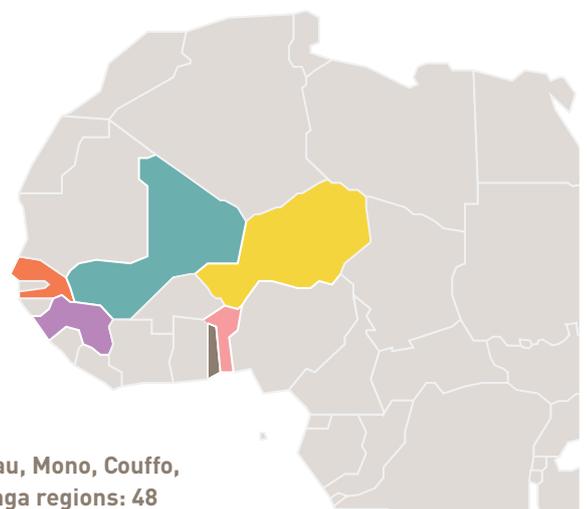
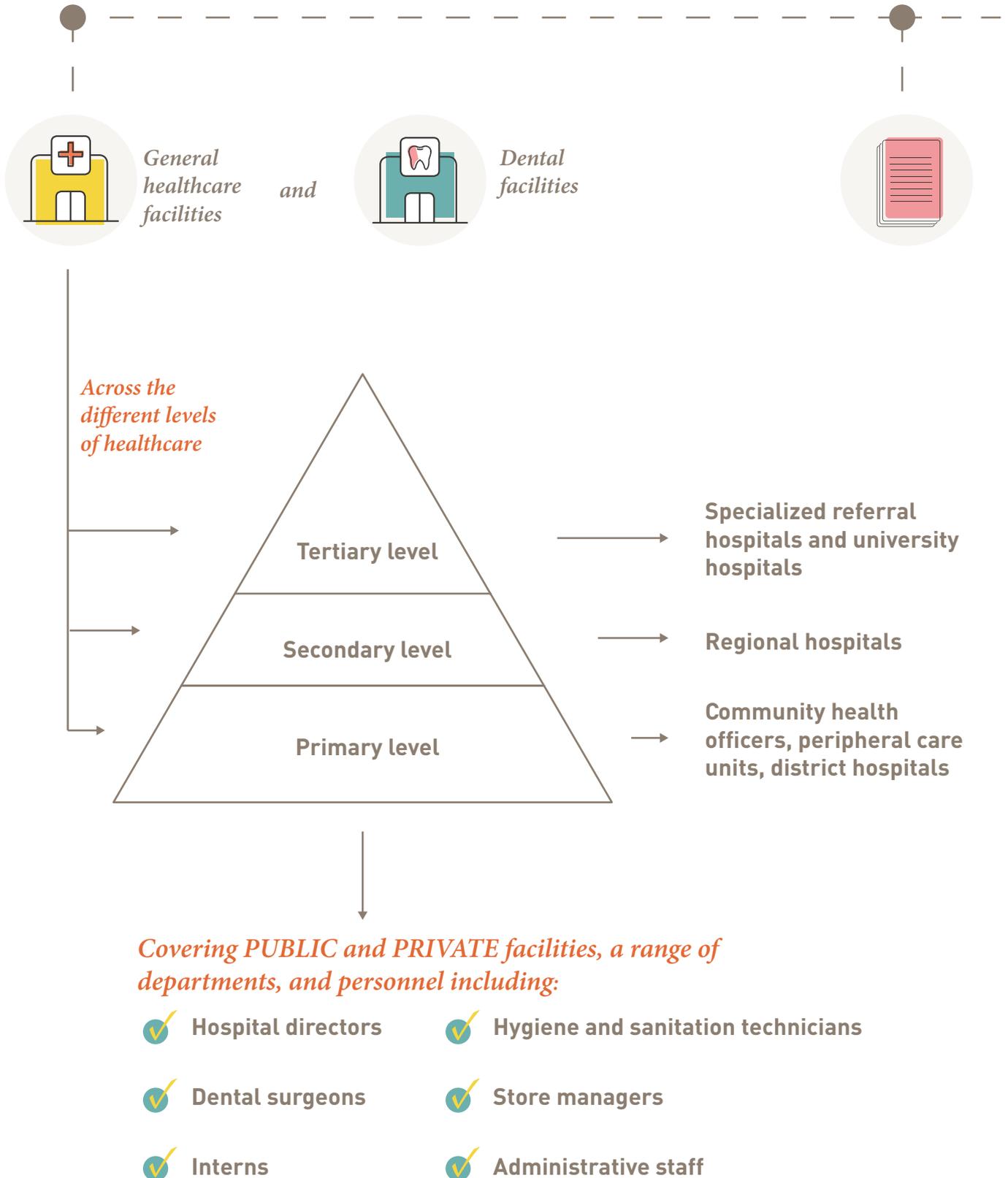


Figure 4. Methodology at a glance

Sampling

Background research



Questionnaire development and use

Direct observations

Summary of a questionnaire developed at a workshop organized by WHO AFRO



Photos were taken in Benin and Guinea



Dental amalgam

Sample question: What is the number of dental restorations performed in your facility?

- Dental restoration practices
- Suppliers
- Amalgam storage



Mercury-containing equipment

Sample question: What types of mercury-containing equipment or devices do you use?

- Amount of mercury-containing equipment
- Suppliers



Sample question: Has anyone from your facility received training on mercury waste management?

- Accidental spillage
- Projects to limit the use of mercury-containing instruments
- Knowledge of the sources of exposure and the danger to health that mercury poses



Waste management

Sample question: How do you handle waste containing mercury?

- Amount of waste produced
- Biomedical waste management
- Wastewater management

3. Results

This study showed that there is still a reliance on dental amalgam and mercury-containing instruments in the West African facilities assessed. Only few of the facilities had waste management procedures in place for mercury-containing equipment, and as a result, management thereof was poor. Dental amalgam handling and elimination, in addition to management of biomedical waste and wastewater was also poor, although some countries did fare better than others. Overall, training was shown to be insufficient and health

workers had limited knowledge on the dangers of mercury. In reporting the results from the questionnaires, some of the countries differentiated between dental clinics and general health structures, some differentiated between private and public facilities, and some specified areas. Results in this report are therefore not always directly comparable across countries, and are represented in accordance with the country findings. If more detailed results are required, the country reports can be referred to.

3.1 Dental amalgam

Results from the six West African countries combined showed that amalgam-based dental restorations, composite resin and ionomer glass cement were the three most commonly cited forms of dental restoration used in the surveyed dental facilities (Fig. 5. The most commonly cited forms of dental restoration). Over 70% of the dental facilities across five of the countries (Benin, Mali, Niger, Senegal and Togo) used amalgam in dental restoration. Results from Guinea varied across regions, but the most common type of restoration material was composite resin. Fewer than half of assessed facilities in all regions in Guinea

used amalgam in restorations. Over 90% of the facilities in Mali, Senegal and Togo reportedly used composite resin, and ionomer glass cement was used in all of the Senegalese dental facilities.

The Malian facilities saw 30 420 dental amalgam restorations occur in one year (Fig. 6. Number of dental restorations performed in the facilities in one year), which was the highest of all the assessed countries, and used the same number of amalgam capsules (Fig. 7. Dental amalgam used in the facilities in one year).

