



**DESK STUDY ON WASTE MANAGEMENT
PRACTICES AND TRADE FLOW OF DENTAL
AMALGAM AND ITS ALTERNATIVES IN
KENYA, TANZANIA AND UGANDA**

SUBMITTED BY:



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EXECUTIVE SUMMARY

This desk study was initiated by the United Nations Environment Programme (UNEP) and the World Health Organization (WHO) Global Oral Health Program in collaboration with the respective Ministries of Health and the Ministry of Environment and in line with global initiatives to reduce mercury pollution. It is a component of the East Africa Dental Amalgam Project (EADAP) whose aim to explore essential conditions for a phase down in the use of dental amalgam and its alternatives. The study aimed at obtaining data and information on dental amalgam trade flows and current dentists' practices in handling and waste management of dental amalgam and its alternatives in three East African countries- Kenya, Tanzania and Uganda.

UNEP in collaboration WHO mandated ILima Organization to conduct the desk top survey. iLima nominated a consultant in Kenya to undertake the study. The research team comprised of 4 researchers from University of Nairobi, the Ministry of Medical services (MOMS) and Ministry of public health and sanitation (MOPHS) in Kenya.

The team developed two questionnaires in collaboration with the United Nations environmental program (UNEP), the World Health Organization (WHO), World dental federation (FDI), International Association of Dental Manufacturers (IDM) and national coordinators from the three participating countries. The questionnaire was administered in a cross sectional survey in the three East African countries to a) all traders in dental amalgam and its alternatives b) all registered dentists. The intended mode of administration was an on line survey.

Results and recommendations were presented in an inception workshop that was held on 18th and 19th December 2012 in Nairobi Kenya. These results will inform demonstration projects for phasing down the use of dental amalgam and its alternatives that are scheduled to be implemented in the three East African countries. It is our intention that the results will also inform policy in the use dental amalgam and its alternatives especially in the three countries and in different regions.

We wish to thank all partners and respondents who made this study a success.

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TABLE OF CONTENTS

1.0	INTRODUCTION.....	1
1.1	Emission of mercury to the environment.....	1
1.2	Health risks of mercury exposure.....	1
1.3	Contribution of dental sector to mercury exposure.....	3
1.4	Phase-down approach of dental amalgam in East Africa.....	5
1.5	Objectives.....	5
2.0	METHODOLOGY.....	6
2.1	Study design.....	6
2.2	Study area/ Study sites.....	6
2.3	Study population.....	6
2.4	Sampling.....	7
2.5	Data collection /Data collection instruments.....	7
2.5.1	Questionnaire formulation.....	7
2.5.2	Administration of the questionnaire.....	9
2.5.3	Authority to conduct the study.....	11
2.5.4	Data analysis.....	11
3.0	RESULTS.....	12
3.1.1	Response rate.....	12
3.1.2	Socio-demographic characteristics.....	12
3.1.3	Use of dental amalgam and other restorative materials.....	13
3.1.4	Procurement of restorative materials.....	15
3.1.5	Concerns on use of amalgam and non-amalgam restorative materials.....	16
3.1.7	Disposal of waste amalgam and non-amalgam waste.....	18
3.2	Traders Survey.....	23
3.2.1	Amount stocked.....	27
4.0	DISCUSSION.....	30
5.0	CONCLUSION.....	33
6.0	RECOMMENDATIONS.....	34
	REFERENCES.....	35
	APPENDIX 1: QUESTIONNAIRE TO ASSESS DENTAL AMALGAM AND NON- DENTAL AMALGAM RESTORATIVE MATERIALS WASTE MANAGEMENT PRACTICES AMONG EAST AFRICAN (KENYA, TANZANIA, UGANDA) DENTAL PRACTITIONERS.....	36
	APPENDIX 2: QUESTIONNAIRE TO ASSESS TRADE FLOW OF AMALGAM AND NON-AMALGAM FILLING MATERIALS IN EAST AFRICA - KENYA, TANZANIA AND UGANDA.....	44

LIST OF TABLES

Table 1: Registered dentists, dental practitioners and dental amalgam traders in three East African countries (Kenya, Uganda and Tanzania)	6
Table 2: Highest level of education	13
Table 3: Use of dental restoration in the facilities	14
Table 4: Mean procedures by time period per facility	14
Table 5: Amount of material procured in one year	16
Table 6: Method of disposal of amalgam capsules	19
Table 7: Disposal of excess restorative material	20
Table 8: Disposal of extracted teeth with amalgam and non-amalgam fillings	20
Table 9 : Cost of various types restorations	23
Table 10: Amount of material procured by two suppliers	24
Table 11: Number of traders supplying amalgam and non-amalgam restorative materials to various dental sectors	26
Table 12: Amount of materials supplied in the last 12 months	27
Table 13: Amount of amalgam in stock	27
Table 14: Most and least used type of capsule	28
Table 15: Cost of dental amalgam and non-amalgam restorative materials	29

ACRONYMS AND ABBREVIATIONS

GIC	Glass Ionomer Cement
EADAP	East Africa Dental Amalgam Project (EADAP)
FDI	World dental federation
IDM	International Association of Dental Manufacturers (IDM)
KEMSA	Kenya Medical supplies Agency
KMTC	Kenya medical training College
MOMS	Ministry of Medical services
MOPHS	Ministry of public health and sanitation
MPH	Master in public Health
SPSS	Statistical package for Social scientists
UNEP	United Nations environmental program
WHO	World Health Organization

1.0 INTRODUCTION

Mercury is a heavy metal and a constituent element of the earth which occurs naturally in the environment. It exists in various forms. In its' pure form it is called "elemental" or "metallic" mercury. It is more commonly found within organic and inorganic compounds (WHO, 2003).

1.1 Emission of mercury to the environment

Mercury pollution occurs as emissions to air, directly to water and land. Natural emission to the atmosphere occurs through volcanic activities and weathering of rocks, while anthropogenic (human activities) are the major contributors to releases of mercury to the atmosphere, water and soil (UNEP, 2011). Examples of human activities are coal-fired power and heat production, cement production, burning of fossil fuels, industrial processes and mining (such as small scale gold mining and silver mining). Of these, mercury use in artisanal and small-scale gold mining is the largest mercury-demand sector globally. Mercury-containing products such as dental amalgam, electrical applications such as switches and fluorescent lamps, laboratory and medical instruments (such as clinical thermometers and barometers), batteries, seed dressings, antiseptic and antibacterial creams, and skin-lightening cream may also pollute the environment (UNEP, 2002).

1.2 Health risks of mercury exposure

Mercury vapour and organic forms particularly methyl mercury, are toxic to both humans and wildlife due to their bio-accumulative property. Exposure to humans may occur from

inhalation of metallic liquid mercury vapours, from eating mercury contaminated foods and breathing contaminated air (WHO, 2003).

Inhalation of metallic liquid mercury vapour by humans may occur as occupational exposure such as from mercury spills or from breakage of thermometers. In dental amalgam fillings though mercury is stabilized in the intermetallic compound, insignificant vapour is produced during function. The mercury vapour is absorbed through the lungs and into the blood stream and may damage the lungs and other body organs such as kidneys. Besides, people can inhale large amounts without knowing it because the vapour is odourless and colorless. Workers who are exposed to mercury, such as in small scale gold and silver mining are particularly susceptible.

Mercury that is ingested by animals changed by microbial metabolism to a particularly hazardous form called methyl mercury which concentrates up food chains (Jones, 1995). Once ingested by humans this compound readily passes the placental barrier and the blood-brain barrier. The risk to the developing nervous system of the foetus, the newborn and young children include developmental deficits and developmental delays during childhood. Mercury had also been linked to tremors, impaired vision and hearing, paralysis, insomnia, emotional instability, attention deficit and heart disease in adults who have high levels of mercury in their blood. Susceptible populations at risk of mercury poisoning include communities who consume higher amounts of contaminated fish or marine mammals. Mercury toxicity occurs when acceptable daily mercury concentrations 40 µg/L in blood , vapour pressure of 0.05mg/m³ in a dental clinic and 0.2-0.5mg/L in waste water among others are exceeded (Craig, 1997), or when

individuals daily average intake is 300 µg/day, or 4.3 µg Hg/day/kg body weight (Jones,1995)

The adverse impact of adverse impacts of release of mercury to the environment, both to humans and wildlife, is now a global concern. In the recent past the The United Nations Environment Programme (UNEP) in collaboration with World Health Organization (WHO) and the global community have recommended the need for a global action to reduce the effects of mercury to the environment in various sectors including the health sector as documented in the ongoing negotiations for a legally binding instrument on mercury (Earth Negotiations Bulletin, 2007; Earth Negotiations Bulletin, 2010)

1.3 Contribution of dental sector to mercury exposure

The health sector is among the sectors that are targeted in the reduction of mercury release to the environment (WHO, 2009; UNEP, 2002). The medical sector contributes to the burden of mercury release to the environment in activities such incineration of medical waste and the release of untreated wastewater for example from dental practises. Spills of elemental mercury such as from broken instruments can settle into cracks or cling to materials like carpet and fabric, or wood which are difficult to clean. This leads to mercury exposure to patients and health-care staff.

Within the health sector, dental amalgam is one of the mercury added products. Dental amalgam is a mixture of mercury in elemental form (45-55%) and a metal alloy, the other metals being silver (30%), tin, copper, and other trace metals such as zinc. It is

the oldest dental restorative material and has been in use in dentistry for more than 150 years. This material is widely used in dentistry because it is safe, efficate, easy to handle, durable and is relatively cheaper when compared with other non amalgam dental restorative materials, such as composites, Glass Ionomer Cement (GIC) and compomers.

