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Dental solid and hazardous waste management and safety practices in developing countries: Nablus district, Palestine

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This study investigated the dental waste management practices and safety measures implemented by dentists in the Nablus district, Palestine. A comprehensive survey was conducted for 97 of the 134 dental clinics to assess the current situation. Focus was placed on hazardous waste produced by clinics and the handling, storage, treatment and disposal measures taken. Mercury, found in dental amalgam, is one of the most problematic hazardous waste. The findings revealed that there is no proper separation of dental waste by classification as demanded by the World Health Organization. Furthermore, medical waste is often mixed with general waste during production, collection and disposal. The final disposal of waste ends up in open dumping sites sometimes close to communities where the waste is burned. Correct management and safety procedures that could be effectively implemented in developing countries were examined. It was concluded that cooperation between dental associations, government-related ministries and authorities needs to be established, to enhance dental waste management and provide training and capacity building programs for all professionals in the medical waste management field.

Keywords: dental waste, developing countries, hazardous waste, infection control, safety, waste management

Introduction

Rising public concern has drawn attention to the lack of proper waste management of medical waste in developing countries worldwide (Shinee *et al.* 2008). Although dental clinics generate relatively small quantities of solid waste compared to other medical facilities, the incorrect disposal of these wastes that place human health and the environment at risk cannot be ignored. Proper waste management practices and enforcement of safety measures are therefore necessary (Darwish & Al-Khatib 2006).

Dental solid waste consists of both hazardous and non-hazardous waste, categorized according to whether the waste does or does not contain any substance that poses a hazard to human/animal health or to the environment. Non-hazardous waste comprises mainly office solid waste. Hazardous waste includes X-ray fixers and film, chemical disinfectants, sharps such as needles, blood-soaked dressings, mercury, silver, lead, various solvents and other chemicals. Waste paper, plastic, latex and glass, much of which is contaminated with body fluids, comprise a large quantity of dental waste (Svenson *et al.* 1996, Treasure & Treasure 1997). A significant increase in the quantity of dental solid waste generated has been noted due to the increased use of plastic barriers, gloves and masks, believed to compromise about 90% of the solid waste (Farmer *et al.* 1997). This is due to increased

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safety measures implemented as well as the replacement of reusable items with disposable ones (Treasure & Treasure 1997). Other hazardous waste produced in minor quantities includes fluorescent lamps, unused chemicals, drugs and highly flammable cleaners for developer systems that may contain chromium, vapour sterilizer chemicals and formaldehydes (Arenholt-Bindslev 1998). Mercury from dental amalgam is considered the most problematic waste due to its toxic potential (Al-Khatib & Darwish 2004). Mercury can enter the environment as solid waste by the disposal of extracted teeth as well as through the wastewater collection system by the disposal of amalgam particles during dental operations (Arenholt-Bindslev 1998, Chin *et al.* 2000).

Generally, management of dental waste in most developing countries lacks proper health and safety requirements (Henry *et al.* 2006, Al-Khatib *et al.* 2007, Abdulla *et al.* 2008, Shinee *et al.* 2008). Furthermore, there is a lack of organization and planning in waste management due to insufficient information about regulations and financial restrictions (Vesilind *et al.* 2002, Tiynmaz & Demir 2006). Consequently, generated dental waste has the potential to be discharged into the wastewater system and the majority of dental solid waste is dumped into household disposal sites and landfills without any recycling or separation processes. This practice creates a potential risk to human health and the environment (Farmer *et al.* 1997). In many areas of Palestine, the current practice is to dispose of dental waste along with other healthcare waste as part of the solid waste management system which is collected and dumped in uncontrolled landfills (Al-Khatib *et al.* 2007).

Most regulations categorize solid waste originating from medical clinics into several sub-groups including household-type waste, infectious waste, sharps, radioactive waste, non-hazardous chemical waste and hazardous chemical waste. Dental waste is often regulated under medical waste regulations (Palestinian Ministry of Environmental Affairs 2000, LaGrega *et al.* 2001). The main basis for dental waste management in the European Union is the Waste Framework Directive that requires Member States to take necessary measures to ensure waste is disposed of without endangering human health or the environment. Directive 91/689/EEC addresses hazardous waste and by Decision 2000/532/EC a list of wastes was adopted, which includes dental amalgam waste.

By following the environmental regulations that deal with different types of dental waste, the hazardous effects of such waste can certainly be reduced or even eliminated. Previous studies regarding dental waste in developing countries are limited, regarding the safety of dentists and precautions taken while handling dental waste. Investigating the occupational health and safety of dentists is critical in developing an effective waste management scheme. This study aims to identify the dental solid waste management practices and their effects on the safety of dentists in the Nablus district in Palestine.