Figure 5. The most commonly cited forms of dental restoration

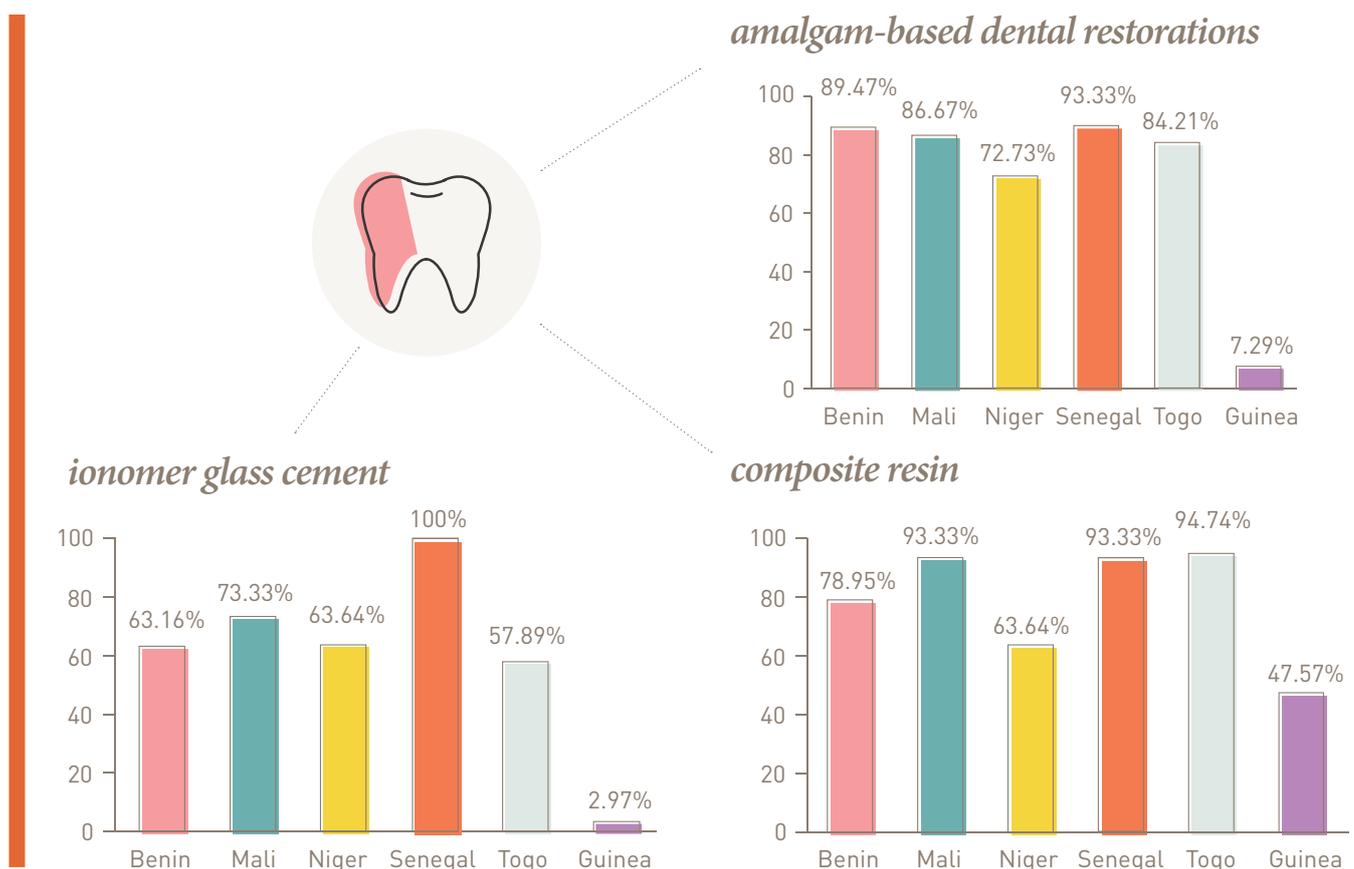


Figure 6. Number of dental restorations performed in the facilities in one year

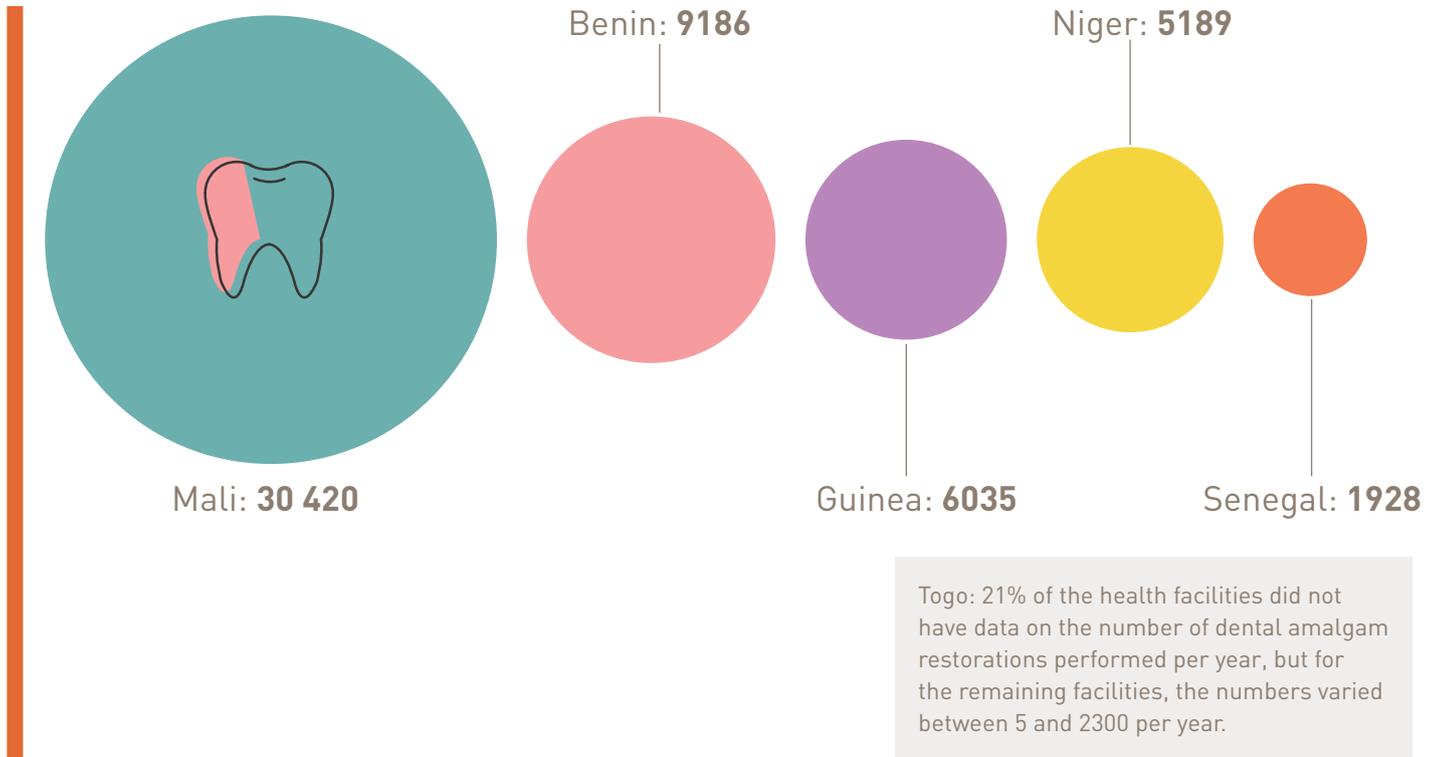
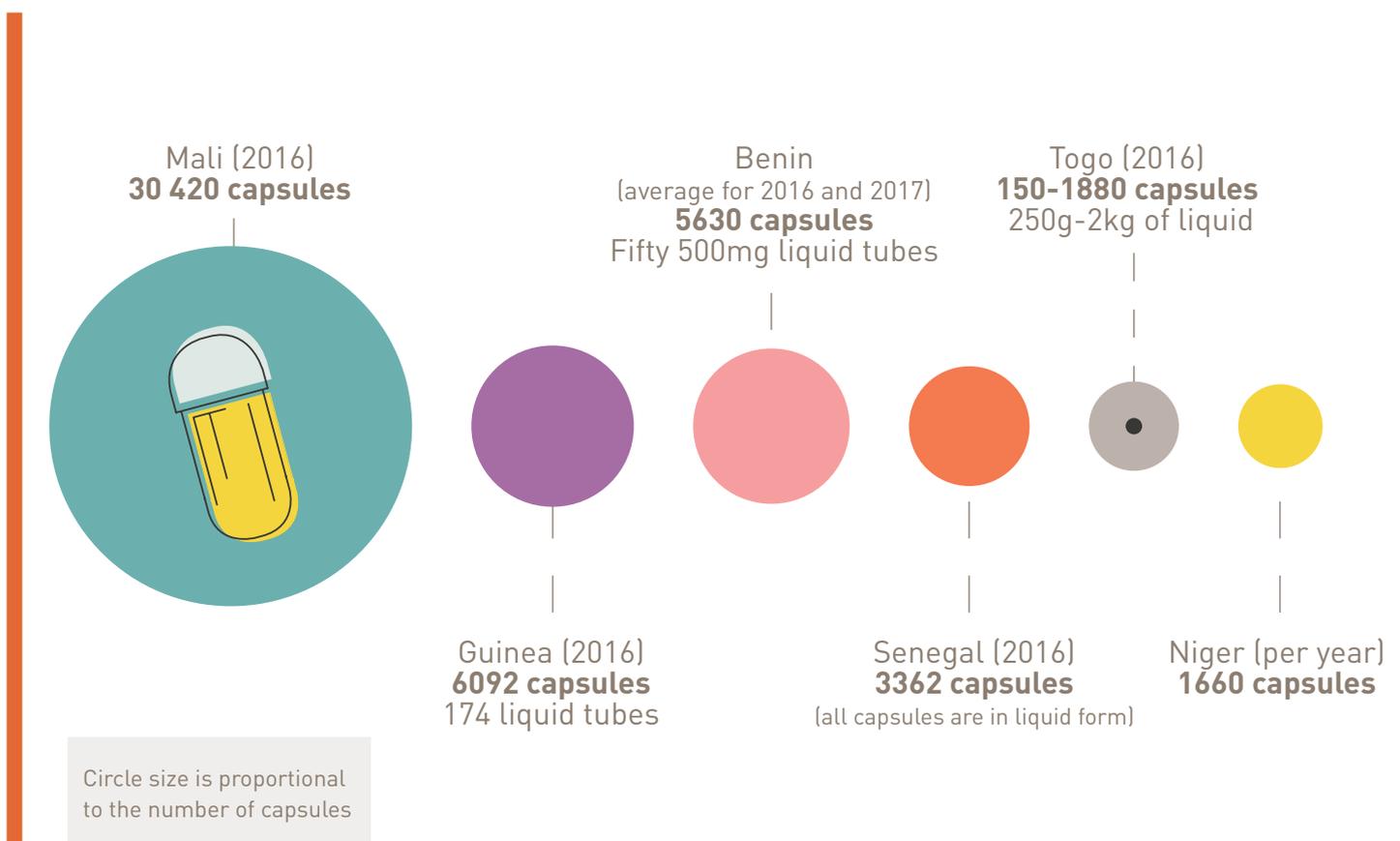