Mercury contained in dental amalgam is a source of mercury vapor in non-industrialized settings (WHO, 2009; Pohl & Bergman, 1995). Mercury releases may occur at different stages of the life cycle of dental amalgam such as during manipulation prior to dental filling, placement of fillings, progressive deterioration of amalgam fillings and at the end of life in cremation or burial. In its recommendation, the UNEP in collaboration with the global community have urged countries to assess current mercury usage and waste management programs as part of the action to reduce human generated releases. In the dental sector, two approaches were identified; the phase out and the phase down approach. The phase out approach recommends a total switch from amalgam as filling material to alternatives. in line with the ongoing global discussions (Earth Negotiations Bulletin 2007, Earth Negotiations Bulletin, 2010;Andresen et al., 2012), some developed countries, such as Norway, Sweden, France and Germany have phased out the use of amalgam in dental practice in favour of the alternative materials several countries. This approach may be a challenge especially to developing countries, where there is shortage of oral health manpower, inadequate equipment and infrastructure for alternative dental materials and where majority population may not afford prices of dental restorative materials.

On the other hand, the non-amalgam resin composite that contain Bis-phenal A have been associated with oestrogenicity and potential carcinogenicity in vitro (Sasaki et 2005). In these settings a phase down approach is a more practical approach. This will include putting in place safe handling procedures for mercury / dental amalgam to minimize or to eliminate exposures to mercury.

1.4 Phase-down approach of dental amalgam in East Africa

UNEP and WHO Global Oral health program in collaboration with countries in different regions of the world are in the process of initiating demonstration projects for phasing down the use of dental amalgam and its alternatives. In East African the three selected countries were Kenya, Tanzania and Uganda in collaboration with the respective Ministries of Health and Ministry of Environment. This desktop study is a component of the East African Dental Amalgam Project (EADAP).

1.5 Objectives

The objectives of this study were:

1. To assess dental amalgam trade flows and its alternatives in the three selected countries, Kenya, Uganda and Tanzania.
2. To assess the current practices of dental amalgam waste management and its alternatives in the three countries.
3. To estimate the environmental cost externalities/avoidance costs with non-amalgam use.

2.0 METHODOLOGY

2.1 Study design

This was across sectional survey in three East African countries.

2.2 Study area/ Study sites

The three East African three countries selected in the study Kenya, Uganda and Tanzania.

2.3 Study population

The waste management survey targeted all dentists who are currently practicing in public and/or private practices in Kenya, Uganda and Tanzania. The trade survey targeted all traders of dental materials in Kenya, Uganda and Tanzania. Table 1 shows the number of registered dentists and dental restorative materials traders in three East African countries (Kenya, Uganda and Tanzania).

Table 1: Registered dentists, dental practitioners and dental amalgam traders in three East African countries (Kenya, Uganda and Tanzania)

	Dentists/dental practitioners/specialists	Dental amalgam traders
Kenya	565	17
Uganda	300	10
Tanzania	189	4
Total	1,028	31

In Kenya there are a total of 967 dentists practicing but only 565 are retained in the regulatory body register. In Tanzania the approximate number dentists is 189 and Uganda 300 dentists in both private and public sector. There are seventeen (17) traders in Kenya, ten (10) in Uganda and four (4) in Tanzania.

2.4 Sampling

All dentists who were registered with the respective regulatory bodies up to year 2012 and traders in the three countries as shown in Table 1 above were included in the study.

2.5 Data collection /Data collection instruments

Data was collected using self-administered questionnaires.

2.5.1 Questionnaire formulation

A team of 4 dental researchers developed two questionnaires

- i. A questionnaire on waste management practices in dental restorative materials in Kenya, Tanzania and Uganda (Appendix 1)
- ii. A questionnaire on trade in dental restorative materials in Kenya, Tanzania and Uganda (Appendix 2).

Both questionnaires had two sections.

Section A of the questionnaire on waste management practices in dental restorative materials had ten questions to assess the background characteristics of the respondents. These were – name, gender, telephone, address, qualifications/ education; year(s) since graduation, institution where trained, speciality country, type of facility/clinic. In section B there were four areas of assessment: Administration and procurement of amalgam and non amalgam dental restorative materials; handling of

dental amalgam and non amalgam dental restorative materials; waste handling/ of amalgam and non amalgam dental restorative materials; waste disposal of amalgam and non amalgam dental restorative materials.

For the traders in dental restorative materials questionnaire, five questions to assess the background characteristic were developed which were - name, telephone, address, qualifications, and country in the first section. In the second section, there were four areas of assessment of trade practises which were: types of materials, amounts of materials, frequency of procurement of dental amalgam and other restorative materials and the scope of their clientele. For both questionnaires there were additionally questions to assess their opinions regarding the demands of dental amalgam and other restorative materials among dentists and dental practitioners.

The research team reviewed both questionnaires in subsequent meetings. Questions that were not clear were rephrased and those that were repeated or irrelevant were deleted. The questionnaires were similarly reviewed by the expert team from UNEP and WHO and revised accordingly. To further refine the questionnaires, the revised drafts were pretested among 8 dentists and 2 traders.

The questionnaires were initially formatted for interviewer administration in word version and later translated to an online mode to be administered using the online web-based survey software called Survey Monkey. The change to transform the desk study mode

was decided on in a meeting on 5th October by the Project steering committee, iLima and the country coordinators.

2.5.2 Administration of the questionnaire

The administration of the questionnaire was coordinated by a lead consultant from Kenya. Contact persons (coordinators) were identified in each of the three countries to spearhead questionnaire administration. The online links of the questionnaires were then sent to the country coordinators via e-mail.

First, all registered dentists, their telephone contact and e mail addresses were obtained from the regulatory bodies and National Dental Associations in Kenya, Uganda and Tanzania to enable the teams to reach all the respondents on line. The country coordinators subsequently rolled out the questionnaire links to all dentists and traders in their respective countries. This was commenced at different dates in the three countries the earliest being Kenya, followed by Uganda and lastly Tanzania. Soon after commencing the study, it was noted that respondents answered section A that requested Bio-data and did not proceed to Section B which had the key questions on the study. It was also noted that most respondents were from Kenya. An e email appeal was made to request the respondents to answer all the questions. The country co coordinators utilized the National Dental Associations to sensitize the dentists, send e mail and short text messages to the respondents.

Communication between the research teams in the three countries was done by the team leader on phone, many e mails and letters as well. Respondents frequently complained about the on line mode of administration. The response speed was low with more logins but few respondents completing the Section B of the questionnaire throughout the study duration.

With regard to the traders' questionnaire, a similar process was employed in following up the respondents. The participation of the traders was noted to be very low and only a few traders from Kenya filled the questionnaire on line. The other questionnaires were completed offline.

Towards the end of the data collection period it was confirmed that no on line questionnaire will be realized on line from Uganda traders, and Tanzania dentists and traders. Following this a word version questionnaire was e mailed and forwarded to the Tanzania coordinator who printed and distributed to the above dentists to fill. These were subsequently collected, filled offline and emailed to the Kenyan team. These were keyed into the SPSS database. In Uganda the coordinator printed, distributed, collected, scanned and e mailed.

All respondents who inserted their telephone numbers and did not complete the questionnaires were called and by the team and encouraged to fill the questionnaire. In general there was a low response rate with no trader responding from Tanzania.

2.5.3 Authority to conduct the study

A Written approval was obtained by UNEP via letters from the respective Ministries in the three countries that endorsed the study. In addition letters from WHO Region office and iLima were written and forwarded to all respondents together with the questionnaire on line link in order to introduce the study to the respondents.

2.5.4 Data analysis

Data was exported from the *Survey Monkey* programme into Excel and converted to SPSS. The questionnaires filled off line were entered into the SPSS version 17 database, after which data was cleaned. Descriptive analysis was done using frequencies, range, sum and mean.

3.0 RESULTS

3.1 Results for the Dentists

3.1.1 Response rate

There were 565 registered dentists in Kenya, 300 in Uganda and 189 in Tanzania. Out of these 48, 5 and 15 from Kenya, Uganda and Tanzania answered the questionnaire giving a response rate of 8.5%, 1.7% and 7.9% Kenya, Uganda and Tanzania respectively.

3.1.2 Socio-demographic characteristics

One hundred and eighty eight dentists logged into the web with only 52 completing the questionnaire online. Of these, 45 (86.5%) were from Kenya, 7 (13.5%) from Uganda and none from Tanzania. Fifteen questionnaires from Tanzania and one from Kenya were filled using word document and sent via e-mail. Therefore a total of 68 questionnaires were analyzed. There were more males 41(60.3%) than females 19(27.9%), 8(11.8%) did not indicate their gender. Slightly over half, 39(57.4%) were graduates of the University of Nairobi, 13(19.1%), Muhimbili University of Health and allied Science (MUHAS), 5(7.3%) Makerere University. There was one (1.5%) graduate from each of the following institutions: Kenya Medical Training College (KMTC), Pakistan, Cairo university, University of Bombay, Liaquat Medical College, University of London and Hyderabad Sindh.

