College of Graduate Studies

Institute of Water and Environmental Science

Composition, production rate and management of dental solid waste in two Palestinian governorates

مكونات مخلفات عيادات الاسنان الصلبة، معدل انتاجها وإدارتها في محافظتين فلسطينيتين.

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M. Sc. Thesis

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Dedication

To my Parents, my lovely Ala', my children Tamam, Mofeed, Gaith and Qaise, my brothers, and my sisters.

With Love and Respect.

Acknowledgment

I want to express my sincere gratitude thanks to God at first. It is to confirm that without the great care, assistance and encouragement of my great parents, I could not have finished this study. I will never forget their effort in taking care of my kids.

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Abstract

This study aimed to identify the measures taken by dentists in Salfit and Nablus districts to manage dental solid waste, in addition to identify the occupational hazards resulting from their practice. Also, it is to analyze the components of the dental waste and their percentages. Then can be considered as national strategy to all Palestine. Data was collected by two means: the first one was a questionnaire that was distributed simple randomly sample to a 100 of dentists (one dentist from each dental clinic) and the second was through the collection of dental solid waste clinics in Nablus and Salfit governorates and segregating them into several categories. Each category was weighed separately, and the percentage of each component was recorded.

This study shows that the majority of dentists dispose their waste through trash. About 71% of the dentists always wear masks during their practice. All of them were vaccinated against hepatitis type B. The study also demonstrated that 45% of the dentists complain of tension and 29 % of them complain of headaches. These are the two of most important occupational health problems among dentists. There is lack of available resources required for disposal of dental waste, such as special boxes, sacks, and special equipment and devices. A large number of dentists (96% for example does not a have a system for recycling dental waste) did not pay attention to the management of medical waste properly, although they were aware of its importance.

The study reveals that there is 57.2g/patient/day total dental waste, out of them 39.0g/patient/day infectious and 15.4g/patient/day domestic. Dental waste

generation in rural areas (76.5 g/patient /day) is more than urban areas (44.4 g/ patient /day).

The demographic factors should be taken into consideration when designing any awareness campaign or refreshing course. Age of dentist, years of experience, graduation country, gender of dentist, and residence location are all important factors that affect practices and attitudes of dentists.

Finally, the study shows that the current disposal methods of dental clinic waste, sterilization methods, preventive and mitigation measures, and other occupational safety and health followed in most of the dental clinics in Salfit and Nablus were not sufficient and not effective. The concerned authorities should carry out rapid intervention and measures in order to increase awareness of health and safety career in dental clinics.

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List of Abbreviations

AIDS	Acquired Immune Deficiency Syndrome
Atm.	Atmospheric
EQA	Environmental Quality Authority
ADA	American Dental Association
GS	Gaza Strip
HBV	hepatitis B virus
HCF	Health care facility
MAX	Maximum
Min	Minimum
MoH	Ministry of Health
OPD	out-patient-department
SPSS	Statistical Package For Social Science
Tem	Temperature
WB	West Bank
WHO	World Health Organization
PA	Palestinian Authority
EPA	Environmental Protection Agency
(MSDS).	Material safety date sheet

Chapter one
Introduction

1.1 Introduction

The rapid development of technology, random growth of cities, high population growth, and the incorrect way in which natural resources are being exploited, the environmental imbalance has brought to the surface the discussion on the environmental impacts caused, along with the implications for the health of the population and safety of working personnel (Neto et al. 2012; Hong and Zhaojie, 2010).

One of the main problems that require attention is the growing output of dental solid waste and its impact on the health of the general public. With this broader concept of health, the correct management of dental waste has become an essential issue in the preservation of people's health and quality of life (Ozbek and Sanin, 2004).

Dental waste management has high social importance to the community, the environment and the profession, since waste when properly managed, it contributes to better quality at work, both for the professional and for the public (Fan and McGill, 1989.)

It is well known that the components of different constituents of waste vary in accordance to site, season, lifestyle, food habits, and standards of living. It is also the level of development that has a very direct of impact on the rate and type of solid waste generated .The problem of dental solid waste is very much influenced with the high increase in population. There is a variety in the rate of increase of dental solid

waste. But generally it is increasing in the rate of 3.2-4.5% in developed countries. For the developing countries, the percentage is lower 2-3% (Kurt et al., 2001).

In 1994, the Palestinian National Authority was responsible for the health sector in the West Bank and Gaza. This coincided with a large horizontal and vertical increase in health services. The increase in services was in all areas rural and urban. This resulted in exploring the problem of healthcare wastes as a serious issue. In parallel with that, there was no proper dental waste management system. For example, in Salfit governorate (West Bank), there are 22 dental clinics and in Nablus 126 private dental clinics (Taha, 2011).

1.2 Study area framework and characteristics

The study area is Salfit and Nablus governorates. Salfit city is one of Palestinian towns in the central West Bank. It is located in the central highlands adjacent to the Israeli settlement of Ariel, 570 m meters above mean sea level. The population of Salfit governorate is about 69,179 in 2014 according the Palestinian Central Bureau of Statistics (PCBS). Nablus governorate is located in the northern West Bank. Nablus city is one of the largest populated cities in the West Bank of Palestine, and the most important economical center in the north of the West Bank. The center of Nablus is 550meters above mean sea level, which is less than its mountain which is 941 meters. The population of Nablus governorate is about 372,620 in 2014 according the Palestinian Central Bureau of Statistics (2014b).

1.3 Problem statement

One of the main problems that require attention is the growing output of dental solid waste and its impact on the health of the public. With this broader concept of health, the correct management of dental waste has become an essential issue in the preservation of people's health and quality of life (Ozbek and Sanin, 2004).

1.4 Objectives of the study

The main aim of this study is to assess the real situation of dental solid waste management in the dental clinics in the governorates of Nablus and Salfit. The specific objectives of this study are:

1) Examine the current dental solid waste management practices in Salfit and Nablus governorates.
2) Determine the composition and production rate of dental solid waste.
3) Assess the occupational safety of dentists.

Chapter Two

Literature Review

2.1 Classification and identification of dental waste

There are many components of dental waste produced from dental clinics and healthcare centers and include chemical waste, pressurized containers; radioactive waste, clinical waste, and general waste.

Dental wastes are defined as: “any waste which consists wholly or partly of human or tissue, blood or other body fluids, excretions, drugs or other pharmaceutical products, swabs or dressings, syringes, needles or other sharp instruments, being waste which unless rendered safe may cause hazardous to any person coming into contact with it” (Putrajaya, 2009).

2.2 Sources of hazardous dental waste

The wastes generated by dental clinics may be described as hazardous wastes if they were from the following sources (Managing solid waste generated by dental clinics, 1995):

1- X-ray fixer containing silver that makes it hazardous waste.

2-X-ray film: The more the darker areas are, the more the Silver content, and thus the more is the hazardous effect.

3- Lead foil and mercury amalgam/ silver.

Also there are other sources that could make the waste hazardous. This may be at lower level. It includes wastes like cleaners for developer systems and cleaners that contain chromium so, we can Check the cleaner's Material Safety Data Sheet

(MSDS), if the MSDS lists have some form of chromium, for example sodium dichromate, the waste cleaner solution should be managed as hazardous waste (Managing Waste Generated by Dental Clinics, 1995).

In addition, used sharps or dressings swabs are considered hazardous waste because they contain body fluid as blood. To protect waste hauler from infection, containers of sharps cannot be compacted (AL-Khatib and Darwish, 2004).

2.3 Health and environmental effects of dental waste

The percentage of infectious waste in dental clinics was reported to be in the range of 10 to 25% of the total generated waste (Michael, et al. 2010).

Additionally, there are cross infectious risks related to the mismanaged waste. Among others, hazardous wastes may include cadmium, chromium and amalgam (Michael, et al. 2010).

Dental waste from clinics has a lot of risks. These risks can be displayed in the follows.

2.3.1 Health risk

As the types of dental solid waste differ, the hazardous wastes also differ. It can be chromium, cadmium and amalgam that may have adverse effects on humans. The hazardous effect of Chromium is on liver, kidney and may cause respiratory damage .The adverse effect of cadmium is by causing kidney disorders and lung cancer (Michael, et al. 2010).

The effect on health depends on the type of waste as follows:

2.3.1.1Acute infectious waste

Dental solid waste may contain many infectious medical waste and large amounts of different variety of pathogens. Combined with the presence of sharps in the waste, the risk of skin prick or cut with sharp contaminated materials become more serious. It may cause inflammatory skin diseases which arise due to the exposure to pathogens found in the medical waste such as cotton and gauze bedside (Case Studies of Five Dental Mercury Amalgam Separator Programs, 2008).

2.3.1.2 Chemical and pharmaceutical waste

Pharmaceutical waste, chemical waste is common in dental waste resulting from dental clinics. It causes genetic mutations, cancer and damage to the employees, labor and the surrounding environment. In case of fire or explosions, it may cause pollution to environment (Hamde,2003).

In addition, may a vital environmental damage happens when residual of chemicals thrown in public sewer network due to the inability of sewage treatment plants to eliminate and get rid of those materials compared with the ease of getting rid of microbes. Some pharmaceutical residues have devastating effects for microbial systems.

In other studies, dental personals may also be exposed to mercury vapor from dental effluent treatment devices (King et al., 2002).

In other case, some pharmaceutical waste residues of antibiotics and other drugs used to treat teeth diseases when mixed with the remnants of heavy metals such as mercury, phenolic compounds, and toxic derivatives resulted to cause harmful effects to natural environmental system (Chin et al., 2000).

In addition to that chemical dental X-ray waste is considered one of the serious problems. In most developed countries, there is a professional management of dental waste. Everything is monitored and controlled in a systematic process, nothing is left for coincidence. For example, 90% of the Silver used in fixer solutions used for developing X-ray films is recovered. After that the remaining solution with a Silver content less than 10% of its original content can be safely discarded into drain (Al-Khatib and Darwish, 2004).

2.3.1.3 Residues of toxic drugs

Toxic drugs used for patients that brae discharged and disposed of, may cause damage to health labor due and to the ability of these materials to attack human cells and cause faults .The exposure to this type of damage may be through inhalation of dust or gas (Neto, et al., 2012).

The ability of these materials in the formation of cancerous tumors and mutations is high. These drugs are irritating the cells and tissues after topical exposure of the skin and eye, the symptoms such as headache, nausea, and some of the changes, and skin abnormalities are common (Hamde, 2003).

Nowadays, the cross-infection is an important parameter and concern for patients, dentists and dental personnel (Singh et al., 2012).

2.3.1.4 Radioactive medical waste

Severity of diseases that are caused by exposure to radioactive waste depends on the type and amount of radiation. Symptoms vary from simple symptoms such as headaches and vomiting to more serious symptoms such as cancers (WHO, 1999).