Figure 7. Dental amalgam used in the facilities in one year



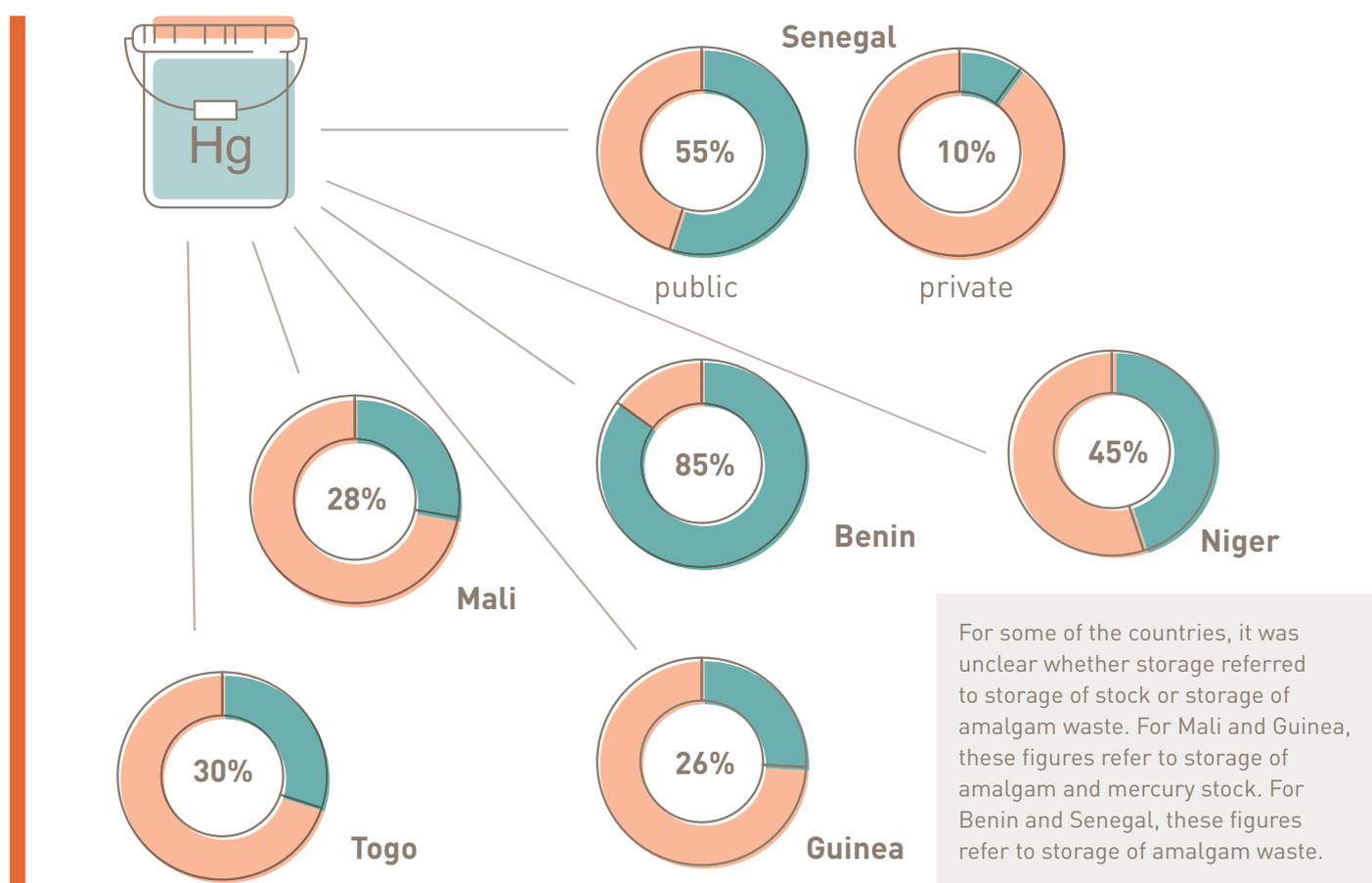
Taken together, the facilities in the assessed countries used between 7 (Togo) to 26 (Mali) suppliers for dental amalgam (Fig. 8. Number of dental amalgam suppliers used by the facilities). The supply of dental amalgam used in dental care entities was shown to be largely unregulated. The amalgam used in dental facilities consisted of numerous brands, and was from a wide range of suppliers, both local and international. A number of suppliers were also listed as "unknown": 10 in Mali,

two in Senegal and four in Togo. Regarding storage, in most of the countries, dental amalgam was rarely stored separately as recommended. In Guinea, 25.75% of the facilities had special boxes for storing dental amalgam and mercury (Fig. 9. Percentages of facilities that have specific storage places for dental amalgam and mercury). In Mali, in 27.60% of the facilities, dental amalgam was stored with pharmaceuticals; there was no specific storage place in 72.40% of the facilities.

Figure 8. Number of dental amalgam suppliers used by the facilities



Figure 9. Percentage of facilities that have specific storage places for dental amalgam and mercury



3.2 Medical instruments containing mercury

Thermometers were by far the most used mercury-containing instrument across the six assessment countries (Fig. 10. Number of mercury-containing instruments used in one year). In Benin, 147 440 thermometers were used annually across the 48 facilities (Fig. 11. Mercury-containing equipment used in the facilities in one year), while the facilities studied in Senegal reported using an average of only 13 thermometers per month, although the facilities did not have procedures in place to accurately calculate this. In Mali, 1980 thermometers were found in use in the facilities studied, but these were all reportedly held by individual healthcare practitioners and were not stored in the hospitals. In Togo, 83.3% of the health facilities have mercury thermometers. This amount varies, but is estimated between 4 to 7200 units per year. In Mali, no other mercury-containing instruments were reportedly used. Other equipment that featured prominently in the facilities included sphygmomanometers and manometers in Guinea, barometers in Benin, and tensiometers in Guinea and Niger. In Togo, 86.67% of health facilities no longer use mercury sphygmomanometers, and of those that do, the numbers vary from one to four devices per facility. Other equipment in use included 931 care lamps

in Benin, two sterilizers in Niger and 10 unspecified pieces of equipment in Guinea. In Senegal, 17 of the 58 facilities (40% of private facilities and 28.30% of public facilities) reported not using mercury-containing instruments at all.

Thermometers were by far the most used mercury-containing instrument across the six assessment countries

As with dental amalgam, the supply of these products was shown to be largely unregulated. In Benin, 26 local and international suppliers provided a range of brands of mercury-containing medical instruments. However, in Senegal, the National Supply Pharmacy currently provides 45.5% of the supply, although it is capable of providing the entire national demand. The Guinea Central Pharmacy can provide more than 80% of equipment.