Their work experience ranged from less than one year to 40 years with a mean of 11.20 \pm 9.3 SD years. Twenty four (35.3%) of the dentists were in private facilities, 34(50%)

were in public-government institution, 7 (10.3%) from training institution, one (1.5%) was in both private and public sector while 3 (4.4%) did not indicate the type of practice. Table 2 shows the highest level of education attained by the respondents. Majority, 49 (70.6%) of the dentists had a Bachelor degree, one (1.5%) had a diploma in Community Oral Health, one (1.5%) had a PhD while the rest had Master degrees in various areas of specialization.

Table 2: Highest level of education

Highest level of training	Number	%
Bachelor degree	49	70.6
Masters in Public Health (MPH)	6	8.9
Masters in Restorative dentistry	3	4.4
Masters in Peadiatric dentistry	3	4.4
Implant dentistry	1	1.5
Diploma in Community Oral Health	1	1.5
Masters in Oral Pathology	1	1.5
PhD	1	1.5
Not indicated	3	4.4
TOTAL	68	100%

3.1.3 Use of dental amalgam and other restorative materials

Majority said they use of dental amalgam, 63 (92.6%) while 3(4.4%) were not doing filling in the facility they were working since the government had not provided them with equipment and materials, and 3 (4.4%) did not indicate whether they were using amalgam or not. Other materials in use included resin composite 62 (91.2%), glass

ionomer cement (GIC) 65 (95.6%), compomers 14 (20.6%), ceramic 12 (17.6%) and one (1.5%) did gold inlays (Table 3).

Table 3: Use of dental restoration in the facilities

Type of restoration	Number	%
Dental amalgam	63	92.6
Resin composite	62	91.2
Glass Ionomer Cement (GIC)	65	95.6%
Compomers	14	20.6%
Ceramic	12	17.6%
Gold inlays	1	1.5

The number of patients ranged between 3 -140 per week with a mean of 41.54 ± 27.44 SD patients per facility. Table 4 shows the mean number of procedures by time period, ranging from one month to one year, per facility is shown. The most frequently procedures done were extractions.

4: Mean procedures by time period per facility

Type of procedure	One month Mean (SD)	Six month Mean (SD)	One year Mean (SD)
Extractions	123 (180.4)	723.4(1084.4)	1504(21.2)
Amalgam fillings	27.7(34.8)	134.9(187.7)	299.2(423.7)
Composite resin restoration	31.7 (47.7)	178.2(277.1)	370.5(571.3)
Glass Ionomer Cement	20.2(50.9)	112.4(304.7)	249.9(638.1)
Ceramics	1.5 (8.7)	5.3(22.4)	9.8(40.3)
compomers	1.9(6.4)	8.2(24.5)	15.4(48.1)
Other fillings	5.7(27.0)	31.8(162.2)	64.3(324.6)

Among the restorative materials, composite resin restorations were the most popular followed by amalgams fillings and Glass Ionomer Cement (GIC) fillings. Ceramics and compomers were relatively less frequently used. Of all the total 64,246 restorations done 31.7% of the restorations were dental amalgam.

3.1.4 Procurement of restorative materials

Dental suppliers in the three countries included Afrodent, Dentmed, Wema dental and medical engineering, Rycedental, BMS links 3000 LTD, Dentrum, Beetimes, Annalik services, Uneed medical and dental world Uganda, Trismed, Modern dental supplies, Medifast, Mssrs, Megalloy EZ, Alphadent, Kenya Medical Supplies Agency, (KEMSA), Mdswoodvale pharmacy, Brand Quayle, direct importation Local importers, Gs80-, Bilova, SDI , gtel, Megascope, Newstetic , Ministry of Health Tanzania, Kayonza and Annex supplier and Uganda medical and dental suppliers, Uneed golbal group, Dental world, Crown health ltd, Pan dental, Prestige dental, Kololo poly clinic, Sino Africa medical and dental equipment, Nairobi enterprises, Harley's Uganda/dentmed. There are also dentists who import dental materials direct from the manufacturers.

Table 5 shows the average restorative materials purchased by the respondents in the last one year. The major amount of amalgam purchased was F1 capsules followed by F3. Only 3 (4.4%) of the respondents purchased liquid mercury. Of these, one purchased four 460g bottles in the last one year which is 1.84Kg, the other purchased 0.2 (92g) of a bottle while the third purchase minimal quantity. The three purchased powder with one purchasing 2 (30g) tins of powder, 0.2 (6g) of a tin and minimal

amount of powder in a year respectively. The total amount of mercury liquid is 1.93Kgs whereas the alloy powder amounted to 0.066Kgs.

Table 4: Amount of material procured in one year

Type		Mean (per year)	SD
Amalgam	F1	294.1 capsules	726.6
	F2	57.8 capsules	175.5
	F3	136.5 capsules	760.5
Resin Composites		20.1 kits	121.0
Glass Ionomer Cements		4.0 kits	24.9
Compomers		0.4 kits	1.8
Others		1.01	3.6

The total weight of the capsulated dental amalgam used in a year by the 68 dentists is F1 (16Kg), F2 (4.7Kg) and F3 (14.9Kg) amounting to 35.6Kg.

3.1.5 Concerns on use of amalgam and non-amalgam restorative materials.

Half 34(48.5%) of the respondents had at least a concern with the use of amalgam by dental personnel in the dental clinic while the other half did not have any concern. The concerns included mercury spill which could be hazardous, disposal via incinerator and lack of proper disposal methods, health issues such damage to the brain, renal, respiratory system, digestive system, skin and other internal organs, neurotoxicity, nephrotoxicity, lack of proper protection such as gloves leading to mercury being

absorbed into the body, inhalation of mercury when removing amalgam filling, contamination of environment through waste water, lack of proper guidelines on proper disposal methods, poor ventilation, spillage, hypoxia and hypersensitivity.

Only 15 (22.1%) of the respondents had concerns about non-amalgam filling materials. The concerns included acid burn, allergy, lack of proper understanding on long term effect of these materials, carcinogenicity of composite, lack of adequate information and literature, effect of curing on eye sight, lack of trapping mechanism when removing the filling, accidental spillage, monomer hazards, photosensitivity, Bisphenol A in BIS-GMA is suspected to have systematic toxic effect, strength and durability.

3.1.6 Method handling amalgam and non-amalgam restorative materials

Out of 22 (32.4%) persons who used mercury liquid and powder, 7(10.3%) mixed it manually using motor and pestle, 9(13.3%) used powder-liquid mixer, while 6 (8.8%) put the liquid and powder in the capsule before mixing. For the resin 8 (11.8%) mix manually and 60(88.2%) used light cure composite. Most 61 (89.7%) of the participants who use GIC mix it manually, 7(10.3%) used light cure and one (1.5%) mixed mechanically. Nineteen (27.9%) of the participants used light cure for compomers and 3 (4.4 %) mixed manually. Five (7.3%) used computer aided design for ceramics and 17(25.0%) used fired ceramics.

One (1.5%) respondent had mercury spillage during the last one month, 4 (5.9%) in the last one years and 8 (11.8%) in the last 10 years and 54(78.4%) had never had spillage. For those who had spillage, they used cleaning agents such as soap, water and detergents, suctioned into the dental unit, big ball scooped and placed in the container

with water and lid, collected and re-used and then mop the room, used soaked gauze, used cotton wool. However majority indicated they no longer use liquid mercury.

On what the facilities had in stock, 36(69.2%) had F1 capsules, 44(84.6%) had F2 and 17(32.7%) had F3. Only 12 (17.6%) stocked all the capsule sizes. On the largest amount of capsule they had in stock 30 (44.1%) had F2, 20(22.1%) had F1 and 2(2.2%) had F3. When was asked the least number of capsules they had in stock 15 (22.1%) said F1, another 15 (22.1%) F2 and 7(10.3%) said F3.

Only 8 (11.8%) amalgamators were calibrated, 36 (52.9%) were not calibrated while 10 (29.4%) did not know whether the amalgamators were calibrated. Of the eight amalgamator that were calibrated four were calibrated yearly, one ever two years, one had stayed for more than two years and one said there was no specific time when the amalgamator was calibrated.

3.1.7 Disposal of waste amalgam and non-amalgam waste

On disposal of used amalgam capsule, 29 (42.6%) discarded the waste with hazards waste, 16 (23.5%) in general waste, 18 (26.5%) placed in a container, 1(1.5%) re-used the capsule and one disposed it with sharps while another one places in liquid x-ray fixer (Table 6). Only 29 (42.6%) reassembled the amalgam capsules after use with 19 (36.5%) doing it immediately, one said the assistant may not reassemble the capsule always.

Table 5: Method of disposal of amalgam capsules

Method of disposal	Number	%
Discarded the waste with hazards wasted	29	42.6
Dispose in general waste	16	23.5
Place in a separate container	18	26.5
Re-use the capsule	1	1.5
Dispose in sharp container	1	1.5

Majority 56 (82.4%) separated waste infectious waste while 10(14.7%) did not. Most of the respondents 66 (97.1%) separated sharps from other waste, 57 (83.8%) separated amalgam waste, 29 (32.4%) separated waste from non-amalgam, 8 (11.8%) separated pharmaceutical waste and 17 (27.9%) separated other waste. For non-amalgam waste 3 (4.4%) had separate containers and 24 (35.3%) asked the patient to spit into the sink.

One (1.5%) placed contact amalgam and non-amalgam with sharps, 28(41.2%) in infectious container, 12 (17.7%) in regular garbage, 21(30.9%) in separate marked container. The containers used included 5 liter plastic jerry can, big water bottle, glass bottle, bottle with fixer, dampen dishes, jar, and sealed tins, waste polythene bags and plastic bags with a lid.