2.3.1.5 Dental amalgam fillings

Amalgams (silver and copper) have been applied in stomatology since 1819. In 1971 the Ministry of Health of the USSR prohibited to produce copper amalgam containing mercury (Managing Waste Generated by Dental Clinics, 1995).

This prohibition was caused by significant disadvantages of copper amalgam fillings and hygienic hazard of mercury.New types of filling material are being developed, but the amalgam is still used and is expected to be used wider as durable and long-lived material (Mutter, 2011).

Amalgam is the main raw materials used by dentist in their work. Over a century it was and it is still being used as a filling material. It mainly consist of mercury 50% by weight and an alloy powder of silver, tin or copper 50% by weight. The concern with amalgam comes from its mercury component that should be dealt with care (Al-Khatib and Darwish, 2004).

Consumption of mercury for one filling is equal to 350 mg in average (based on information from palest nine manufacturers) and about 700 kg of mercury is annually used for 2 million fillings, which are finally released to the environment. Mercury used for amalgams is imported from many countries ,this enterprise annually supplies up to 500,000capsules for amalgam making in capsules.Such

amalgam is ready for use in dental clinics without additional component (Sawair et al., 2010).

It is anticipated that mercury becomes bioavailable in the environment. "The main health and environmental problems connected with mercury releases are chiefly due to the bacteriological transformation of inorganic mercury to the highly toxic compound methyl mercury" (Maxon, 2007).

The mercury in amalgam can reach the environment through many ways such as solid waste, water, and air (Kizlary et al, 2004). However, the problem is the presence of special type of bacteria that will convert mercury into methyl mercury. The methyl mercury is a potential neurotoxin (Mumtaz et al, 2010).

2.4 People affected by dental waste

People who are exposed to the risks of medical waste can be displayed as follows: dentists, paramedical staff, labor in health institutions and clinics, patients, visitors and that labor dealing with waste handling, collection, treatment and transportation. Also kids, who may be playing outside health institutions or close to the waste containers, are vulnerable to these risks.

The individual cases of injuries infected as a result of medical waste are many and varied but it is difficult to be identified due to many factors, especially in the developing countries. Exposure to the medical waste is neglected and the lack of knowledge or facilities at their disposal leads to multiple injuries due to the diversity of the pathogen (WHO, 1999).

In 1992, there were eight cases of infection with the HIV virus in France because of injuries to professional health workers.

In 1994, there were 39 cases of infection with the same virus in the United States of America (Hamde, 2003).

The causes were represented in 32 cases due to contaminated needles prick, and one case because of a scalpel wound contaminated, and one case because of the broken pipe wound had the blood of an infected patient, and another one was due to a sharp material, and four cases were due to contamination of the skin or mucous membranes contaminated blood with the virus. However in 1996, cases increased to 51 cases and were mostly nursing staff, doctors and technicians of laboratory analysis. As for the Hepatitis viruses, the situation was much worse. In the Report of the U.S. Environmental Protection Agency (EPA), there were between 162 to 321 cases of infection with HIV Hepatitis B because of sharp medical waste from the total number of injuries per year due to prick needles, which were up to 300,000 cases per year (Abd -Alhmeed and Al Majrase, 2004).

In addition to that, burning of medical gloves and needles cause the emission of a toxic substance called PVC plastic.

2.5 Management of dental solid waste

The general objective of any future policies in relation to management of mercury in dental amalgam will be to reduce the environmental impacts from the use of mercury in dentistry and to reduce the contribution of dental amalgam to the over all mercury problems (Mudgal et al., 2012).

The environmental regulations that deal with different types of dental waste and the hazardous effects of such waste can help in reducing or even eliminating such hazards. Minimizing the effects in their clinics is strongly related to the behavior of dental care professionals (Kontogianni et al 2008)

After the world reorganization of the importance of waste management, many countries are planning towards the elimination or minimization of the noxious effects of such waste. While several developed countries have established a comprehensive system for the management of dental health care wastes (Al-Khatib and Darwish 2006).

Dental amalgam waste should be recycled to prevent its mercury release of to the environment (American Dental Association, October 2007; Kontogianni, 2008).

Many developing countries still suffer from improper waste disposal, lack financial resources, insufficient awareness of health hazards and few data on health care waste generation and disposal. In most areas of the West Bank of Palestine, dental waste along with other health care waste is sometimes disposed as part of the solid waste management system which is collected and dumped in uncontrolled landfills, resulting an environmental harmful (Al-Khatib and Darwish 2004).

Although Mercury is a naturally occurring metal; 50% of its amount in environment is generated by man activities. It is known that only 13% of the amount generated by man comes from general industry and general activities. The major player in generating this metal is burning fuels for generating energy.

The other 34% comes from waste burning. It is to confirm that dentistry share in this input does not exceed 1% (Johnson, 2000).

The seriousness of mercury comes from the fact that it can enter through the food chain through fish. Fish will consume mercury present in water. The mercury in water comes directly from water or from the air. It is reported that 43% of the total lakes area in USA had mercury as a second pollutant (American Dental Association October 2007).

These cautions are important because in some case, and especially in developing countries the waste is burned. Burning the waste with all the amalgam inside, which contain mercury will evaporate it and release it to the air. By this opportunity to enter into the water cycle and then to the food chain will increase. This will increase the potential hazard on the environment (American Dental Association, October 2007).

2.5.1 Amalgam separation:

The good thing that extracting mercury from amalgam is a process that can be done. The distillation of amalgam will recover the mercury and to be reused in new products. The ADA addressed the issue of recycling amalgam as a mitigation measure for decreasing the impacts of this filling material (American Dental Association, October 2007).

Many companies offer several services to the dentists to manufacture install and maintain amalgam separators in Europe countries, some mercury ends up in municipal and biomedical waste streams, which represents an additional cost to be local taxpayers (Mudgal et al., 2012)

Chapter Three

Methodology

3.1 Size of the population and sample

The study sample consisted of 100 dental clinics which were randomly selected out of clinics working in Salfit and Nablus governorate.

The number of registered dental clinics in Nablus and Salfit governorate was 149 and 32 respectively according the Palestinian Central Bureau of Statistics (PCBS) in the year 2012 (PCBS, 2014c). These were distributed as shown in Table 3.1.

Table 3.1 Distribution of dental clinics in Salfit and Nablus governorate

Governorate	Total no. of dental clinics
Salfit	32
Nablus	149
Total	181

Collection of data for this study was carried out through two means. The first a questionnaire was distributed to 100 dentists. The second part was analyzing the composition of dental wastes collected from twenty clinics. The data was collected in Salfit and Nablus governorates between October 2013 and December 2013.

3.2 Collection and analysis of data using questionnaire

A questionnaire was developed to collect data about dental waste management and the occupational health of dentists. A random sample of 100 officially registered dental clinics in Salfit and Nablus governorates were selected for the purpose of this study. One dentist was interviewed from each dental clinic. 30 dental clinics were selected from Salfit governorate and 70 from Nablus governorate.

Different studies were reviewed and used in developing the questionnaire, mainly (Adegbembo et al., 2002; Al-Khatib and Darwish, 2004; Darwish and Al-Khatib,2005; Michael et al., 2010). The main data included in the questionnaire were clinic location, date of graduation of the dentist, gender of dentist, type of degree (Bachelor or higher degree), type of clinic (private, governmental,..), the establishing date of the clinic, staff number of the clinic, and dentist vaccination against Hepatitis B. Part II of the questionnaire addressed the issue and characteristics of waste produced by the dental clinics on daily basis. There ware questions concerning with the type of amalgam they used.

There were extra questions concerning with the disposal of the old extracted the extra newly placed amalgam fillings and other aspects of dental waste management. The last part included the questions related to the occupational safety for the cleaning personnel who handle dental wastes, especially sharps.

Analysis of data was carried out using Statistical Package for Social Science (SPSS) version 18. To explore significant relationships between the demographic variables and other variables, tests of significance were carried out. The other

variables are related to knowledge, and practices relating to management of dental waste. Frequencies, means and cross tabulations were used.

The Chi-square test was utilized to test presence of differences in waste management among various observed variables such as country and year of graduation and gender of dentist.

3.3 Collection and analysis of dental waste samples

Regarding waste composition and generation rate, the dental solid waste was collected from 10 dental clinics in Nablus governorate and 10 dental clinics in Salfit governorate. The generation rate was determined, and the weight of each category of dental solid waste produced during the study were period recorded. Dental solid waste was classified into three main categories: (1) Infectious and potentially infectious waste, (2) Non-infectious waste and (3) Domestic-type waste (Tiejen, 2003).

The category of infectious waste was classified as hazardous and includes infectious metal, amalgam, components without metal, cotton and toilet paper, paper, extracted teeth, plastic and rubber.

Dentists were asked to keep the waste they generated. The dental wastes were separated into two parts. The first part contained mainly used ampoules, sharps, such as needles, extracted teeth, syringes, broken glass, dental tools, etc.) These were kept in yellow, thick wall plastic containers, of 5.4 liters capacity and were labeled properly. The second part contained non-sharp items used in dental practice, such as blood contaminated cotton, plastic gloves, plastic glasses, paper, paper towels, gypsum, wax, etc..

These were kept in yellow plastic sacks labeled properly. Sacks and containers were given numbers to maintain the anonymity of the sample. The samples collected were taken out when working time was over. Then, each sample was handled separately and transferred to a special room at the house of the researcher. Then, the waste was manually separated to sub-fractions. All fractions were weighed by means of a simple scale. Dental wastes were manually separated by hand sorting.

Two baskets were distributed to the dental clinics. The first type was specified for dental solid waste and the other type was specified for sharp waste. The empty weight has been recorded before collection. A special sheet for weight of dental waste recording was prepared .In these sheets, the solid dental waste was divided into several categories: infectious metal waste, non-infectious waste, domestic, amalgam, blood soaked dressings, paper, extracted teeth, plastic and rubber(Singh et al. ,2012).

Fig 3.1 Dental solid waste samples collected from dental clinics

Fig 3.2 Dental solid waste samples segregation to different components after collection

Sub-fractions were classified into three groups including domestic type, infectious and potentially infectious, and non-infectious wastes as defined below (Nabizadeh et al., 2012):

Domestic type wastes: "dry paper towel, dry gauze, dry cotton, dry dental rolls, nylon, plastic, syringe and needle packaging, nylon-coated paper, articulating paper, sand paper, paper, carton and cardboard, newsprint, carbon steel, textile, masks, film packet paper, film packet plastic, empty (used) amalgam capsules, plastic tumbler, leather, gypsum, mixed gypsum and gauze, paper banderole, brilliant banderole, sticking plaster, matchwood, food waste, food waste packaging, tea slag, filter tip, mixed soil and gypsum, medicine ampoule packaging" (Nabizadeh et al., 2012).

