

DENTAL HEALTHCARE WASTE MANAGEMENT PRACTICES IN THE GREATER TSHWANE REGION

by

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Student Declaration

I, Tebatso Mutibi, declare that the dissertation titled “Healthcare Waste Management Practices in the Greater Tshwane Region” submitted for the Masters of Technology at the Central University of Technology (Free State), is my own work and that all sources consulted or cited have been indicated in full. This dissertation or parts thereof, has not been submitted by me or anyone else to any other institution in order to obtain a degree.

Signed:  _____

Date: 12 January 2021

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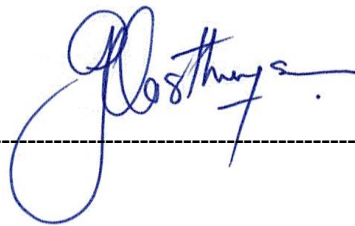
Supervisor Declaration

The work described in this dissertation was carried out in the Faculty of Health and Environmental Sciences; Central University of Technology, Free State, under the supervision of Doctor Jeanné Oosthuysen and the co-supervision of Professor Annabel Fossey and Doctor Henry Gleimius.

We hereby certify that this statement is correct, and as the candidate's supervisors agree to the submission of this dissertation.

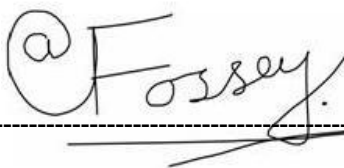
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Abbreviations

DEAT	: Department of Environmental Affairs and Tourism
GHCW	: General healthcare waste
HC	: Healthcare
HCRW	: Healthcare risk waste
HCW	: Healthcare waste
HCWM	: Healthcare waste management
HCF	: Healthcare facility
HCP	: Healthcare professional
HIV	: Human Immunodeficiency Virus
HPCSA	: Health Professions Council of South Africa
KAP	: Knowledge, attitudes and practices
NDoH	: National Department of Health
NGO	: Non-Governmental Organisation
OHS	: Occupational Health and Safety
PPE	: Personal protective equipment
RSA	: Republic of South Africa
SABS	: South African Bureau of Standards
NHS	: National Health System
USA	: United States of America
UN	: United Nations
WHO	: World Health Organization
WMP	: Waste Management Plan

Abstract

The healthcare waste management practices undertaken at dental healthcare facilities are of great importance due to the infectious and hazardous nature of the waste and associated risks on the environment and public health. In this study, the knowledge, attitudes and practices of respondents towards the practices or procedures used in managing dental healthcare risk waste in the Greater Tshwane region, were explored.

Data were collected from 52 respondents using a questionnaire, which probed their knowledge, attitudes and practices towards healthcare waste management (HCWM) at dental healthcare facilities. Dental healthcare staff and facility managers of a dental academic hospital, two public hospitals, one public clinic and several private dental healthcare facilities were approached to complete the questionnaire. Their responses were captured and statistically analysed through the QuestionPro® online survey software.

The results were positively indicative that dental healthcare staff consider they have sufficient knowledge of HCWM. In this study, the respondents obtained an aggregated mean average score of 83% for knowledge, 75% for attitudes and 54% for practices towards managing dental healthcare risk waste at their respective facilities. With a score of 75%, the healthcare professionals displayed good attitudes towards HCWM and the need thereof. Attitude has a direct impact on the dental healthcare waste management practices applied. Practices at 54% were a clear indicator of what is happening at the dental healthcare facilities. It was interesting to note that public dental healthcare facilities were more compliant with HCWM than the private dental facilities. Results also indicated that there was no association between practices and the age or gender of the respondents, but rather that education and training were the determining factors for the appropriate execution of HCWM protocols. However,

healthcare waste management practices are influenced by and affect staff, patients, community and environment in a long run.

Among other findings, the study found that 65% of the respondents had received training on the different aspects of HCWM either as undergraduate students or at the beginning of their new employment, which leaves the question of what happened to the remaining 35%. At least 80% of the respondents agreed that they should be vaccinated against hepatitis B and that such vaccination should be paid for by the employer. Again, the question is, what happens to those where the employer is not paying for the vaccination?

The replies from participants on the in-house training they received from their employer may be subjective according to his or his or her own understanding or perspective. The need to routinely educate all categories of dental healthcare staff members in order to ensure that the appropriate and standard execution of healthcare waste management practices is effected, is of greater importance than what the participants perceived. This will further increase compliance with healthcare waste management practice protocols. The results of this study provide a baseline of the knowledge, attitudes and practices of dental healthcare staff with regard to HCWM of dental waste. It is suggested that this baseline be used by dental healthcare facilities to develop an improvement plan to address the gaps identified.

Key words: KAP studies; Dental waste management practices; Healthcare risk waste; Waste management

Chapter 1

Introduction to the Study

1.1 Introduction

The healthcare sector generates growing quantities of healthcare waste (HCW) while rendering healthcare at health facilities. This waste includes both general waste and healthcare risk waste (HCRW), which presents special health and environmental risks. Healthcare risk waste generated at dental healthcare facilities, including sharps and other infectious waste, is classified as hazardous and poses a serious risk to human health and the general environment. Unsafe management of hazardous HCW may increase the risk of injuries and transmission of infectious agents. Non-compliance with specific standards, regulations and policies, in particular the ineffective removal and disposal of healthcare waste, may expose unsuspecting individuals and community members to unnecessary and entirely preventable risks. Many first world countries, including the United States of America (USA), Great Britain, Australia and New Zealand, have specific recommendations and specifications for oral healthcare professionals to inform them of best practice to prevent and control disease transmission (Oosthuysen, 2015).

1.2 Background and rational

The World Health Organization (WHO) describes oral health as *“being free of chronic mouth and facial pain, oral and throat cancer, oral sores, birth defects such as cleft lip and palate, periodontal disease, tooth decay and tooth loss, including other diseases and disorders that affect the mouth and oral cavity”* (WHO, 2014). It is every South African citizen’s constitutional right to receive health care in an environment that is not harmful to his or her well-being (South Africa, Constitution of the Republic of South Africa, 1996).

The healthcare sector is comprised of a diverse range of healthcare facilities (HCF), of which oral healthcare forms a part. These facilities are an integral part of our society, which endeavour to reduce oral health problems and eliminate any forthcoming threats to people's health. In the course of treating dental health problems, vast volumes of healthcare waste are generated, some of which may be hazardous to those who are exposed to it (Abhishek *et al.*, 2015). HCRW increases the possibility of many diseases, including the incidence of nosocomial infections, through pollution of air, water and soil. This occurs when items are contaminated with body fluids or contain a great variety of pathogenic agents (Singh *et al.*, 2014).

The possibility of experiencing a healthy environment is unpleasantly affected when waste generation without proper management is encountered. Without appropriate management of healthcare waste generated at oral healthcare facilities, the dental healthcare staff, people in the immediate vicinity, the waste handlers and the public at large can be adversely affected due to the production of toxins and cross-contamination caused by human pathogens from oral secretions (Singh *et al.*, 2014). It is essential to use appropriate skills, tools and technology to manage waste everywhere, including the urban, rural, healthcare, industrial and mining environments. Hazardous healthcare waste management is a concern for every healthcare organisation (South Africa, National Department of Health (NDoH), 2020).

Oral healthcare facilities have increased over the years due to demand for the service caused by increased financial independence, modern lifestyles and cosmetic awareness. This has led to vast quantities of infectious and non-infectious waste containing high concentrations of heavy metals being generated at these facilities. Oral health diagnoses and treatment procedures generate several types of hazardous solid healthcare waste, including amalgam, etching acid equipment, caustic powders, used x-ray fluid, disinfectants and lead foil packets, among others. If improperly managed and disposed of, healthcare waste materials contaminated with blood and other body fluids, such as

sharps, can expose patients, oral healthcare practitioners and their families to cross-transmission of blood-borne pathogens, including hepatitis B, hepatitis C and human immunodeficiency virus (HIV) as well as other opportunistic pathogens (Oosthuysen *et al.*, 2010; Singh *et al.*, 2014).

A combination of continuous education, positive attitudes, regulated practices and the drive of all dental team members and relevant stakeholders is required for an efficient dental healthcare waste management (HCWM) system to be achieved. Relevant knowledge on healthcare waste management regulations, with the emphasis on the individual responsibility of each team member, is paramount to ensure effective and efficient HCWM practices. Therefore, this study aims to identify strengths, weaknesses, opportunities and strategies for HCWM at dental healthcare facilities in the Greater Tshwane region from questionnaires on knowledge, attitudes and practices (KAP).

1.3 Aim and objectives

The aim of the study is intended to contribute to the development of a HCWM plan specifically for dental healthcare facilities and as a basis for minimising risks to the health and well-being of the practitioners and people as well as the environment. Therefore, the main aim of this study is to explore dental healthcare waste management practices in the Greater Tshwane region.

Objective 1

- To explore the practitioners' knowledge of healthcare waste management
- To determine the practitioners' attitudes towards healthcare waste management
- To evaluate the healthcare waste management practices executed by staff working at dental healthcare facilities
- To identify strengths, weaknesses, opportunities and strategies for HCWM at dental healthcare facilities, and
- Literature review of knowledge, attitudes and practices towards dental HCWM.

Objective 2

- Pilot survey to assess the reliability and validity of the questionnaire, then issue the questionnaire to dental healthcare practitioners, assistants and facility managers at dental healthcare facilities.

Objective 3

- To collect the data from the questionnaires and then analyse the data.

Objective 4

- To report and make recommendations to improve the current policies, and
- To evaluate the possibility of developing an integrated healthcare waste management plan for dental healthcare facilities.

1.4 Significance of this study

The main aim of this study is to assess dental healthcare waste management practices through an exploration of the knowledge, attitudes and existing practices in handling and disposing of healthcare waste at dental healthcare facilities in the Greater Tshwane region of South Africa. This project forms an important part of studies conducted to minimise the environmental pressures resulting from practices at healthcare institutions in Tshwane. Results from this study will contribute to the current discussions on healthcare waste management in the Tshwane Districts. It will serve to form the review process of current policies and practices so as to improve the quality and efficiency of healthcare waste management at dental healthcare practices in the Tshwane District. Consequently, the public and dental patients will benefit from this study.

1.5 Layout of the dissertation

This dissertation has been arranged into seven chapters:

Chapter 1: Introduction

Chapter 1 provides a brief introduction to the study, and outlines the aim, objectives, ethical clearance, limitations and the layout of the study.

Chapter 2: Healthcare waste management at dental healthcare facilities: A review of the literature

Chapter 2 provides a review of existing literature on healthcare waste management at dental healthcare facilities and related literature.

Chapter 3: Materials and Methods

Chapter 3 provides details on the methodology used in this study.

Chapter 4: Knowledge, attitudes and practices towards healthcare waste management: Questionnaire construction

Chapter 4 provides the results from the data collection and includes a copy of the data collection instrument (questionnaire) in the sections investigating the knowledge, attitudes and practices towards healthcare waste management at the dental healthcare facilities.

Chapter 5: Knowledge, attitudes and practices towards dental healthcare waste management in the Greater Tshwane region

Chapter 5 provides an overall discussion and concluding remarks on the study.

Chapter 6: Discussion and Concluding Remarks

Appendix A: Copy of ethical clearance certificate – University of the Free State

Appendix B: Copy of ethical clearance certificate – Gauteng Department of Health

Appendix C: Copy of the questionnaire

Appendix D: Consent letter

Appendix E: Certificate of language editing

Chapter 2

Healthcare waste management at dental healthcare facilities: A review of the literature

The previous chapter focussed on the background of the study, the aim and objectives, ethical considerations and the limitations and significance of the study, as well as a layout of the dissertation. This chapter focuses on the literature relating to healthcare waste management studies done previously and that are considered relevant to this research study.

2.1 Introduction

Medical care is a vital part of human life, health and well-being. As ironic as it is, a healthcare delivery system that is established to provide treatment and safeguard people against illnesses, becomes a source of infection and means of spreading diseases while in the process of providing the health care. With health care comes waste generation from medical activities. This waste can be hazardous, toxic and even lethal, which poses enormous risk to patients, healthcare providers, waste pickers and the community at large. So, it is essential that the disposal is comprehensively and scientifically managed (Babanyara *et al.*, 2013). Effective and efficient management of HCRW remains a major problem throughout the world (Olaifa *et al.*, 2018).

In the mid-19th century, a cholera outbreak spread throughout the world and Joseph Lister, a British surgeon and a pioneer of antiseptic surgery, made the connection between poor sanitation and inadequate healthcare waste disposal practices with the spread of disease in hospitals and the community (Ramodipa, 2018). Where there is humankind, waste is bound to be produced. Waste produced without management will cause problems. As early as 1751, with the upsurge in

industrialisation and urban growth, the volume of waste increased and became a burden, like in London where the streets were grossly dirty and unkempt due to the lack of waste management guidelines. This led to the development of waste management systems where waste collection and incineration was done.

Healthcare waste (HCW) production in the developing world is increasing exponentially (Zafar, 2020). The main reasons for higher volumes of HCRW are increases in population, dental schools, clinics and hospitals; improved dental access which allows a greater number of people to receive dental services of personal choice; and the use of disposable medical products (Windfeld & Brooks, 2015). Another reason that is adding to the increased production of HCRW in developing nations, is the trend away from using medical devices multiple times to safer, single-use medical devices. This is causing a rapid increase in the HCRW that requires safe disposal (Mbongwe *et al.*, 2008). To prevent and control potential infections of health workers, patients and the environment, it is crucially important that HCRW is managed through proper collection, storage, transportation, treatment and disposal (NDoH, 2020).

Major contributors of HCW are regarded as those generators that produce more than 20kg, including the weight of the container, per day. These include medical and dental training institutions, general hospitals, emergency medical care services, healthcare centres and dispensaries, obstetric and maternity clinics, outpatient clinics, dialysis centres, long-term healthcare establishments and hospices, transfusion centres, military medical services, prison hospitals or clinics and medical laboratories. In addition, there are also research centres, mortuary and autopsy centres, testing centres, blood banks, blood collection services and nursing homes for the elderly (WHO, 2014).

The minor contributors of HCW are small healthcare establishments, excluding domestic sources, that generate up to 20kg HCW, inclusive of the weight of the container, per day. These minor producers

include dental clinics, first-aid posts and sick bays, physicians' offices, acupuncturists, chiropractors, recovering nursing homes, psychiatric hospitals and disabled persons' institutions. Other secondary generators include activities involving intravenous or subcutaneous interventions, cosmetic ear-piercing and tattoo parlours, illicit drug use and needle exchanges, funeral services, ambulance services and home treatment. Minor and scattered sources will produce a little HCW in varying quantities and composition (WHO, 2014).

It is important to recognise that minor sources of HCW, like dental healthcare facilities, generate a large quantity of contaminated products, such as cotton, plastic, latex, glass, sharps, extracted teeth, chemicals and mercury from amalgam restorations as well as photographic chemicals like fixer and developer. If these contaminated products are not safely disposed of, they can pose a threat to the environment and public health (Khandelwal *et al.*, 2013). The portion of dental HCRW is relatively small when compared with general waste or the HCW from other healthcare departments. However, if the small volume of dental HCW is mixed with general waste, it enlarges the bulk of potentially infectious waste, which in turn increases the risk of infections and environmental dangers (Vieira *et al.*, 2009; Windfeld & Brooks, 2015).