Table 7 shows where excess restorative materials was placed with 28(41.2%) placing it in infectious container. Only 21(30.9%) placed excess restorative materials in a separate container.

Table 6: Disposal of excess restorative material

Where placed	Number	%
Infectious container	28	41.2
Sharp container	1	1.5
Regular garbage	12	17.7
Separate container	21	30.9

On where they place extracted teeth 54(79.4%) place extracted teeth that have amalgam and non-amalgam in the infectious container, 12(17.7%) in regular garbage, one (1.5%) in a sealed container and one (1.5%) in surgical waste (table 8). None of the respondents stored extracted teeth with amalgam fillings in sealed containers.

Table 7: Disposal of extracted teeth with amalgam and non-amalgam fillings

Disposal	Number	%
Infectious container	54	79.4
Regular garbage	12	17.7
Sealed container	1	1.5
Surgical waste	1	1.5

Majority 53 (77.9%) did not separate contact amalgam from and non-contact amalgam and 56 (82.4%) did no separate non-contact amalgam from other waste. Only

11(16.2%) said they decontaminate content of contact amalgam and non contact amalgam. The method used include use of disinfectant, incineration as infectious waste , running water, soap, chlorine and soaking in water for 10 minutes.

Asked whether they knew of a standard measures for minimizing amounts of amalgam waste, 33 (48.5%) said you should keep amalgam usage for each restoration to the smallest amount necessary for the procedure, 37(54.4%) said you should use pre-capsulated amalgam only, 38 (55.9%) said you should stock amalgam capsules in variety of sizes, one (1.5%) said you should use high volume suction when removing old amalgam and 3(4.4%) said they do not know.

About a quarter 19 (27.9%) of the facilities did not have a mechanism for handling amalgam and disposal, 13 (19.1%) used chair side traps, 4(5.9%) used amalgam separators, 2 (2.9%) used vacuum pump filters, 11(16.2%) segregated amalgam waste, 2 used commercial recycling services, 3 (4.4%) had written records of waste generation and disposal of waste amalgam, one (1.5%) asked the patient to spit in the sink, and one (1.5%)incinerated the waste. On how they handled amalgam from the filter one added it to the amalgam container, one place it in empty infectious bags. One cleaned the filter after sometimes and one stored it in a fixer solution. On type of protection used 50 (73.6%) used latex gloves, 53 (78.0%) used face masks, 32 (47.1%) use gloves, 36 (52.9%) used eyeglasses.

Only 2 (2.9%) said someone had been trained in mercury waste management in the facility, 56 (82.4%) said nobody had been trained and 3 (4.4%) did not know whether there was anyone trained in mercury waste management. For those who said they know of a trained person in the facility, one said the facility had outsourced an external trainer while in the other the principal dentist had attended talks on amalgam waste management. Most 47(69.1%) of the respondents said dental support team members did not get occupational health training, 15 (22.1%) said they did and 2 (2.9%) said they did not know.

Only one respondent knew of a commercial amalgam and non-amalgam waste disposal services. Five (7.4%) of the facilities had a plan for disposal of amalgam waste with 12(17.6%) having a written plan and 12 (19.1%) for non-amalgam with 6 (8.8%) having a written plan. On what they do with filled amalgam containers, 21(30.9%) said they store it safely, 9 (13.2%) sent to a recycler, 2 (2.9%) facilities disposed it in hazardous hospital waste, 2 (2.9%) said it is handled by a garbage collection company, 2 (2.9%) dispose in the infectious waste, one (1.5%) place it in soak pit, one incinerated it while one (1.5%) said none has so far filled. Only 2 (2.9%) of the respondents had excess liquid mercury and alloy. One covers the bottle to avoid release or spillage while the other had only powder. Only 19 (27.9%) planned to install amalgam separators with only two having knowledge on how to install the device and how to maintain it.

Asked to comment freely on amalgam and non-amalgam waste management among oral health care workers the following challenges were indentified; poor handling of

amalgam waste due to lack of guidelines and policy, inadequate knowledge and training, lack of seriousness and compliance on amalgam waste management. Highlighted was the need to sensitize and train workers in waste management.

Table 9 shows the mean cost of various restorations. Amalgam is the least expensive with a mean of \$22.7 while ceramics are the most expensive with a mean of \$178.6.

Table 8 : Cost of various types restorations

Type of restoration	Range (cost) USD	Mean (cost) USD
Amalgam	3.5-70.6	22.7
Resin composite	1.2-82.4	25.8
Glass Ionomer Cement	1.2-70.6	26.5
Compomers	1.2-176.5	35.4
Ceramics	23.5-352.9	178.6

3.2 Traders Survey

Eleven suppliers filled the questionnaire with only two fully completing the questionnaire. Of these 2 were from Uganda, 9 Kenya and none from Tanzania. Table 9 shows the total amount of restorative material procured by two suppliers in the last one week, last one month and last one year. The rest of the suppliers did not respond to that particular question.

Of the two, one supplier procured 5kg of liquid mercury and 0.5 kg of alloy, the rest did not respond to the question. One supplier had procured 600 F1 in the last one week; the rest did not indicate how much amalgam they had procured during the period indicated. On F2 one supplier procured 450 and another 1000 in the last one week, the rest did not indicate the amount they had procured during the period indicated. One had procured 400 conventional resin composite in the last one week while on had procure 60 and another 600 GIC. Table 10 shows the total shows the total amount of material procured. F2 capsule constituted the largest amount of material procured by time period.

Table 9 Table 9: Amount of material procured by two suppliers

Type of material	Last one week	Last one month	Last one year
Mercury liquid	0	0	5 Kg
Alloy	0	0	0.5Kg
Amalgam F1	600 capsules	-	-
F2	1450 capsules	-	-
F3	100	-	-
Conventional resin composite	400		
Glass Ionomer Cement (GIC)	660	-	-
Ceramics	20	-	-
Compomers	20	-	-
Other materials	0	-	-

The total weight of the capsulated amalgam procured by the two suppliers was F1 0.68Kg, F2 1.74Kg and F3 0.16Kg. Total 2.58kg

Most of them (9) supply dental materials to both the dentists and dental material suppliers nationally and internationally. Only one supplied dental materials to dental suppliers nationally and internationally and only one supplied dental materials directly to the dentists. The suppliers imported their materials from BMS (Italy), Vladmiva(Russia), 3M(USA), PrimoDent (USA), Clinic Medical Centre, Dentong (Turkey), ivoclar Vivadent (Germany), ardent (Sweden), SDI (Austraria), Zeyco(Brazil), Dentsply (UK), Utradent (USA), GC Fuji (Japan) and Switzerland.

Asked to mention other local dental suppliers, the following were mentioned: Dentimed, crown Healthcare, Afro dental, Rycedental, Trophydent, Uneed globalgroup, prestige dental suppliers Uganda, medical equipment and dental suppliers, Ruby dental, modern dental suppliers, Alphadent and city Interscope. Seven of the suppliers said dental amalgam is imported while 3 said dental amalgam is manufactured in the country. On non-amalgam restorative materials, 4 said they are imported, one said they are manufactured in the country while one did not know. The restorative materials were imported from China, USA, UK, Germany, Italy, Turkey, Sweden, India, Australia, Mexico and Brazil.

All the suppliers supplied dental amalgam capsules and 7 supplied elementary mercury and alloy powder. Five use ship, 10 use air, and 2 used truck/overland to transport the

materials. All suppliers said the dental capsules (packaged) format was demanded most when compared to mercury and alloy.

Table 11 indicates the number of traders who supplied amalgam and non-amalgam to different sectors. All the respondents supplied amalgam and non-amalgam to the both government and private sector. Five were sub-suppliers for amalgam and seven were sub suppliers for non-amalgam restorative materials.

Table 10: Number of traders supplying amalgam and non-amalgam restorative materials to various dental sectors

Type of facility	Number of traders supplying amalgam	Number of traders supplying non-amalgam
Government/Public institutions	9	11
Teaching institution	4	7
Private clinics	11	11
Civil Society/ NGO	5	5
Sub-suppliers	5	6
Others	3	5

Table 12 shows the total amount of restorative material supplied in the last 18 months. The private sector, government sector and teaching institutions procured the largest amount of amalgam. Mercury and alloy was also supplied to the teaching institution.

Table 11: Amount of materials supplied in the last 12 months

Facility	Dental amalgam	Amount (Kg)
Government/Public institutions	F1	450.04
	F2	98.06
	F3	22.08
Teaching institution	Mercury	0.46
	Alloy	0.03
	F1	735
	F2	6
	F3	6
Private clinics	F1	1504.04
	F2	6.06
	F3	3.08
Civil Society/ NGO	-	26
Others (within the country)	-	45
Others (outside the country)	-	45

3.2.1 Amount stocked

Table 13 shows the amount in kilograms of amalgam products. F2 capsules had the highest stock. The suppliers still stocked mercury liquid and alloy.

Table 12: Amount of amalgam in stock

Type	Amount (Kg)
F1	173.68
F2	416.88
F3	259.68
Mercury liquid	18.66
Alloy	12

Table 14 shows the least and most type of capsule. Five said the most used type of capsule was F2 while 7 said the least used capsule was F3.