Methodology

The methodology for this study was based on collected data and information from a statistically significant number of dental clinics in the Nablus district through a questionnaire. The questionnaire was specifically designed for this study to obtain information about procedures used for the disposal of waste from dental practices and safety measures adopted by dentists. It covered socio-economic characters of the dentists in addition to questions about their waste handling attitudes and practices. The questionnaire was reviewed and pilot-tested by three experts from Palestinian universities.

The questionnaire was split into three sections. The first section focused on obtaining socioeconomic data, for example, type of clinic, average working hours, gender and degrees obtained. The second section examined the types of wastes generated on a daily basis and addressed the handling and disposal of the processing solutions from X-ray units, sharps and blood-soaked dressings. Focus was placed on the presence of puncture-resistant containers in the clinics and the personnel in charge of their collection from the clinic. Other information included an estimation of the average number of simple tooth extractions performed per week and the average number of minor oral surgeries performed per month. The third section of the questionnaire focused on occupational health and safety issues such as preventive measures and infection control practices, for example, wearing gloves, masks and eye protection, vaccination against hepatitis B virus, methods and types of sterilization, use of disinfectants and the occupational hazards dentists are exposed to. Furthermore, symptoms of adverse health effects among dentists were examined.

This study was carried out in the Nablus district, located in the northern part of the West Bank, Palestinian Territories. The population of the Nablus district is projected at 319 948 (PCBS 1999). The study population consisted of 134 dental clinics spread between institutional and private sectors in the district (Palestinian Dental Association 2003). The sample size was 97 dental clinics (where each clinic has only one dentist). A simple random sampling procedure was utilized in the selection of the study sample. The questionnaire was completed in each dental clinic during a structured interview process over a period of two months, May and June. Site visits and field observations were particularly helpful in obtaining information and observing common practices with regards to the management of the dental waste.

The collected data was checked for consistency and completeness and then coded in a database for further analysis. Analysis of data was performed by the use of Statistical Package for Social Sciences (SPSS) computer program version 11.0. Descriptive statistics such as frequencies and means were utilized. The major results are presented in this paper.

Results and discussion

Site visits and field observations conducted alongside the questionnaires completely agreed with the results of the questionnaires for all the dental clinics. The response rate was 100%, with all dental clinics being very cooperative with the survey team.

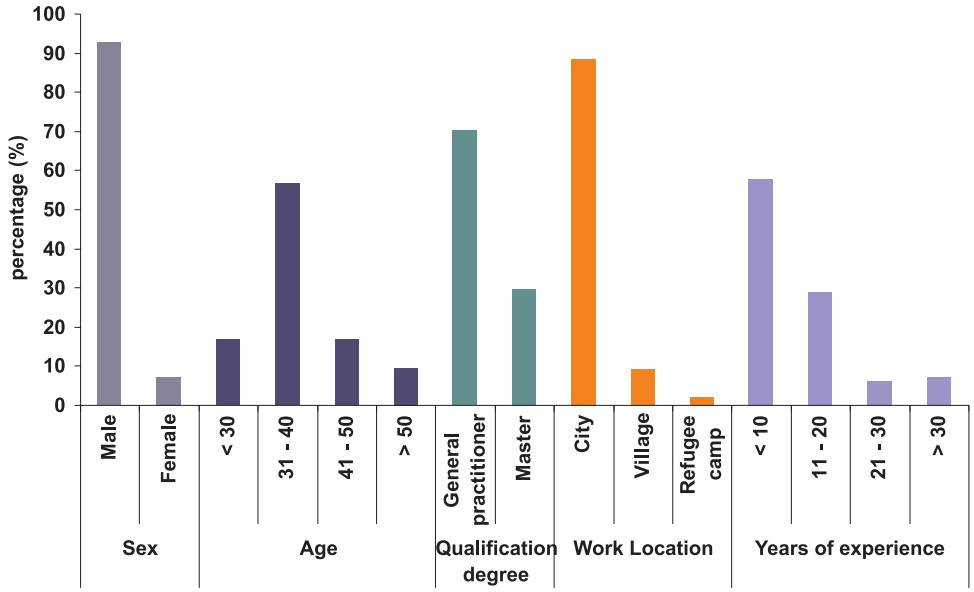

Fig. 1: Socio-demographic and work experience of dentists in dental clinics in Nablus district.