The total quantity of HCW generated at a hospital in an industrialised country is approximately 1.2 to more than 200 times greater than HCW generated in some developing countries. It was found that the percentage of risk waste in the total healthcare waste stream in developing countries was about 63% compared to 51% in an industrialised country, such as Portugal (Diaz *et al.*, 2008). The difference in volume is because developed countries invest much more money in healthcare systems, which results in the generation of larger quantities of HCRW (Maamari *et al.*, 2015). The world's top HCW producing nation is the United States of America (USA), which alone generates over 3.5 million tons of HCW per year of which only 3% was found to have been generated by dentists (Priyaranjan *et al.*, 2019). In South Africa (SA), the HCW generated in 2007 was 42 000 tons with the estimated cost of

its safe disposal being in the region of R71 000 per year. This increased to 45 000 tons in 2013 and 48 749 tons in 2017 (Olaifa *et al.*, 2018; Olaniyi *et al.*, 2019). 5211114578 Using the 42 000 tons of waste generated in 2007 as a reference, the Department of Environmental Affairs and Tourism (DEAT) in South Africa reported that with a predicted annual increase of 1.06% in the human population, the rate of generation of HCW would increase annually by 1.5% (Olaniyi, *et al.*, 2019).

Whilst significant progress has been made to safely manage healthcare waste, there are still many challenges and room for modification and improvement to existing HCWM practices. Promotion of public awareness and enforcement of the legislation and regulations as well as the establishment of proper waste management policies are considered to be the principal remedial measures required to ensure sound environmental protection. Investigations showed that appropriate management practices can reduce infectious waste generation by up to 15% and cause less health and environmental problems in the handling, storage and disposal of hospital waste. On this basis, training hospital staff and preparing a guideline for the separation of infectious waste at the source would be appropriate measures towards ensuring a more effective waste management system is in place (Alagoz & Kocasoy, 2008). If not managed properly, HCRW generated at dental healthcare clinics and hospitals can create various health hazards to dental professionals, dental auxiliaries, patients and the other dental healthcare service providers who work at dental healthcare facilities (Mahasa & Ruhiiga, 2014).

2.2 Definition of healthcare waste

Healthcare waste includes healthcare risk waste (HCRW) and general waste (NDoH, 2020). It is defined as the total waste stream from a healthcare facility (WHO, 2014). It can be any unwanted, discharged, redundant by-product or residue generated by patients or healthcare personnel in the course of administering health care. It can include HCW from healthcare facilities, research centres, laboratories, medical and dental facilities, funeral services, cosmetic piercing and tattooing as well as

procedures involving diagnosis, treatment or immunisation of human beings or animals (Adedigba *et al.*, 2013; Maamari *et al.*, 2015). HCRW requires sound management through proper collection, storage, transportation, treatment and disposal in order to prevent and control potential infections, which may occur as a result of poor management, in health workers, patients and the environment (NDoH, 2015).

2.3 Classification of healthcare waste – modified from SANS 10248

Waste is classified according to the Globally Harmonised System (GHS) of Classification. Hazardous substances, as classified by GHS, are specified in SANS 10234 of the National Waste Management Strategy (South Africa: Department of Environmental Affairs (DEA), 2011).

Table 2.1 below illustrates the different dental healthcare waste categories and sub-categories, the colour coding for segregation purposes, the international hazard label and an example thereof. It is acceptable for general waste to be taken to the municipal disposal facility, however, HCRW should be taken by a HCRW service provider for special treatment (NWMS, 2011).

Table 2.1: Healthcare waste categories and SANS colour coding (NDoH, 2020)

Waste	Waste sub-category	Colour coding and international hazard label	Examples dental HCW
General waste 75%	Municipal waste and not contaminated	No hazard label Black, beige, white or transparent plastic bags.	General waste, includes normal household and administrative waste, paper, packaging materials, cardboard boxes, plastic bags, etc.
Human or animal anatomical waste	None	RED International infectious hazard label 	Includes any parts from a body, e.g., extracted teeth or biopsy specimens.

Infectious non-anatomical waste	None	RED International infectious hazard label 	All types of waste that is likely to contain pathogenic microorganisms or agents. At dental healthcare facilities, anything that has been in contact with saliva is considered as infectious, e.g. disposable items, such as gloves, masks, cotton rolls, saliva ejectors and others.
Sharps	None	YELLOW Marked "DANGER" "CONTAMINATED SHARPS" International infectious hazard label	Examples of sharps used in dental healthcare include burs, scalpel blades, suture needles, dental syringe needles, glass and glass cartridges, metal matrix bands, wires, endodontic files and reamers, orthodontic wires and instruments, and wedges.
Chemical waste including pharmaceutical waste 5%	Chemical or pharmaceutical waste	DARK GREEN International hazard label	Includes all kinds of discarded chemicals, including pharmaceuticals that pose a special risk to human health and environment, e.g. fixers, disinfectants.
	Cytotoxic pharmaceutical	DARK GREEN Cytotoxic hazard label	Amalgam products
Radioactive waste	None	No colour coding International radiation hazard label 	This includes solid, liquid and gaseous waste contaminated with radionuclides. Radioactive waste is normally not generated at dental healthcare facilities.

2.4 Legislation pertaining to waste management

2.4.1 International conventions relating to healthcare waste management

The Basel Convention was adopted in 1989 and came into force in 1992 (United Nations Environment Programme (UNEP), 1992). It has nearly universal membership with 175 signed Parties as at 31 March 2011. It governs transboundary movements of hazardous waste and is also applicable to

healthcare waste. Countries signing the Convention accept that legitimate transboundary shipments of hazardous waste can only be exported from countries that lack the facilities or expertise to safely dispose of certain wastes to countries that have both the facilities and expertise. Any exported waste should be labelled according to the United Nations (UN) recommended standards (UNEP, 1992).

International agreements have been reached on a number of underlying principles that govern public health or safe management of risk waste. These principles, outlined below, should be taken into consideration when national legislation or regulations governing HCWM are formulated to guide efficient waste management:

- *The polluter-pays principle* requires that all producers of waste are legally and financially responsible for the safe and environmentally sound disposal of the waste they produce, thus creating an incentive to produce less waste. This principle also strive to assign accountability to the party that causes damage (Prüss-Üstün, 2005).
- *The precautionary principle* is a main principle governing health and the safe keeping and protection of the environment. When there is uncertainty on the extent of a particular risk is uncertain, it should be assumed that the risk is significant and measures to protect health and safety should be designed accordingly. The lack of full scientific knowledge should not be used as a reason for to defer implementing affordable ways measures to prevent environmental degradation or threats of serious or irreparable damages (Prüss-Üstün, 2005).
- *The duty of care principle* set out that any person handling or managing hazardous substances or related equipment is ethically accountable for using the utmost care in the duty (Prüss-Üstün, 2005). Therefore, each generator of HCRW is required to prepare, maintain and implement a written plan in accordance with national, provincial, regional and municipal regulations and legislation. According to this principle, they are obliged to identify all HCRW

generated within their facility and the manner in which it is handled (Mulder & Mulder-van Staden, 2018).

- *Prior informed consent* requires that affected communities and other stakeholders be notified of the hazards and risks involved in the transport of waste as well as the location and operation of waste treatment and disposal facilities (WHO, 2014).
- *The proximity principle* recommends that treatment and disposal of hazardous waste be done to the closest location of generation to minimize the risks during transportation. Another similar principle advocates that communities should recycle or dispose of the waste they produced inside their own area (UNEP, 1992; Prüss-Üstün, 2005)

2.4.2 Legislation governing healthcare waste management in South Africa

Waste management in South Africa is governed by the National Environmental Management: Waste Act (NEMWA), No. 59 of 2008, which came into effect on 1 July 2009 (South Africa, Waste Act, 2008). In order to achieve the objects of the Act, the Minister of Environmental Affairs established the National Waste Management Strategy (NWMS) in terms of Section 6(1) of the enacted Waste Act. Cabinet approved the implementation of the NWMS in November 2011 (DEA, 2011). The NEMWA supports the waste management hierarchy in its approach to waste management. The hierarchy promotes cleaner production, minimising waste, reusing, recycling, recovering and treating waste, with disposal seen as the least preferred option in the management of waste (South Africa: Department of Environment, Forestry & Fisheries (DEFF), 2014).

The legislation requires that all health facilities that generate healthcare waste have a duty to manage waste safely. The generator of the healthcare waste is legally and financially responsible for the safe handling and environmentally sound disposal of the waste produced; must always assume that the waste is hazardous until shown to be safe; and the waste remains the generator's responsibility from

the point of generation until its final treatment and end-disposal. This approach defines the “*cradle-to-grave*” principle, which is outlined in strategic documents (NDoH, 2015; NDoH, 2020).

Legislation stipulates that major healthcare waste generators must have a cost effective HCWM plan that is signed off by the CEO/financial officer of the facility as well as a waste management committee in place (NDoH, 2020). Minor generators may prepare HCRW management plans as a self-regulatory measure but must also have a Standard Operating Procedure in place to guide the management of HCRW (NDoH, 2020). The HCWM plan must include the following information: facility information relating to workload; contact details of person/officer in charge of the healthcare waste; categories of healthcare waste generated; classification of waste streams; description of waste management systems (generation, segregation, containment, transportation, treatment and disposal); contracting systems for transportation and end point disposal; and details of on-going training programmes, including Infection Prevention and Control as well as Occupational Health.

According to the Department of Environmental Affairs, challenges facing HCWM in South Africa are limited understanding of waste, its complications, management and enforced regulations, inadequate waste services, unpleasant living conditions as well as polluted and unhealthy environments (DEA, 2008). There is a historical backlog of structured waste services in urban informal areas, tribal areas and rural formal areas. Although 61% of all South African households have had access to domestic waste collection services since 2007, this access remains favourable to the affluent and urban societies. It is not obligatory to supply data and where data are available, they are often unreliable and contradictory. With a growing economy and a population estimated at 58 million (South Africa, Department of Statistics (Stats SA), 2019), increased volumes of waste generation are inferred. This puts pressure on outdated waste management facilities and infrastructure that is already in short supply, as well as on a declining level of capital investment and maintenance. The increased complexity of the waste stream because of urbanisation and industrialisation also contributes to

aggravate the situation. The complexity of the waste stream directly affects the complexity of its management, which is compounded when hazardous waste is mixed with general waste.

Cradle-to-grave management of healthcare waste activities and actions is required to manage waste from its origin to its final disposal. The importance of HCWM to preserve the environment and protect the public cannot be denied. Therefore, periodic sensitising and training programmes in dental healthcare waste management is required to keep all staff members up to date with the latest scientific knowledge of safe waste management practices (Health Professions Council of SA (HPCSA), 2016; Srinivasan, 2018). Training should incorporate matters of occupational health and safety in HCWM, including precautions for all persons who manually handle containers of untreated HCRW; wearing of appropriate personal protective equipment (PPE); additional PPE to be provided in accordance with risk assessment; health and safety guideline/policy and strategy to guide occupational health and safety matters related to waste management; and matters to be reported to responsible staff members, such as exposure to blood and body fluids due to a sharps injury or spillage, or exposure to chemicals, radiation and other noxious substance, or back injury or physical injury during transportation of waste (NDoH 2020).

The seven steps identified in the cradle-to-grave management of healthcare waste and the appropriate measures that must be taken at each step for infection prevention and control purposes should be covered in detail:

- Step 1: Healthcare waste generation
- Step 2: Segregation, minimisation and containerisation of healthcare waste
- Step 3: Internal and external storage of healthcare waste
- Step 4: Internal and external transport and collection of healthcare waste at a HCF
- Step 5: Labelling and administration of waste records

- Step 6: Treatment of waste
- Step 7: Disposal of treated waste

2.5 Risks associated with dental healthcare waste

Globally, about 5.2 million people, of which 4 million are children, die each year from waste related diseases (Hasan *et al.*, 2015). In 2009, there was an outbreak of hepatitis B in Gujarat, India due to the reuse of injection equipment as well as second-hand medical devices, especially syringes, being traded in, re-packed and sold illegally. Out of at least 240 cases, 60 lives were lost (WHO, 2014).

The reuse of materials at a healthcare facility (HCF) has provoked much debate, in particular, concern over the reuse of single-use medical devices. In general, the use of non-disposable items for medical procedures should be encouraged, especially when sterilisation cleaning can be demonstrated to minimise infection transmission to acceptably low levels (Olaniyi *et al.*, 2019).

Furthermore, a study on the management of HCRW, conducted by the WHO in 2000, estimated that 2 000 contaminated syringes, reused injections and equipment from healthcare facilities (HCF) resulted in 2.6 million HIV infections, of which 5% were new infections and 21 million hepatitis B infections, of which 32% were new infections, as well as 2 million hepatitis C infections, of which 40% were new infections (Manga *et al.*, 2011). Adverse incidents of this magnitude can be prevented if all staff handling HCW are appropriately trained and the management of healthcare waste is executed according to recommended guidelines and regulations.

Dental healthcare workers have been identified to be at increased risk of cross-contamination with infection after needle-stick injuries. Their chances of infection with hepatitis B is 6 – 30% after a single needle-stick incident (WHO, 2014). An occupational health report on a hospital in Mpumalanga province, SA, revealed an increase in the number of needle-stick injuries among hospital ward

cleaners (Makhura, 2016). Cleaners do not routinely use needles nor sharps, so it is not expected that they would experience such injuries. However, studies showed that cleaners are injured by needles incorrectly disposed of by healthcare staff (Makhura, 2016). In 2000, sharps injuries to healthcare workers were estimated to have caused about 66 000 hepatitis B (HBV), 16 000 hepatitis C (HCV) and 200 – 5 000 HIV infections among healthcare workers (Prüss-Üstün *et al.*, 2005). For healthcare workers, the infections that were caused by percutaneous occupational exposure to HBV, HCV and HIV was 37%, 39% and 4%, respectively (WHO, 2014). A rinsed but unsterilised syringe can still have a 1.8% chance of passing on HIV if used for an intravenous injection and 0.8% if used in the administration of an intramuscular injection (WHO, 2014).

Nemutandani (2008) reported occupational exposure (78.4%) and sharp injuries (83%) among dental assistants at dental clinics in Limpopo due to a lack of formal or other structured training in HCRM. The occupational risk to dental assistants increased 9.9 times when compared to those for the semi-trained auxiliary nurses. The lack of training may therefore be a leading cause of occupational injury to dental assistants. Nemutandani further reported that two-thirds of the respondents were injured when removing and/or cleaning instruments and of the dental assistants, 65.3% obtained injuries from direct punctures (Nemutandani, 2008). This study highlighted the fact that additional contributing factors can be attributed to the injuries to dental assistants, including the fact that dental facilities were understaffed and had increased workloads.

The report on post-exposure management among dental assistants indicated that almost a quarter of the respondents (23%) failed to report exposures and injuries (Nemutandani, 2008). Among the dental assistants who reported exposure incidents, the majority were only provided with wound cleaning (83%), while a small percentage (23.8%) were placed on antiretroviral treatment for post-exposure prophylaxis (Nemutandani, 2008). In another study on the handling and transporting of HCRW, including sharps, at clinics in a rural health district in KwaZulu-Natal, approximately 50% of the

respondents were unaware of the possibility of any particular post-exposure prophylaxis management or treatment (Gabela & Knight, 2010).