Table 14: Most and least used type of capsule

Type	Number who said it is most used	Number who said it is Least used
F1	2	2
F2	5	1
F3	0	7

Seven of the respondents said they met the clientele demand. The ones who met the demand said they always had adequate supplies in stock. They had all the options including alloy and liquid, at affordable rates. For the ones who did not meet the demand they said they sometimes run out of stock.

The challenges faced by the suppliers included classification of mercury as a dangerous commodity requiring extra care and increased cost of importation, high cost of alloy and mercury, price fluctuation. On the other hand challenges in non-amalgam restoratives are competition, shortages, price fluctuation, foreign language on handling brochures and low quality packaging.

Eight out of eleven respondents felt the demand for amalgam and non-amalgam products has increased with one saying the demand for alloy and mercury has decreased, two said it has decreased and one did not know. Six stocked amalgam

bonding agent, 2 stocked composite bonding agent. The cost of 50 F1 capsules ranged between USD 47-70, F2 USD 59-64, F3 USD 65-70, alloy powder USD 45 per 50g and USD 106 per 500g of mercury liquid and resin composite 16 USD Table 15.

Table 15: Cost of dental amalgam and non-amalgam restorative materials

Restorative material	Unit Package/quantity	Cost USD
Dental amalgam (50capsules)	F1	47-70
	F2	59-64
	F3	65-70
Alloy powder	(50g)	45
Mercury liquid	(500g)	106
Resin composite	(Syringe)	16

4.0 DISCUSSION

Majority of the dentists had a Bachelor degree. This can be explained by the fact that regional Universities in the region have very few Masters Degree programmes that graduate very small classes. One of the respondents was a Clinical Oral Health Officer who filled the questionnaire for the facility. The respondents who participated in the on line waste management study were 52(4.9%) out of the total 1,054 dentists who were send the questionnaire links in the Kenya Uganda and Tanzania. Overall a total 68 respondents responded to the survey via both on line and the hard copy distributed questionnaires. The study depicted challenges in the completing the on line questionnaire among the respondents with Tanzania having no single respondent, this can be explained by partly the limited accessibility to internet and the level of detail requested in the questionnaire that called for annual records reference in some sections. Moreover dentists frequently expressed that the questionnaire was too involving.

Most dentists used capsulated versions of dental amalgam which is in line with Best Management practice. In addition there has been a global shift towards capsulated presentation of dental amalgam. There however a few facilities 5.8% used elemental mercury (Hg) and alloy powder which is unacceptable. This could be because of lack of concern the hazards associated with the use of mercury as they portrayed adequate knowledge on the hazards of mercury. Most dentists purchased two or more sizes of dental amalgam capsules which is good practice in terms of cost and environment friendly.

Dental amalgam, resin composite and GIC were available in almost all the facilities and stocked by all the suppliers as well. It was interesting to note that dental amalgam, resin composites and glass ionomer cements restorations were in use in 92.6%, 91.2% and 95.6% facilities respectively.

Extractions were the most prevalent (61%) this is in line with the Ministry of Health reports in Kenya 2010/2011 where filling extraction ration was 1:29. This could be due to late presentation, socio economic reasons, lack of equipment in public facilities and lack of knowledge in available care. Amalgam restorations constituted 31.7% of the total restorations which is in line with a study conducted in USA in 2005, where 31.6% amalgam constituted of all the restorations. Resin composite restorations were most prevalent among the restorations (39%). However considering that the on line accessibility could have been restricted to the elite proportion of the respondents this may perhaps not represent the situation in the region.

Pertaining the waste management both amalgam and non-amalgam restoratives, the storage and disposal methods used in most facilities did not conform with best dental amalgam management practice. None of the respondents disposed filled correctly. This could be due to lack of knowledge, laxity, guidelines and policy. In addition the cost of amalgam, filters and separators and recycling plants is prohibitive. Notably even the half of the respondents who had concern on the potential hazardous effects in the use of dental amalgam none of their concern was environmental related. This could be due to the focus on personal health effects.

Traders and the dentists procured restorative materials from several countries across the globe. This makes it difficult to standardize the quality of materials. The questions that called for record reference were not answered by most respondents which could be because they have poor records, laxity to consult and possibly fear to disclose. Some of the traders indicated that dental amalgam and non-amalgam restoratives are manufactured locally. This could be due to lack of knowledge as there are no known manufacturing plants in the region. One of the challenges faced by the traders is procurement of mercury which is classified as a dangerous commodity, which reveals that there is some control.

The cost of resin composite, GIC, Compomer and Ceramic was higher than that of dental amalgam. The cost is higher when factors such as equipments, technique and longevity of the restorations are considered.

5.0 LIMITATIONS

The response rate was 6.5% which is far below the acceptable response rate. This was attributed to the mode of administration of the questionnaire which was on line. Only respondents competent in information technology and those who are accessible to internet were in a position to access and fill the questionnaire. Measures to increase the number of responses, such as personal communication and sensitization in workshops, repeated telephone calls and short message system (SMS) through mobile phones, did not yield much, besides resulting into bias.

5.0 CONCLUSION

- Dental amalgam and non-amalgam restorative materials are widely supplied and used in the three countries.
- These restorative materials are all imported as there is no local manufacturer in the region. However, there is regional (cross border) trading among the three countries.
- The most prevalent treatment was dental extraction.
- Dental amalgam and resin composite and GIC are the commonly used dental restorative materials.
- Although capsulated amalgam was mostly used there were some facilities still procuring and using liquid mercury and alloy powder
- The cost of the commonly used alternatives resin composites and glass ionomer cements was higher than that of dental amalgam. Thus a shift to these alternatives requires willingness of the dentists, appropriate equipment and technique as well as a confirmation of the safety of the amalgam alternatives.
- Majority of the dentists did not handle waste according to best dental amalgam practice guidelines.
- In the phase down approach, emphasis on best waste management practices for amalgam and its alternatives at dentists' and at country level, as well as oral health promotion activities are recommended as immediate actions.

6.0 RECOMMENDATIONS

- There is need to develop guidelines and policy in supply, handling and waste management of dental restorative materials to minimize health risks and environmental pollution.
- There is need to incorporate a module in waste management of dental restorative materials in the present dental curricula, with emphasis on environmental concerns related to waste amalgam. Similar training sessions need to be developed and implemented among qualified dentists.
- Installation of amalgam separators in all dental practices and recycling plants in the three countries are urgently but the cost is prohibitive. There is need for financial assistance and technical support to install these equipments.
- Oral health promotion and preventive programs need to be implemented to minimize the need for dental restorations.
- A survey with a representative sample of the entire population in the East Africa region needs to be conducted.
- Although the phase down of amalgam has been successful in some developed countries, there is need to assess the readiness (willingness of the dentists, appropriate equipment and infrastructure) in resource constrained settings.

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APPENDIX 1: QUESTIONNAIRE TO ASSESS DENTAL AMALGAM AND NON-DENTAL AMALGAM RESTORATIVE MATERIALS WASTE MANAGEMENT PRACTICES AMONG EAST AFRICAN (KENYA, TANZANIA, UGANDA) DENTAL PRACTITIONERS

PLEASE FILL IN YOUR RESPONSES BY TYPING INTO THE HIGHLIGHTED SPACES OR BY CLICKING IN THE BOXES APPROPRIATELY. IF POSSIBLE, PLEASE ENSURE ALL SPACES ARE FILLED (UNLESS MARKED AS OPTIONAL).

SECTION A

In this section, you will be asked to answer questions of personal nature and relating to your facility. Note you do not have to answer questions on personal information. Your data will be treated confidentially.

Name (<i>optional</i>):	_____
Gender (<i>optional</i>):	_____
Telephone (<i>optional</i>):	_____
Address (<i>optional</i>):	_____
Qualifications/Education:	_____ _____
Institution(s) where you were trained (<i>optional</i>):	_____ _____
Year(s) since you graduated (<i>optional</i>):	_____
Speciality :	_____
Country:	<input type="checkbox"/> Kenya <input type="checkbox"/> Tanzania <input type="checkbox"/> Uganda
Type of facility/clinic:	<input type="checkbox"/> Public- government <input type="checkbox"/> Training institution <input type="checkbox"/> Private <input type="checkbox"/> Civil Society/Non-Governmental organization(NGO) <input type="checkbox"/> Others(specify)

SECTION B

In this section, you will be asked to answer questions on amalgam and non-amalgam dental restorative materials. In this questionnaire non-amalgam dental restorative materials will refer to resin composites, glass ionomer Cement (GIC), compomers and ceramics.