Sample distribution

Figure 1 shows the surveyed sample distribution based on sex, age, qualification degree, work location and years of experience. It was found that the majority of the respondents were male (92.8%), aged between 31 to 40 years (56.8%) and held a general practitioner in dentistry degree (70.1%). Furthermore, most of the respondents were located in the city (88.6%) and had experience less than 11 years (57.7%). Low percentages were noted for dentists working in refugee camps (2.1%), aged above 50 (9.5%) and who had more than 30 years of experience (7.2%).

Dental waste handling and treatment

This section examines the handling and disposal of dental waste, with focus placed on hazardous waste (mercury, lead, processing solutions from X-ray units, sharps and blood-soaked dressings). Table 1 shows the disposal routes used by dentists to dispose of the hazardous waste.

Dental amalgam

Two main types of dental restoration practices are used in Palestine: dental composite (otherwise known as white fillings), a blend of glass or ceramic particles dispersed in a photo-polymerizable synthetic organic resin matrix, and dental amalgam, consisting of approximately 1:1 mixture of metallic mercury and a powdered alloy consisting of silver, tin, copper, zinc in addition to other metals (Scarmoutzos & Boyd 2003). It is therefore due to the high concentration of mercury that this latter waste is classified as hazardous. However, the use of elemental mercury in amalgam instead of the safer encapsulated amalgam is often preferred as it is less expensive, even although accidental spills can put the dental personnel at risk

Table 1: Disposal routes used by dentists for hazardous waste.

Waste	Disposal route (%)				
Extra newly placed amalgam	Thrown in trash		Down the drain	Separate bottle	
	65.6%		23.6%	10.8%	
Old amalgam	Down drain, passing through coarse filter	Caught in filter, then thrown in trash	Filter, drain and trash used	Caught in vacuum filter	Thrown in trash
	17.3%	21.6%	52.2%	4.4%	4.5%
Sharps	In puncture-resistant containers (special containers)		Thrown in trash	In separate plastic bottles	
	61.9%		29.9%	8.2%	
Used processing solution for X-ray unit	Down the drain				
	100%				
Lead foil shielding X-ray film	Thrown in trash				
	100%				
Blood-soaked dressings*	Thrown in trash				
	100%				

*Including gauze, cotton and extracted teeth

of mercury toxicity. In fact, many patients seem to prefer this filling to any other different kinds of dental restoration as it is not costly. These results may be directly attributed to the bad economic situation in Palestine (Al-Khatib & Darwish 2004). This is reflected in the results of the survey that the majority of dentists (57%) use amalgam, while only 27% use composite and 16% use both these types of restorations.

In the European Union, a recent report by the European Commission (2008) listed the types of amalgam used with varying metal concentrations:

- conventional dental amalgam alloys contain 67–74% silver, 25–28% tin and up to 6% copper, 2% zinc and 3% mercury;
- dispersion type amalgam alloys contain 70% silver, 16% tin and 13% copper; and
- high-copper content amalgam alloys contain up to 30% copper (copper amalgams, containing approximately 30% copper and 70% mercury, are no longer recommended).

It is noted that some of the dental amalgam alloys currently in use only contain a small quantity of mercury necessary to facilitate the amalgamation reaction, as opposed to the amalgam used in Palestine which typically contains approximately 50% mercury.

In Palestine, the average number of newly placed amalgam fillings per week was 19 and 18 for small- and medium-sized clinics, respectively. The average number of removed old amalgam fillings per week per clinic was 4. Assuming that each unit of amalgam filling releases 0.55 g of mercury, this number of fillings would produce approximately 30 g of mercury from amalgam waste per week per clinic (this calculation is based on that provided by the United States Environmental Protection Agency 1997). Multiplying this quantity by the total number of practicing dentists throughout 48 working weeks per year gives a clear picture of the large quantities of mercury that could be released into the environment. The large majority of dentists revealing their incorrect disposal methods of newly placed and old removed amalgam fillings in the Nablus district further highlights the potential threat caused by mercury pollution; 65.6% of the dentists dispose of newly placed amalgam in the trash whilst 23.6% flush it down the drain. 17.3% of dentists flush old removed amalgam down the drain through a coarse filter, 21.6% catch in the filter and then throw it in the trash, 52.2% distribute between the filter, drain and trash, 4.5% throw it in the trash while only 4.4% catch it in a vacuum filter.