Infectious and potentially infectious wastes: "dental wedge, Blood-contaminated paper towel, dental floss , blood-contaminated gauze, saliva-contaminated gauze, syringes, blood-contaminated cotton, absorbent paper, contaminated cotton, blood-contaminated dental rolls, saliva contaminated dental rolls, nylon gloves, latex gloves, saliva ejectors, sharps and needles, extracted teeth, dental mirror, stitch string, stitch needle, surgical blades, gutta-percha points, dental bridges, tongue blade, dentistry pallet, brackets, polishing strip, matrix band, saliva-contaminated paper towel" (Nabizadeh et al., 2012).

Chemical and pharmaceutical wastes: "film packet's, used medicine ampoules, amalgam-contaminated dental rolls, wax, amalgam-contaminated cotton, dental

impression material, acrylic, calcium hydroxide, amalgam-contaminated paper towel, amalgam-contaminated gauze" (Nabizadeh et al., 2012).

Toxic wastes: "Amalgam particles, amalgam-contaminated paper towel, film packet's lead foil, amalgam contaminated gauze, amalgam-contaminated cotton, amalgam-contaminated dental rolls" (Nabizadeh et al., 2012).

Chapter Four

Results and discussion

The results of the study are divided into three parts. Part one dealing with results of the questionnaire that was filled by the dentists, part two that deals with the analysis of relationship existing between the demographic and other attitude and behavior practices toward dental waste, and part three that deals with the composition and rate of generation of dental waste.

4.1 Demographic and socioeconomically characteristics of sample

The study sample consisted of 100 dental clinics which were randomly selected out of clinics working in Salfit and Nablus governorate, of which 79% were run by male dentists. Table 4.1 shows the demographic characteristics of the sample.

Majority of dentists (41%) ranged in the age group (31-40 year).

With respect to scientific qualification (80%) of the dentist were general practitioners, (16%) having master degree, and only 4% were with doctoral degree.

All clinics were licensed. This is a good indicator of the systematic work for licensing and monitoring of health centers. About (30%) of clinic have area more than 80 m^2 as shown in Table below.

Table 4.1: Demographic characteristics of the sample

Item	Percentage of respondents			
Gender	**Male**		**Female**	
	79%		21%	
Age	**<30**	**31-40**	**41-50**	**>50**
	21%	41%	29%	9%
Experience	**<11**	**11-20**	**21-30**	**>30**
	47%	44%	7%	2%
Qualification	**General Practitioner**	**Master**	**PhD**	
	80%	16%	4%	
Clinic area	**<50 m2**	**51-80 m2**	**>80 m2**	
	35%	35%	30%	
Graduation country	**India, Pakistan, and others**	**Previous Soviet Union**	**Arab country**	**Palestine**
	15%	42%	27%	16%

4.2 Attitudes and behavior of dentists relating to medical waste issues

This factor was measured using five questions in the questionnaire (V19, V20, V37, V55, and V71). The results are illustrated in Table 4.2.

Table 4.2 Attitudes of dentists toward dental waste issues

Indicator	Positive attitudes
Belief of serious health risks when collecting dental waste.	97%
Belief of serious health risks because of amalgam	74%
Knowing that material used for developing films contain chromium	59%

From Table 4.2, 97% of dentists believe that there are serious health risks while dealing with dental waste. While 74% of them believed to have serious health risks because of amalgam. Only 59% of dentists know that material for film developing contain chromium. It is red alarming indicator that 26% of dentists do not believe in serious health risks because of amalgam. Also, the issue of presence of chromium in developing films is not known or even thinking about for 41% of dentists.

When dentists were asked about the definition of medical waste (V55), the answers were as in Table 4.3. A significant percentage (11%) considers the medical waste as the sharps, and by this ignoring the other wastes that may be infectious. The seriousness of this ignorance is that it comes from the well-educated slice of society (dentists) who are supposed to educate community about the seriousness of infectious wastes and its hazards.

Table 4.3 Definition of medical wastes

Definition of medical waste	**Percentage**
Waste that should be separated from domestic waste	18%
Sharps	11%
Residual of the materials used in the patient treatment in addition to the other wastes from patients	61%
All products resulting from patients treatment	9.3
Total	**100**

According to Putrajaya (2009), dental clinical wastes are defined as "Any waste that consists wholly or partly of blood or other body fluids, human or tissue, excretions, swabs or dressings, drugs or other pharmaceutical products, syringes, needles or other sharp

instruments, being waste which unless rendered safe may prove hazardous to any person coming into contact with it".

The dentists were asked about the method of disposal of dental medical waste (V71). The results were as shown in Table 4. 4.

Table 4.4 Answers of dentists concerning disposal method of wastes

Disposal method of dental waste	Percentage
Special division for solid medical waste	46%
Incinerator	35%
With domestic wastes	19%

It is to address that 46% of dentists believe in the presence of a special division for medical waste disposal. There was specific site for disposing dental wastes in Salfit and Nablus governorate. This indicates lack of enough knowledge of dentists regarding this issue. Ministry of health should increase its awareness to dentists about all the solid waste issues including their collection and final disposal. If dentists knew the lack of special division for dealing with dental waste, they might be keener on separating dental waste and keeping sharps in safety boxes.

4.3 Source and generation of dental wastes:

The results of which are illustrated in Table 4.5. It is to note that 35% of dentists have X-ray unit in their clinic. Only 65% of these dentists develop the films

inside clinic. It is to note that current trend is now for digital films. This will reduce the waste generated from film developing.

The question V32 deals with methodology of disposing liquids resulting from development of X-ray films. The answers were as presented in the Table 4.5. It is noted that about 55% of dentists are disposing the liquids directly into trash, without paying any attention toward its bad effects on environment and on public health in case anyone was accidently exposed to it.

Regarding generation of dental solid waste the results are as presented in the Table 4.5.It is observed that clinics produce infectious waste sometimes (68%). These infectious wastes include cotton contaminated with blood or saliva. It is observes also, that 91% of the clinics produce sharp medical waste (such as needles and syringes and lancets etc.). Moreover, clinics produce sometimes pharmaceutical waste that is used in the treatment (59%). They are considered dangerous chemicals to human health and the environment. There are 58% of the clinics also produces pathological waste. Also, 78% of these clinics produce medical liquid waste such as blood and saliva and human fluids.

About 62% of the dentists believe that clinics do not produce radioactive waste. This is due to the use of digital devices in the filming of the teeth, so no need to acidification. Whereas, the film development is dangerous for the environment and causes pollution as it produces chromium which is a heavy metal. The Table shows that 52% of the clinics produce sometimes other heavy metals such as mercury poison. The large percentages of infectious, sharps, pharmaceutical wastes produced confirm the need for a comprehensive system for dealing with

these hazardous products. This system should include handling, collection, disposal as well as awareness.

Table 4.5 Sources and generation of dental waste

Presence of X-ray waste sources			Percentage
Presence of X-ray in clinic			35%
X-ray films are developed in clinic			65%
Disposal method of liquids used in X-ray film development	Trash	Drain	No need (digital films)
	55%	36%	9%
Clinic produces infectious wastes	Always	Sometimes	Never
	16%	68%	18%
Clinic produces sharp wastes	91%	7%	2%
Clinic produces pharmaceutical wastes	5%	59%	36%
Clinic produces pathological wastes	20%	58%	22%
Clinic produces liquid wastes	78%	15%	7%
Clinic produces heavy metals wastes	35%	52%	13%
Clinic produces heavy radioactive wastes	10%	28%	62%

4.4 Practices relating to professional health and public safety:

The results are presented in Table 4.6. Although 71% of dentists always wear mask during patient treatment, it is not a sufficient percentage. This means that 29% are not always wearing the mask, and thus are vulnerable to infection.

Awareness should be targeted to dentists to follow the professional safety standards.

Regarding the ventilation system, which is necessary for prevention and protection from contaminants, 71% of clinics are using window as the only ventilation system. On the other hand, they must follow the proper ventilation system to pull air and harmful gases outside the clinic. The van would be a necessity, especially in cold days, when opening the window is not realistic.

About 19% of dentists are using dry sterilization as shown in Fig. 4.1. This practice should be improved and this percentage should be lowered down, as wet sterilization is more effective.

The study shows 100% of dentist had been vaccinated against hepatitis B. This is good indicator of a safety measure taken by dentists as well as the increase of awareness among dentists in this area. The finding of study shows that 84% reported stick needle injuries, which emphasizes the need for vaccination.

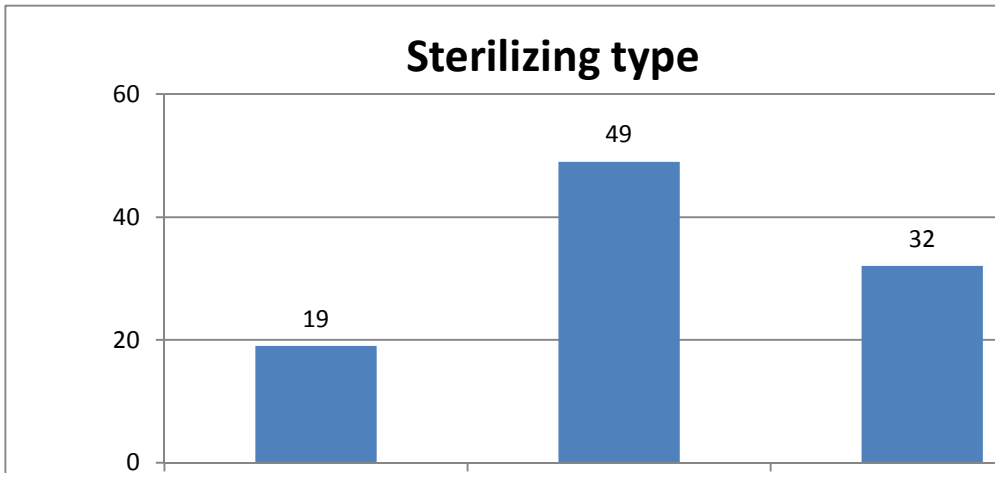

Figure 4.1 Type of used sterilization agent

Table 4.6 Practice relating to professional health and public safety

Wearing masks during patient treatment	**Always**	**Mostly**	**Sometimes**	**Rarely**
	71%	15%	13%	1%
Ventilation system in clinic	**Fan**	**Window**	**Fan and window**	
	3%	71%	26%	
Type of sterilizing agent	**Dry**	**Wet**	**Dry and wet**	
	19%	49%	32%	
Type of liquid sterilizing agent	**Glutaraldehyde**	**Alcohol 70%**	**More than one liquid**	
	59%	1%	40%	
Have taken the HBV vaccination	100%			
Exposure to needle stick injuries during patient treatment	84%			
Having diseases caused by practicing the dentistry	11%			
Having been infectious with hepatitis because of injuries during patient treatment	0%			
Examining the production and expiry date of materials used in the clinic	100%			

4.5 Monitor, control, and follow up

The results are presented in Table 4.7.It is noted that only in 42% of clinics there were instructions for dealing with medical waste. This percentage is very low and it indicates weakness in distributing regulations and spreading awareness among dentists and need follow up. The percentage of being visited by specialist to discuss medical waste issues is even worse (32.3%). The percentage of being visited by specialist to discuss professional safety issues is the worst (26%). A lot

of efforts should be directed toward improving these issues. This may be through making periodic bulletin concerning medical waste issues and conducting periodic visits to enhance awareness of dentists about dental waste and professional health and public safety.