1.	What dental restorative materials do you use in your facility/clinic? <i>(more than one option can be ticked)</i> <input type="checkbox"/> Dental Amalgam <input type="checkbox"/> Resin conventional resin composite <input type="checkbox"/> Packable resin composite <input type="checkbox"/> Glass Ionomer Cement(GIC) <input type="checkbox"/> Compomers <input type="checkbox"/> Ceramics <input type="checkbox"/> Others (please specify _____)																																		
2.	What is the volume of work in your facility/clinic? <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 40%;"></th> <th style="width: 15%;">Number in the last month</th> <th style="width: 15%;">Number in the last six months</th> <th style="width: 15%;">Number in the last year</th> </tr> </thead> <tbody> <tr><td>Tooth extractions</td><td></td><td></td><td></td></tr> <tr><td>Amalgam restorations</td><td></td><td></td><td></td></tr> <tr><td>Composite restorations</td><td></td><td></td><td></td></tr> <tr><td>GIC restorations</td><td></td><td></td><td></td></tr> <tr><td>Compomers restorations</td><td></td><td></td><td></td></tr> <tr><td>Ceramics restorations</td><td></td><td></td><td></td></tr> <tr><td>Other restorations</td><td></td><td></td><td></td></tr> </tbody> </table>				Number in the last month	Number in the last six months	Number in the last year	Tooth extractions				Amalgam restorations				Composite restorations				GIC restorations				Compomers restorations				Ceramics restorations				Other restorations			
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3.	On average, how many dental patients are seen by one dentist in this facility/clinic per week? _____																																		
4.	Who supplies you with the dental restorative materials that you use in your facility/clinic? a) Dental amalgam <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 60%;">Name</th> <th style="width: 40%;">Brand</th> </tr> </thead> <tbody> <tr><td> </td><td> </td></tr> <tr><td> </td><td> </td></tr> <tr><td> </td><td> </td></tr> <tr><td> </td><td> </td></tr> </tbody> </table> b) Non-amalgam dental restorative materials <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 60%;">Name</th> <th style="width: 40%;">Brand</th> </tr> </thead> <tbody> <tr><td> </td><td> </td></tr> <tr><td> </td><td> </td></tr> <tr><td> </td><td> </td></tr> <tr><td> </td><td> </td></tr> </tbody> </table>			Name	Brand									Name	Brand																				
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5. How much of the following dental (amalgam and non-amalgam) restorative materials did you procure over the last year?

a) Dental Amalgam

Restorative material:	Amount procured in the last year:
Liquid mercury (in kg)	
Amalgam powder(in kg)	
F1 amalgam capsules	
F2 amalgam capsules	
F3 amalgam capsules	

b) Non-amalgam materials

Restorative material:	Amount procured in the last year:
Composite	
GIC	
Compomers	
Ceramics	
Others	

6. a) Do you have any occupational concerns with the use of dental amalgam by dentists/personnel in the dental clinic?
Yes No
If yes, please briefly explain how amalgam can be an occupational danger/potential health risk to the dentists/ personnel in the dental clinic.

Do you have any occupational concerns with the use of non-amalgam dental restorative materials by dentists/personnel in the dental clinic?
Yes No
If yes, please briefly explain how non-amalgam restorative materials can be a danger/potential health risk to the dentists/personnel in the dental clinic.

7. a) If you use the liquid/elemental mercury and the amalgam powder (alloy), how do you mix it? (*more than one option can be ticked*)
 I mix manually, e.g. using motor and pestle
 I use the powder - liquid mixer
 I put it in used capsules before I mix it

b) If you use non-amalgam dental restorative materials please briefly explain how you mix them :
i) Resin composite
 I mix manually
 I use light cure
ii) Glass ionomer cement
 I mix manually
 I mix mechanically
 I use light cure

	<p>iii) Compomers</p> <p><input type="checkbox"/> I mix manually</p> <p><input type="checkbox"/> I use light cure</p> <p>iv) Ceramics</p> <p><input type="checkbox"/> I use fired ceramics</p> <p><input type="checkbox"/> I use computer aided designed</p>
8.	<p>a) Have you ever had a mercury spillage?</p> <p><input type="checkbox"/> Yes, in the last one month</p> <p><input type="checkbox"/> Yes, in the last 1 year</p> <p><input type="checkbox"/> Yes, in the last 10 years</p> <p><input type="checkbox"/> No, I have never had a mercury spillage</p> <p>b) If your answer is yes, how often did you have a spillage and how did you manage this (these) spillage(s)?</p> <p>_____</p>
9.	<p>If you use dental amalgam capsules, what capsule sizes are available in your facility/clinic? <i>(more than one option can be ticked)</i></p> <p><input type="checkbox"/> F1 <input type="checkbox"/> F2 <input type="checkbox"/> F3</p>
10.	<p>Among the dental amalgam capsule sizes that you stock, which capsule size do you procure in largest and least quantities? If possible, please indicate how much of each type you procure.</p> <p>F1 _____</p> <p>F2 _____</p> <p>F3 _____</p>
11.	<p>Has your amalgamator ever been calibrated?</p> <p><input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> I don't know</p>
12.	<p>If your answer above is yes, how often is your amalgamator calibrated?</p> <p><input type="checkbox"/> Every one year</p> <p><input type="checkbox"/> Every two years</p> <p><input type="checkbox"/> More than two years ago</p> <p><input type="checkbox"/> Other (please specify)</p> <p>_____</p>
13.	<p>How do you handle the used amalgam capsules? <i>(optional, more than one option can be ticked)</i></p> <p><input type="checkbox"/> I discard the empty capsules with biohazard waste</p> <p><input type="checkbox"/> I dispose the empty capsules in general waste/garbage</p> <p><input type="checkbox"/> I place the empty capsules separately in a container</p> <p><input type="checkbox"/> I reuse the empty capsules for mixing amalgam liquid and powder</p>

	<input type="checkbox"/> Other (please specify) _____																
14.	<p>a) Do you reassemble capsules immediately after dispensing the amalgam dental restorative material? <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Other (please specify)</p> <p>_____</p> <p>b) Do you reassemble capsules immediately after dispensing the non-amalgam restorative materials? <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Other (please specify)_____</p> <p>Dental health facilities do generate several types of waste materials</p>																
15.	<p>a) What kind of waste do you generate in your health facility/clinic and how much do you generate each month?</p> <table border="1"> <thead> <tr> <th>a) Type of waste (<i>more than one option can be ticked</i>)</th> <th>b) Average amount generated per month</th> </tr> </thead> <tbody> <tr> <td><input type="checkbox"/> General/regular garbage (kg)</td> <td></td> </tr> <tr> <td><input type="checkbox"/> Sharps (containers)</td> <td></td> </tr> <tr> <td><input type="checkbox"/> Infectious and clinical materials (e.g. used gloves) (kg)</td> <td></td> </tr> <tr> <td><input type="checkbox"/> Amalgam waste/ waste from removal of old amalgam restorations (grams)</td> <td></td> </tr> <tr> <td><input type="checkbox"/> Non-amalgam waste (in grams)</td> <td></td> </tr> <tr> <td><input type="checkbox"/> Chemicals (liquid and solid) e.g. x- ray film processing solutions, x-ray films (litters)</td> <td></td> </tr> <tr> <td><input type="checkbox"/> Pharmaceutical waste e.g. expired drugs, pills, capsules (grams)</td> <td></td> </tr> </tbody> </table>	a) Type of waste (<i>more than one option can be ticked</i>)	b) Average amount generated per month	<input type="checkbox"/> General/regular garbage (kg)		<input type="checkbox"/> Sharps (containers)		<input type="checkbox"/> Infectious and clinical materials (e.g. used gloves) (kg)		<input type="checkbox"/> Amalgam waste/ waste from removal of old amalgam restorations (grams)		<input type="checkbox"/> Non-amalgam waste (in grams)		<input type="checkbox"/> Chemicals (liquid and solid) e.g. x- ray film processing solutions, x-ray films (litters)		<input type="checkbox"/> Pharmaceutical waste e.g. expired drugs, pills, capsules (grams)	
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16.	<p>Do you separate waste (into separate bins or bags or containers) in your facility/clinic? (<i>please tick one for each question</i>)</p> <table> <tbody> <tr> <td>a. General/regular garbage</td> <td>Yes <input type="checkbox"/> No <input type="checkbox"/></td> </tr> <tr> <td>b. Sharps</td> <td>Yes <input type="checkbox"/> No <input type="checkbox"/></td> </tr> <tr> <td>c. Infectious waste</td> <td>Yes <input type="checkbox"/> No <input type="checkbox"/></td> </tr> <tr> <td>d. Waste from amalgam/ amalgam from old restorations</td> <td>Yes <input type="checkbox"/> No <input type="checkbox"/></td> </tr> <tr> <td>e. Waste from non-amalgam restorations</td> <td>Yes <input type="checkbox"/> No <input type="checkbox"/></td> </tr> <tr> <td>f. Pharmaceutical waste e.g. expired medicines and tablets</td> <td>Yes <input type="checkbox"/> No <input type="checkbox"/></td> </tr> </tbody> </table>	a. General/regular garbage	Yes <input type="checkbox"/> No <input type="checkbox"/>	b. Sharps	Yes <input type="checkbox"/> No <input type="checkbox"/>	c. Infectious waste	Yes <input type="checkbox"/> No <input type="checkbox"/>	d. Waste from amalgam/ amalgam from old restorations	Yes <input type="checkbox"/> No <input type="checkbox"/>	e. Waste from non-amalgam restorations	Yes <input type="checkbox"/> No <input type="checkbox"/>	f. Pharmaceutical waste e.g. expired medicines and tablets	Yes <input type="checkbox"/> No <input type="checkbox"/>				
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	When doing dental amalgam restorations, there is usually excess/waste amalgam either from removal of old fillings or from unused amalgam in the capsule or the excess from the curved filling.																