Research work has shown that improper disposal of mercury waste may be detrimental to the environment and public health. A variety of health problems linked to mercury intoxication range from joint pain to multiple sclerosis. Various symptoms include tremor, loss of memory, insomnia, irritability, slowed nerve conduction, psychological distress and gingivitis (Extrand *et al*. 1998, Factor-Litvak *et al.* 2003, Hörsted-Bindslev 2004, Atesagaoglu *et al*. 2006). A study conducted in Seattle found that approximately 14% of the mercury loading in the metropolitan sewerage system originated from dental offices (Municipality of Metropolitan Seattle 1991). Most dentists and their assistants are exposed daily to mercury, in particular, elemental vapour (Brownawell *et al.* 2005). Mercury toxicity depends on its chemical speciation. Under anaerobic conditions, metallic mercury is converted to methyl mercury, which is bio-accumulated and bio-augmented through the food chain. When dental waste containing amalgam is incinerated, a significant amount of mercury is released into the atmosphere (US EPA 1997). Correct disposal methods for mercury escaping with amalgam particles to the wastewater are capturing on screens or in traps (Arenholt-Bindslev 1998, Chin *et al.* 2000). The amalgam waste should remain in a properly labelled sealed container that is appropriate for storing contaminated amalgam waste and should be sent for the contents to be recycled, mainly mercury and silver (Al-Qaroot 2001, Palenik 2003). Used and empty amalgam capsules may be disposed of as solid waste since they are non-hazardous.

X-ray unit

Approximately half of the dental clinics surveyed had X-ray units. All these clinics used a single processing solution for the X-ray unit that was disposed of down the drain. However, no data on the composition or concentration of the used solution was provided on the packaging bottle. Generally, disposal of hazardous waste via the drain is not advisable for clinics connected to a septic system, as is the situation in Nablus city, as this could potentially lead to groundwater contamination.

User fixer from X-ray processing is defined as a hazardous waste as it contains high concentrations of silver (3000–8000 ppm). Therefore, discarding of used fixer down the drain or into the garbage, as is done by dentists in the Nablus district, poses a serious threat to the environment and human health. This should be collected in a clearly marked container and should subsequently be recycled or treated as hazardous waste. The WHO recommendations require a silver recovery unit to be installed at the end of the X-ray processing unit (Prüss *et al.* 1999). The recovered silver can then be sold to a metal reclaimer and the treated fixer can be disposed of down a drain. As most dental clinics in Palestine and many developing countries produce small amounts of waste individually, the silver recovery unit designed to these standards is needed rather than the more commonly designed units that handle larger and continuous quantities of waste. Dentists should then follow the proper equipment operating and maintenance procedures to ensure the amount of silver remaining in the wastewater is at levels that meet current Palestinian hazardous waste regulations before disposing down the drain. Furthermore, lead foil, used to shield the X-ray film, should be dealt with as hazardous waste and not disposed of with the regular waste as is the current practice (MnTAP 1995). Lead aprons, used on patients during X-ray filming, contain lead which is hazardous. Therefore, lead

aprons should be reused and returned to the manufacturer once the useful life is over. Currently, these solutions are not yet available locally in Palestine which leads to incorrect disposal procedures.

Sharps

Sharps such as needles, syringes, broken glass, used ampoules, extracted teeth and dental tools comprise a subgroup of infectious waste and require special handling. They may cause injury and transmit diseases, especially to waste collection, treatment and disposal personnel (Farmer *et al.* 1997, Prüss *et al.* 1999, Ozbek & Sanin 2004). Viral diseases such as hepatitis B, Acquired Immunodeficiency Syndrome (AIDS), herpes simplex and cytomegalovirus are important risks (Qudeimat *et al.* 2006). These wastes must be segregated at the point of origin and packaged in a rigid, leak-proof, puncture-resistant container and the container must be specially labelled (Treasure & Treasure 1997, Punchanawat *et al.* 1998). Proper handling of sharps is essential because personal protective barriers, such as gloves, will not prevent all needle stick accidents. To minimize the potential for exposures, needles should not be recapped, bent or broken by hand.

Used sharps such as needles, slides, cover slips and scalpel blades that are potentially infectious are addressed in the medical waste control regulations (Ministry of Environmental Affairs 2000). In the present study, a high proportion of dentists used puncture-resistant containers (62%); however, 30% of dentists disposed of sharps in the garbage and 8% placed needles in separate plastic bottles. Studies conducted in Riyadh found 72% of dental clinics in primary health care centres had containers for disposable needles and sharp instruments (Kurdy & Fontaine 1997) and 56% of dentists had special containers for sharp objects (Al-Rabeah & Mohamed 2002).

Blood-soaked dressings

In the Nablus district, all the dental clinics surveyed disposed of blood-soaked dressings, including gauze, cotton and extracted teeth, in the trash with the regular waste. Swabs or dressings that are contaminated with blood or other body fluids are regulated by infectious waste rules (Treasure & Treasure 1997, Punchanawat *et al.* 1998). These should be placed in sealed, sturdy impervious bags to prevent leakage of the contained items (CDC 2007).