The transmission of infection and its control is well explained by the “chain of infection”, which consists of an infectious agent, reservoir, portal of exit, mode of transmission, portal of entry and susceptible host. It is essential that healthcare workers understand the significance of each link and the means by which the chain of infection can be interrupted. Hence, good HCRW management can be viewed as an infection control procedure. Control measures for HCRW are most often directed at the mode of transmission stage in the chain of infection, although it is also important to note that breaking any link in the chain will prevent infection, (WHO, 2014).

It is imperative for infection control to be seen as a key element in providing a safe environment for patients and staff within a dental healthcare practice (Smith *et al.*, 2009). Dental healthcare facilities are supposed to be places of caring/healing, but instead, can become places where infections are spread because of poor healthcare waste management (Charania & Ingle, 2011). Dental healthcare professionals are continuously in contact with traumatised tissue, saliva and blood, which increases the risk of disease transmission. It is estimated that one drop of saliva may contain up to 600 000 bacteria (Oosthuysen, 2015). Therefore, at any dental healthcare facility, it is imperative for infection prevention and control to be part of healthcare risk management in providing a safe environment for patients, staff and the general public (Smith *et al.*, 2009).

A risk associated with dental restorative materials is posed by the use of dental amalgam, as it contains mercury. Mercury can corrode, has a low-flame point and is a reactive, oxidizing explosive as well as being highly toxic, especially in its elemental form or as methylmercury. It may be fatal if inhaled and is harmful if absorbed through the skin or mucous membrane. Roughly 80% of the inhaled mercury vapour is absorbed into the blood through the lungs, which can then lead to the nervous, digestive,

respiratory, immune systems and kidneys as well as the lungs being harmed. Adverse health effects from mercury exposure include tremors, a potent neurotoxic reaction that can affect the brain and spinal cord, kidney damage, impaired vision and hearing, paralysis, insomnia, emotional instability, developmental disabilities during foetal development as well as attention deficit and developmental delays during childhood (WHO, 2014b).

According to a survey conducted by the WHO in 22 developing countries in 2002, it was found that 18% – 64% of HCF did not use proper waste disposal methods and these practices are common in many developing countries (Thakur & Ramesh, 2015). Legal reasons for Occupational Health and Safety (OHS) management relate to the preventative, punitive and compensatory effects of laws that protect workers' safety and health. OHS management can reduce the costs related to injury and illness among employees, including medical care, sick leave and disability benefits. OHS management can also enhance or tarnish a HCF's reputation and its image among stakeholders (Battaglia *et al.*, 2015).

2.6 Healthcare waste management activities

The objectives of waste management activities are structured around the steps of the waste management hierarchy, which is the approach that informs waste management in South Africa. The waste management hierarchy consists of actions for waste management during the lifecycle of waste, arranged in descending order of priority similar to that illustrated in Figure 2.1. Where feasible, stakeholders should apply the waste management hierarchy in making decisions on how to manage waste (DEA, 2011).

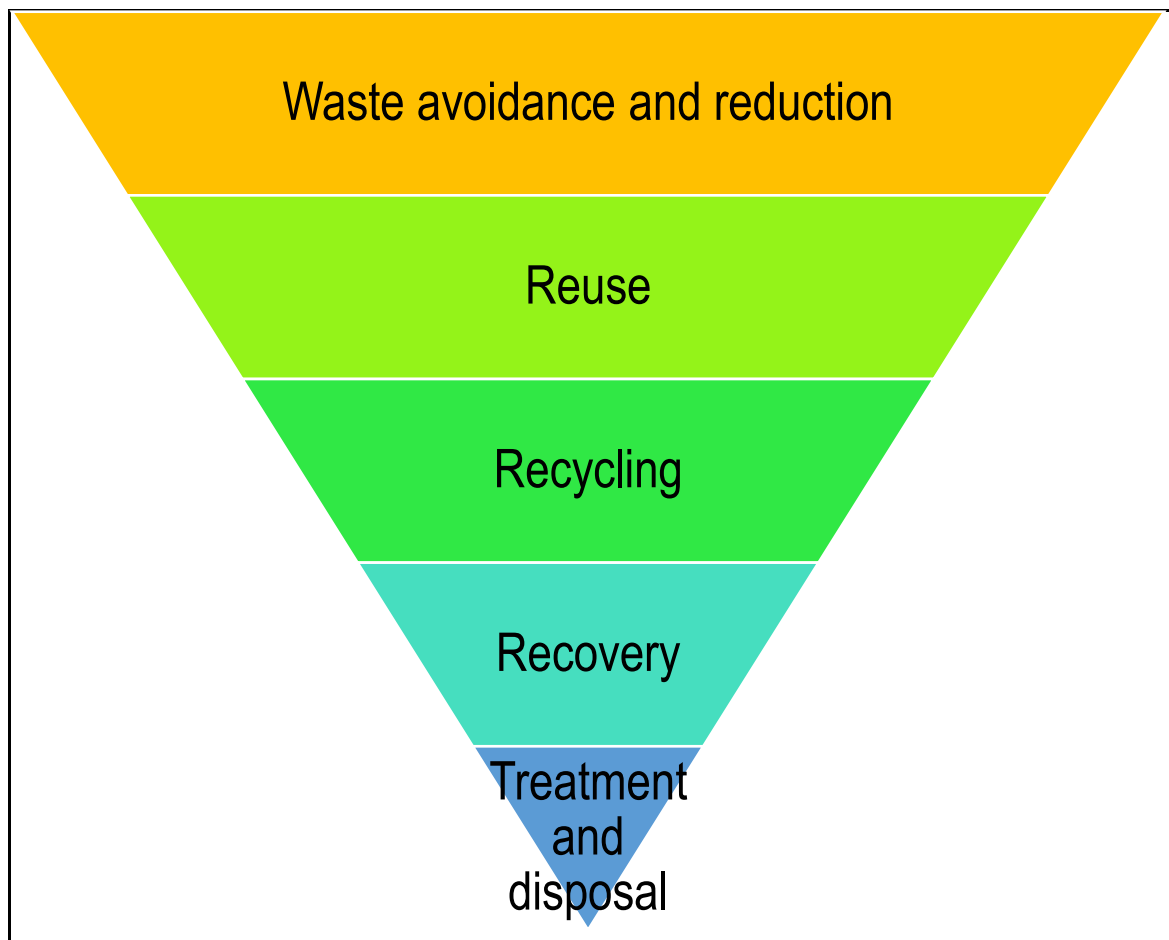


Figure 2.1: Waste management hierarchy, from most to least preferred waste practice actions (Adapted from DEA, 2011)

2.6.1 Waste generation

Waste generation from day procedures requires proactive planning and determining which products can be saved for reuse or is waste that can be recycled. Waste generation also depends on various factors, such as waste management methods, administrative categories of the dental establishment, specialisations of the facility, ratio of reusable items and the number of day-care patients. Variations differ according to the type or level of HCF as well as between rural and urban facilities due to differences in the services provided, scale, organisational complexity, availability of resources and the number of dental healthcare staff.

Waste generation data are used in estimating the capacities required for containers, storage areas, transportation and treatment technologies. Waste generation data are also used to establish baseline data on rates of production in different dental areas, for procurement revenues from recycling, for waste management systems and environmental impact assessments (Alagoz & Kocasoy, 2008).

In India, Srinivasan (2018) revealed that knowledge, attitudes, and practices regarding dental healthcare waste management were low. Results from this study indicated that a large percentage of dentists (89%) were not acquainted with the process of waste management, whereas about half of the respondents were moderately to slightly aware of the recycling/reusing of dental healthcare materials.

2.6.2 Healthcare waste segregation and minimisation

Segregation and minimisation of healthcare waste are the most important steps towards successfully managing healthcare waste (NDoH, 2020). The evolution to separate HCW within the municipal waste stream dates back to the late 1970s, when it was observed that hazardous waste, including syringes and bandages, washed up on the eastern coast of the USA. Following a public outcry to this situation, the US Medical Waste Tracking Act of 1988 was ratified on 01 November 1988 (USA, 1988). Two years later the European Union established that HCW needed to be considered as a priority waste due to the potential hazards it poses to human health and the environment (United States Environmental Protection Agency (US EPA), 2017).

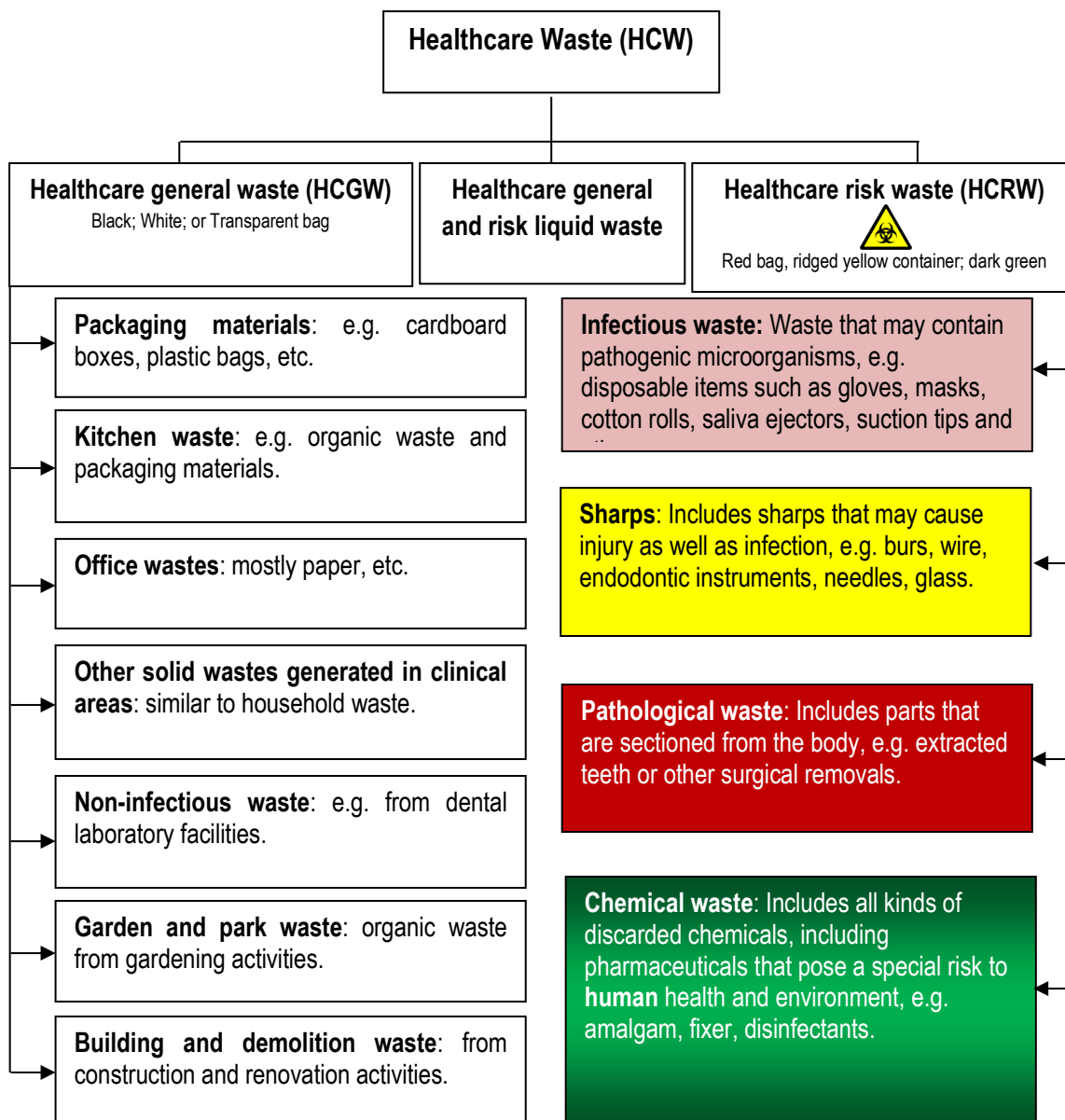
Segregation refers to the process of separating and labelling HCRW into various waste classification types. It is identified as a very important step of HCWM as it reduces the risk and quantity of hazardous waste. Importantly, this process is in place to ensure that hazardous and general waste are separated from each other at the original place of generation and stored in separate appropriate containers to aid waste handlers identify and treat them accordingly (Prüss-Üstün *et al.*, 2005). If there is no certainty about the classification of a waste item, it should be placed into a container used for HCRW

as a precaution. Research reports that the absence of source segregation at the place of generation is the main reason why HCRW is disposed of together with general waste, which in turn increases unwanted disposal costs (Ananth *et al.*, 2010). Segregation ensures possible recycling of non-hazardous general waste (Aliyu *et al.*, 2017).

The correct segregation method of HCRW is the responsibility of the person who produces the waste, regardless of their position in the organisation. The HCF management is responsible for making sure there is suitable segregation, transport and storage systems in place as well as ensuring all staff adhere to the correct waste management procedures, have adequate personal protection equipment (PPE) and are immunised for diseases such as hepatitis A and B (Aliyu *et al.*, 2017). Healthcare waste segregation methods should be clearly set out in the HCF's waste management policy. Dental healthcare staff and waste handlers should understand the reasons for and the operation of: segregation practices, waste auditing and spill management as well as accident and injury reporting. Training should be repeated periodically to ensure that all staff are aware of their responsibilities.

Healthcare waste should be segregated by category into the appropriate colour bags/bins at the point of generation, such as at private general/specialist clinical dental areas and dental surgeries, public dental clinics, primary healthcare facilities and mobile dental units. Clear visible posters should be displayed at the point of waste generation to indicate what type of waste goes into which colour bag or container as shown in Table 2.2.

Table 2.2: Primary healthcare waste categories for dental healthcare facilities (Accessed and adapted from Oosthuysen 2015)



Once HCRW is placed in the designated container, such as a plastic bag, it must not be decanted for any reason and must be disposed of as a single unit. Reusable containers (which hold the plastic bags) should be effectively disinfected before reuse. HCRW containers must clearly display the appropriate international hazard symbol and be marked as prescribed in the SANS 10248-1: Management of Healthcare Waste (DEA, 2011) (Fig. 2.2).