Figure 10. Number of mercury-containing instruments used in the facilities in one year

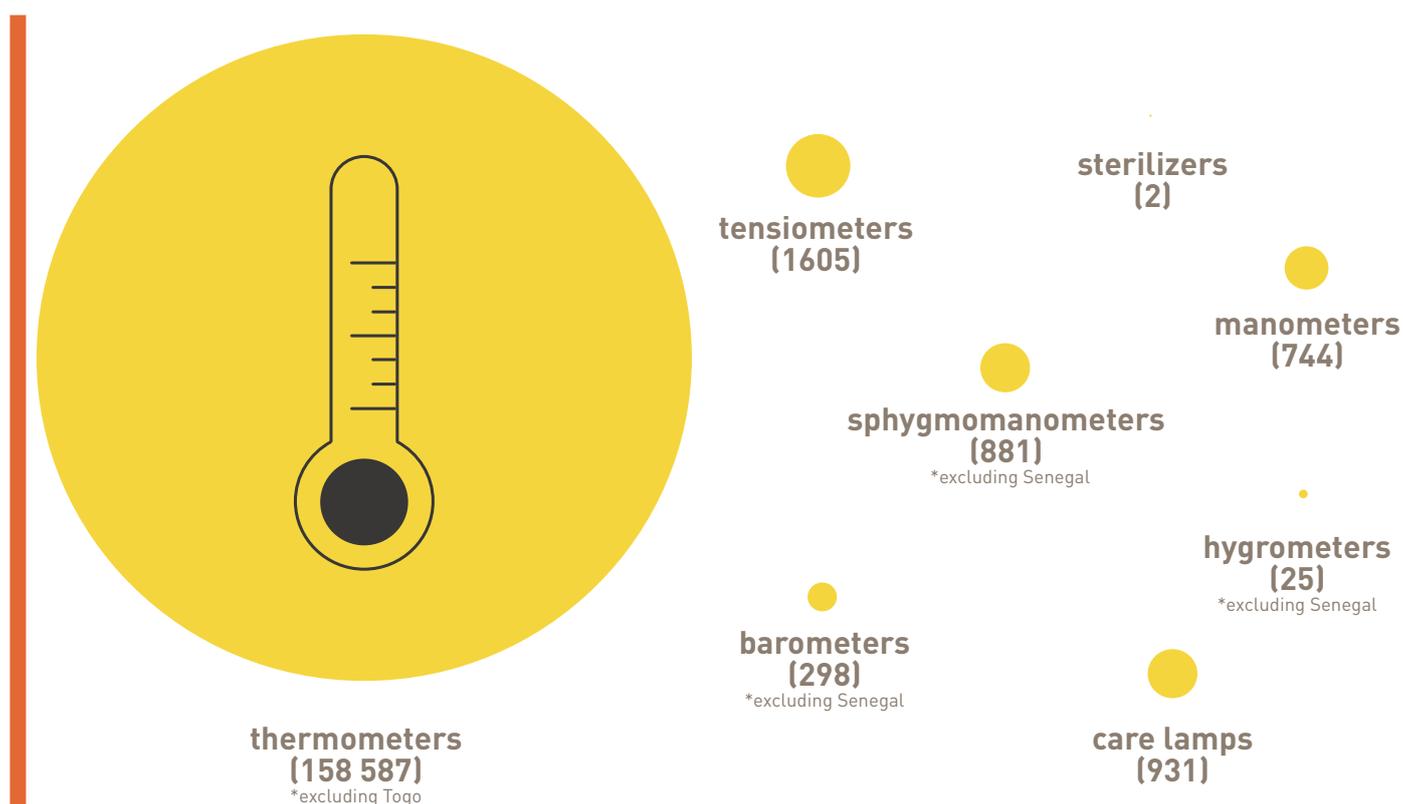
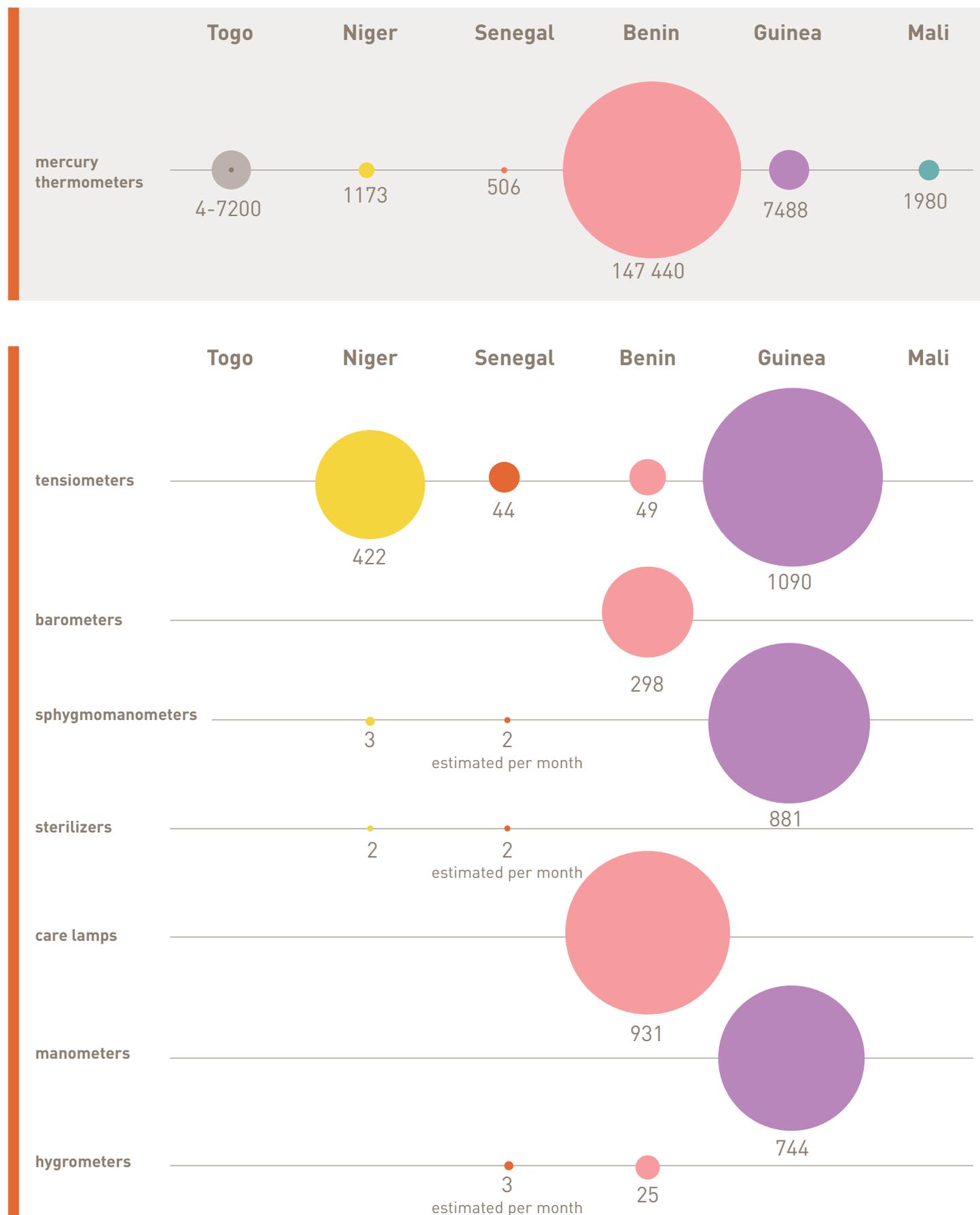


Figure 11. Mercury-containing equipment used in the facilities in one year



3.3 Mercury waste management

This section outlines the methods of waste disposal for each assessed country of dental amalgam in dental facilities, mercury-containing instruments from healthcare facilities, and biomedical waste from healthcare facilities. Although biomedical waste and wastewater are not mercury-specific, most of the healthcare workers – not equipped with the training on how to dispose of mercury waste – combine mercury waste with biomedical waste. When amalgam is not correctly separated, this often ends up in the wastewater.

Most of the dental facilities reported practicing poor dental amalgam waste management, characterized by a lack of both training and waste management plans.