Non-hazardous waste

Non-hazardous dental solid waste comprises mainly office solid waste and waste that originates from clinics that do not contain any substance that would pose a hazard to human/animal health or to the environment. Typical components of waste are paper, cardboard, plastics, wood, food waste, glass and metal (Tchobanoglous *et al.* 1993). These types of waste can be recycled or put into the trash and disposed of as regular non-hazardous waste (Ozbek & Sanin 2004). No recycling or recycling collection takes place as there are currently no such units available in Palestine.

Waste disposal

Following the collection of the solid dental waste from dental clinics, most of them are disposed of in nearby containers alongside domestic solid waste. Transportation then also becomes an issue as no extra safety measures are taken in view of the mixed hazardous and non-hazardous waste. These wastes eventually end up in open unsanitary dumping sites. The villages within the Nablus district dispose of the solid waste randomly; some may dispose of it in the Nablus Municipality open dumping site while others in haphazard locations. Open air burning of the waste, as is common practice, normally causes smoke nuisance. The waste also gives rise to an offensive smell, littering and pollution potential (Abu Zahra 2006). Another issue requiring attention is scavengers collecting metals from public containers in roads where dental waste is usually disposed. This exposes the scavengers to the risk from sharps, mercury and other hazardous waste. Unfortunately, all these practices are seen in the whole country as well as in many other developing countries.

A central treatment plant for all medical waste in the Nablus district would be beneficial for all healthcare facilities. In order to limit the number of collection sites, hospitals could extend their facilities to storing waste onsite for neighbouring dental clinics and other health care centres. Transportation can then be organized to deal with the collection of only hazardous waste; transportation risk, daily carrying load and collection cost are considered decision criteria in solving routing and scheduling problems of hazardous waste materials (Shih & Lin 2003). In this way, considerable money could be saved in the current difficult economic situation in Palestine and potential health risks could be significantly reduced. It is worth mentioning that a newly established sanitary landfill, Zahret Al-Finjan in the Jenin district (near the Nablus district), is now in operation. This sanitary landfill includes a specified area for all types of medical waste. Therefore, medical waste, including dental waste, may be collected from Nablus district according to the procedure described and safely disposed of at the Zahret Al-Finjan sanitary landfill.

Safety measures and infection control procedures

Due to the high risk of disease transmission while treating patients, it is essential that infection control becomes an integral part of the dentistry practice in developing countries. However, protective and infection control measures are still below the recommended level set by the World Health Organization as a high percentage of dentists do not adhere to safety measures and infection control procedures. This exposes dentists to numerous biological, chemical, mechanical, physical and psychosocial workplace hazards, such as blood-borne pathogens, pharmaceuticals and other chemical agents (US Department of Labor 2007).

Cross-infection between dentists and patients has become a major concern, even more so given the presence of persons affected by hepatitis B and C and HIV viruses within the Palestinian community. It has been shown by various studies that dentists have an increased risk of hepatitis and Human

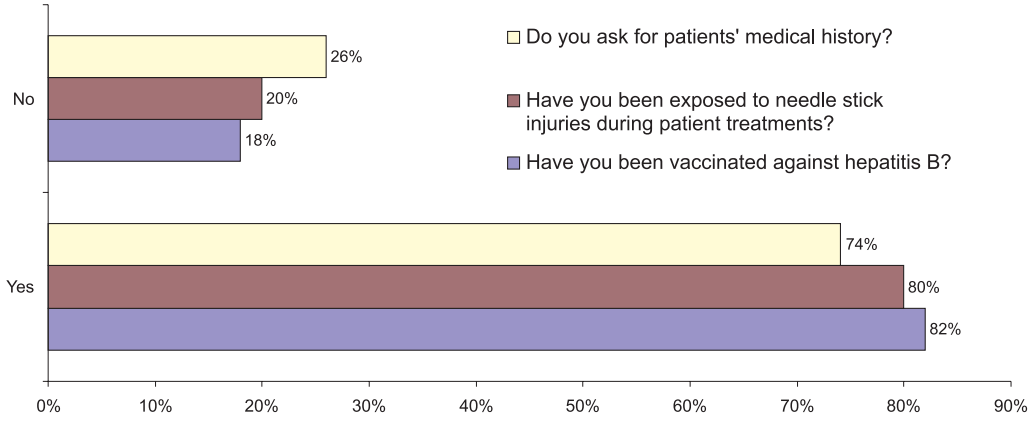

Fig. 2: Percentage of surveyed dentists that question patients' medical history before giving treatment, that are vaccinated against hepatitis B and that have been exposed to needle stick injuries during treatment of patients.