17.	<p>How do you handle contact amalgam pieces (amalgam that has been in the patient's mouth) and non-amalgam restorative materials after removal of old restorations or particles left in the mouth after inserting a new filling? <i>(more than one option can be ticked)</i></p> <p><input type="checkbox"/> I place them in infectious waste containers</p> <p><input type="checkbox"/> I place them in sharps containers</p> <p><input type="checkbox"/> I place them in regular garbage</p> <p><input type="checkbox"/> I have a separate marked container for handling waste amalgam</p> <p><input type="checkbox"/> I have a separate marked container for handling waste non-amalgam</p> <p><input type="checkbox"/> I ask the patient to spit into the sink / I flush the waste down the drain</p> <p><input type="checkbox"/> Other (please specify)</p> <hr/>
18.	<p>If you store contact amalgam and non-contact amalgam (e.g. excess mixed dental amalgam from used capsules or dampen dish that has not been in touch with oral tissues), what type of containers do you have for storing?</p> <hr/>
19.	<p>How do you handle extracted teeth that have amalgam/ non-amalgam fillings? <i>(please tick one)</i></p> <p><input type="checkbox"/> I place them in infectious waste containers</p> <p><input type="checkbox"/> I place them in sharps containers</p> <p><input type="checkbox"/> I place them in regular garbage</p> <p><input type="checkbox"/> I keep them in sealed (contact) amalgam containers</p> <p><input type="checkbox"/> I keep them in sealed (contact) non-amalgam containers</p> <p><input type="checkbox"/> Other (please specify)</p> <hr/>
20.	<p>a) Do you separate contact amalgam and non-contact amalgam (e.g. from used capsules)</p> <p>Yes <input type="checkbox"/> No <input type="checkbox"/></p> <p>b) Do you separate contact non-amalgam waste?</p> <p>Yes <input type="checkbox"/> No <input type="checkbox"/></p>
21.	<p>Do you decontaminate the contents of contact amalgam/non amalgam?</p> <p>Yes <input type="checkbox"/> No <input type="checkbox"/></p>

	If yes briefly explain: _____
22.	<p>Which of the following amalgam waste handling and disposal practices do you practise in your facility/clinic, if any? (<i>more than one option can be ticked</i>)</p> <p><input type="checkbox"/> None</p> <p><input type="checkbox"/> Using chair side traps,</p> <p><input type="checkbox"/> Amalgam separators</p> <p><input type="checkbox"/> Vacuum pump filters</p> <p><input type="checkbox"/> Segregation of waste amalgam</p> <p><input type="checkbox"/> Recycling /using a commercial waste disposal service to dispose of waste amalgam collected</p> <p><input type="checkbox"/> Written records of waste generation and disposal of waste amalgam</p> <p><input type="checkbox"/> Other (please specify) _____</p>
	<p>If you are using vacuum pump filters, how do you handle amalgam from the vacuum pump filters?</p> <p>_____</p>
23.	<p>What personal protective equipment do you use in your facility/clinic when handling liquid/elemental mercury? (<i>more than one option can be ticked</i>)</p> <p><input type="checkbox"/> Latex gloves</p> <p><input type="checkbox"/> Masks</p> <p><input type="checkbox"/> Gloves</p> <p><input type="checkbox"/> Eye glasses</p> <p><input type="checkbox"/> Others (please specify)</p> <p>_____</p>
24.	<p>Has anyone at your facility/clinic received training in mercury waste management in the past year?</p> <p><input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Do not know</p>
25.	<p>Do dental support team members get any occupational health training in your facility/clinic?</p> <p>Yes <input type="checkbox"/> No <input type="checkbox"/></p> <p>If yes, please briefly explain:</p> <p>_____</p>

26.	<p>Do you know of any commercial waste disposal service to dispose of the amalgam and non-amalgam collected?</p> <p>Yes <input type="checkbox"/> No <input type="checkbox"/></p>																		
27.	<p>Does your facility/clinic have a waste disposal plan for amalgam and non-amalgam waste?</p> <p>Amalgam waste: Yes <input type="checkbox"/> No <input type="checkbox"/></p> <p>Non-amalgam waste: Yes <input type="checkbox"/> No <input type="checkbox"/></p>																		
28.	<p>If yes, do you have a written copy of the plan available at your facility/clinic?</p> <p>Yes <input type="checkbox"/> No <input type="checkbox"/></p>																		
29.	<p>What do you do with filled waste amalgam containers? <i>(more than one option can be ticked)</i></p> <p><input type="checkbox"/> I send it to a recycler</p> <p><input type="checkbox"/> I Store it safely. I have stored for the last _____ (specify time period)</p> <p><input type="checkbox"/> Others. Please briefly explain</p>																		
30.	<p>Do you have excess liquid/elemental mercury or amalgam powder (alloy stored on site)?</p> <p>Yes <input type="checkbox"/> No <input type="checkbox"/></p> <p>If so, do you have a way to properly manage it to ensure that the mercury is not released or spilled? Please explain.</p> <p>_____</p>																		
31.	<p>Are you planning on installing an amalgam separator?</p> <p>Yes <input type="checkbox"/> No <input type="checkbox"/></p> <p>If so, do you know how to install the device properly and how to maintain it?</p> <p>Yes <input type="checkbox"/> No <input type="checkbox"/></p>																		
32.	<p>Please comment freely on amalgam and non-amalgam use and waste management among oral health care providers you have worked with.</p> <p>_____</p>																		
33.	<p>What is the cost of dental amalgam and non-dental amalgam fillings in your facility/clinic?</p> <table border="1" data-bbox="280 1480 1490 1759"> <thead> <tr> <th data-bbox="280 1480 683 1560">Filling material</th> <th data-bbox="683 1480 1089 1560">Unit (e.g. filling, inlay etc)</th> <th data-bbox="1089 1480 1490 1560">Cost (Kenyan/ Ugandan / Tanzanian shillings)</th> </tr> </thead> <tbody> <tr> <td data-bbox="280 1560 683 1602">Dental amalgam</td> <td data-bbox="683 1560 1089 1602"></td> <td data-bbox="1089 1560 1490 1602"></td> </tr> <tr> <td data-bbox="280 1602 683 1644">Resin composite</td> <td data-bbox="683 1602 1089 1644"></td> <td data-bbox="1089 1602 1490 1644"></td> </tr> <tr> <td data-bbox="280 1644 683 1686">Glass ionomer</td> <td data-bbox="683 1644 1089 1686"></td> <td data-bbox="1089 1644 1490 1686"></td> </tr> <tr> <td data-bbox="280 1686 683 1728">Ceramic</td> <td data-bbox="683 1686 1089 1728"></td> <td data-bbox="1089 1686 1490 1728"></td> </tr> <tr> <td data-bbox="280 1728 683 1759">Compomers</td> <td data-bbox="683 1728 1089 1759"></td> <td data-bbox="1089 1728 1490 1759"></td> </tr> </tbody> </table>	Filling material	Unit (e.g. filling, inlay etc)	Cost (Kenyan/ Ugandan / Tanzanian shillings)	Dental amalgam			Resin composite			Glass ionomer			Ceramic			Compomers		
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APPENDIX 2: QUESTIONNAIRE TO ASSESS TRADE FLOW OF AMALGAM AND NON-AMALGAM FILLING MATERIALS IN EAST AFRICA - KENYA, TANZANIA AND UGANDA

PLEASE FILL IN YOUR RESPONSES BY TYPING INTO THE HIGHLIGHTED SPACES OR BY CLICKING IN THE BOXES APPROPRIATELY. PLEASE ENSURE THAT ALL THE SPACES ARE FILLED, EXCEPT THOSE MARKED AS OPTIONAL.

SECTION A

You will be asked to answer questions of personal nature. Note that answering these questions is optional. Your data will be treated confidentially.

Name (<i>optional</i>):	_____
Telephone (<i>optional</i>):	_____
Address (<i>optional</i>):	_____
Qualifications (<i>optional</i>):	_____
Country:	<input type="checkbox"/> Kenya <input type="checkbox"/> Tanzania <input type="checkbox"/> Uganda