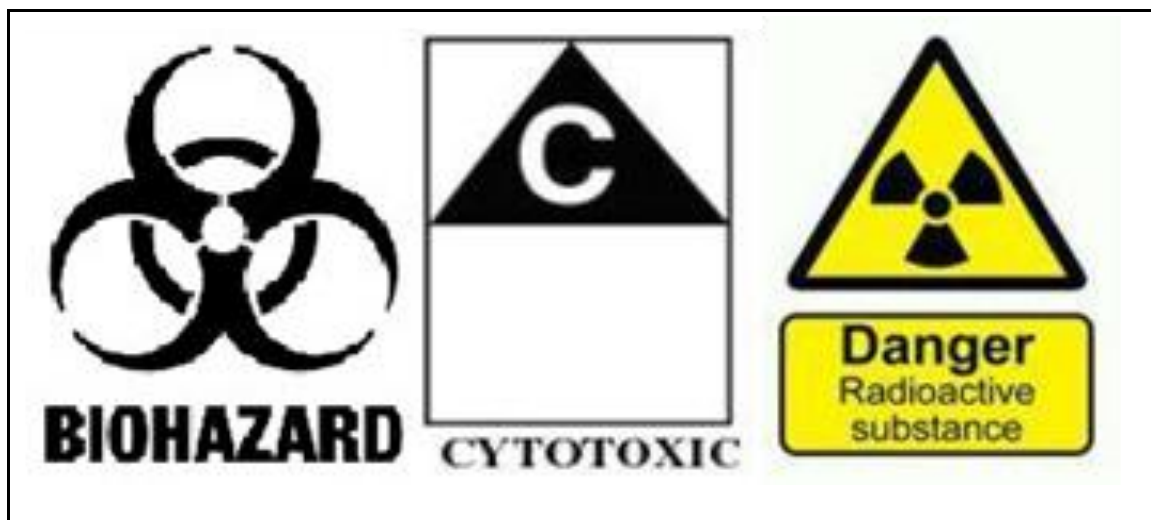


Figure 2.2: International hazard symbols (Accessed and adapted from NDoH, 2015; 2020)

Waste minimisation comes from the waste management foundation of the cradle-to-grave principle and waste management hierarchy that is based on the concept of the 4R's, namely reduce, reuse, recycle and recover. The waste management hierarchy indicates the desirable order of preference for the actions to reduce and manage waste. The aim of the waste management hierarchy is to extract the maximum practical benefits from products and to generate the least quantity of waste as possible, thus minimising the volume of waste entering the waste stream. Further, this approach continues to seek ways to reuse or recycle a product even when it reaches the end of its life span. In this way, it becomes an input in the production of new products and materials. This cycle repeats itself until as small a portion as possible of the original product eventually enters the next level of the waste management hierarchy. Greater awareness of the environmental impacts of waste is required and acknowledgement that most of the non-hazardous waste from HCF is potentially recyclable or compostable. Some material can be recovered by reclaiming some components or materials can be used as fuel (DEA, 2011).

Minimising waste not only reduces the cost of waste treatment and disposal, but also reduces the carbon footprint impact, enhances public health and worker safety and improves public image.

Recycling and reduction practices should become part of the everyday operations throughout a HCF. Staff, patient and public safety can be improved if all adhere to waste minimisation practices routinely in their daily work. (WHO, 2014).

The preferred management solution in dental treatment is to avoid wasteful ways. To achieve lasting waste reduction, the focus should be on working with dental healthcare staff to change clinical practices so less materials are used or opt for reusable materials. Although waste minimisation is most commonly applied at the point of generation, healthcare managers can implement measures to further reduce the production of waste by adapting their procurement and stock control strategies. It is also advisable to select supplies that are less wasteful as smaller quantities can be used or that produce a less hazardous waste product. Using all of the contents in each container can minimise waste as well as using the oldest batch of a product first.

2.6.3 Storage of waste

Depending on the size of the dental healthcare facility, generated healthcare waste can be stored in larger containers in an intermediate storage place, like a utility room or available space in close vicinity to the facility, while awaiting internal or external removal and transportation. This space should be separate from patients and public access so that the healthcare waste is isolated while awaiting collection and transportation to a central storage facility (WHO, 2014).

Waste containers come in different shapes and sizes and are manufactured from different materials, including reused plastic and metal. Modern waste containers are designed for automated systems that quickly empty the contents into the waste disposal system and then are mechanically washed and disinfected. In all cases, they should be sturdy, leak-proof and be lined with a sturdy plastic liner, except in the case of sharps containers. The recommended thickness of bags for infectious waste is 70 μm (International Organization for Standardization (ISO), 2004).

Containers should have well-fitting lids, either removable by hand or preferably operated by a foot pedal. Both the container and the bag should be of the correct colour for the intended waste, labelled clearly and properly and, if possible, be lockable. Mixing colours, such as having yellow bags in black bins, should be avoided because it may cause confusion and lead to poor waste segregation. The appropriate waste receptacle bags, bins and sharps boxes should be available to dental healthcare staff where the waste is generated in the facility. This permits staff to segregate and dispose of waste at the point of generation and thus reduce unnecessary exposure to HCRW later on.

Since sharps can cause injuries that leave people vulnerable to infection, both contaminated and uncontaminated sharps should be collected in a puncture-proof and resistant container that is difficult to break open once closed. Sharps containers may be disposable or designed to be disinfected and reused. Disposable boxes are made of plasticised cardboard or plastic, while reusable designs are made from plastic or metal. Containers should be clearly relabelled “sharps containers” (WHO, 2014).

Waste has to be safely stored prior to treatment or picked up by external transport providers (Hassan, 2008; Aliyu *et al.*, 2017). Infectious waste should be stored in an identified area with signs that validate the storage of biohazard material. Floors and walls should be sealed or tiled to allow for easy disinfection. The compacting of untreated HCRW destined for off-site disposal is not permitted. Sharps can be stored as is for a period of time, but other risk waste, if stored for more than a week, should be kept cool or refrigerated at a temperature, preferably no higher than 8°C. Unless a refrigerated storage facility is available, storage time for HCRW (e.g. the time gap between generation and treatment) should not exceed the following periods: in a temperate climate, 72 hrs in winter and 48 hrs in summer, while in a warm climate, 48 hrs during the cool season and 24 hrs during the hot season. Hazardous waste should be stored according to their chemical characteristics (DEA, 2011).

Chemical waste storage areas should have adequate lighting and quality ventilation to prevent the accumulation of toxic fumes. The storage zones should be labelled according to their hazard class, such as explosive waste, corrosive acid waste, corrosive alkali waste, toxic waste, flammable waste, oxidative waste, halogenated solvents and non-halogenated solvents. If more than one hazard class is defined for a specific waste, the most hazardous classification should be used. The label should have a hazard symbol(s), waste classification, date and point of generation, if applicable (WHO, 2014).

2.6.4 Transport of waste materials

This section describes the collection process and routes from the point of generation to intermediate storage areas and then to on/off-site treatment facilities. Transportation of waste can pose a hazard to people and the environment. The treatment facility is required to provide fixed trolleys and specify collection times that are appropriate to the volume of HCRW being produced in each area of the dental HCF, such as which theatres generate higher volumes of potentially high-risk waste and therefore require several collections during the day. These collections must also fit in with the schedule of operations and, if preventable, the routes must not cross through patient care areas (NDoH, 2020).

Drivers of vehicles transporting hazardous HCW should receive appropriate training on the risks associated with the handling of hazardous waste. Training should include relevant legal regulations, waste classifications and risks, safe handling of hazardous waste, labelling and documentation as well as emergency and spillage containment procedures. Details about the waste being carried should be provided to the driver. For safety reasons, vaccination against tetanus and hepatitis A and B is recommended and records of the vaccinations and training details of staff should be documented. In case of emergencies, the contract details and telephone numbers of emergency responders and other service departments should be carried in the driver's cab. A fundamental requirement is for the vehicle transporting HCRW to be roadworthy and have identifiable signage that indicates its load. The payload must be secured so as to minimise the risk of accidents and spillages (DEA, 2011).

If waste has to be transported across an international border for treatment, international agreements and national regulations have to be complied with by the transporters of HCRW (UNEP, 1992). The United Nations recommendations may be referred to by authorities where there are no national regulations on the transportation of dangerous goods (DEA, 2011).

2.6.5 Labelling and administration of records of waste

Labelling and administration of healthcare waste records are very important steps in waste management because it is essential that the dental healthcare facility takes further responsibility for the waste it has created. When waste bags or sharps containers are 75% filled, they should be sealed and labelled “ready for collection”. While still at point of generation, the waste bags and containers need to be labelled with the type of waste and dated to allow them to be tracked from generation to disposal. Where possible, the weight of the shipment should also be recorded. Plastic bags should never be stapled but may be tied or sealed with a plastic tag or tie. Replacement bags or containers should be available at waste collection sites in case the integrity of the original bag is compromised (WHO, 2014).

The transport vehicle should be labelled according to the type of waste that is being transported. Any HCRW transported off-site should have waste tracking documentation attached. The waste tracking documentation should be designed around the waste transportation control system in operation within a country. In case of accidents or official inspections, the driver of the vehicle transporting a HCRW load should carry waste tracking documentation that includes the following information: waste classes, waste sources, weight, pick-up date, destination, driver’s name, number of containers or volume, waste producer and receipt of the load received from the responsible person at each pick-up area.

Anyone involved in the production, handling or disposal of HCRW should accept a general “duty of care”. That is, they have an obligation to ensure that waste handling, treatment and disposal as well

as the associated documentation comply with national regulations. To ensure appropriate control of waste management, it is important that the dental healthcare facility manager or the person in charge of HCRW management should keep clear records of the waste being stored, when it is collected for treatment and the disposal dates (WHO, 2014).

2.6.6 Treatment of waste

Waste treatment refers to the activities required to ensure that waste has the least practical impact on the environment. Unsafe HCRW treatment methods release pathogens and toxic pollutants into the environment that may potentially harm the flora and fauna. These pollutants can cause foul odours that attract flies, cockroaches and vermin as well as contaminate underground water tables when untreated medical waste is deposited in landfills. Many diseases or medical disorders, such as respiratory damage, central nervous system effects, reproductive system damage, diarrhoea, leptospirosis, typhoid, cholera, human immunodeficiency virus (HIV) and hepatitis B, may be caused as well (Nemathaga *et al.*, 2008; Vieira *et al.*, 2009; Mahasa & Ruhiiga, 2014; Maamari *et al.*, 2015).

In South Africa during 2016, 48 441 tons of HCRW was treated using the non-burn treatment method (Ramodipa, 2018). Treatment options that can be utilised are mechanical processes, thermal processes, chemical processes, irradiation technologies and biological processes.

Mechanical processes

These processes, which include shredding, grinding, mixing and compaction technologies, cannot destroy pathogens. They merely reduce the waste size. Mechanical processes are usually not stand-alone HCW treatment processes, but supplement other treatment methods. Mechanical destruction renders waste unrecognisable (its origin and purpose is no longer identifiable) and can be used to destroy needles and syringes, depending on the type of shredding. In the case of thermal or chemical treatment processes, mechanical devices, such as shredders and mixers, can also improve the level

of heat transfer or expose more of the surface area to the waste treatment. If mechanical devices are used to prepare waste before engaging other forms of waste destruction, the level of management and maintenance required to treat HCRW safely and efficiently is significantly enhanced (WHO, 2014).

Shredders, mixers and other mechanical devices should only be used as an integral part of a closed treatment system and they should not be used before the incoming healthcare waste is disinfected. If they are not in a closed system, workers are at an increased risk of being exposed to aerosol transmission due to pathogens being released into the environment when mechanical destruction of the untreated waste bags occurs. However, if mechanical processes are part of a closed system, the technology should be designed in such a way that the air in and from the mechanical process is disinfected before being released into the surroundings (WHO, 2014).

Autoclaving

It requires the proper combination of temperature (130°C to 160°C), pressure and exposure time for periods estimated at 30 minutes to ensure that the numbers of pathogens are reduced to below acceptable levels. The technology is, however, not suitable for the treatment of pathological or chemical HCRW nor radioactive waste (Ramodipa, 2018).

Hydroclaving

Waste hydroclaving is a similar process to autoclaving except that the HCRW is subjected to indirect heating by applying high temperature steam into the outer jacket of the cylinder. The HCRW is continuously fragmented and tumbled in the inner chamber during the process.

Shredding and autoclaving

Waste shredding is a process by which HCRW is cut into smaller pieces before it is disinfected to make the waste unrecognisable general waste so it can then be safely disposed of via the regular waste disposal system. However, the shredder is often the weak point in the treatment chain as it is susceptible to mechanical failure or breakdown. With an integrated treatment system, the industrial autoclave uses shredding with the autoclaving procedures of heat, steam and pressure in the processing of healthcare waste. All waste, except anatomical and pharmaceutical waste, can be shredded and autoclaved (NDoH, 2020).

Thermal processes

These processes rely on heat (thermal energy) to destroy pathogens in the waste. Most treatment facilities across the world make use of these processes. This category can be further subdivided into low-heat and high-heat designs, although the low and high is relative. These differences produce very different atmospheric emission characteristics.

Low-heat thermal processes operate at temperatures high enough to destroy microorganisms but not sufficiently high to cause combustion or pyrolysis of the waste. This occurs at elevated temperatures but does not involve reactions with oxygen. In practice, it is difficult to have a completely oxygen-free atmosphere, so some oxidation will take place.

In general, low-heat thermal technologies operate between 100°C and 180°C and take place in either moist or dry-heat environments. Moist or wet thermal treatment involves the use of steam to disinfect waste and is commonly performed in an autoclave or steam-based treatment system. Microwave treatment is essentially a moist thermal process because disinfection occurs through the action of moist heat (hot water and steam) generated by microwave energy. Dry-heat processes use hot air

without the addition of water or steam and in these systems, the waste is heated by conduction, convection and/or thermal radiation using infrared or resistance heaters (WHO, 2014).

Incineration (primary treatment technology)

Incineration is a combustion process under high temperature where waste is completely oxidised and any harmful microorganisms present are destroyed (Ramodipa, 2018). Incineration and other high-temperature waste treatment systems are described as "thermal treatment". Incineration accommodates all categories of waste and converts the waste into ash, flue gas and heat (NDoH, 2020).

Dry-heat treatment technologies:

In dry-heat processes, heat is applied by conduction, natural or forced convection or thermal radiation without adding steam or water. In forced convection heating, resistance heaters or natural gas heat the air that is circulated around the waste in the chamber. In some technologies, the hot walls of the chamber transfer heat by conduction and natural convection, while other technologies use radiant heating by means of infrared or quartz heaters. Generally, dry-heat processes use higher temperatures and longer exposure times than steam-based processes and therefore is usually used to treat only small volumes. It is known that *Bacillus atrophaeus* spores are resistant to dry-heat, so the presence of these spores are commonly used as a microbiological indicator to measure the success of dry-heat technologies (Emmanuel, 2001; Emmanuel & Stringer, 2007). In South Africa, incineration and autoclaving are the treatment systems commonly used for dental HCW (Ramodipa, 2018).

Chemical processes

Routinely in HCF, chemical disinfectants are used to destroy or inactivate microorganisms on medical equipment, floors and walls. This process is now being extended to the treatment of HCRW, but usually results in disinfection rather than sterilisation. Chemical treatment methods use disinfectants, such as dissolved chlorine dioxide, bleach (sodium hypochlorite), peracetic acid, lime solution, ozone gas and dry inorganic chemicals (e.g. calcium oxide powder). Chemical processes often require shredding, grinding or mixing to increase exposure of the waste to the chemical agent. In liquid systems, the waste may go through a dewatering section to remove and recycle the disinfectant. Besides chemical disinfectants, there are also encapsulating compounds that can solidify sharps, blood or other body fluids within a solid matrix before disposal. Another example of chemical processes is a system that uses heated alkali to digest tissue, pathological waste, anatomical parts and animal carcasses in heated stainless-steel tanks (South Africa, Department of Environmental Affairs & Tourism (DEAT), 2008).

Disinfection

Disinfection is defined as the process of eliminating or reducing disease-causing microorganisms (pathogens) to minimize the potential for disease transmission. The efficiency of the disinfection process depends on the operational conditions within treatment equipment (WHO, 2014).