Most of the dental facilities reported practising poor dental amalgam waste management, characterized by a lack of both training and waste management plans. Between 50% (Guinea) and 78.79% (Mali) of the dental facilities in five of the assessed countries used a filter at the level of the spittoon/sink (Fig. 12. The most common methods of dental amalgam waste handling in the facilities). This was the only method of amalgam waste handling in Togo. Although used at considerably lower levels than a filter, dental amalgam separators were used in dental chairs in facilities in Niger (37.5%), Benin (18.4%), Mali (18.2%), Guinea (12.5%) and Senegal (public facilities: 50%, private facilities: 5%). None of the dental facilities reported collecting or recycling dental amalgam waste by any specialized services. Dental amalgam waste was most commonly disposed of with biomedical waste and with general waste. In Benin, 85.29% of facilities had special storage containers for amalgam waste, but only 35.29% of the studied facilities used them. In Senegal, there was a discrepancy between private and public facilities regarding storage of mercury waste: 55% of public facilities had a storage place for amalgam and mercury waste compared to only 10% of private facilities.

In Niger, Senegal and Togo, there were no waste management procedures in place to manage mercury-containing equipment. In Benin, 6.25% of the facilities had procedures in place, and in Mali, only 1.75% – this was one private dental facility (Fig. 13. Percentage of facilities that have specific waste management procedures in place for mercury-containing equipment). Healthcare facilities did also not have mercury filters in their sinks. Only 6.25% of the healthcare facilities in Benin and 2.25% of facilities in Niger had such filters.

Numerous medical facilities did not respect the four biomedical waste management steps. This was especially visible in Guinea, where between only 14.82% and 17.37% of the facilities adhered to the different steps of triage, collection, secured transport and storage. Mali reported adhering to the total process in 89% of the healthcare facilities studied, which was the highest adherence to the total process. Respondents stated that biomedical waste was predominantly eliminated by incineration, but also through controlled burns and transportation to a landfill.

Wastewater was most commonly disposed of using septic tanks.

Wastewater was most commonly disposed of using septic tanks. This ranged from 95% of the facilities in Mali to 38% of the facilities in Senegal. Results on wastewater management were not provided for Togo. Wells/sumps were the second most commonly used method of disposing wastewater in Benin (68.75%), Niger (57.78%) and Guinea (23.32%). None of the facilities in Senegal had wastewater treatment plants and 31% of the facilities dumped wastewater, which was the highest of the assessed countries. Between only 1.70% and 4.44% of the facilities in Benin, Guinea, Mali and Niger had wastewater treatment plants.

Figure 12. The most common methods of dental amalgam waste handling in the facilities

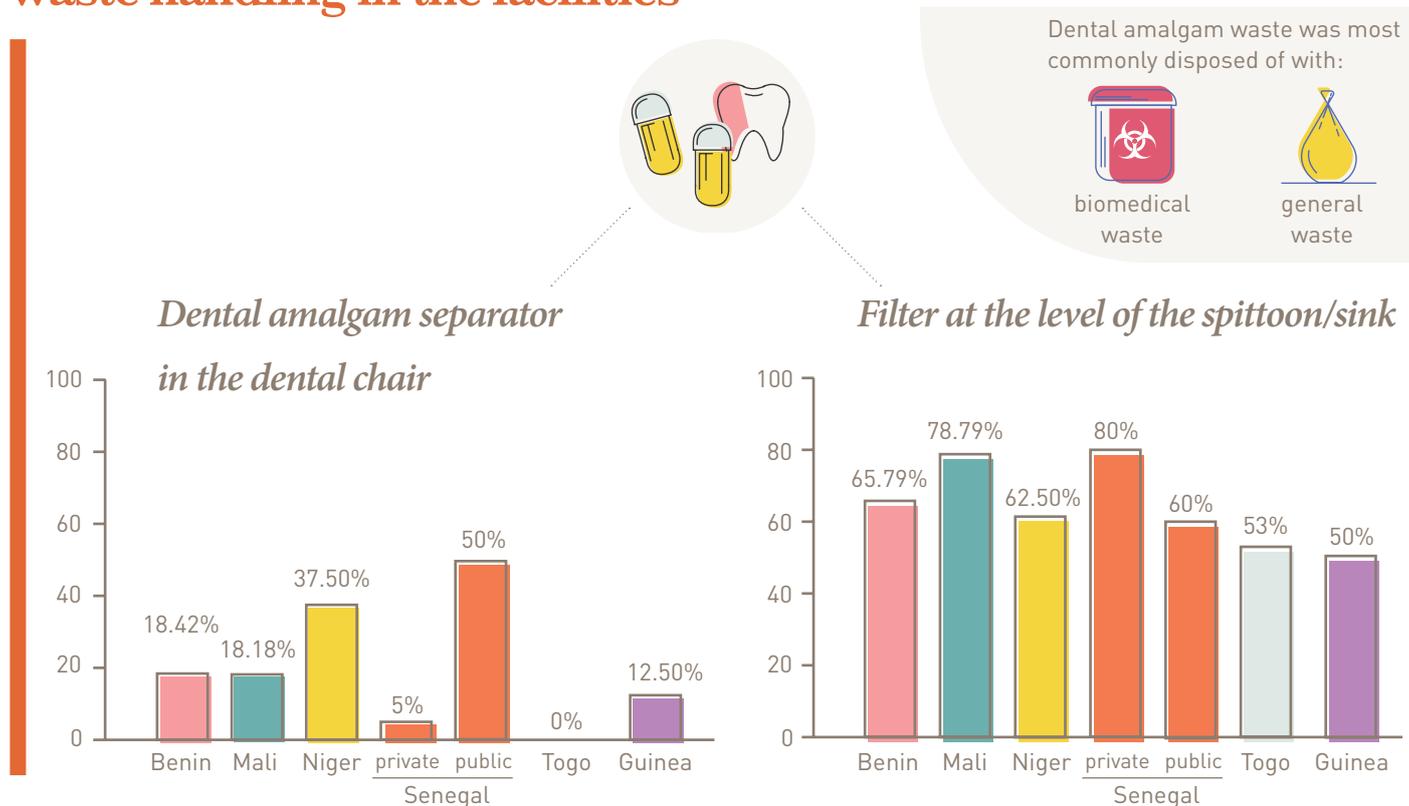
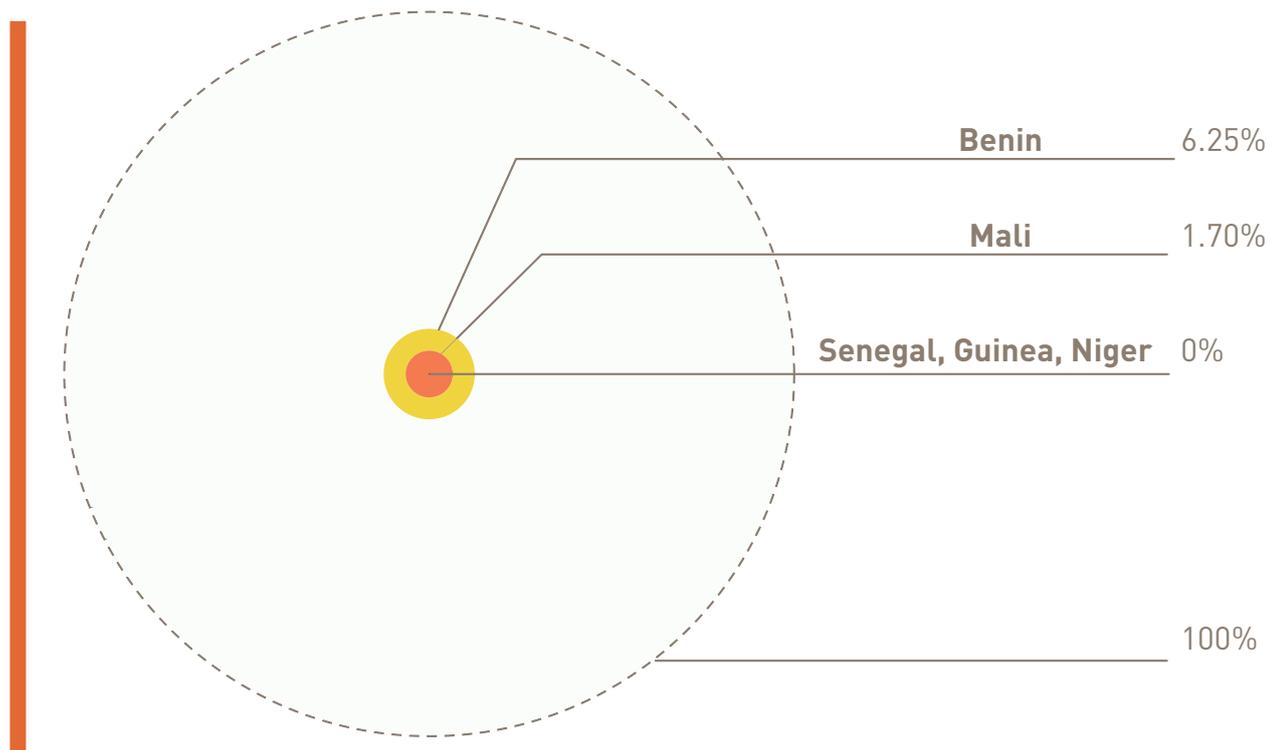


Figure 13. Percentage of facilities that have specific waste management procedures in place for mercury-containing equipment



3.4 Knowledge, skills and practices with respect to mercury-containing material and the management of their wastes

It is essential that mercury is disposed of by trained staff. Training should cover all aspects of waste management activities from identification and classification of wastes to considerations guiding their safe disposal using both non-incineration or incineration strategies. The majority of respondents in the facilities studied had not received training on mercury waste management and did not have a thorough understanding of the health risks associated with mercury and mercury-containing instruments.