In the case of presence of written instructions, the source of these instructions in most cases (92%) is the Ministry of Health. The role of other institutes like UNRWA, Universities, Environment Authority, municipalities and others is nearly absent. There should be efforts to engage all these parties to take their role and duties for better management system of dental wastes.

In the case of being visited by specialist for discussing issue of medical waste, the visitor was from Ministry of Health in all cases. Again, the role of other parties is absent, as if the public safety is only concern of Ministry of Health. There should be a cooperative effort to engage all these parties and assign tasks and responsibilities for each party.

In the case of being visited by specialist for discussing issue of professional health of dentist, the visitor was from the Ministry of Health in 94%. Only in 6% it was a university student.

So it is required that Ministry of Health to intensify its efforts for edification of dentists on ways to deal with dental waste. Subject of occupational safety of dentist is very important; the doctor needs more awareness and guidance to always be on the lookout for developments in modern science.

Table 4.7 Indicators for monitoring, controlling and following up dental waste management

Presence of written instruction for dealing with dental waste			42%
Being visited by specialist for discussing issue of dental waste			32%
Being visited by specialist for discussing issue of professional health of dentist			26%
Source of instruction	Ministry of Health	UNRWA	University
	92%	4%	4%
Reprehensive discussing professional health	Ministry of Health		University student
	94%		6%
Reprehensive discussing issue of dental waste	Ministry of Health		
	100%		

4.6 Practices and trends related to waste management and clean environment

The results are presented in Table 4.8. About 74% of dentists have a system for disposal of dental waste. Again this is not good and the percentage should be raised to 100%. The segregation of dental waste from other waste is only 54% which is not good if it is compared with Hamdan in Iran it is 70% (Nabizadehl, 2012).

Regarding the presence of system for dental waste recycling it is only 4% which is a catastrophic. If we compare this with Hamdan the percentage there is 0% recycling (Nabizadeh, 2012).

Again, for amalgam recycling the percentage is only 19%. If we compare this with Hamdan the percentage there is 0% amalgam recycling (Nabizadeh, 2012).

When dentists were asked about the separation system of hazardous waste, the results show that (36%) of dentists only separate the infectious waste from other wastes that are not contaminated. The percentage using safety box for the sharp wastes is 85%. Again this percentage had to be increased to 100%, as the 15% of presence of sharps in waste may cause a real danger to people handling waste or to scavengers. Although if we compare this with Hamdan the percentage there is 40% which is not appropriate at all (Nabizadeh, 2012).

The percentage of treatment of infectious waste before disposal is only 40% which is a red light alarm. Practices of dentists in this field should be improved and monitored to ensure proper handling of dental waste inside clinic.

Table 4.8 Handling dental waste in clinic

Item -Handling waste in clinic	**Percentage**
Presence of disposal system for dental waste	74%
Presence of separation system for dental waste	54%
Presence of system for dental waste recycling	4%
Presence of system for amalgam recycling	19%
Presence of safety box	85%
Presence of filter for metals and other impurities	27%
Use of excess water when removing amalgam	93%
Treatment of infectious waste before disposal	40%
Separation of infectious waste (blood and others) from non-infectious waste	36%

Regarding the trends and practices of waste management the results are presented in Table 4.9. Unfortunately, our finding strongly shows that the majority of the

surveyed dental clinics were not following the basic principles of dental waste disposal. It is impressing that 11% are never willing to separate dental waste, 18% they are sometimes willing.

Why only 71% of dentists are willing to separate the dental waste, although they know its hazards. This is a question that needs to be addressed by socialists, dentists, psychologists, and any concerned sector in society. Again, in only 40% of cases there is a special location for dental waste inside clinic. This means that no attention is paid to where waste is discarded in clinic, and thus making health of patients (especially kids0 vulnerable to hazardous waste. The fact that (9%) of surveyed sample were disposing sharps into trash and do not use special containers for this purpose confirms our finding that dentists in general are not following the standard procedures required for reserving health and safety in regard to dental waste.

This management procedure is very important since a variety of bacterial, viral and fungal microbes are consider as major contaminates of such sharps. Thus carless disposal of such objected imposes high risk not only to dental team and patients, but also to the community in general.

Table 4.9 Trend and practice regarding dental waste in clinic

Trend and practice for dental waste	Always	Sometimes	Never
Willingness to separate dental waste in clinic	71%	18%	11%
Presence of specific locations for dental waste inside clinic	40%	15%	45%
Placing sharps (waste) inside special containers	83%	8%	9%
Containers and sacks used for collecting dental waste are in proper condition	66%	25%	9%
Checking vacuum pump filters	54%	35%	11%

Table 4.10 shows the disposal methods in of different dental waste components. It is noted that 19% of dentists dispose the filings residuals in drain, and 41% in trash and thus causing pollution to both grey water and soil.

Better management should be introduced for a friendly environment method of disposal of the fillings. Unfortunately, and even with the 32% who dispose the filling residuals into a special container, this waste ends in the domestic dumping site, as there is no special disposal method for these wastes. This percentage agrees previous survey done by Al- Khatib in Ramallah where the result was 39.4% in special container and 6.1% in drain and trash, and 54.5% in trash and 12.1% in drain (Al -Khatib, 2004).

9% of dentists were disposing sharps in trash, 56% were disposing sharps in special container, and 35% in plastic bottles. It is to address that 84% of surveyed dentists had needle stick injury during their work. 86% of dentists dispose the empty bottles of the sterilizing agent into trash with all chemical residuals

inside without any action to separate them from other wastes. There should be efforts to change the current situation to better practices.

Table 4.10. Disposal methods in of different dental waste components

Disposal of fillings residuals	**Drain**	**Trash**	**Special container**	**Drain and trash**
	19%	41%	32%	8%
Disposal of sharps	**Trash**	**Special container**	**Empty bottles**	
	9%	56%	35%	
Disposal of empty sterilizing agent	**Trash**		**Separated from other wastes**	
	86%		14%	

4.7 Amalgam filling

Table 4.11 shows the results of filling used- quantities and properties. All the dentists used amalgam fillings in varying proportions. About 82% of dentists themselves use amalgam in their mouth. The most common types of amalgam filling used in the dental clinics were capsules and composite. Out of 100 surveyed clinics (8%) were using compost filling and (65%) were using the capsule filling.

Table 4.11 Filling used- Quantities and properties

Type of filling used	Capsules	Composite	Capsules and composite
	65%	8%	27%
Weekly number amalgam filling-small size	<6	6-15	>15
	42%	34%	24%
Weekly number amalgam filling- moderate size	<6	6-15	>15
	41%	39%	20%

4.8 Miscellaneous

Table 4.12 shows the distribution of dental clinics according to the use of temperature in autoclaving.

Table 4.12: Temperature used in autoclave

Temperature used in the Autoclave	Percentage
$<134^{o}$ C	32%
$>134^{o}$ C	68%

4.9 Relationships between demographic and factors with dental waste management trends and practices

To figure out evidences of relationships among different dependent and independent variables, the chi- square test was conducted. If the value of P value was less than 0.05, this implies that there is a statistically significant relationship for this level. The results were as follows.

4.9.1 Significant relationships with age of dentist

Summary Table for factors affected by age are presented in the following Table s. In order to find effect of age, dentists were classified into two groups, the first who are less than 40 and the second who are more than 40. Table 4.13 illustrates relationship between age of dentist and trend of wearing mask during patient treatment. It is clear from the Table that there is a tendency for younger dentists to wear mask during treatment. As those who always wear masks is 79% for dentists less than 41 years, while this percentage become 58% for older dentists. So, awareness campaigns for this issue should concentrate on older dentists than younger ones.

Table 4.13 Relation between age and wearing masks during patient treatment

Age	**Always**	**mostly**	**sometimes**	**rarely**	**Total**
< 41	79%	15%	6%	0%	100%
≥ 41	58%	16%	24%	3%	100%
Total	**71%**	**15%**	**13%**	**1%**	**100%**
df = 3, P-value = 0.036					

The clinic is provided with a system for recycling dental waste

It is clear from Table 4.13 that the clinic is not provided with a system for recycling dental waste for younger dentists. As this percentage is 0% for dentists less than 41 years, while this percentage become 11% for older dentists. It seems

to be not of the priorities of a dentist to make like this system. And he may make it in the future if there was a chance to do it.

Table 4.14. Relationship between age and presence of system for recycling dental waste

Age	**Yes**	**No**	**Total**
< 41	0%	100%	100%
≥ 41	11%	89%	100%
Total	4%	96%	100%
df = 1, P-value = 0.009			

Relationship between type of sterilizing agent and age

It is clear from the Table 4.15 that there is a tendency for younger dentists to use both dry and wet sterilizing agent (39%), while the percentage is (21%) for older dentists. The tendency for using dry sterilization is high in older dentists (34%) compared to younger 10%. Again, awareness toward using the wet method should be concentrated on older dentists.

Table 4.15: Relationship between age and type of sterilizing agent

Age	**Dry**	**Wet**	**Dry and wet**	**Total**
< 41	10%	52%	39%	100%
≥ 41	34%	45%	21%	100%
Total	19%	49%	32%	100%
df = 2, P-value = 0.007				

Relationship between presence of Safety Box in clinic and age

From Table 4.16 that there is a tendency for younger dentists to acquire safety box (92%), while the percentage is (74%) for older dentists. Again, awareness should be targeted more toward older dentists.

Table 4.16: Relationship between age and presence of safety box in clinic

Age	**Yes**	**No**	**Total**
< 41	92%	8%	100%
≥ 41	74%	26%	100%
Total	85%	15%	100%
df = 6, P-value = 0.002			

Relationship between location of developing X-ray films and age

From Table 4.17 that there is a tendency for younger dentists to develop the films inside clinic (77%) compared to older dentists (42%). So, awareness regarding disposal of liquids used in films development should be targeted more toward younger dentists.

Table 4.17: Relationship between age and location of developing X-ray films

Age	**In clinic**	**Out of clinic**	**Total**
< 41	77%	23%	100%
≥41	42%	58%	100%
Total	65%	35%	100%
df = 1, P-value = 0.038			

Relationship generating radioactive wastes and age

It is clear from the Table 4.18 that there is a tendency for younger dentists to generate more radioactive wastes (15%) compared to older dentists (3%). For those who never produce radioactive wastes the percentage was 48% for younger dentists which is low compared with older dentists (84%). This trend may be due to dependency of younger dentists to make precise diagnosis before any treatment step.