SECTION B

1.	<p>Which of the following dental restorative materials do you procure and supply? Please also indicate how much you have procured in the last week, in the last month, and in the last year.</p> <table border="1" data-bbox="280 485 1344 1140"> <thead> <tr> <th data-bbox="280 485 646 548"></th> <th data-bbox="646 485 873 548">Amount in the last week (kg)</th> <th data-bbox="873 485 1105 548">Amount in the last month (kg)</th> <th data-bbox="1105 485 1344 548">Amount in the last year (kg)</th> </tr> </thead> <tbody> <tr> <td data-bbox="280 548 646 590">Liquid/elemental mercury</td> <td data-bbox="646 548 873 590"></td> <td data-bbox="873 548 1105 590"></td> <td data-bbox="1105 548 1344 590"></td> </tr> <tr> <td data-bbox="280 590 646 632">Amalgam powder(alloy)</td> <td data-bbox="646 590 873 632"></td> <td data-bbox="873 590 1105 632"></td> <td data-bbox="1105 590 1344 632"></td> </tr> <tr> <td data-bbox="280 632 646 674">F1 amalgam capsules</td> <td data-bbox="646 632 873 674"></td> <td data-bbox="873 632 1105 674"></td> <td data-bbox="1105 632 1344 674"></td> </tr> <tr> <td data-bbox="280 674 646 716">F2 amalgam capsules</td> <td data-bbox="646 674 873 716"></td> <td data-bbox="873 674 1105 716"></td> <td data-bbox="1105 674 1344 716"></td> </tr> <tr> <td data-bbox="280 716 646 758">F3 amalgam capsules</td> <td data-bbox="646 716 873 758"></td> <td data-bbox="873 716 1105 758"></td> <td data-bbox="1105 716 1344 758"></td> </tr> <tr> <td data-bbox="280 758 646 852">Composite : Conventional resin composite</td> <td data-bbox="646 758 873 852"></td> <td data-bbox="873 758 1105 852"></td> <td data-bbox="1105 758 1344 852"></td> </tr> <tr> <td data-bbox="280 852 646 947">Packable resin composite</td> <td data-bbox="646 852 873 947"></td> <td data-bbox="873 852 1105 947"></td> <td data-bbox="1105 852 1344 947"></td> </tr> <tr> <td data-bbox="280 947 646 1010">Glass ionomer cement (GIC)</td> <td data-bbox="646 947 873 1010"></td> <td data-bbox="873 947 1105 1010"></td> <td data-bbox="1105 947 1344 1010"></td> </tr> <tr> <td data-bbox="280 1010 646 1052">Ceramics</td> <td data-bbox="646 1010 873 1052"></td> <td data-bbox="873 1010 1105 1052"></td> <td data-bbox="1105 1010 1344 1052"></td> </tr> <tr> <td data-bbox="280 1052 646 1094">Compomers</td> <td data-bbox="646 1052 873 1094"></td> <td data-bbox="873 1052 1105 1094"></td> <td data-bbox="1105 1052 1344 1094"></td> </tr> <tr> <td data-bbox="280 1094 646 1140">Others (please specify)</td> <td data-bbox="646 1094 873 1140"></td> <td data-bbox="873 1094 1105 1140"></td> <td data-bbox="1105 1094 1344 1140"></td> </tr> </tbody> </table>		Amount in the last week (kg)	Amount in the last month (kg)	Amount in the last year (kg)	Liquid/elemental mercury				Amalgam powder(alloy)				F1 amalgam capsules				F2 amalgam capsules				F3 amalgam capsules				Composite : Conventional resin composite				Packable resin composite				Glass ionomer cement (GIC)				Ceramics				Compomers				Others (please specify)			
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Others (please specify)																																																	
2.	<p>What are the main activities of your business?</p> <p><input type="checkbox"/> Agent - I supply dental materials to dental materials suppliers (nationally, internationally)</p> <p><input type="checkbox"/> I supply dental materials directly to the dentists/dental clinics (nationally/internationally)</p> <p><input type="checkbox"/> Both</p>																																																
3.	<p>a) Who is/are your dental amalgam and other dental restorative materials supplier(s)?</p> <p>_____</p> <p>b) Are you aware of other local suppliers of dental amalgam and other dental restorative materials in the region?</p> <p>If Yes, please state below _____</p>																																																
4.	<p>a) Where do your supplier(s) above get their dental amalgam and non-amalgam supplies from?</p> <p><input type="checkbox"/> The dental amalgam supplies are imported</p> <p><input type="checkbox"/> The dental amalgam supplies are manufactured in the country</p> <p><input type="checkbox"/> The non- amalgam supplies are imported</p> <p><input type="checkbox"/> The non- amalgam supplies are manufactured in the country</p> <p><input type="checkbox"/> I do not know</p> <p>b) If your supplier(s) import the dental amalgam supplies, please indicate below the country/countries that supply/supplies them.</p> <p>_____</p>																																																

5.	<p>In what form is the dental amalgam that you purchase for sale? <i>(more than one option can be ticked)</i></p> <p><input type="checkbox"/> Dental amalgam capsules</p> <p><input type="checkbox"/> Elemental mercury and alloy powder</p> <p><input type="checkbox"/> Others (please specify)</p> <p>_____</p>												
6.	<p>How much (in kg) of the dental amalgam and non-amalgam do your suppliers import?</p> <p>_____</p>												
7.	<p>What transport medium(s) do the suppliers use to ship the dental amalgam and non-amalgam supplies? <i>(more than one option can be ticked)</i></p> <p><input type="checkbox"/> Ship</p> <p><input type="checkbox"/> Air</p> <p><input type="checkbox"/> Truck/overland</p>												
8.	<p>If you supply dental amalgam packaged in more than one format (see question 5) which type is demanded most by your clients?</p> <p>_____</p>												
9.	<p>Do you repackage the dental amalgam before supplying it?</p> <p><input type="checkbox"/> Yes <input type="checkbox"/> No</p> <p>If yes please explain</p> <p>_____</p>												
10.	<p>Please specify the types and numbers of dental facilities you supply with dental amalgam.</p> <table border="1" data-bbox="280 1079 1451 1402"> <tr> <td><input type="checkbox"/> Public/Government institutions</td> <td>How many? _____</td> </tr> <tr> <td><input type="checkbox"/> Teaching hospitals</td> <td>How many? _____</td> </tr> <tr> <td><input type="checkbox"/> Civil Society/NGO</td> <td>How many? _____</td> </tr> <tr> <td><input type="checkbox"/> Private clinics</td> <td>How many? _____</td> </tr> <tr> <td><input type="checkbox"/> Others, within the country</td> <td>How many? _____</td> </tr> <tr> <td><input type="checkbox"/> Others, internationally</td> <td>How many? _____</td> </tr> </table>	<input type="checkbox"/> Public/Government institutions	How many? _____	<input type="checkbox"/> Teaching hospitals	How many? _____	<input type="checkbox"/> Civil Society/NGO	How many? _____	<input type="checkbox"/> Private clinics	How many? _____	<input type="checkbox"/> Others, within the country	How many? _____	<input type="checkbox"/> Others, internationally	How many? _____
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<input type="checkbox"/> Others, internationally	How many? _____												
11.	<p>Please specify the types and numbers of dental facilities you supply with non-amalgam dental restorative materials <i>(please tick as appropriate)</i></p> <p><input type="checkbox"/> Public/Government institutions How many? _____</p> <p><input type="checkbox"/> Teaching hospitals How many? _____</p> <p><input type="checkbox"/> Civil Society/NGO How many? _____</p> <p><input type="checkbox"/> Private clinics How many? _____</p> <p><input type="checkbox"/> Others, within the country How many? _____</p> <p><input type="checkbox"/> Others, internationally How many? _____</p>												

12. a) Please indicate below the form (*liquid/elemental mercury, amalgam powder (alloy); capsules F1, F2, or F3*) and quantity of dental amalgam (*in kg*) that you supplied to each of your clientele (*referred to in question 10 above*) in the last year.

Who I supply with dental amalgam	In what form? Liquid/elemental mercury Amalgam powder (alloy) Capsules - F1, F2, or F3 (<i>please indicate in kg</i>)	Quantity
Public/Government institutions		
Teaching Hospitals		
Civil Society/NGO		
Private clinics		
Others, within the country		
Others, internationally		

b) Please indicate below the form (*conventional resin composite or packable resin composite; GIC; ceramics*) and quantity of non-amalgam dental restorative materials (*in kg*) that you supplied to each of your clientele (*referred to in question 11 above*) in the last year.

Who I supply with non amalgam dental restorative materials	In what form? conventional resin composite or packable resin composite GIC Ceramics (<i>please indicate in kg</i>)	Quantity
Public -Government institutions		
Teaching hospitals		
Civil society/NGO		
Private clinics		
Others, within the country		
Others, internationally		

13. Among your local clients who are the largest consumers of dental amalgam?
 Urban clients
 Rural clients
 I do not know

14. Among your local clients who are the largest consumers of non-amalgam dental restorative materials?
 Urban clients
 Rural clients
 I do not know

15. Do you have dental amalgam capsules in stock?
 Yes No
 If yes, how much of each type of dental amalgam capsules (in kg) do you have in stock?
 F1 capsules _____

	F2 capsules _____ F3 capsules _____
16.	Please specify the size of dental amalgam you sell most and which one you sell least. If possible, please also provide the quantities for each type. F1 capsules _____ F2 capsules _____ F3 capsules _____
17.	Do you have liquid mercury and amalgam powder in stock? Yes <input type="checkbox"/> No <input type="checkbox"/> If yes, how much of liquid mercury and amalgam powder (in Kg) do you have in stock? Liquid mercury _____ Amalgam powder(alloy) _____
18.	Do you think that you meet the dental amalgam demand of your clientele? Yes <input type="checkbox"/> No <input type="checkbox"/> Please briefly explain your answer _____
19.	What challenges do you face in procuring and in supplying dental amalgam and non-amalgam restorative materials? Challenges in procurement of dental amalgam _____ Challenges in supply of non amalgam dental restorative materials _____
20.	In your opinion has the demand of dental amalgam and non-amalgam changed over the last five years? <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> I do not know
21.	If yes, has it increased or decreased? _____
22.	Please specify whether you stock a) amalgam bonding agents Yes <input type="checkbox"/> No <input type="checkbox"/> b) Composite/Compomers bonding agents Yes <input type="checkbox"/> No <input type="checkbox"/>
23.	a) Have you ever stocked and or sold equipments for storing waste amalgam Yes <input type="checkbox"/> No <input type="checkbox"/> If yes how many? _____ b) Have you ever stocked and or sold equipments for storing non amalgam waste Yes <input type="checkbox"/> No <input type="checkbox"/> If yes how many? _____

24.	What is the cost of dental amalgam and non- amalgam dental filling materials?		
	Filling material	Unit (please specify)	Cost (Kenyan/ Ugandan / Tanzanian shillings)
	Dental amalgam		
	Resin Composite		
	Glass Ionomer Cement		
	Compomers		
	Ceramics		



Participants at the Inception Workshop held on 18th-19th December in Nairobi, Kenya.



From Right to Left: Dr M. Wandera,Uganda,Prof F Kahabuka,Tanzania, Ms.Desiree Narvaez, UNEP-Chemicals, Prof Bary, UNEP-ROA, Dr.Poul Erickson,WHO-Geneva