The surveyed health facility personnel in Benin, Mali and Niger reported that no one from their facility had received training on mercury waste management.

In five of the six countries, the survey participants had witnessed accidental spillage of mercury (Fig. 14. Percentage of facilities reporting accidental mercury spillage), with staff from 90% of the facilities in Togo having witnessed this. Only in Guinea did none of the participants report having witnessed accidental mercury spillage.

The surveyed health facility personnel in Benin, Mali and Niger reported that no one from their facility had received training on mercury waste management. Only staff from 37% of Guinean facilities, 5% of Senegalese facilities, and 13% of Togolese facilities studied knew of people with any training (Fig. 15. Facilities with staff trained in waste management).

The percentage of participants who understood the effects of mercury on health varied from country to country. Respondents from the majority of the facilities in Togo (76.67%) and Mali (76%) and Benin (60.42%) knew the effects of mercury on health. In Guinea, knowledge of the risks of mercury and mercury-containing materials varied across the 8 regions where health facilities were studied. In more than half of the

regions, none of the surveyed health personnel knew about the effects of mercury on health. Researchers found that people may have said that they knew the effects of mercury on health, but when asked to name them, their knowledge was proven to be superficial. In Senegal, pharmacists and paediatricians stood out as groups with far more knowledge of the effects of mercury-containing instruments than other groups – 75% of pharmacists surveyed were knowledgeable of the effects of mercury on health.

In all the countries, respondents typically identified nurses, dentists, doctors and maintenance workers as those most at risk of mercury exposure. Laboratory staff and pharmacists were less frequently identified. Other populations identified in Benin as at-risk included orderlies, warehouse workers, children and the elderly; and in Guinea, volunteers, interns and people picking up waste were added to the list. In Guinea, interviewees understood that all professional and non-professional categories using health services are exposed to mercury through the use of materials that contain them, but also through the mismanagement of the waste that comes from it.

In all the countries, respondents typically identified nurses, dentists, doctors and maintenance workers as those most at risk of mercury exposure.

Perhaps surprisingly, knowledge of the risks that mercury poses to health did not correspond with which countries had the greatest proportion of facilities limiting the use of mercury-containing instruments. Mali had the greatest proportion of facilities with initiatives to limit the instruments (Fig 16. Facilities with projects limiting the use of mercury-containing instruments). Neither Togo nor Guinea reported any projects limiting use. However, in Togo, 16.67% of respondents expressed that they would like a replacement programme for thermometers.

Figure 14. Percentage of facilities reporting accidental mercury spillage

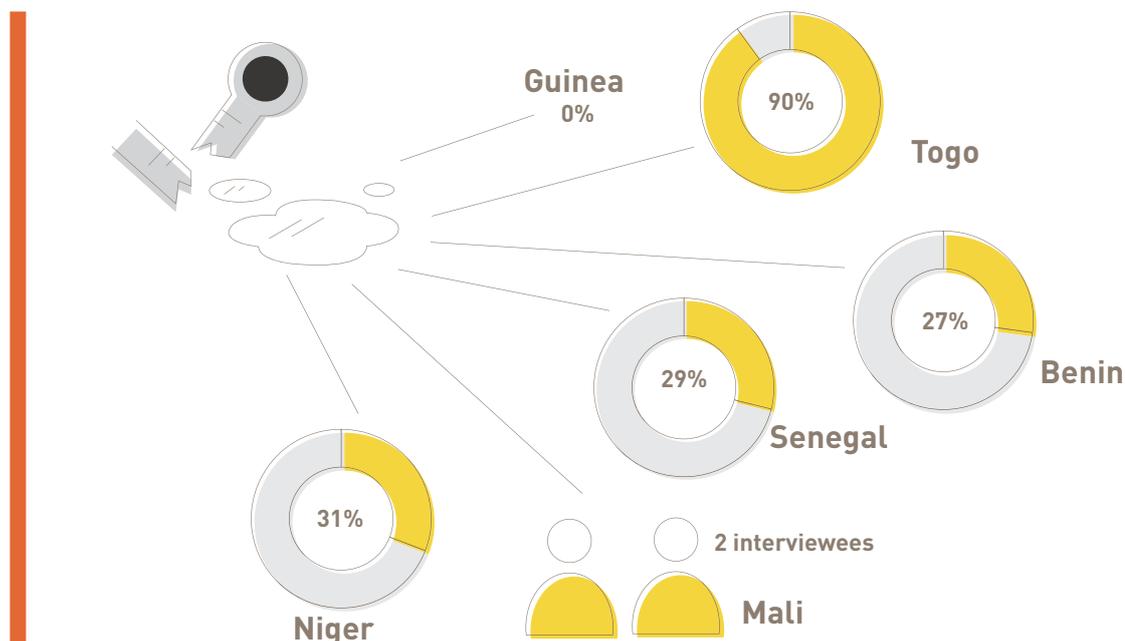


Figure 15. Facilities with staff trained in waste management

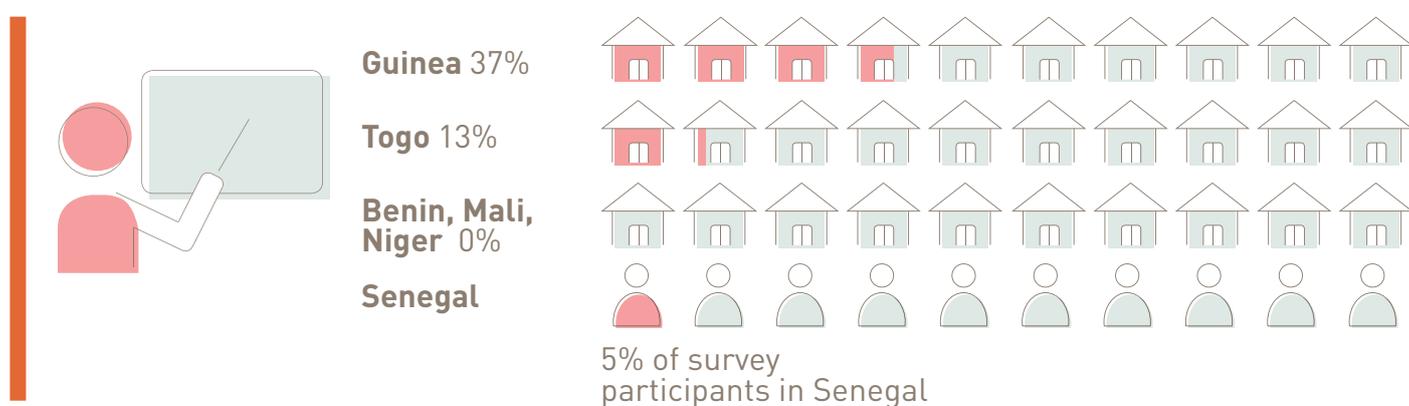


Figure 16. Facilities with projects limiting the use of mercury-containing instruments



4. Discussion and Recommendations

4.1 Discussion

This study has shown that patients, dental workers and general healthcare workers remain at risk of exposure through the ongoing use of dental amalgam and mercury-containing materials. This is due to the high use of these materials, poor waste handling and management of mercury waste, and limited knowledge of the sources of mercury and its effects on health.