Sterilisation

Sterilisation refers to any process that removes, destroys or deactivates all forms of microbial life and steam sterilisation is the most widely used process. Theoretically, the complete destruction of all microorganisms is unlikely, so logarithmic (log) reduction of a specified microorganism that is highly resistant to the treatment process is the standard used for quantifying sterilisation.

Generally, dental surgical instruments require effective sterilisation protocols of $6 \log_{10}$ (i.e. a 99.9999% reduction) or greater reduction. A $6 \log_{10}$ reduction, sometimes also written as “log-6 kill”, corresponds to a one cell in every million (0.000001) survival probability of the microbial population (WHO, 2014).

Irradiation technologies

Irradiation treatment encompasses processes that expose the HCW to radiation from electron beams, cobalt-60 or ultraviolet sources. It is therefore essential that shielding is provided to prevent elevated occupational exposure to the electromagnetic radiation. The pathogen destruction efficacy depends on the quantity of radiation absorbed by the waste mass. Electron beams are powerful enough to penetrate waste bags and containers. However, germicidal ultraviolet radiation is not able to penetrate closed waste bags but has been used to destroy airborne microorganisms as a supplement to other treatment technologies (WHO, 2014)).

Microwaving

It is a steam-based process where water contained in the waste is rapidly heated by microwave energy at a frequency of about 2450 MHz and a wavelength of 12.24 cm. The water converts to steam with temperatures reaching 100°C resulting in the microorganisms being killed in the process. (Mahasa & Ruhiiga, 2014).

Biological processes

Biological processes are found in natural living organisms but when applied to HCW treatment, these processes refer specifically to the degradation of organic matter. Some biological treatment systems make use of enzymes to speed up the destruction of pathogens in the organic waste. Two biological

processes are composting (decomposition of organic waste) and vermiculture (digestion of organic waste through the action of worms). They have been used successfully in the decomposition of hospital kitchen waste as well as other organic digestible waste and placenta waste. The natural decomposition of pathological waste through burial is another example of biological processes (DEAT, 2008).

Other suitable treatment methods for infectious waste include electro thermal deactivation and encapsulation.

Electro thermal deactivation, is a non-burning treatment method appropriate for most categories of waste, except anatomical and pharmaceutical waste. *Encapsulation* is when waste is confined in sealed containers and this method is used when there is no need to remove the waste material and/or the cost of removal is prohibitive. The main objective of containment is to prevent or control liquid or semi-liquid contaminated wastes from leaking or leaching into surrounding areas. Encapsulation is mainly recommended for hazardous liquid waste, like radioactive waste, which is highly toxic (WHO, 2014).

2.6.7 Disposal of treated waste

As a last resort, waste enters the least preferred and last level of the waste management hierarchy (DEA, 2011). If waste has to be disposed of, it should be done in the safest manner. Where the quantity of waste cannot be reduced during production, the purpose of implementing the waste management hierarchy is to use waste as a resource and divert these potential resources from landfill. Although landfill is widely considered the most affordable way to manage waste disposal, it does not take into account other factors, such as the environmental impact of landfills; the cost of developing and maintaining additional landfill capacity to accommodate the increasing rate of waste disposal and the cost of closing the landfill and remediating the site (WHO, 2014).

Knowing the type and quantity of waste produced at a HCF is an important first step in safe disposal. Whilst there are a number of companies offering various treatment and disposal methods, if the generation rate far outweighs the available treatment and disposal capacity, it may result in the HCF being noncompliant with the current legislation (Ramodipa, 2018).

In countries that have signed the Stockholm Convention, the emissions generated by incinerators should comply with national standards in accordance with the Stockholm Convention BAT and best environmental practices (BEP) guidelines. If the relevant authorities have not established such regulations, the BAT/BEP guidelines or international standards can be followed. In South Africa, HCW incinerators are classified as a listed activity in terms of the National Environmental Management: Air Quality Act and thus, in order for any HCW incinerator to operate legally, an atmospheric emission licence (AEL) is required. This ensures that strict emission standards apply to the emissions from such incinerators (South Africa, Air Quality Act, 2004)

In all waste systems, the removal of the remaining HCRW materials after minimisation or treatment requires access to land for final disposal. In less developed areas, a municipality or HCF without the capacity to treat waste before disposal, is reliant on the direct use of a landfill for much of the material produced. The alternative is the accumulation of HCRW at the health facility until it is openly burnt or spread around the facility's grounds. However, this constitutes a far higher risk of transmission of infection than controlled disposal in a land disposal site, even if the land disposal site is not designed to the precise standards used in higher income places (WHO, 2014b).

Two types of waste disposal onto land are common, namely uncontrolled dumping and controlled landfilling.

Uncontrolled dumping

Uncontrolled dumping is when deposits of waste are scattered without control at a site. It is a practice that almost always leads to critical pollution problems, fires and high risks for disease transmission. Depositing HCRW on or around uncontrolled dumps should be avoided due to the resultant negative health impacts on people and animals coming into contact with any infectious pathogens or hazardous materials (WHO, 2014).

Controlled landfilling

Controlled landfilling is characterised by better operating practices and design improvements to decrease health and environmental impacts. Firstly, there is “controlled dumping” where small control improvements can restrict environmental consequences and physical access to waste. Next is “engineered landfill” where evolving standards of engineering are used to improve geological isolation of wastes from the environment and to allow wastes to be covered daily. Disposing of certain types of HCRW (i.e. infectious and small quantities of pharmaceutical wastes) in engineered landfills is possible within the constraints of local regulations. A well-engineered landfill is designed to minimise contamination of soil, surface water and groundwater; limit atmospheric releases and odours; block access to waste by pests and vectors; and prevent contact with the public (WHO, 2014).

If a municipality or HCF is unable to treat waste before disposal, the use of a landfill is a realistic option to protect public health. A starting point can be to use an existing municipal waste site or suitable sites provided by private operators where disposal is done in a controlled manner. Scavenging must be prevented when municipal waste landfill is used for HCRW disposal.

In more developed situations, the residual material from treated HCRW is typically disposed of in landfill sites. However, treatment of HCW, disposal methods and financial challenges makes it difficult

for many municipalities to upgrade to more modern controlled landfills, but this is no reason for municipal authorities to abandon the move towards more regulated and safer land-disposal procedures. Essential features of regulated landfills include controlled access to the site; designated and supervised working areas for waste delivery; adequate sealing of the base and sides of the site to reduce the movement of wastewater off the site; adequate mechanisms for wastewater and leachate collection; and where necessary, treatment systems to reduce the pollution potential before the waste is discharged off-site (WHO, 2014).

Traditionally, ash from incineration is considered to be hazardous because it is very likely to contain heavy metals and may also include dioxins and furans. Ash should preferably be disposed of in sites specifically designed for hazardous wastes by being placed in designated cells at engineered landfills, encapsulated and placed in specialised monofill sites, or disposed of in an ash pit dug in the ground. Before HCRW is sent for disposal, it is advisable and sensible to ensure that the landfill site is sensibly controlled for waste deposition (WHO, 2014).

2.7 Conclusion

An efficient HCWM system has two important components, namely legislation and a comprehensive policy on segregation, transport, disposal and treatment of HCRW. Robust and comprehensive legislation governing HCWM needs to be in place. Every country has their own legislation with some countries, such as those in Europe and South Africa, adhering to their stringent regulations and standards but some undeveloped countries, mostly in Asia and Africa, do not. This literature review revealed that HCWM practices differ from one country to another and the studies showed that various countries do not prioritise HCWM (Manga *et al.*, 2011).

Segregation, minimisation and temporary storage are more easily implemented at most HCF and executed by the professionals and staff. Unfortunately the risks come with the treatment and disposal

processes as the waste is no longer in the hands of the generator, which means a potential loss of overall control. Waste services suffer from pervasive under-pricing, which means that the cost of waste management is not fully appreciated by consumers and due to the wrong set of incentives, the inexpensive waste disposal in landfill is preferred over more expensive options, such as waste treatment and incineration.

Chapter 3

Materials and methods

3.1 Introduction

In this chapter, the researcher focuses on the research design, study site, study population and the method used to collect and evaluate the data in line with the aims and objectives of the study research (Horrocks *et al.*, 2018). Healthcare waste management practices at dental healthcare facilities in the greater Tshwane region were explored. A questionnaire was used to collect data. Data analysis, reliability, validity, limitations and ethical considerations are also outlined.

Healthcare waste management (HCWM) is an integral part of a dental healthcare facility's hygiene, infection control and management. Education and practicing the chain of infection helps identify effective points at which disease transmission can be prevented. The safe management of healthcare waste (HCW) is the responsibility of all healthcare professionals (HCP) and staff at each healthcare facility. All personnel should understand how healthcare waste is classified, segregated, stored and collected before disposal.

Since 1993, it has been recommended that South African dental healthcare practitioners adhere to the infection control guidelines issued by the US Centers for Disease Control and Prevention (CDC) (CDC, 2003). But in 1998, Edward-Miller reported that many healthcare facilities in South Africa lacked basic services required for effective infection control, such as water and electricity, therefore making it difficult to adhere in any way to these recommendations (Oosthuysen *et al.*, 2010).

3.2 Study location

The City of Tshwane Metropolitan Municipality is the northern metropolitan municipality within the local government structure of the Gauteng province, South Africa. While the Metropolitan area is centred

on the city of Pretoria, a number of surrounding towns and local authorities are included in the local government area. The Metropolitan area covers an area of 6 298 km² and had an estimated population of 2,125 million in 2016 (Stats SA, 2019). The study centred on public and private dental healthcare facilities in central, eastern, western and northern Tshwane as well as one academic training institution in northern Tshwane.

Figure 3.1 shows the geographical map of Greater Tshwane, including some of the surrounding towns. The questionnaires were distributed within this study area.



Figure 3.1: Map of the City of Tshwane Metropolitan Municipality (Sourced from Metropolitan Municipality, 2017)

3.3 Study design

Study design refers to the framework that is created to find answers to the research questions thereby ensuring that it effectively addresses the research problem it represents as well as provide the blueprint for collecting and analysing the variables specified in the research problem (Trochim, 2007). In this descriptive and cross-sectional study design, a survey was conducted to investigate the relationship between risk factors and outcomes of interest, for a given population, with the purpose aimed at public health planning (Levin, 2006).

Phase 1 Planning

- Literature review of dental healthcare waste management knowledge, attitudes and practices;
- Draft questionnaire to address healthcare waste management;
- Pilot of the questionnaire to assess the reliability and validity; and
- Finalise questionnaire

Phase 2 Administration of questionnaire

- Issue and administer the questionnaire to dental healthcare practitioners, assistants and facility managers at dental healthcare facilities in order to explore the knowledge, determine attitudes and evaluate the healthcare waste management practices of staff working at dental healthcare facilities.

Phase 3 Data collection, analysis and interpretation

- Collect data;
- Capture the data in the questionnaire and then analyse; and
- Report and make recommendations to improve the current policies and evaluate the possibility of developing an integrated healthcare waste plan for dental healthcare facilities.

The three phases of the methodological approach to the research study design is illustrated in Figure 3.2.

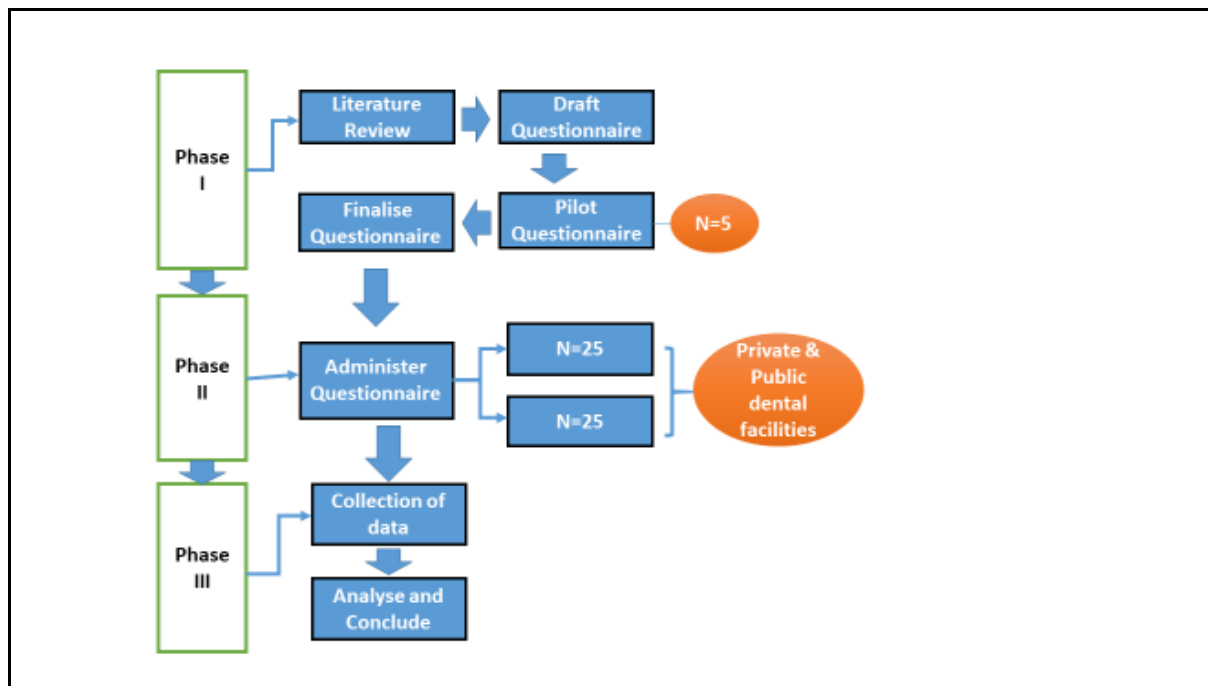


Figure 3.2: Three phases of the research study design

Phase 1: Planning

Phase 1 involved a literature review and drafting, piloting and finalising the questionnaire. Previous and relevant studies were adapted to form the basis of the draft questionnaire. The questionnaire was designed using closed ended questions. The draft questionnaire was reviewed by five panel members, which consisted of the researcher's two supervisors, a waste management specialist, one dental practitioner and a person from outside the dental healthcare field. The purpose of the questionnaire review was to establish the validity and reliability of the content of the questionnaire before presenting it to the pilot group.

Phase 2: Administration of questionnaire

After permission was granted from all relevant stakeholders, the ethics committees, research committees and employers, a questionnaire survey with 71 questions were distributed to respondents.

Three questions were duplication and two were irrelevant to the to the outcome of the survey, leaving the questionnaire with a total of 68 questions. The target population was to get 50 respondents. The questionnaire was given to 58 respondents of which six started but did not complete the survey. Eventually 52 respondents completed the survey. The questionnaire was distributed in two manners: the first batch of questionnaire were distributed electronically using QuestionPro® online survey software program Version 15 that was accessed online through the Central University of Technology (CUT) institutional licence from <https://www.questionpro.com/v15/> and the second batch were distributed in hard copies. The hard copies was for those who had challenges with computers/ laptops, signal or data. The hard copies allowed the interviewer to explain questions to the respondents experiencing challenges to understand. QuestionPro® enabled the researcher to facilitate online participation and for capturing of data from the online responses. The hard copies responses were inserted into the QuestionPro® program manually.