Immunodeficiency Virus (HIV) infections (Al-Rabeah & Mohamed 2002). In particular, dentists have a higher chance (by a factor of 5–10) of acquiring hepatitis B than the general public (Miller 1996). As shown in Figure 2, 82% of dentists question patients' medical history before giving treatment, 74% were vaccinated against hepatitis B and 80% were exposed to needle stick injuries during treatment of patients. In Palestine, the incidence rate of hepatitis B cases per 100 000 ranged between 1.7–3 during the period 2000–2004 (Ministry of Health 2005). Given this risk of exposure to hepatitis B antigen, there should be hepatitis B vaccination coverage for all dentists and dental workers. This value is similar to some other countries in the developing world, for example in Saudi Arabia only 64% of dentists employed in the private sector in Riyadh were vaccinated against hepatitis B (Al-Rabeah & Mohamed 2002). Developed countries generally have higher percentages, for example, in Ontario, Canada, 92% of dentists received HBV vaccine (McCarthy & MacDonald 1997) and in Scotland, 88% of dentists completed a course of hepatitis B vaccinations (Gore *et al.* 1994).

Although most dentists in Palestine are exposed daily to mercury, in particular elemental vapour by handling dental silver amalgam, a large proportion do not wear gloves (52%) during restoration. Similar figures for wearing gloves were also obtained for general patient treatment (55%). As far as wearing face masks and eye protection, only 36% and 16%, respectively, adhered to such safety measures. These results are summarized in Figure 3. It is important to note that, especially for mercury, poisoning can result from vapour inhalation, ingestion, injection or absorption through the skin (Schuurs 1999). These figures are low even compared to other developing countries; in Saudi Arabia, all dentists confirmed they wore gloves during patient treatment (Al-Rabeah & Mohamed 2002) and in Kuwait 90% of dentists wore gloves, 75% wore masks and 52% wore eyeglasses (Morris *et al.* 1996). The situation in developing countries, although generally better, still has some exceptions such as in New Zealand: Treasure & Treasure (1994) found that only 42% of dentists wore gloves, 65% wore masks and 66% wore eye protection.

It is interesting to note that practicing dentists have been found to have generally higher levels of mercury in their hair and nail samples and more than four times the level of mercury in their urine than academics. Although practicing dentists reported more kidney disorders and memory problems than academics, these were not found to be directly related to the higher urinary mercury levels. (National Center for Chronic Disease Prevention and Health Promotion 2003). In the current study, dentists were questioned if they had any symptoms or signs of adverse health effects. The most common of these were headaches (48%), stress (37%), fatigue (10%), skin allergy (10%) and dizziness (7%). Other less frequent symptoms included memory loss, numbness, low back pain, muscle tremor, visual problems, blood pressure, gastrointestinal problems and insomnia. Further investigation is necessary to determine the mercury blood levels of dentists to ascertain the extent of the reported health threats which are a consequence of high levels of exposure to mercury.

In order to effectively reduce the risk of infectious diseases, spread by saliva or blood from contaminated impression material, use of different disinfectants is common practice amongst dentists in Palestine. The most commonly used disinfectants by the surveyed dentists were alcohol 70% (54%), chlorohexidine (36%), Dettol and Microten (8.2%) and Glutaraldehyde 1–2% (2.1%). The concentrations of chlorohexidine used ranged from 0.05% to 5%, often where concentrations higher than 1.5% were diluted with water. Chlorohexidine is often one of the active ingredients in mouthwash used to improve bad breath as it kills dental plaque and other oral bacteria. Used as a disinfectant on pellicle coated enamel surfaces, it has an immediate bactericidal action and a prolonged bacteriostatic action due to adsorption. Dettol was used in diluted form. Microten (Unident, Geneva) is a trade name used for a disinfectant that can be considered similar to Dettol. It should be noted that the chemical ingredients of this product were not given on the label, except that it contained ammonium compounds without mentioning the concentration. This product was used diluted with water (1:10). Glutaraldehyde 2% is a chemical