The assessment showed that dental amalgam is still an important form of dental restoration. However, alternatives such as composite resin and ionomer glass cement were also commonly used, and could be used as replacements in the phasing out of amalgam. The supply of dental amalgam used in dental care entities was shown to be largely unregulated, which poses difficulties in regulating and limiting its import.

Regarding dental amalgam storage, in most of the countries, dental amalgam was rarely stored separately as recommended, which places all staff with access to the pharmaceutical storage areas at risk of exposure. However, these risks surrounding dental amalgam could be lowered through legislation on the import and use of amalgam, and educating healthcare workers on dental amalgam storage and stocktaking, in addition to education on the dangers of dental amalgam use.

The assessment showed that dental amalgam is still an important form of dental restoration. However, alternatives such as composite resin and ionomer glass cement were also commonly used.

Health facilities in West Africa used an array of dated medical instruments containing mercury. In some of the countries, such as Guinea and Mali, some of the equipment was owned and carried by health workers and not stored in the hospitals. Coupled with the lack of training on mercury waste management, this makes it difficult to regulate the waste management of this privately-held equipment. The lack of training is also concerning given the high occurrence of accidental spillage witnessed by the survey participants.

As with dental amalgam, the supply of mercury-containing equipment was reportedly largely unregulated. Some countries, such as Senegal, relied heavily on a national provider to source mercury-containing equipment, in this case the National Supply Pharmacy. In countries such as Senegal, which use few providers to source their equipment, this makes it easier to control the purchase of these items. Although some countries have facilities which have started implementing mercury replacement plans, most facilities in the countries studied have not begun to address the issue. This shows that there is still much work to be done to lower mercury use.

Although some countries have facilities which have started implementing mercury replacement plans, most facilities in the countries studied have not begun to address the issue.

Because there are no mercury waste management procedures in place, most mercury waste ends up being incinerated or burnt with biomedical waste, or is sent to the landfill with general waste. All six countries are lacking in wastewater treatment plants and most wastewater is disposed of in septic tanks or wells/sumps. This incorrect waste management is a source of mercury contamination to air, land and water. This requires legislation, development of standard operating procedures and training of all staff involved.

The percentage of participants who understood the effects of mercury on health varied from country to country, but was mostly poor. Without a thorough understanding of the dangers of mercury, staff could inadvertently put themselves and others at risk of contamination through improper use of equipment. As proper waste management does not appear to be prioritized by the facilities, staff also might not see the importance of undergoing training on mercury waste management until this is made an immediate priority.

4.2 Recommendations for the reduction and elimination of mercury exposure

There are several steps that need to be taken to reduce and eliminate mercury exposure in the health sector, which are outlined below. Although all the steps under these categories are important, some can be done immediately, while others will require the development of legislation, funding, and buy-in from more parties, which will make the ideal outcome longer-term.



Develop legislation to reduce and eliminate the use of mercury

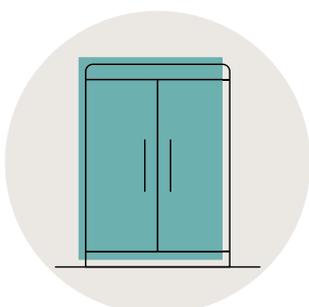
1. To lower and gradually phase out the use of mercury in health and dental facilities, legislation needs to be developed that necessitates a reduction in the use of mercury and prohibits its import.
2. Alternatives to dental amalgam and mercury-containing instruments need to be encouraged and registered for use. This requires buy-in from national supply pharmacies to reduce orders for mercury-based materials (in countries such as Senegal, who purchase their goods through these sources) and to clamp down on the sale of illicit health products (specified by Togo).
3. While alternatives are being encouraged, mercury-containing materials should be removed from dental and health facilities and, as suggested by Benin, further research and development for mercury alternatives should also be undertaken.

While dental amalgam is still being used in facilities, recommendations coming from Togo suggest intermediate management practices, including: amalgam separators should be installed in dental practices, single-use amalgam capsules should be used to minimize the risk of accidental leakage and exposure, and nitrile gloves should be used rather than latex gloves.



Availability of strategy and standard operating procedures to improve mercury waste management

1. Health facilities need to be supported in the development of waste management strategies and detailed procedures for managing mercury-containing waste, including collection, sorting, transport and disposal. In Guinea, this involves supporting the implementation of the National Strategy for Biomedical Waste Management.
2. Mercury waste, both amalgam and out of use mercury-containing equipment, must be kept separately in special containers according to standard operating procedures, prior to recycling or appropriate disposal.
3. Appropriate structures need to be in place to deal with mercury waste once it has been separated by health facilities.



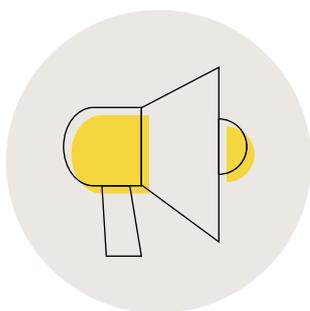
Storage and stock management of amalgam and mercury-containing equipment

1. Dental amalgam and mercury-containing instruments should be stored separately, according to standard operating procedures.
2. Stocks of mercury-containing materials need to be monitored so that amounts are known and can be replaced with alternatives.



Education and capacity building for health workers

1. Guides and training modules on heavy metals and mercury aimed at those working in the health sector need to be developed.
2. Health personnel need to be trained to monitor stocks of amalgam and mercury-containing equipment so that these materials can be replaced with alternatives.
3. Health personnel need to undergo training to improve their knowledge of the risks associated with mercury and on their capacity to manage waste appropriately.



Education of the public

1. The Minamata Convention should be widely disseminated so that policy makers and civil servants in different fields are aware of the health risks of mercury and this piece of legislation.
2. The public should also be educated on the dangers of mercury so that they know to ask for mercury alternatives.

Short-, medium-, and long-term priorities

Regarding the recommendations outlined above, priority should first be taken to develop methods for the storage and disposal of mercury and its waste, considering dental facilities and general health facilities currently have a high level of mercury in their facilities. Healthcare workers should be provided with training on managing mercury waste and protective equipment should be distributed to all facilities. The knowledge and capacity on proper containment of waste is required across all sectors involved in waste management.

In the medium term, the use of mercury-containing devices and dental amalgam should be lowered, and import of such instruments should be dissuaded. This should be coupled by increased use of already existing alternatives, and further research and development into other mercury alternatives.

In the long term, it is expected that mercury-containing medical devices will not be used, and alternative dental restoration and medical instruments will be used in place of these items, and strict waste management for mercury will be adhered to.

6. Annex: **Country tables**

Table A1. Type of dental restorations

Country	Forms of dental restoration named	% of facilities studied
Benin	Amalgam-based	89.47%
	Composite Resin	78.95%
	Ionomer Glass Cement	63.16%
	Ceramics	21.05%
	MRI	5.26%
	Dycan	2.63%
	SDR composite	2.63%
	Amalgomer	2.63%
	Cast metal crowns	2.63%
Guinea	Dental amalgam	7.29%
	Composite Resin	47.57%
	Ionomer Glass Cement	2.97%
	Ceramic	0.27%
	Other (Amalgam Association)	33.22%
Mali	Amalgam	86.67%
	Composite resin	93.33%
	Cement	73.33%
	Ceramic	16.67%
Niger	Amalgam-based	72.73%
	Composite Resin	63.64%
	Ionomer Glass Cement	63.64%
	Ceramic	18.18%
	Other	18.18%
Senegal	Amalgam-based	93.33%
	Composite Resin	93.33%
	Ionomer glass cement	100%
Togo	Amalgam-based	84.21%
	Composite Resin	94.74%
	Ionomer Glass Cement	57.89%
	Ceramic	47.37%

Table A2. Number of dental amalgam restorations performed per year in the dental facilities

Country	Number of restorations in the dental facilities
Benin	9 186
Guinea (2017)	6 035
Mali (2016)	30 420
Niger	5 189
Senegal	1 928
Togo	-

Table A3. Percentage of facilities that have specific storage places for dental amalgam and mercury

Country	% of facilities	Comments
Guinea	25.75%	25.75% of health facilities studied have special boxes for storing dental amalgam and mercury. But there are no special places for storing only amalgam dental or mercury.
Mali	27.60%	In 72.4% of the facilities, dental amalgam is stored with pharmaceuticals, i.e. there is no specific place in 72.4% of the facilities.
Niger	45.45%	
Togo	30%	
Senegal	55% of public facilities, 10% of private facilities	This refers to storage of amalgam and mercury waste.
Benin	85.29%	This refers to storage of amalgam and mercury waste.