Phase 3: Data collection, analysis and interpretation

Staff working at dental healthcare facilities responded by completing the study questionnaire. This was a convenient sample as the researcher went from door to door of dental healthcare facilities to request participation from staff. The questionnaire survey link and hard copies were only sent or given to those who agreed to participate. Those who agreed to the terms and conditions gave their consent by signing the on the last page of the hard copy questionnaire or by means of responding on the electronic questionnaire. When the hard copy of the questionnaires were completed, they were each assigned a number to ensure anonymity. Then the different variables were captured on QuestionPro® online survey software in order to analyse the data and present results. The identified variables that were examined included: demographic information, knowledge on healthcare waste management, attitudes towards healthcare waste management and practices of healthcare waste.

3.3.1 Study population

The study population comprised of healthcare professionals employed in both public and private at dental healthcare facilities across the Tshwane region. The participants were all aged between 18 and 65. The study was not limited to a particular gender or race. The study population profession specific distribution is illustrated in table 3.1 below. Respondents that could understand, speak and read fair English were selected.

Table 3.1: Study population distribution

Male Population	Female Population	Dental Assistant	Dentist	Dental Therapist	Oral Hygienist	Public Sector	Private Sector
21%	73%	42%	23%	10%	6%	51%	49%

3.3.2 Analysis

A structured questionnaire was used and the respondents were healthcare professionals working at private and public dental healthcare facilities. The questionnaire schedule data was captured and cleaned prior to analysis by the researcher. After data was collected, the hard copy and electronic responses were captured and the data was cleaned before tabulating the frequency tables. A statistician assisted with data analysis and with the interpretation of the results.

3.3.3 Ethics

As research ethics govern the standards of conduct for scientific researchers, it is important to adhere to ethical principles in order to protect the dignity, rights and welfare of research participants (WHO, 2015).

Ethical clearance was obtained from the University of the Free State: Health Sciences Research Ethics Committee prior to collection of data (UFS-HSD2018/0782/2711). The study was approved by the

Faculty and Institutional Research Committees of the Central University of Technology, Free State. To safeguard the respondent's information and privacy, the researcher observed standard professional and ethical principles. In addition, the Gauteng Department of Health (GP_201810_054) gave permission to conduct the research in the City of Tshwane. The ethical clearance certificates are included as Appendices A and B.

3.3.4 Informed consent

Informed consent is a voluntary agreement by research participants to participate in a research study. It is not merely a form that is signed but it is a process central to the ethical conduct of the research as the participants are provided with an understanding of the research and its risks (Manti & Licari, 2018). Prior to participating in the study, participants received detailed information leaflets and consent forms.

A covering letter explaining the purpose and aim of the study was attached to the questionnaire (see Appendix D). After reading and agreeing to participate in the study, the participants signed on the last page of the letter.

3.3.5 Anonymity and confidentiality

The participants' anonymity was respected. They were treated as human beings and their freedom of choice was safeguarded. The participants were shown respect for their basic human rights as an individual human being and their dignity was respected. The researcher is professionally qualified to do this research and strived to be honest and fair at all times.

Confidentiality was recognised under all circumstances and all communication was conducted in English to ensure clarity and understanding of factual data. Consideration was given to emotional and

cultural values with no exploitation of vulnerable people and there was no undue advantage taken of any participant or the misuse of authority and influence.

All information obtained on hard copy was kept in a locked cabinet and electronic information was stored on a program that was password protected. No names were recorded and respondents were given an arbitrary number. The information that was obtained was utilised for the purpose intended. All records of the respondents will be kept for a period of five years and thereafter destroyed.

3.3.6 Voluntary participation

The consent was voluntarily without duress, coercion or bribery. Anyone could terminate their participation after giving consent without suffering any consequences. No harm was implied or caused to the respondents in the study. The collected data was only used for research study purposes.

3.3.7 Validity and reliability

Throughout the research study, validity and reliability were ensured by applying recognised and acceptable statistical procedures and methods. The questionnaire was pre-tested for reliability and validity. Data collection was done in English and the respondents were healthcare professionals conversant in English.

3.4 Conclusion

The questions posed and data generated during this study were aimed at the dental healthcare fraternities who were employees of an academic hospital, public and private dental healthcare facilities in the Greater Tshwane region. Data was collected from a convenience sample. Further studies may include larger geographical populations, such as the Gauteng province or even South Africa.

This chapter explains how data collection was planned and executed. The sample size was determined by the statistician. The data collected are described and discussed in the next chapter in order to give an in depth understanding of how healthcare waste management practices are viewed in the Oral healthcare industry.

Chapter 4

Knowledge, attitudes and practices towards dental healthcare waste management: Questionnaire construction

4.1 Introduction

This chapter outlines the data analysis based on the responses to the completed questionnaires on knowledge, attitudes and practices towards healthcare waste management by dental healthcare workers in the Greater Tshwane region. Data analysis was done using the QuestionPro® online survey software program. The results are presented as frequencies and percentages in tables, charts and graphs.

4.2 Construction of KAP dental healthcare waste management questionnaire

The draft questionnaire was constructed in different stages. It started off with the identification and selection of specific KAP dental healthcare waste management themes. Thereafter, the framework of the draft questionnaire was formed by adding a demographic section and general views in the sections on the selected dental healthcare waste management themes. Finally, various items that addressed the knowledge, attitudes and practices (KAP) domains within each section were added.

4.2.1 Themes in draft questionnaire

The literature reviewed revealed that various local and international dental healthcare waste management guidelines were based on guidelines and recommendations from prominent authorities, such as the South African Bureau of Standards (SABS), the Health Professions Council of South Africa (HPCSA) and the World Health Organization (WHO). From the literature review, ten waste management themes were identified and formed the framework of the draft questionnaire. Table 4.1

outlines and describes the healthcare waste management themes that were surveyed in the questionnaire.

Table 4.1: Waste management themes

Waste management themes	Description
1. Identification of the healthcare risk waste category	The management of healthcare risk waste shall start with the correct identification of the waste, followed by classification, segregation, collection and minimisation. The generators of the waste shall be responsible for the identification and segregation of the waste.
2. Segregation of the healthcare risk waste into an appropriate colour-coded container	The healthcare waste shall be segregated at the point of generation and shall be containerised to minimise the risk of contamination or pollution to the environment and humans.
3. Training in work procedures and work instructions	Waste management training received either formally or informally as well as frequency of refreshers courses, seminars or workshops that address waste management issues. Employees shall be trained in the correct identification and segregation of the waste.
4. Cleaning and disinfection	The range of infection control and healthcare waste management duties performed before, during and after the delivery of oral health care treatment to patients.
5. Correct use of facilities, equipment and personal protective equipment	The correct use of facilities, equipment and personal protective equipment when healthcare risk waste is segregated and contained at the point of generation (where applicable) and shall be the first step in the removal of the healthcare waste to its final disposal point.
6. Storage of the healthcare risk waste at the point of generation until its collection	Placement of healthcare waste in a suitable location or facility where isolation, environmental and health protection as well as human control (e.g. limitation of access) are provided with the intention that the waste will be subsequently retrieved for treatment or disposal (or both).
7. Transportation of the containerised healthcare risk waste for storage	Correct procedures for segregation, containerisation, storage and internal transportation of healthcare risk waste.
8. Transportation of the healthcare risk waste for treatment	When transported, all healthcare risk waste shall be packed and labelled in accordance with the guidelines for immediate and appropriate delivery to the waste disposal facility.
9. Healthcare risk waste treatment	Appropriate and safe disposal of all healthcare risk waste generated.
10. Final disposal of healthcare risk waste in accordance with relevant requirements and regulations	How the waste generated in the oral healthcare facilities is finally disposed of.

4.2.2 Sections in the draft questionnaire

As indicated in Table 4.2, the draft questionnaire was divided into ten sections with the first section surveying the respondents' demographic information. The other sections represented the identified KAP dental healthcare waste management themes.

Table 4.2: Sections in the draft questionnaire

Section number	Section names
1.	Demographic Information of Respondent
2.	Dental Healthcare Waste Management Training and CPD
3.	Classification of Dental Healthcare Waste (General, Chemical, Sharps & Infectious)
4.	Healthcare waste Generation and Minimisation
5.	Segregation and Storage
6.	Waste Administration
7.	Transport of waste material
8.	Waste Disposal
9.	Waste Treatment
10.	General Views of Dental Healthcare Waste Management

4.2.3 Items in the draft questionnaire

Various questions, also referred to as items, were added to each of the sections in the draft questionnaire. These items aimed to measure the respondents' knowledge, attitudes or practices (KAP) within the specific healthcare waste management theme. Instructions on how to respond to the items were provided.

Response options to the items measuring the different KAP domains varied. Items surveying knowledge required a yes, no or not sure response. The items measuring attitudes had a five-point Likert-type response rating of strongly disagree, disagree, neutral, agree and strongly agree. The

practice items examined whether any actions were performed or the frequency of the actions performed. Therefore, the responses to practice items was either yes/no or on a Likert type scale of always, often, seldom or never. However, further variation in the response rating occurred as some items required respondents to rank as well as arrange options in the correct order. Table 4.3 illustrates the number of items per KAP domain within each dental healthcare waste management theme in the draft questionnaire.

Table 4.3: Number of items across all sections

Sections of Draft questionnaire	Nr of items per domain			Total
	K	A	P	
1. Demographic Information of Respondents	N/A	N/A	NA	8
2. Dental Healthcare Waste Management Training and CPD	4	1	2	7
3. Classification of Dental Healthcare Waste (General, Chemical, Sharps & Infectious)	8	1	0	9
4. Healthcare waste Generation and Minimisation	0	0	4	4
5. Segregation and Storage	0	0	7	7
6. Waste Administration	1	0	6	7
7. Transport of waste	0	0	2	2
8. Waste Disposal	1	0	4	5
9. Waste Treatment	1	0	3	4
10. General Views of Dental Healthcare Waste Management	6	9	0	15
Total items per KAP domain	21	11	28	68

4.2.4 Suggested changes to the draft questionnaire

The draft questionnaire was scrutinised by various experts who made suggestions on improving the questionnaire. These review groups included academic staff and colleagues within the public and private oral healthcare field, including dentists, oral hygienists, dental assistants, as well as experts within the oral healthcare field. Several modifications, additions and/or deletions of items were suggested by reviewers and included. Feedback received from the reviewers was implemented to

improve the first draft of the questionnaire. The second draft of the questionnaire was then created in the QuestionPro® online survey software program so as to facilitate online participation and to ease the capturing of data from the hard copies as well as help in the transfer of data to MS Excel spreadsheets, PowerPoint and Word documents.

4.3 Description of the project and obtaining consent

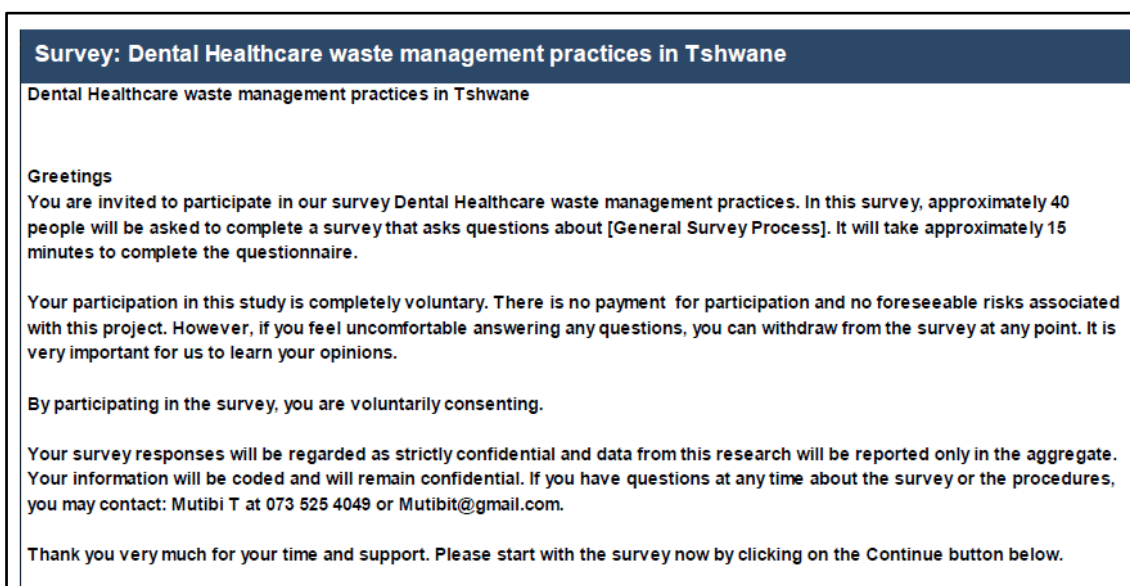
Constructing a valid and reliable questionnaire for this project involved several steps that explored the following aspects of dental healthcare waste management. Firstly, a good understanding of the research problem and objectives were gained through the review of literature on dental healthcare waste management at oral healthcare facilities. Several dental healthcare waste management themes were identified for the main framework of the questionnaire, including: Section 1: Demographic Information of Respondents; Section 2: Dental Healthcare Waste Management Training and Continuous Professional Development; Section 3: Classification of Dental Healthcare Waste (General, Chemical, Sharps and Infectious & Pathological); Section 4: Generation and Minimisation; Section 5: Segregation and Storage; Section 6: Waste Administration; Section 7: Transport; Section 8: Waste Disposal; Section 9: Waste Treatment ; Section 10: General Views of Dental Healthcare Waste Management.

The next step was to generate the items or statements in the questionnaire. Items that addressed specific knowledge, attitudes and practices (KAP) domains within dental healthcare waste management were added to the framework. This formed the first draft of the KAP dental healthcare waste management questionnaire.

The draft KAP dental healthcare waste management questionnaire was subjected to multiple reviews. In addition to the reviews done by the supervisor and co-supervisor, the questionnaire was also scrutinised by external expert subject reviewers. These reviewers included subject-matter experts at

private and public oral healthcare facilities as well as academic lecturers. Various aspects of the draft questionnaire were evaluated. Suggestions and recommendations from the reviewers were used to refine the draft questionnaire.

The revised KAP dental healthcare waste management questionnaire draft was administered to a pilot study population of five respondents. The results of this pilot study were not included in the final results of this study, but merely utilised to refine and improve the questionnaire. The data obtained in the pilot study was furthermore subjected to statistical analysis processes to measure the reliability and validity of the draft dental healthcare waste management questionnaire. The results of the statistical tests were used to make further refinements to the draft questionnaire. The final instrument was then done electronically by utilising the QuestionPro® online survey software program so as to facilitate online participation and to ease the capturing of data from the hard copies as well as help in the transfer of data to MS Excel spreadsheets, PowerPoint and Word documents. The first question included a general introductory section as well as the request to the participant for their consent and continuation to complete the questionnaire (Fig.4.1).



Survey: Dental Healthcare waste management practices in Tshwane

Dental Healthcare waste management practices in Tshwane

Greetings
You are invited to participate in our survey Dental Healthcare waste management practices. In this survey, approximately 40 people will be asked to complete a survey that asks questions about [General Survey Process]. It will take approximately 15 minutes to complete the questionnaire.

Your participation in this study is completely voluntary. There is no payment for participation and no foreseeable risks associated with this project. However, if you feel uncomfortable answering any questions, you can withdraw from the survey at any point. It is very important for us to learn your opinions.

By participating in the survey, you are voluntarily consenting.