Table 4.18: Relationship between age and whether there are radioactive wastes generated in the dental clinic

Age	**Always**	**Sometimes**	**Never**	**Total**
< 41	15%	37%	48%	100%
≥41	3%	13%	84%	100%
Total	10%	28%	62%	100%
df = 2, P-value = 0.001				

Relationship between presence for specific location for collecting waste inside the dental clinic and age

It is clear from Table 4.19 that there is a tendency for younger dentists to provide a specific location for collecting waste inside clinic (47%) compared to older dentists (29%). This implies that new generation of dentists have better practices compared to older ones. Awareness toward such practices should concentrate more on older dentists.

Table 4.19: Relationship between age and whether there is specific location for collecting waste

Age	Always	Sometimes	Never	Total
< 41	47%	18%	35%	100%
≥41	29%	11%	62%	100%
Total	40%	15%	45%	100%
df = 2, P-value = 0.05				

4.9.2 Significant relationships with graduation country of dentist

From Table 4.20 it is clear that dentists graduated from Arab countries are the least provided with a system for disposal of dental waste (60%) compared with dentists from Palestine or Previous Soviet Union (80%). The highest percentage was for dentists graduated from India, Pakistan, ..etc. (100%).

From the Table it is clear that dentists graduated from Arab countries are the least provided with a system for separating dental waste (28%) compared with dentists from Palestine (67%) or Previous Soviet Union (57%). The highest percentage was for dentists graduated from India and Pakistan (71%)which is the highest.

It is clear that dentists graduated from Palestine are not provided with a system for recycling amalgam (0%). The largest percentage is for dentists graduated from India and Pakistan (36%).

From Table 4.20 it is clear that dentists graduated from previous Soviet Union countries are the least provided with a safety box (68%) compared with dentists from Palestine (100%) which is the largest and other Arab countries (96%).

It is clear that dentists graduated from Arab countries are the most affected by diseases because of practicing dentistry (28%), compared with dentists from Palestine, India and Pakistan (0%) which is the largest.

These relationships are very important when designing awareness programs for dentists. For example clinics of dentists graduated from Arab countries are the least equipped with a system for disposal, a separation system of dental waste, or a system for recycling amalgam. So when edification this slice of dentists, more concern and efforts should be paid.

Table 4.20 Relationships with graduation country

Graduation country	**Palestine**	**Arab country**	**Previous Soviet Union**	**India, Pakistan, .etc.**
The clinic is provided with a system for disposal of dental waste	80%	60%	81%	100%
df = 3, P-value = 0.03				
The clinic is provided with a system for separating dental waste	67%	28%	57%	71%
df = 3, P-value = 0.023				
The clinic is provided with a system for recycling amalgam	0%	4%	30%	36%
df = 3, P-value = 0.005				
The clinic is provided with a safety box	100%	96%	68%	86%
df = 3, P-value = 0.023				
Having diseases because of practicing dentistry	0%	28%	5%	0%
df = 3, P-value = 0.005				

4.9.3 Significant relationships with gender of dentist

It is clear from Table 4.21 that female dentists attitude towards dental waste management inside clinic is better than those of male dentists. Presence of system for separating dental waste is 81% for female which is better than male (47%). The presence of a system for recycling dental waste is very low in both genders, although it is better for female (14%) compared with male (1%). For the safety box it is 100% for female compared with 81% for male. So more efforts for awareness should be directed towards male dentists.

Table 4.21 Relationships with gender

Gender	**Male**	**Female**
Presence of system for separating dental waste	47%	81%
df = 1, P-value = 0.005		
Presence of system for recycling dental waste	1%	14%
df = 1, P-value = 0.028		
There is a safety box in the clinic	81%	100%
df = 1, P-value = 0.021		

4.9.4 Significant relationships with residence of dentist

It is clear from Table 4.22 that best practices are for dentists who are residents of villages. For example, presence of system for separating dental waste is 77% in villages compared to 46% in city or 0% in camp. The percentage of getting disease because of practicing dentistry is the largest in camp (50%) while it is 0%

for residences of village. Regarding separation of infectious waste from other waste the worst practice comes from camp residences (0%) while village residences are the best (57%). Again edification and awareness should be directed more toward dentists residing in camps more than others.

Table 4.22: relationships with residence of dentist

Residence of dentist	**City**	**Camp**	**Village**
Presence of system for separating dental waste	46%	0%	77%
df = 2, P-value = 0.005			
Having diseases because of practicing dentistry	15%	50%	0%
df = 2, P-value = 0.021			
Separation of infectious wastes from others	28%	0%	57%
df = 2, P-value = 0.014			

4.9.5 Significant relationships with governorate (Salfit / Nablus)

Table 4.23 shows relationships with governorate. Presence of a system for disposal of dental waste in clinic is much better in Salfit (93%) compared to Nablus (70%). Presence of a system for separating dental waste in clinic is also much better in Salfit (73%) compared to Nablus (46%). Presence of a special filter for separating metals in clinic is also much better in Salfit (40%) compared to Nablus (21%). Again more efforts should be directed for edification of Nablus dentists than of Salfit dentists. It is clear from the Table that best practices are in Salfit.

Table 4.23: Relationships with governorate of dentist

Governorate	**Salfit**	**Nablus**
Presence of system for disposal of dental waste in clinic	93%	70%
df = 1, P-value = 0.011		
Presence of system for separating dental waste in clinic	73%	46%
df = 1, P-value = 0.011		
The clinic contain special filter for separating metals	40%	21%
df = 1, P-value = 0.049		

4.9.6 Significant relationships with years of experience

It is clear from Table 4.24 that best practices for wearing mask during patient treatment, presence of safety box in the clinic is for dentists with years of experience <11. The percentage is 92% while it is decreasing for dentists with higher experience until it reaches 0% for experience >30. It seems as the dentist gets older, he became carless about professional health issues.

On the other hand best practices for Presence of system for disposal of dental waste in clinic and Presence of system for recycling dental waste in clinic and Presence of system for recycling amalgam in the clinic is for dentists with larger years of experience (100%).

The presence of safety box is 0% for those with experience >30 years compared with 94% for dentists with less than 11 years experience..

Table 4.24: Relationships with years of experience of dentist

Years of experience	**<11**	**11-20**	**21-30**	**>30**
Wearing mask during patient treatment	92%	89%	57%	0%
df = 9, P-value = 0.005				
Presence of system for disposal of dental waste in clinic	79%	82%	29%	100%
df = 3, P-value = 0.015				
Presence of system for recycling dental waste in clinic	2%	2%	29%	0%
df = 3, P-value = 0.008				
Presence of system for recycling amalgam in the clinic	17%	11%	57%	100%
df = 3, P-value = 0.001				
Presence of safety box in the clinic	94%	80%	86%	0%
df = 3, P-value = 0.002				

4.10 Composition and rates of generated dental waste.

4.10.1 Separation and identification of waste components

The solid waste was collected from dental clinics. Then, the process of separating the waste into three main groups 'infectious waste, noninfectious waste and domestic waste' was carried out. Classification of the solid waste components into one of the three groups was according to Table 4.25.

Each component was weighed separately and its weight was recorded. Using these data, the average daily production of each group was calculated for both Salfit and Nablus governorate. It was also calculated on the basis of locality type whether it is urban, rural , or camp.

It is to note that infectious wastes constitute the largest percentage and contains parts that are contaminated with blood and other infectious oral fluids, sharps and amalgam. The infectious waste is classified as hazardous waste.

Table 4.25 Classification of dental solid waste.

infectious waste				**non-infectious waste**	**Domestic -type Waste**
Infectious metal		**Infectious non metal**	**Amalgam (powder)**		
sharp	**Non sharp**				
needles	ejectors	Paper	Amalgam	gypsum	Food waste
syringes		Plastic	Amalgam capsule	Lead shields	News paper
Bridges		Gloves/ rubber			
		cotton			Soil
Micro tools		Toilet paper			House hold products
		Extracted teeth			

Sometimes It is difficult to distinguish between infectious waste and non-infectious waste.

4.10.2 Total production of dental solid waste

Based on the results from the selected 20 private and public dental clinics, the average production rate of dental solid waste was 57.2 g/practice /day. The production rate was 67.2 g/practice /day in Salfit governorate and 44.7 g/practice/day in Nablus governorate. The production rate of 57.2 g/d/p differs a

lot from Xanthi in Greece where the rate was 513g/p/d (Kizary, 2005). That refers to different practices of dentist in this field and laundry habits to patients.

Dental solid waste was classified in three main categories: (1) Infectious and potentially infectious waste, accounting for 68.3% by weight. (2) Non-infectious waste, accounting for 4.8% byweight. (3) Domestic waste, accounting for 26.9% by weight. The results are presented in Table 4.26.

Table 4.26 Average waste in g/ p/ day according to district

Governorate		**Infectious waste**	**Non-infectious waste**	**Domestic**	**Total**
Total	g/practice /d	39.0	2.7	15.4	57.2
	%	68.3	4.8	26.9	100.0
Salfit	g/practice /d	44.2	2.1	20.9	67.2
	%	65.8	3.2	31.0	100.0
Nablus	g/practice /d	32.6	3.5	8.6	44.7
	%	73.0	7.9	19.2	100.0

Table 4.27 shows comparison between dental waste components according to governorate. It is no note that the percentages are close for both governorates. Although, the percentage of infectious waste is higher a little pit for Nablus (72.9%) compared to Salfit (65.8%).