Table A4. Dental amalgam suppliers

Country	Suppliers				Brands		
	Total number	International	National	Unknown	Number	Unknown brands	Most common
Benin	17	-	-	-	18	16%	-
Guinea	15	0	15	0	4	1 (1.9%)	Chinese (5.6%)
Mali	26	3	12 (some could be from other African countries)	10	26	3	Novalgame NG 50
Niger	10	2	7	1	7	6	2sdell12gk 600 mg blucap, Marballo, Densalley, Mon valley, Venturu mg cap2, DEN ALLOU 1dose, 2 doses and DMPLTD MARVALLEY
Senegal	10	3	5	2	10	3	Ruby CAP Marvalloy Cavex TCA-Afrimed Seveler (Turquie) ATM Biomateriels GK Safety Alloy Prime dent Annal2000
Togo	7	2	1	4 (Four dental surgeons stated that they obtain their supplies abroad during their travels.)	11	NA	Ventura

Table A5. Amount of dental amalgam used

Country	Amount of dental amalgam (number of capsules) in the dental facilities	Amount of dental amalgam (kg) in the dental facilities in capsules	Amount of dental amalgam (number of capsules) in public institutions studied	Amount of dental amalgam (number of capsules) in private institutions studied	Dental amalgam in the form of liquid or powder	Comments
Benin	5 630	2.123kg	3 125	2 505	Fifty 500mg liquid tubes	
Guinea (2016)	6 092	6 092mg	5 522	600	174 doses of liquid/ powder	
Mali	30 420	-	-	-	0	
Niger	1 660	0,996kg	1 328	332	0 liquid or powder	
Senegal	3 362 capsules (112.06 per facility)	6.724kg for the 30 dental facilities	115 per facility	102 per facility	All capsules are in liquid form	2 grams of mercury per capsule Values by establishments are averages
Togo	150-1 880	-	-	-	250g-2kg of liquid	

Table A6. Dental amalgam waste management

Country	Stores dental amalgam waste in a special container (total)	Stores dental amalgam waste in a special container (public facilities)	Stores dental amalgam waste in a special container (private facilities)	Throw away with other dangerous/ infectious materials	Throw away with other trash	Recycle for re-use	Use other practices
Benin	-	-	-	50%	32.35%	0%	
Guinea	19.3%	-	-	0%	80.7%	0%	0%
Mali	-	-	-	74.07%	2.22%	0%	-
Niger	-	-	-	62.5%	50%	0%	0%
Senegal	20%	50%	5%	50%	47%	0%	3%
Togo	-	-	-	-	-	-	-

Table A7. Dental amalgam elimination

Country	filter at the level of spittoon / sink	dental amalgam separator in the dental chair	collects or recycles dental amalgam waste by a specialized service / company	stores dental amalgam in a special container	Other practices
Benin	65.79%	18.42%	0%	20.59%	23.53%
Guinea	50%	12.5%	0%	50%	0%
Mali	78.79%	18.18%	0%	3%	NA
Niger	62.5%	37.5%	0%	0%	0%
Senegal	Private: 80% Public: 60%	Private: 5% Public: 50%	0%	0%	20% (landfill)
Togo	53%	0%	0%	0%	-

Table A8. Equipment used per year

Country	Equipment							
	Mercury thermometers	Tensiometers	Barometers	Hygrometers	Manometers	Sphygmomanometers	Others Care lamps	Other
Benin (yearly in facilities studied)	147 440	49	298	25	-	-	931	-
Guinea (yearly in facilities studied)	7 488	1090	0	0	744	881	-	10 (not specified)
Mali	NA However, 1 980 were found in use in facilities studied. These were all held individually by professionals.	0	0	0	-	-	-	-
Niger (used or broken per year in facilities studied)	1 173	422	0	0	0	3	-	2 sterilizers
Senegal (used per month in the facilities studied)	Approximately 13 used per month; 506 thermometers were available in the facilities at the time of the survey.	Less than 1 used per month; 44 were available in the facilities at the time of the survey.	2	3	0	1	0	0
Togo (yearly in th facilities studied)	4 to 7 200	NA	NA	NA	NA	NA	0	0

Table A10. Biomedical waste management steps adhered to (% of facilities studied)

Country	Process adhered to (in total)	Triage	Collection	Secured transportation	Storage	Elimination
Benin	NA	77.08%	66.67%	58.33%	47.92%	
Guinea	14.46%	16.57%	17.37%	16.36%	14.82%	Incineration: 14.46% Burning in the open air: 10.41% Landfill: 5.4%
Mali	89%	NA	NA	NA	NA	Most structures dispose of waste by incineration in other locations.
Niger	28.88%	51.11%	95.56%	75.56%	66.67%	Most eliminate waste by incineration, a few by controlled burns and almost none by landfill.
Senegal	No structure has met all stages of waste management.	67.24%	72.41%	44.64%	53.40%	Most structures incinerate bio-medical waste.
Togo	NA	76.70%	73.30%	30.00%	46.70%	Waste is disposed of by incineration, landfills or controlled burns.

Table A11. Biomedical waste elimination (% of facilities studied)

Country	incinerate the waste	burns them in the open air	bury them in the ground	Other
Benin	77.08%	12.50%	2.08%	18.75%
Guinea	14.46%	10.41%	5.4%	4.57%
Mali	-	-	-	-
Niger	64.44%	42.22%	6.67%	13.33%
Senegal	43.10%	1.72%	3.45%	5% use autoclaving or routing to unknown destination
Togo	-	-	-	-

Table A12. Percentage of facilities that have mercury waste management procedure in place to manage mercury-containing equipment

Country	Mercury waste procedure in place
Benin	6.25%
Guinea	There are no procedures in place.
Mali	1.7%
Niger	There are no procedures in place; and only one facility has a mercury filter in the sink (2.22%).
Senegal	There are no procedures in place, but 14% separate mercury-containing equipment from other waste.
Togo	0

Table A13. Type of waste management procedures for equipment containing mercury (% of facilities studied)

Country	Process adhered to (in total)	Triage	Collection	Secured transportation	Storage
Benin	NA	25%	27%	83%	8%
Guinea	0%	-	-	-	-
Mali	1.7%	-	-	-	-
Niger	0%	37,5%	37,5%	0%	12,5%
Senegal	0% (because even after separation, the bags will end up in the same final disposal systems as the other waste: burial, burning in the open air etc.)	14%	14%	7%	2%
Togo	0	-	-	-	-

Table A14. Facilities with mercury filters in their sinks (% of facilities studied)

Country	% of facilities with mercury filters
Benin	6.25%
Guinea	0%
Mali	NA
Niger	2.22%
Senegal	0%
Togo	0%

Table A15. Wastewater management (% of facilities studied)

Country	use septic tanks	have treatment plants	use wells / sumps	Dumping	Other
Benin	83.33%	4.17%	68.75%	0	2%
Guinea	54,82%	2.125%	23.32%	19.76%	0%
Mali	95%	1.70%	0	3.30%	0
Niger	93.33%	4.44%	57.78%	8.89%	15.56%
Senegal	38%	0	2%	31%	0
Togo	NA	NA	NA	NA	NA

Table A16. Facilities limiting the use of mercury-containing instruments (% of facilities studied)

Country	% of facilities with projects limiting the use of mercury-containing instruments
Benin	14.58%
Guinea	0%
Mali	50%
Niger	35.56%
Senegal	12%
Togo	0%

Table A17. Knowledge of effects of mercury on health and dangers of mercury-containing materials and instruments

Country	% of facilities that knew the effects of mercury on health (E2)	% of facilities that knew the dangers of mercury-containing materials and instruments (E5)
Benin	60.42%	60.42%
Guinea	Results are represented by region.	Results are represented by region.
Mali	76%	Less than half
Niger	44.44%	31.11%
Senegal	28% of medical professionals; 75% of pharmacies; 50% of health facility personnel	24%
Togo	76.67%	63.33%

Table A18. Percentage of facilities reporting accidental spillage

Country	% of facilities
Benin	27.08%
Guinea	0%
Mali	2 interviewees
Niger	31.11%
Senegal	29%
Togo	90%

Table A19. Percentage of facilities with staff trained in mercury waste management

Country	% of facilities
Benin	0%
Guinea	37.31%
Mali	0%
Niger	0%
Senegal	5%
Togo	13.33%