Your survey responses will be regarded as strictly confidential and data from this research will be reported only in the aggregate. Your information will be coded and will remain confidential. If you have questions at any time about the survey or the procedures, you may contact: Mutibi T at 073 525 4049 or Mutibit@gmail.com.

Thank you very much for your time and support. Please start with the survey now by clicking on the Continue button below.

Figure 4.1: Introduction and consent required before completing the questionnaire

4.4 Demographic information of the participants

Eight aspects of the demographic profile were identified for investigation in the first section of the questionnaire.

4.4.1 Demographic profile of the respondents (Q2 – 9)

Table 4.4 lists the questions relating to the demographic profile of the respondents according to gender, age, English as language of communication as well as some demographic background on profession and education.

Table 4.4: Questions relating to demographic profile of respondents

Question	Description	Options
Q2	Gender	Female Male Other
Q3	Age	18–25 yrs. 26–35 yrs. 36–45 yrs. 46–55 yrs. 56–65 yrs. 65+ yrs.
Q4	English language	Yes No
Q5	Currently practicing as	Dentist Dental therapist Oral hygienist Dental assistant Practice manager Other University Other
Q6	Years practicing in profession	0–2 yrs. 3–5 yrs. 6–10 yrs. 11–15 yrs. 16–20 yrs. 20+ yrs.
Q7	Sector working in	Public dental clinic Public dental hospital Mobile clinic Dental health training institution

		Private sector: solo practice Private sector: multi-practitioner practice Private clinic
Q8	Location of main dental facility/ practice	City Suburb Rural area Township
Q9	Number of years practicing in dental healthcare facility	0–2 yrs. 3–5 yrs. 6–10 yrs. 11–15 yrs. 16–20 yrs. 20+ yrs.

4.5 Knowledge of healthcare waste management at dental healthcare facilities

The respondents, who were identified to complete the questionnaire, were comprised of dentists, dental therapists, oral hygienists, dental assistants and other staff members of the dental healthcare team working at the dental healthcare facilities. Table 4.5 tabulates the questions identified to assess knowledge of healthcare waste management at dental healthcare facilities referred to the participating respondent's understanding of the given topic or question and also the training received in this regard.

Table 4.5: Knowledge of healthcare waste management at dental healthcare facilities

Question	Description	Options
Q13	Educational training received	In-service training University Other
Q14	Continuous Professional Development (CPD) activities	Yes No Other
Q15	Current knowledge of dental healthcare risk waste management	Average Above average Excellent
Q16	Refreshing knowledge on dental healthcare risk waste management	Formal training at University Employment place Other colleagues Reading books and journals Doing internet search

		Attending CPD events
		None
		Other
Q21	Different categories of dental healthcare risk waste generated	Yes No Not sure
Q23	Specific colour coding used to dispose of different types dental healthcare risk waste	Yes No Not sure
Q24	Example of general waste	Used gauze Papers Used needles Not sure Other (used gloves)
Q25	Example of sharps waste	Fixer solution Papers Used needles Not sure Other
Q26	Example of infectious anatomical waste	Extracted tooth Papers Cotton used in patient's mouth Not sure Other (cotton)
Q27	Example of pathological infectious waste	Extracted tooth Papers Gauze used in patient's mouth Not sure Other
Q28	Example of chemical waste in dental healthcare facilities	Fixer solution Papers Used needles Not sure Other
Q29	Example of pharmaceutical waste	Expired medication Used needles Cotton used in patient's mouth Not sure Other
Q30	All healthcare risk waste generated in facility is hazardous	Yes No Not sure
Q34	Examination gloves is sufficient hand protective equipment when handling healthcare risk waste	Yes No Not sure
Q57	Healthcare risk waste should be disposed of in a specific prescribed manner	Yes No Not sure
Q60		Disagree Neutral

Burning/ incinerating healthcare risk waste is a safe waste treatment method	Agree Not sure
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4.6 Attitudes towards healthcare waste management at dental healthcare facilities

Table 4.6 provides the questions in the questionnaire covering attitudes as referring to the participant's feelings towards the subject as well as any pre-conceived ideas that they may have towards it. Attitudes may have an influence on practices and vice versa.

Table 4.6: Attitudes towards healthcare waste management at dental healthcare facilities

Question	Description	Options
Q18	Frequency of dental healthcare risk waste management training needed	Upon appointment as new staff member When facility implements new dental healthcare waste management material and equipment None of the above Other
Q22	Is it important to separate dental healthcare risk waste generated in dental healthcare facilities into different categories?	Yes No No sure
Q64	Dental healthcare waste management processes a waste of time	Disagree Neutral Agree Not sure
Q65	Dental healthcare waste management and control a waste of money	Disagree Neutral Agree Not sure
Q66	Effective waste management and control products expensive	Disagree Neutral Agree Not applicable Not sure
Q69	Lack of guidance with regards to waste management and control procedures, makes it difficult to execute effective dental healthcare waste management and control procedures	Disagree Neutral Agree Not applicable Not sure

Q71	Dental healthcare waste management is a team effort	Disagree Neutral Agree Not sure
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4.7 Practices of healthcare waste management at dental healthcare facilities

The questions in the questionnaire covering practices of healthcare risk waste management refer to the ways that knowledge and attitudes are demonstrated through actions at dental healthcare facilities (Table 4.7).

Table 4.7: Practices of healthcare waste management at dental healthcare facilities

Question	Description	Options
Q10	Person overseeing quality control and management of the dental healthcare risk waste in facility	Owner/s Dentist Dental assistant Cleaning personnel Other
Q11	Person executing actual procedures of dental healthcare risk waste in facility	Owner/s Dentist Dental assistant Cleaning personnel Other
Q19	Written dental healthcare risk waste management plan/ guideline/ manual for dealing with accidents or incidents	Yes No Not sure Not applicable Other
Q20	Use the dental healthcare risk waste management plan/ guidelines/ manual when the need arises	Yes No Not sure Not applicable Other
Q42	Dental facility you work at, segregate waste at the place of creation	Yes No Not applicable Not sure Other
Q43	Colour container for general waste	Black/clear

		Green Red Yellow Not sure Not applicable Other
Q44	Colour container for sharps waste	Black/clear Green Red Yellow Not sure Not applicable Other
Q45	Colour container for infectious anatomical waste	Black/clear Green Red Yellow Not sure Not applicable Other
Q46	Colour container for extracted teeth with silver amalgam restorations	Black/clear Green Red Yellow Airtight container w/water Not sure Not applicable Other
Q47	Colour container for pharmaceutical waste	Black/clear Green Red Yellow Not sure Not applicable Other
Q48	How/where do you dispose of fixer solution?	Down the drain with water Chemical waste collection Not sure Not applicable Other
Q49	How/where do you dispose of developer solution?	Down the drain with water Chemical waste collection Not sure Not applicable Other
Q51	Make use of the services of a registered and accredited healthcare waste removal company	Yes No Not sure
Q52	Facility / practice keep records of different healthcare risk waste generated in facility	Yes No

		Other
Q53	Facility / practice keep signed records of waste collected by a registered healthcare risk waste removal company	Yes No Other
Q54	Formal training on transportation of healthcare risk waste	Yes No Other
Q55	Staff transport healthcare risk waste e.g. containers with used sharps	Yes No Other
Q56	Received formal training on healthcare risk waste disposal and treatment	Yes No Other
Q58	Facility treat and dispose of their waste generated themselves	Yes No Not sure
Q59	Know how and where healthcare risk waste generated is being treated and disposed of	Yes No Not applicable Not sure

4.8 Discussion

The literature review regarding the knowledge, attitudes and practices towards dental healthcare waste management did not reveal a standardised instrument which could be applied to capture data in this research. In addition to this, consultation with the supervisors of this study and experts in dental healthcare confirmed the need for an instrument, which would be suitable to address the aims and objectives of this research project, to be developed. The development process of the newly developed knowledge, attitudes and practices towards dental healthcare waste management questionnaire was based on the experience of numerous researchers who have published information about questionnaire development. The length of the questionnaire was identified as a possible constraint to participating in the study. Therefore, every effort was made to limit questions to a minimum without sacrificing crucial aspects of the knowledge, attitudes and practices required for dental healthcare waste management surveyed across the three domains. The questionnaire was structured in such a

manner that each section was reasonably short and the response required just a tick in a block. During the pilot study, the time taken to complete the questionnaire ranged between 15 – 20 minutes.

It is thus concluded that a valid and reliable knowledge, attitudes and practices towards dental healthcare waste management questionnaire was constructed. This instrument can be utilised to survey the knowledge, attitudes and practices towards dental healthcare waste management in the future. Furthermore, this instrument can also be applied to future research investigating the knowledge, attitudes and practices towards dental healthcare waste management. Expanded to a broader data base, this questionnaire can enable researchers to also associate findings from similar studies conducted on national and international levels.

Chapter 5

Knowledge, attitudes and practices towards dental healthcare waste management in the Greater Tshwane region

5.1 Introduction

This chapter outlines the results and data analysis of responses from dental healthcare professionals participating in this study. The results are presented as frequencies and percentages in tables, charts and graphs. The questionnaire was distributed to 58 respondents, of whom 6 started but did not complete the survey. A total 52 respondents completed the survey, representing a response rate of 90% (Figure 5.1).

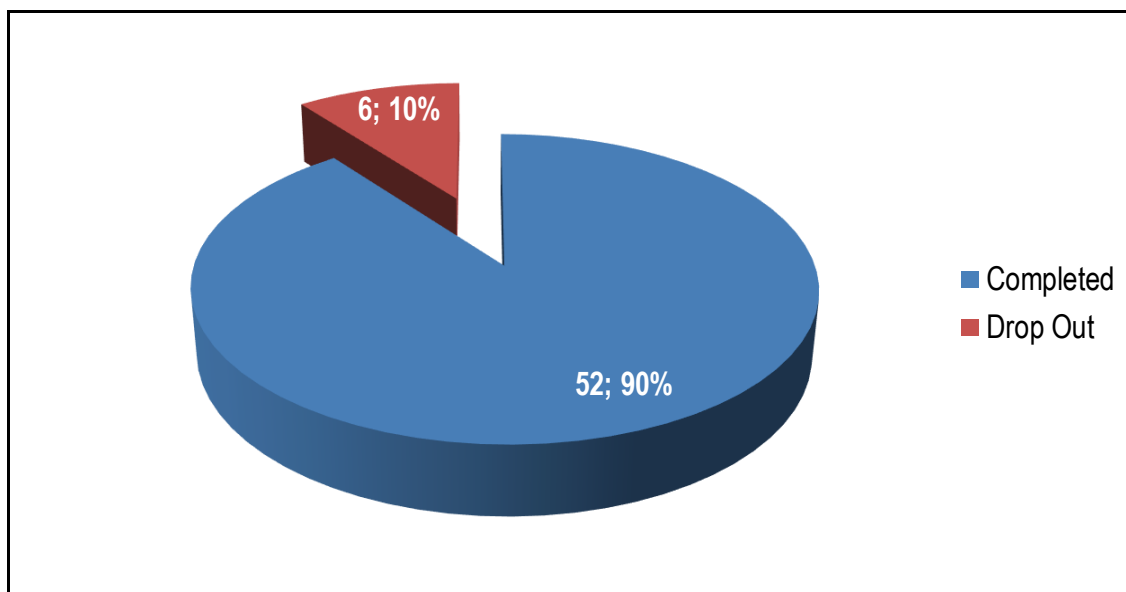


Figure 5.1: Survey completion / drop out overview

The questionnaire, consisting of a total of 71 questions initially, of which 3 questions were eliminated, leaving 68 questions, to be completed by the respondents. The average time recorded to complete the survey was 14 minutes (Figure 5.2).

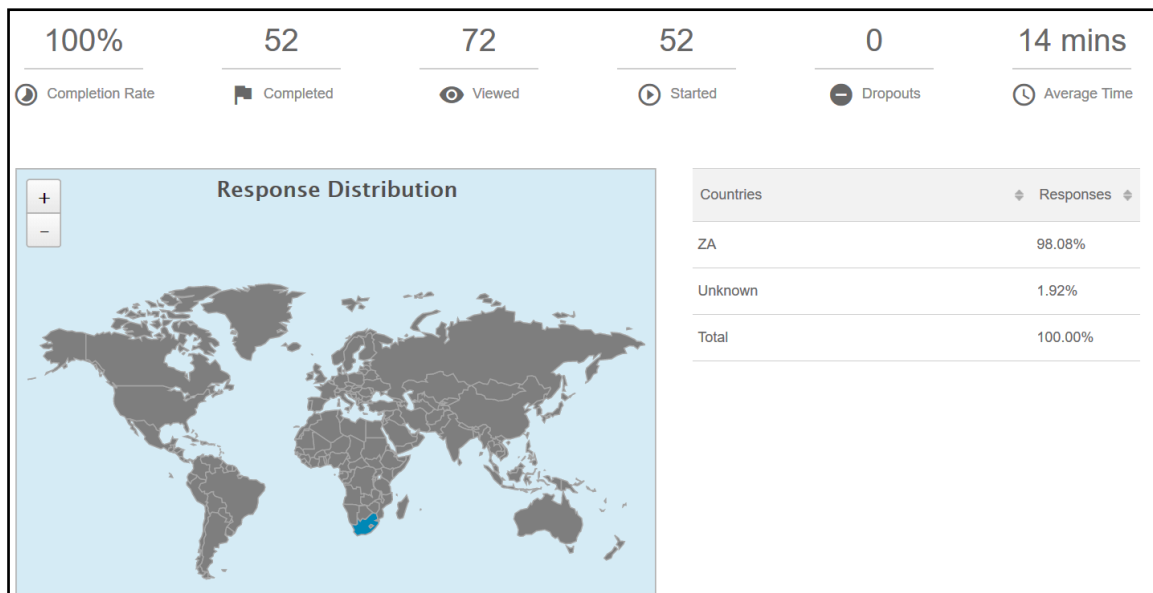


Figure 5.2: Survey response distribution overview

5.2 Background and consent of the participants

The biographical information was obtained directly from the respondents and data collected was representative of the facility where they worked. This research selected only participants who were of working adults in the 18 to 65 age range. Information was obtained from 52 respondents. The majority, approximately two-thirds of the respondents, were female in the 36 to 45 age range. The highest number of respondents were represented by dental assistants, followed by dentists (Table 5.1). The facilities included in the research were Sefako Makgato Oral Health Centre, Kalafong Hospital, Fokateng Hospital (Pretoria West) and K.T. Motubatse Clinic as well as some private dental healthcare facilities that requested to remain anonymous and not have their practice names mentioned. The research focussed on the knowledge, attitudes and practices (KAP) towards dental healthcare waste management (HCWM) as the three variables directly impact HCWM.

As research ethics govern the standards of conduct for scientific researchers, it is important to adhere to ethical principles in order to protect the dignity, rights and welfare of research participants (WHO, 2015). Informed consent is a voluntary agreement by research participants to participate in a research

study. In this study, permission was first obtained from the employer and then secondly from the employee who then became the respondent in the research.

5.3 Demographic information of the participants

The study was conducted in the Greater Tshwane region, around the city formally known as Pretoria or the Jacaranda City. Tshwane is located in the Gauteng province. The participants were drawn from one dental academic hospital, two public hospitals and one clinic with dental facilities as well as private dental healthcare practices for this study. Only employed professionals from the dental healthcare facilities were included in the study. No students or volunteers were approached to participate.