Table 4.27: Category of waste percent by weight according to governorate.

category of waste	Nablus	Salfit	Total
Infectious	72.9%	65.8%	68.3%
Non- infectious	7.9%	3.2%	4.8%
Domestic	19.2%	31.0%	26.9%

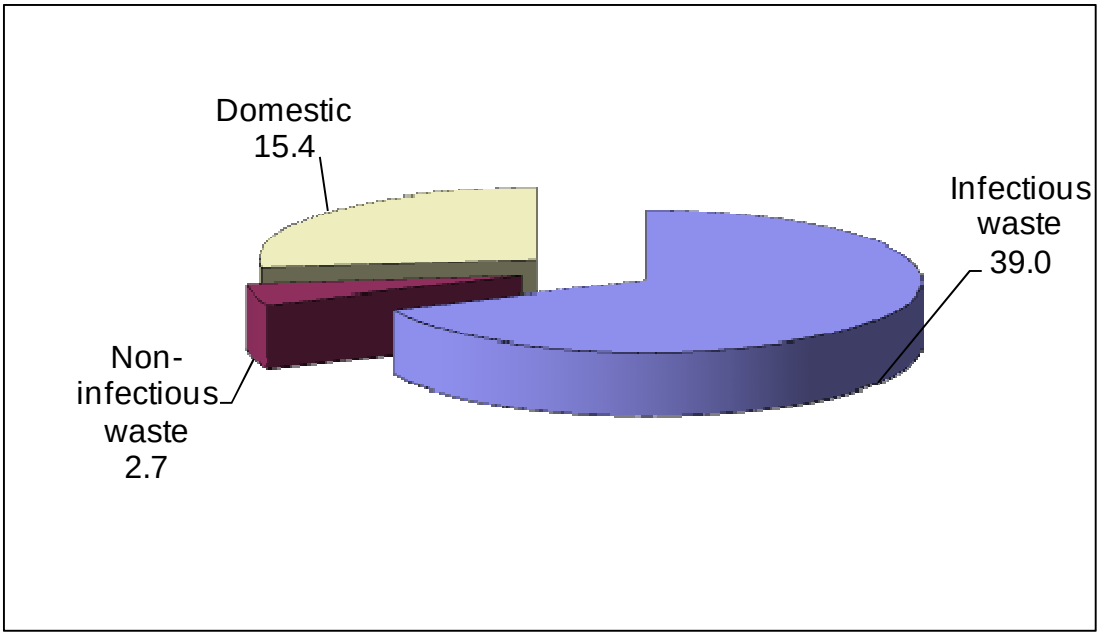

Figure 4.2 Production of dental solid waste - total (g/ patient/ day)

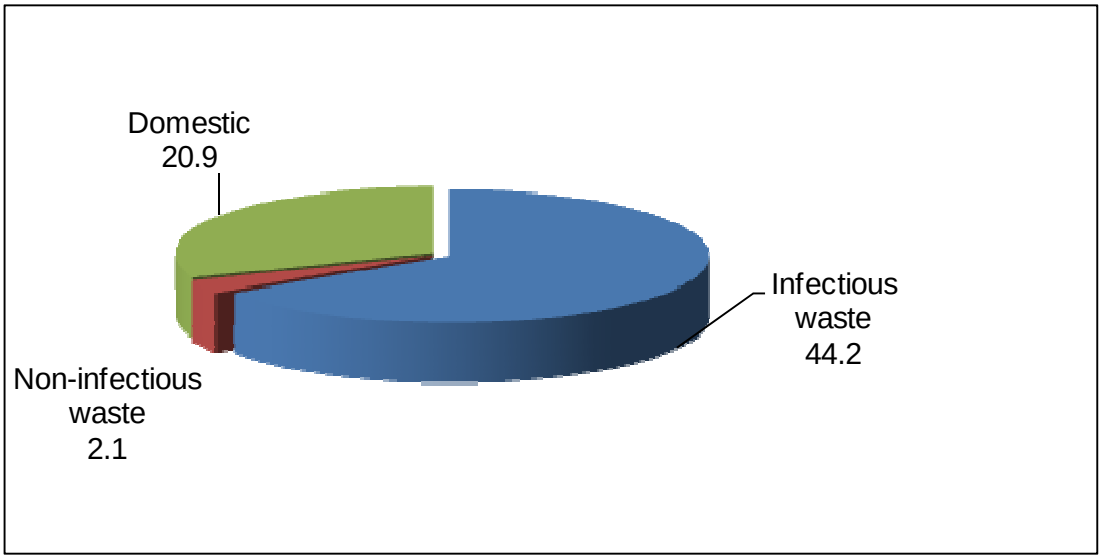

Fig 4.3 Production of dental solid waste - Salfit (g/ patient /day)

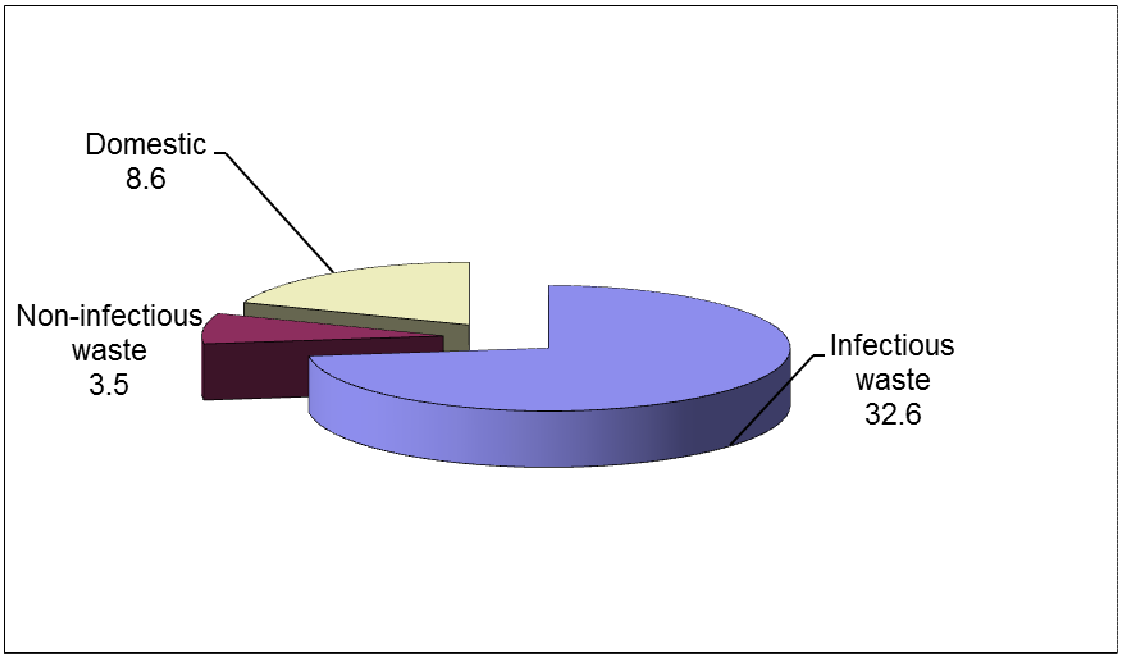

Fig 4.4 Production of dental solid waste - Nablus (g/ patient /day)

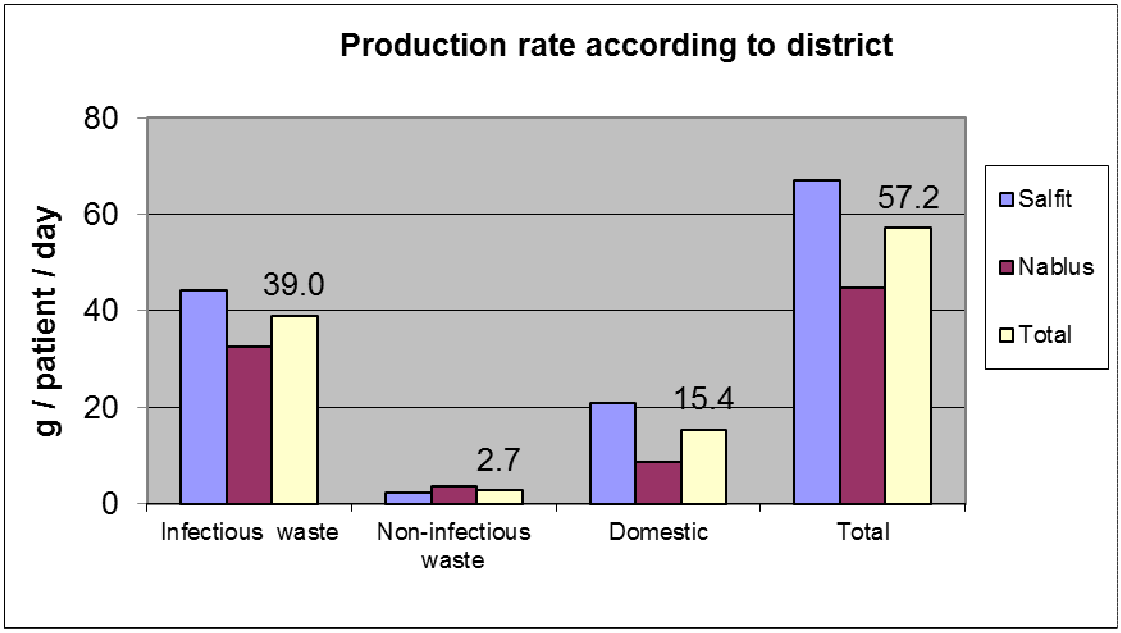

Fig4.5 Dental waste generation ration rate according to governorate (g/ patient/ day)

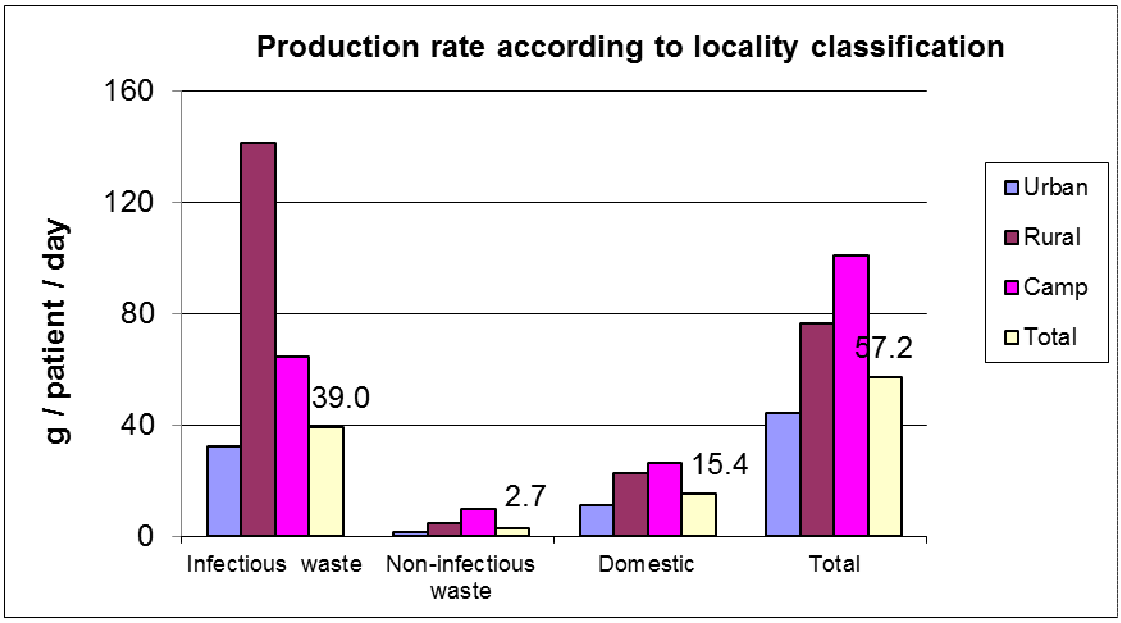

Fig4.6 Dental waste generation ration rate according to locality classification

Table 4.28: Average waste in g/ practice/ day according to locality classification

Classification		Infectious waste	Non-infectious waste	Domestic	Total
Total	g/practice /d	39.0	2.7	15.4	57.2
	%	68.3	4.8	26.9	100.0
Urban	g/practice /d	32.1	1.3	11.0	44.4
	%	72.2	2.9	24.8	100.0
Rural	g/practice /d	141.2	4.6	22.5	76.5
	%	184.6	6.1	29.4	100.0
Camp	g/practice /d	64.4	9.9	26.3	100.6
	%	64.0	9.8	26.2	100.0

4.10.3 Comparison of waste generation among the two governorates

Dental solid waste production from tow governorate is presented in Table 4.29. The total production from Salfit is (67.2 g/practice /day), which is more than Nablus (44.7 g/practice /day). It is noted that infectious waste from Nablus is less than Salfit (32.6 and 44.2 respectively) .