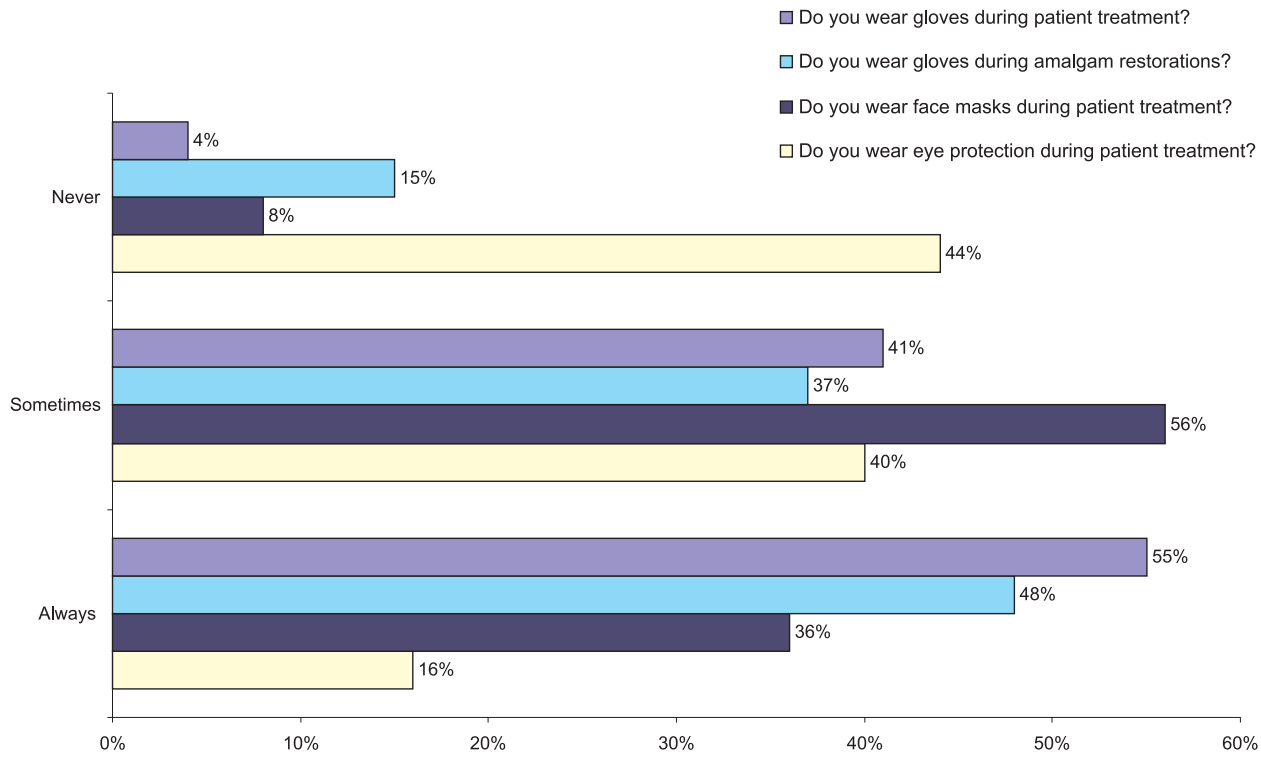

Fig. 3: Proportion of surveyed dentists that wear face masks and eye protection and that wear gloves during restoration and patient treatment.

frequently used as a disinfectant and sterilizing agent against bacteria and viruses (HSDB 1996).

Regarding the disposal of the disinfectants, all dental professionals flushed the used disinfectants down the drain. This is generally acceptable and is in line with the recommendations of different environmental agencies. The agencies agree on disposing frequently used disinfectants in dental offices, such as bleaches and alcohols, in the sanitary sewer if their concentration is less than 10% (North Carolina Division of Pollution Prevention and Environmental Assistance 1997). Products such as Microten of unknown composition and concentration, however, should not be used as they could be toxic or corrosive (Rutala 1996, North Carolina Division of Pollution Prevention and Environmental Assistance 1997, Prüss *et al.* 1999).

In general, all hazardous dental waste should be treated in-house before disposal. None of the dentists followed this criterion although all dental clinics had sterilization for handpieces. An easy and effective procedure for waste treatment is sterilization by moist heat (autoclaving), preferred to dry heat ovens (Palenik 2003, 2004). Other alternatives for dental waste treatment that could be used include incineration, chemical disinfectants, and microwave irradiation (Prüss *et al.* 1999). As shown in Figure 4, dry heat ovens was the most common practice found in this study, with 83% of dentists using this option and only 5% preferring autoclaving. The remaining 12% used both systems. In Riyadh, 38% of dentists in the private dental sector use autoclave to sterilize hand-pieces (Al-Rabeah & Mohamed 2002). In addition, all hazardous waste must be placed into appropriately designed containers, usually red biohazard bags and sharps boxes for

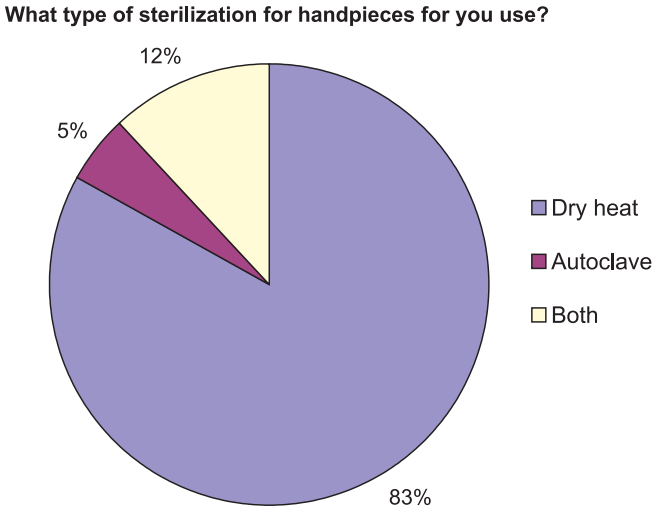

Fig. 4: Proportion of dentists using different types of sterilization for handpieces.

sharps and potential sharps. Amalgam waste should remain in a sealed container appropriate for storing this waste and should be sent for recycling (Al-Qaroot 2001, Palenik 2003).

Safe handling of hazardous waste is essential. All involved personnel need to be aware of the possible health hazards present and must be trained in the appropriate handling, storage and disposal methods. Of special concern are contaminated sharps, such as needles. The dental association in coordination with the Ministry of Health, Ministry of Local

Governments and Environment Quality Authority need to provide formal dental waste management and infection control courses for all dental professionals, with mandatory attendance for continued licensing. Dental waste handling and infection control manuals for dental practice also need to be developed. All dentists and dental assistants must be vaccinated against hepatitis B. Furthermore, continuous supervision of the dental sector should be encouraged and implemented to evaluate and check the facilities for sterilization and disinfection, as well as adherence to standard procedures. It is essential to develop a national policy and implement a comprehensive action plan for dental waste, in addition to other healthcare waste, providing environmentally sound technological measures to improve healthcare waste management in Palestine. More in-depth studies should be conducted to specifically identify hazards occurring or that could potentially occur in the dental waste handling processes, and to correct any misuse of personal protective equipment. Subsequently, follow-up measures to prevent any accidents should be considered.

Conclusions

The current system of dental waste management (including collection, separation, transportation and disposal) in Nablus district of Palestine is under development and is in urgent need of immediate attention and improvement. Improper practice is evident from the point of waste production to final disposal. The separation of dental waste into the appropriate waste categories is incomplete in the majority of dental clinics. There is much concern for the lack of correct waste management practices adopted for hazardous waste. Of these, there is a general trend to handle sharps more carefully than other waste materials by most dentists, who separate them in special boxes. However, the current separation practices for amalgam, used processing solution for the X-ray unit, lead foil that shields the X-ray film and blood-soaked dressings (including gauze, cotton and extracted teeth) are inappropriate as these end up being disposed of with regular garbage or flushed down the drain with no prior necessary treatment. Protective and infection control measures are still below the recommended level by the World Health Organization as a high percentage of dentists do not adhere to safety measures and infection control procedures.

In general, dental clinics do not treat their waste or use safe methods to handle hazardous waste. All dental wastes are improperly disposed of, mostly into open containers located outside the dental clinic buildings. The waste transportation methods currently employed by most dental clinics are inadequate and unsafe and the waste ends up in open unsanitary dumping sites sometimes close to communities where the waste is burned. There is therefore a serious potential risk created not only to the environment but to dentists and the surrounding communities.

The establishment of a comprehensive system for the management of healthcare waste is essential in Palestine as well as in developing countries. As shown by Marinkovic *et al.* (2008), the development of an integrated medical waste management system could greatly reduce quantities and consequently financial strains. However, improper waste disposal, insufficient financial resources, lack of awareness of health hazards, organization and regulations and few data on healthcare waste generation and disposal are some of the main issues impeding this development. Although the economic situation is cited as the main cause of poor waste management in Palestine, dentists can still do much with the limited resources to improve the situation. Collaboration between the dental association, the Ministry of Health, Ministry of Local Governments and Environment Quality Authority is essential to set up and provide formal dental waste management and infection control courses for all dental professions. A central treatment plant for all medical wastes in the Nablus district could be beneficial for all healthcare facilities as this would limit the number of collection sites. Hospitals could store neighbouring dental clinics' wastes onsite. This would save considerable money and, by following the environmental regulations that deal with the different types of dental waste, the hazardous effects of such waste could certainly be reduced or even eliminated.

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