The large difference appears in domestic waste, Salfit governorate produce 20.9 g/practice /day, while Nablus governorate produces only 8.6 g/practice /day. This may be attributed to luxury treatment for dental patient. Also, may be attributed to increase in the number of patients / clinic that makes them spend more time waiting for their turn, and thus producing more domestic waste.

Comparing of dental waste between three groups, urban, rural, and camp is presented in Table 4.28. The average production of camp is the highest; it is around 100.6 g/ practice/ day. While in rural it is 76.5 g/ practice/ day. And the lowest is in urban about 44.4 g/ practice/ day. This clearly refers to the different behaviors between urban, rural, and the camp. The figures below shows that domestic production is the lowest in urban (11 g/practice/day), it is larger in rural (22.5) , while it is highest in the camp (26.3). This is a clear evidence of behavior differences among citizens living in different areas.

Again for the infectious waste it is the least in urban (32.1) and the largest is in rural areas (141.2).

4.10.4 Components of infectious dental waste

The infectious dental waste consists of several components as explained earlier. The different components are shown in Table 4.29. It is noted from Table 4.29 that sharp production is more in Nablus than Salfit (6.0g/p/ d compared to 4.5 g/ p /d). Amalgam production is higher in Salfit (0.4g/p/d compared to 0.2 g/p/d). Plastic and rubber are much more in Salfit (15.8 g/p/d compared to 7.6 g/p/d).The percentage of amalgam agrees with that obtained in Xanthi in Greece where 0.33% from total dental waste. This indicates that practices of dentists in this field be the same (Kizlary, 2005).

Table 4.29.Average infectious waste in g/ practice/ day according to district

Component of infectious waste	Total		Salfit		Nablus	
	g/p/d	% total dental	g/p/d	% total dental	g/p/d	% total dental
Sharps	5.1	9.0	4.5	6.7	6.0	13.4
Amalgam	0.3	0.5	0.4	0.5	0.2	0.5
Blood soaked dressings	16.9	29.5	18.3	27.3	15.1	33.8
Paper	4.4	7.7	5.1	7.5	3.6	8.0
Extracted teeth	0.1	0.2	0.1	0.2	0.2	0.4
Plastic and rubber	12.2	21.3	15.8	23.5	7.6	17.1
Total	39.0	68.3	44.2	65.8	32.6	73.0

4.10.5 Total production of dental waste clinics in The West bank of Palestine

From the measured values of dental waste, the mean value of dental waste produced from dental clinics in Nablus and Salfit governorates was estimated to be 25.6 gm/clinic /day. This value has been used in estimating the total generated dental waste in the West Bank governorates depending on the total number of dental clinics available in each governorate. The results are summarized in Table 4.30. It is noted that total production of dental waste in West Bank is about 31.11 kg/ day which is equivalent to 11.27 tons/ year. Also the table shows that the total production rate of the different components of dental wastes in the West Bank were infectious waste, non - infectious waste and domestic waste to be 8.5, 1.5, and 21.29 kg/day respectively .

(PCBS, 2014c).

Table 4.30 Estimated amount of dental solid waste produced in the West Bank.

governorate	No. of clinics	Total dental waste (kg/day)	Total dental waste (ton/year)	Infectious waste kg/day	Non-infectious dental waste (kg/day)	Domestic dental waste (kg/day)
Jenin	129	3.3	1.2	2.25	0.15	0.9
Tubas	17	0.44	0.16	0.3	0.02	0.2
Tolkarem	74	1.9	0.7	1.3	0.09	0.5
Nablus	149	3.8	1.4	2.60	0.18	1.03
Qalqelia	39	1,0	0,36	0.7	0.05	0.3
Salfit	32	0.8	0.3	0.6	0.04	0.2
Ramallah	194	5.0	1.8	3.4	0.23	1.3
Jericho	11	0.3	0.10	0.19	0.013	0.08
Al-Quds	164	4.2	1.5	2.9	0.2	1.2
Bethlehem	112	2.87	1.05	1.96	0.13	0.8
Hebron	291	7.5	2.7	5.09	0.35	2.0
Total	1212	31.11	11.27	8.5	1.5	21.29

according to the Palestinian Central Bureau of Statistics (PCBS) in the year 2012 (PCBS, 2014c).

Chapter Five

Conclusions and Recommendations

The current practices of dental waste management in Salfit and Nablus governorates contribute to the contamination of the Palestinian environment and endanger the public health. The majority of surveyed dentists were not aware of the risks they were exposed to and only few of them practiced infection control measures.

The study points to the lack of clear instructions, dentists trying to reduce the possibility of contamination as much as possible, stressing the need to take serious steps to address the dental waste management and not blame the conditions and capabilities, but also employ all possible efforts for the safety of human health and the environment.

The study also shows that coordination with governmental departments is ineffective; in addition to that they are not doing the required efforts to address environmental problems as required.

The following conclusions are related to the composition and generation rate of dental solid waste in the governorates of Salfit and Nablus governorates:

Dental solid waste consists of: (1) Infectious and potentially infectious waste, accounting for 68.3% by weight. (2) Non-infectious waste accounting for 4.8%. (3) Domestic-type waste accounting for 26.9 % by weight.

The infectious and potentially infectious waste consists of amalgam (0.5 % by weight), metals included in other components (9.0 % by weight), and components without metal (91.50%).

Sharps constitute 5.1% of infectious and potentially infectious waste. The main component in this category is needles and syringes.

The generation rate of dental solid waste was 57.2 g/ p/d. The production rate of infectious and potentially infectious waste was 39 g/practice/day. This figure includes the production rate of sharps (5.1g/practice/ day), plastic and rubber (12.2), and amalgam (0.3g/practice/day).

Thus, efforts are needed at the national level through the MoH in coordination with Dental Association, in order to reduce the negative impact of the current situation of dental waste management, and to improve infection control procedures and the occupational health of dentists, the following recommendation can be suggested:

1- Proper management of dental waste should be addressed. This can be done through using the three Rs (Reuse, Recycle, and reduction). Source separation should be carried out in the clinic. After that amalgam and lead shields are recycled and the remainder of the infectious waste is sterilized and disposed of in a sanitary landfill.

2- More attention should be paid towards the importance of occupational safety of dentists such as wearing of gloves and masks.

3- Dentists should attend refreshing courses and awareness campaigns on dental waste management.

4- Dental professionals must follow specific guidelines in order to reduce exposure to toxic mercury.

5-Dental care workers must be examined by occupational physicians regularly in order to prevent development of occupational disease.

6- The demographic factors should be taken into consideration when designing any awareness campaign or refreshing course. Age of dentist, years of experience, graduation country, gender of dentist, and residence location are all important factors that affect practices and attitudes of dentists.

7- Additional studies should be conducted to take into account the different seasons of the year, which could affect the type and the rate waste generated.

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Appendixes

بسم الله الرحمن الرحيم

حضرة الطبيب/ة...المحترم/ة.

تحية طيبة وبعد,,

يقوم الباحث بإجراء دراسة لمتطلب رسالة الماجستير (الاطروحة) في تخصص علوم المياه والبيئة من جامعة بيرزيت بعنوان:

(مكونات مخلفات عيادات الاسنان الصلبة, معدل انتاجها وادارتها في محافظتين فلسطينيتين)

composition, production rate and management of dental solid waste in two)

(Palestinian governorates

يرجى التكرم بتعبئة الاستمارة بكل دقة وموضوعية, حيث ستعتمد نتائج هذه الدراسة على رايكم السديد على اعتبار انكم الاكثر علما ودراية بأهمية دراسة هذا الموضوع والاكثر خبرة في الطرق الامثل في التعامل معها, ومن الجدير بالذكر ان هذه الدراسة لا تستخدم الا لأغراض البحث العلمي.

..... شاكرا لكم حسن تعاونكم.....

الباحث سمير القرم

Dentist questionnaire

	المعلومات العامة
رقم الإستبانة _____	V001 ☐
عمر الطبيب/ة _____	V002 ☐
بلد الدراسة والتخرج _____	V003 ☐
الجنس : 1 - ذكر 2- أنثى	V004 ☐
مكانة الإقامة الدائم : 1- مدينة 2- مخيم 3- قرية	V005 ☐
مكان العمل: 1- سلفيت 2 نابلس	V006 ☐
التحصيل العلمي : 1- بكالوريوس 2- ماجستير 3-دكتوراه	V007 ☐
إذا كان التحصيل العلمي اكثر من بكالوريوس، فما هو التخصص في الدراسات العليا؟ _____	V008 ☐
ما هو نوع العيادة التي تعمل فيها: 1- خاصة 2- حكومية 3- أهلية 4-(2+1) 5-(3+1) 6- (3+2) 7- غير ذلك حدد _____	V009 ☐
ما هي مدة خبرتك في العمل كطبيب أسنان _____ سنة	V010 ☐
هل العيادة مرخصة ؟ 1- نعم 2- لا	V011 ☐
ما هو معدل عدد ساعات عملك اليومي _____ ساعة	V012 ☐
ما هي مساحة العيادة؟ _____ متر مربع (م^2)	V013 ☐
عدد العاملين في العيادة. :_____	V014 ☐
هل توجد لديكم تعليمات مكتوبة حول كيفية التعامل مع المخلفات الطبية الناتجة ؟ 1-نعم 2- لا	V015 ☐
اذا كان الجواب نعم فمن مصدر هذه التعليمات؟ _____	V016 ☐
هل تستعمل الكمامات أثناء العمل مع المرضى؟	V018 ☐

1- دائماً 2- غالباً 3- أحياناً 4- نادراً 5- ابدا	
هل تعتقد ان هنالك مخاطر على الصحة الشخصية في جمع نفايات الاسنان ؟ 1- نعم يوجد 2-لا يوجد	V019 ☐
هل تعتقد وجود اضرار صحية لمادة الملغم على صحة الانسان؟ 1- نعم يوجد 2- لا يوجد	V020 ☐
هل تحتوي العيادة على برنامج للتخلص من نفايات الاسنان ؟ 1-نعم يوجد 2- لايوجد	V021 ☐
ما هو نظام التهوية المستخدم في العيادة ؟ 1-الشفاط 2- الشباك 3- 1+2 4- غير ذلك	V022 ☐
هل تحتوي العيادة على برنامج لفصل تفايات الاسنان ؟ 1- نعم يوجد 2- لا يوجد	☐ V023
هل تحتوي العيادة على برنامج لتدوير هذه النفايات 1-نعم يوجد 2- لا يوجد	V024 ☐
هل تحتوي العيادة علىSILVER RECOVERY UNIT ؟ 1- نعم يوجد 2- لا يوجد	V025 ☐
ما هو نوع المعقم المستخدم في العيادة؟ 1- جافا 2- رطبا 3- (1+2)	V026 ☐
هل تحتوي العيادة على برنامج تدوير الملغم 1- نعم يوجد 2- لا يوجد	027V ☐
هل تحتوي العيادة على SAFTY BOX 1-نعم يوجد 2- لا يوجد	☐ V028
ما هو نوع سوائل التعقيم المستعملة في العيادة؟ 1 - glutaraldehyde 2- Alcohol 70%	V029 ☐

3- Detergents 4- Clorohexidine 5- غير ذلك حدد _____	
هل يوجد جهاز أشعة في العيادة؟ 1- نعم 2- لا	V030 ☐
إذا كان الجواب نعم فأين تقوم بتحميض أفلام الأشعة؟ 1- في العيادة 2- في مركز للأشعة خارج العيادة.	V031 ☐
كيف تتخلص من سائل تحميض الأفلام؟الرجاء التفصيل. _____ _____	V032 ☐
تنتج العيادة مخلفات اسنان معدية ا- دائما ب- احيانا ج-لا يوجد	V033 ☐
تنتج العيادة مخلفات طبية حادة (ابر,حقن,مشارط..... ا- دائما ب- احيانا ج-لا يوجد	V034 ☐
هل عيادة الأسنان مزودة بفلتر خاص بتصفية الشوائب والمعادن المستعملة في عيادة الأسنان وغيرها ؟ 1- نعم 2- لا	V035 ☐
اتتفقد جهاز فلتره كرسي الأسنان Vacuum pump filters ؟ 1- يومياً 2- أسبوعياً 3- شهرياً 4- سنوياً 5- لا اتفقدها ابدا 6- غير ذلك حدد _____	V036 ☐
هل تعرف أن مواد تحميض أفلام الأشعة تحتوي على مادة Chromium؟ 1- نعم 2 - لا	V037 ☐
تنتج العيادة مخلفات صيدلانية (ادوية منتهية الصلاحية,مواد كيماوية تستخدم في العلاج) 1-دائما 2- احيانا 3- لا يوجد	V038 ☐

__تنتج العيادة مخلفات باثولوجية (انسجة..بقايا بشرية..) 1-دائما 2-احيانا 3- لا يوجد	V039 ☐
تنتج العيادة مخلفات طبية سائلة (الدم,سوائل اللعاب..... 1- دائما 2- احيانا 3- لا يوجد	V040 ☐
تنتج العيادة مخلفات تحتوي على معادن ثقيلةمثل(الزئبق, حشوة الاسنان,.....) 1-دائما 2-احيانا 3-لا يوجد	V041 ☐
هل تنتج العيادة مخلفات مواد مشعة (صور اشعة,..) 1- دائما 2- احيانا 3- لايوجد	V042 ☐
هل لديك الاستعداد لتطبيق عمليات الفصل والجمع داخل العيادة بشكل صحي وامن؟ 1- دائما 2- احيانا 3- لا يوجد	V043 ☐
هل يوجد مواقع متخصصة للتخلص من النفايات الطبية في عيادتكم ؟ 1- دائما 2- احيانا 3- لا يوجد	V044 ☐
هل توضع المخلفات الطبية الحادة كالابر والمشارط وغيرها في حاويات خاصة في عيادتكم ا- دائما ب- احيانا ج- لا يوجد	V045 ☐
ما هي اقتراحاتكم لتحسين وضع ادارة نفايات الاسنان في عيادتكم؟ _____	V046 ☐
حاويات واكياس الجمع للمخلفات الطبية في عيادتكم ضمن مواصفات صحية وبيئية ملائمة ا- دائما ب- احيانا ج-لايوجد	V047 ☐
على أية درجة حرارة تستعمل المعقم؟ _____ درجة مئوية	V048 ☐
هل سبق وأخذت طعمHBV؟ 1- نعم 2- لا	V049 ☐
هل سبق وأصبت بوخزة أو بجرح بسبب الأدوات الحادة أثناء معالجة المرضى ؟ 1- نعم 2- لا	V050 ☐

هل عندك أمراض أو أعراض مرضية أصبت بها – حسب رأيك – لها علاقة بممارستك لمهنة طب الأسنان؟ 1- نعم 2- لا	V051 ☐
إذا كان الجواب نعم، فما هي بالتفصيل؟ _____ _____ _____	V052 ☐
هل أصبت بمرض التهاب الكبد الفيروسي نتيجة لجرحك أو وخزك بالإبر أثناء التعامل مع المرضى؟ 1 - نعم 2- لا	V053 ☐
ما هو نوع الحشوات التي تستخدمها؟ 1- كبسولات 2- الخليط 3-كلاهما	V054 ☐
ما هو تعريف النفايات الطبية حسب وجهة نظرك؟ _____ _____ _____	V055 ☐
ما هو معدل عدد حشوات الأملغم المستخدمة في العيادة أسبوعياً من الحجم الصغير؟ _____	V056 ☐
ما هو معدل عدد حشوات الأملغم المستخدمة في العيادة أسبوعياً من الحجم المتوسط؟ _____	V057 ☐
كيف تتخلص من بقايا الحشوات الزائدة؟ 1- لمجاري العامة من خلال المغسلة 2- سلة المهملات (القمامة) 3- في حاويات خاصة (علب أو غيرها)	V058 ☐
هل يوجد حشوات الأملغم في فمك ؟ 1- نعم 2- لا ☐	V059 ☐

إذا كان الجواب نعم، فكم عددها؟_____	V060 ☐
عند إزالة حشوات الأملغم هل تستعمل / تشغيل رشاش الماء البارد بكميات وافرة ؟ 1- نعم 2 – لا	V061 ☐
هل زاركأحد (فريق) وناقش معك موضوع طرق التخلص من النفايات في عيادة الأسنان ؟ 1- نعم 2- لا	V062 ☐
إذا كان الجواب نعم، فإلى أية مؤسسة يتبع هذا الشخص (الفريق) _____	V063 ☐
هل زارك أحد وناقش معك موضوع السلامة المهنية لطبيب الأسنان؟ 1- نعم 2- لا	V064 ☐
إذا كان الجواب نعم، فإلى أية مؤسسة يتبع هذا الشخص (الفريق) _____	V065 ☐
هل تتفحص تاريخ الإنتاج والانتهاء للمواد المستعملة في عيادة الأسنان ؟ 1- نعم دائماً 2- غالباً 3- أحياناً 4- نادراً 5- لا	V066 ☐
هل يتم معالجة النفايات الطبية المعدية في العيادة قبل التخلص منها؟ 1- نعم 2- لا	V067 ☐
كيف تتخلص من الأدوات الحادة المستعملة (Sharps) والإبر وغيرها ؟ 1- سلة المهملات 2- عبوات خاصة 3- علب المشروبات البلاستيكية الفارغة (علب الكولا مثلا) 4- غير ذلك حدد _____	V068 ☐
هل تقوم بفصل النفايات الطبية الملوثة بالدم وغيره عن النفايات العادية غير الملوثة؟ 1- نعم 2 - لا	V069 ☐
كيف تتخلص من عبوات سوائل التعقيم الفارغة؟ _____	V070 ☐

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هل لديك فكرة عن كيفية التخلص النهائي من النفايات الطبية الصلبة الناتجة عن عيادة الأسنان؟1- قسم خاص للتخلص من النفايات الطبية الصلبة 2- المحرقة 3- مع النفايات العادية 4- غير ذلك حدد	V071 ☐
ما هي اقتراحاتكم لتحسين وضع ادارة النفايات الناتجة من عيادة طبيب الاسنان ؟ _____ _____	V072 ☐
ما هي اقتراحاتكم لتحسين وضع السلامة المهنية للعاملين في العيادة فيما يختص بالنفايات الطبية ؟ _____ _____	V073 ☐

الملخص

هدفت هذه الدراسة الى التعرف على واقع اطباء الاسنان في محافظتي سلفيت ونابلس من حيث تـــدابير التخلص من النفايات الطبية والمخاطر المهنية الناتجة عن ممارسة مهنة طب الاسنان وكـــذالك تحليـــل مكونات هذه النفايات والنسب الوزنية لها.تكونت طريقة الدراسة من جزئين الجزء الاول عـــن طريـــق توزيع استبيانات على عينة الدراسة والتي كانت 30 طبيب في محافظة سلفيت و 70 طبيب في محافظة نابلس بهدف جمع المعلومات ومن ثم تحليل هذه المعلومات باستخدام الرزمة الاحصائية (SPSS).

والجزء الثاني بجمع عينات من مخلفات عيادات الاسنان و البالغ عددها 10 عينـــات مـــن كـــل مـــن محافظتي سلفيت ونابلس حيث يتم تصنيف المخلفات الى اصناف متعددة ويتم توزين كل صـــنف علـــى حدة ومعرفة نسبته الوزنية.

فيما يتعلق بطرق التخلص من النفايات الطبية بينت هذه الدراسة ان غالبية الاطباء من عينـــة الدراســـة تعمل على التخلص من نفاياتها عن طريق سلة المهملات.

وبينت الدراسة كذالك ان (71%) من اطباء الاسنان يستعملون دائما القفازات خلال ممارستهم لعملهم. وان (100%) طعمو ضد التهاب الكبد الوبائي نوع ب. كما بينت الدراسة ان (45%) مـــن اطبـــاء الاسنان يشكون من التوتر و (29%) يشكون من الصداع. وهذان العرضان هما من اهـــم المشـــاكل الصحية لدى اطباء الاسنان.

اما فيما يتعلق بوسائل التعقيم المتبعة فقد تبين ان ما نسبته (19%) منهم يستعملون جهـــاز التعقـــيم الحراري والجاف وان (49%) يستعملون التعقيم الرطب.

مثل هذه الممارسات لدليل واضح على المعرفة المحدودة او الاهمال في اتباع المعايير السليمة والمتبعة في هذا المجال .

واخيرا فقد تبين ان طرق التخلص من النفايات الطبية السنية وطرق التعقيم والاجراءات الوقائية وغيرها من السلامة المهنية والصحية المتبعة في معظم عيادات الاسنان في محافظة سلفيت و نابلس لم تكن بالقدر الكافي والفعال ، لذالك لا بد من التدخل السريع من قبل الجهات المعنية بهدف زيادة الوعي الصحي والسلامة المهنية في عيادات طب الاسنان.

تم بحمد الله