Eight demographical aspects were investigated in the first section of the questionnaire. It was necessary to establish the profiles as the demographics of the respondents may have influenced the findings. This chapter presents results and discussions from the completed questionnaires. The results of questions relating to the aspects of their profiles are covered.

5.3.1 Demographic profile of the respondents (Q2 – 9)

Table 5.1 summarises the statistics relating to the demographic profile of the respondents and the corresponding frequency distribution. The table shows the frequency distribution of respondents who completed the questionnaire according to gender, age, English as language of communication, as well as some demographic background on profession and education. Almost three quarters of the respondents were female and a quarter were male, all within the 18 to 65 age group. Respondents indicated that they could read and understand English well. It was only picked up from the results that there is a possibility of one candidate that could not read or understand English very well. Of the respondents, more than a third ($n=17$) fell in the mature age group of 36 – 45 years old. More than a quarter of the respondents (26.32%) had received in-service training, while the majority (68.42%) had

been to University. Only 5% of the respondents had other types of training in their relevant profession. Of the respondents, 13.46% (n=7) worked at a public dental hospital and just below 40% (n=20) at dental healthcare training institutions. Almost half of the respondents (n=25) worked in the private sector, including 36.54% in solo practice, 7.69% in multi-practitioner practice and 3.85% in private clinics. Almost half of the respondents (46.15%) worked at a dental healthcare facility in the city, less than one-fifth (19.23%) in the suburbs and more than a third (34.62%) in townships. They had been working at these facilities between 6 months to 20 years or more, with the majority between 3 – 5 years.

Table 5.1: Frequency distribution and demographic profile of respondents

Question	Description	Options	Count (n)	Percentage (%)
Q2	Gender	Female	38	73.00
		Male	11	21.00
		Other	3	6.00
Q3	Age	18–25 yrs.	7	13.00
		26–35 yrs.	11	21.00
		36–45 yrs.	17	33.00
		46–55 yrs.	8	15.00
		56–65 yrs.	9	17.00
		65+ yrs.	0	0.00
Q4	English language	Yes	51	98.00
		No	1	2.00
Q5	Currently practicing as	Dentist	12	23.08
		Dental therapist	5	9.62
		Oral hygienist	3	5.77
		Dental assistant	22	42.31
		Practice manager	0	0.00
		Other	10	19.23
		University	39	75.00
		In service training	10	19.23
		Other	3	5.77
Q6	Years practicing in profession	0–2 yrs.	5	9.62
		3–5 yrs.	10	19.23
		6–10 yrs.	12	23.08
		11–15 yrs.	8	15.38
		16–20 yrs.	8	15.38
		20+ yrs.	9	17.31
Q7	Sector working in	Public dental clinic	0	0.00
		Public dental hospital	7	13.46
		Mobile clinic	0	0.00

		Dental health training institution	20	38.46
		Private sector: solo practice	19	36.54
		Private sector: multi-practitioner practice	4	7.69
		Private clinic	2	3.85
Q8	Location of main dental facility/ practice	City	24	46.15
		Suburb	10	19.23
		Rural area	0	0.00
		Township	18	34.62
		Other	0	0.00
Q9	Number of years practicing in dental healthcare facility	0–2 yrs.	12	23.08
		3–5 yrs.	13	25.00
		6–10 yrs.	12	23.08
		11–15 yrs.	2	3.85
		16–20 yrs.	5	9.62
		20+ yrs.	8	15.38

More than 40% of the respondents were dental assistants, more than 20% were dentists, almost 10% were dental therapists, just below 6% were oral hygienists and less than 20% were other healthcare professionals working at a dental healthcare facility (Figure 5.3).

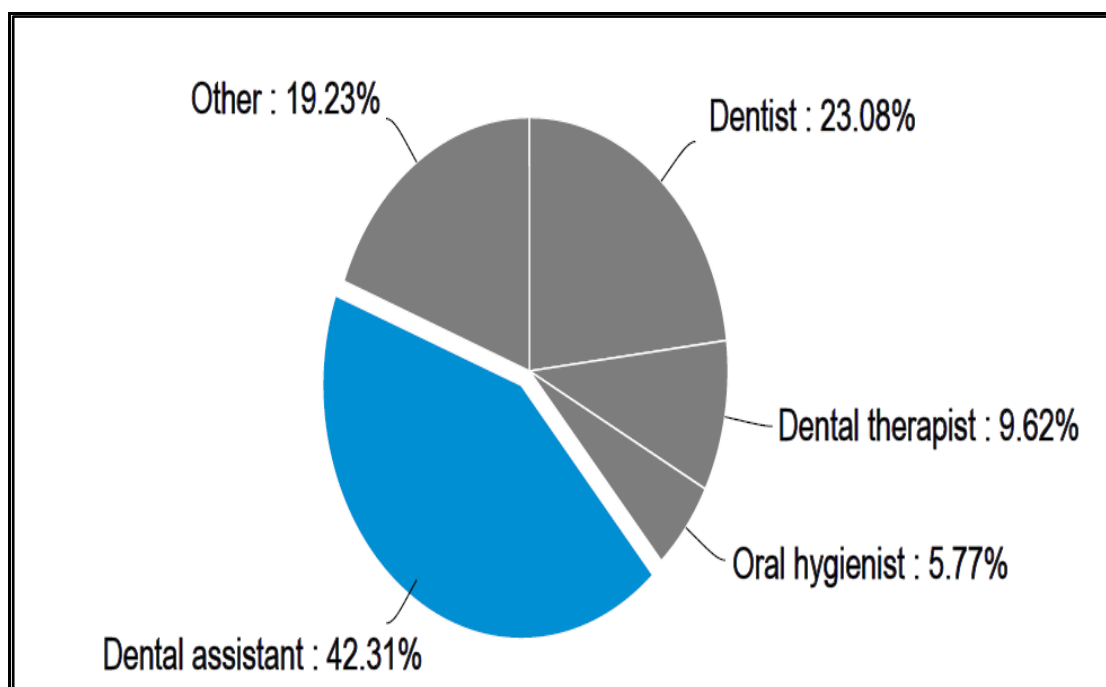


Figure 5.3: Occupations of respondents

5.4 Knowledge of healthcare waste management at dental healthcare facilities

The 52 respondents, who completed the questionnaire, were comprised of 12 dentists (23.08%), 5 dental therapists (9.62%), 3 oral hygienists (5.77%), 22 dental assistants (42.31%) and 10 other staff members (19.23%). The other staff members included an unregistered dental assistant, support staff, a clerk, a professional nurse in dental theatre and dental assistant lecturers. The knowledge of healthcare waste management at dental healthcare facilities referred to the participating respondent's understanding of the given topic or question. In this study, the participating respondents ranged from dentists, dental therapists, oral hygienists, dental assistants and a nurse with formal Higher Education training to those dental healthcare staff members who had only received in-service training. Table 5.2 provides the frequency distribution and knowledge profile of the respondents, of whom 75% had formal University qualifications. It is however, very alarming that despite these formal qualifications, almost the same percentage of respondents were unaware that examination gloves are insufficient as hand protective equipment when handling healthcare risk waste.

Table 5.2: Frequency distribution and knowledge profile of respondents

Question	Description	Options	Count (n)	Percentage (%)
Q13	Educational training received	In-service training	10	19.23
		University	39	75.00
		Other	3	5.77
Q14	Continuous Professional Development (CPD) activities	Yes	38	73.08
		No	12	23.08
		Other	2	3.85
Q15	Current knowledge of dental healthcare risk waste management	Average	30	57.69
		Above average	16	30.77
		Excellent	6	11.54
Q16	Refreshing knowledge on dental healthcare risk waste management	Formal training at University	8	8.00
		Employment place	22	22.00
		Other colleagues	11	11.00

		Reading books and journals	11	11.00
		Doing internet search	18	18.00
		Attending CPD events	23	23.00
		None	5	5.00
		Other	2	2.00
Q21	Different categories of dental healthcare risk waste generated	Yes	48	92.00
		No	1	2.00
		Not sure	3	6.00
Q23	Specific colour coding used to dispose of different types dental healthcare risk waste	Yes	40	93.02
		No	1	2.33
		Not sure	2	4.65
Q24	Example of general waste	Used gauze	7	14.00
		Papers	43	84.00
		Used needles	0	0.00
		Not sure	0	0.00
		Other (used gloves)	1	2.00
Q25	Example of sharps waste	Fixer solution	0	0.00
		Papers	0	0.00
		Used needles	51	100.00
		Not sure	0	0.00
		Other	0	0.00
Q26	Example of infectious anatomical waste	Extracted tooth	46	88.00
		Papers	0	0.00
		Cotton used in patient's mouth	4	8.00
		Not sure	0	0.00
		Other (cotton)	2	4.00
Q27	Example of pathological infectious waste	Extracted tooth	27	52.00
		Papers	0	0.00
		Gauze used in patient's mouth	23	44.00
		Not sure	0	0.00
		Other	2	4.00
Q28	Example of chemical waste in dental healthcare facilities	Fixer solution	51	98.00
		Papers	0	0.00
		Used needles	1	2.00
		Not sure	0	0.00
		Other	0	0.00
Q29	Example of pharmaceutical waste	Expired medication	50	98.00
		Used needles	1	2.00
		Cotton used in patient's mouth	0	0.00
		Not sure	0	0.00
		Other	0	0.00
Q30		Yes	42	81.00
		No	9	17.00

	All healthcare risk waste generated in facility is hazardous	Not sure	1	2.00
Q34	Examination gloves is sufficient hand protective equipment when handling healthcare risk waste	Yes	35	67.00
		No	16	31.00
		Not sure	1	2.00
Q57	Healthcare risk waste should be disposed of in a specific prescribed manner	Yes	44	85.00
		No	2	4.00
		Not sure	6	12.00
Q60	Burning/ incinerating healthcare risk waste is a safe waste treatment method	Disagree	3	6.82
		Neutral	2	4.55
		Agree	25	56.82
		Not sure	14	31.82

5.4.1 Attendance at Continuous Professional Development activities and knowledge refreshment (Q12, 14 and 16)

Most respondents (n=38) indicated that they regularly attend CPD activities, less than a quarter (n=12) of the respondents indicated that they do not attend, while only two respondents indicated that they are not obliged to attend (Fig. 5.4). One of these two respondents indicated that they assisted a periodontist from time to time and sometimes did online activities, while the other felt no need to attend CPD activities.

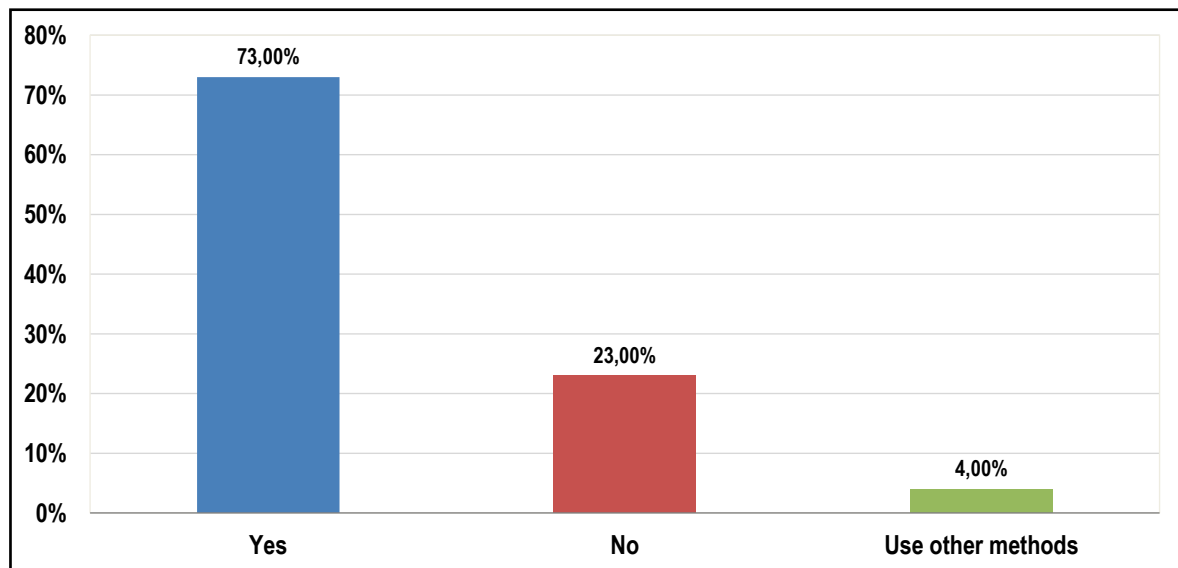


Figure 5.4: Respondents' attendance at Continuous Professional Development activities

On the other hand, one respondent made the remark: "I believe it is important to give dental personnel more training and improve the way of taking care of the dental waste". Respondents further indicated they refreshed their knowledge of dental HCRW management by attending formal training at University (8%) and 22% refreshed their knowledge at their places of employment (Fig. 5.5). Some respondents (11%) refreshed their knowledge from information shared with colleagues, by reading books and journals while less than a fifth (18%) from searches on the internet. Most (23%) was from attending CPD events with 5% by other methods. Only one respondent did not feel the need to refresh their knowledge.

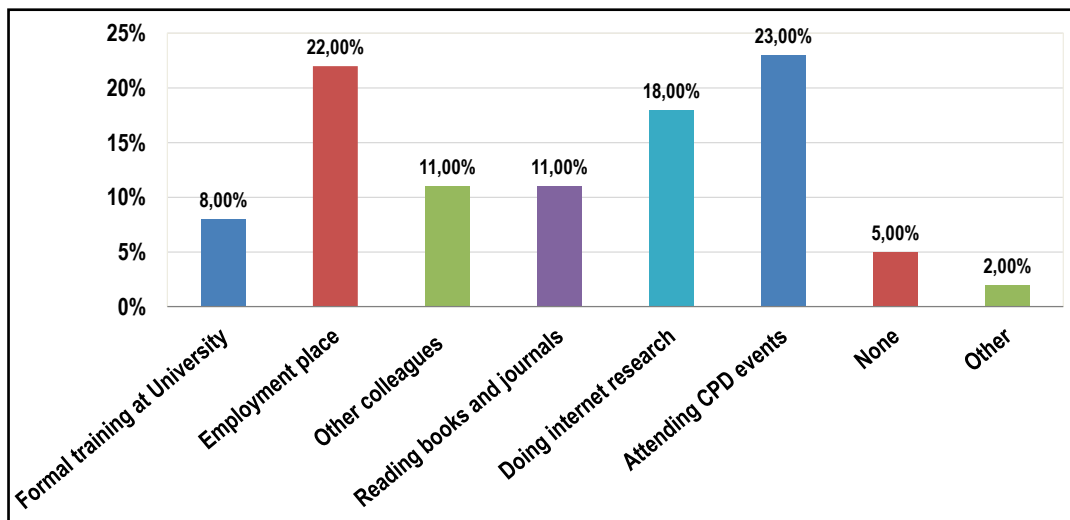


Figure 5.5: Activities by respondents to refresh their knowledge

5.4.2 Personal rating of dental HCWM knowledge (Q15)

Most of the respondents, almost two-thirds, felt that their knowledge of dental HCWM is only average. More than a third of the respondents felt confident with above average knowledge and just above a tenth with excellent knowledge (Fig. 5.6).

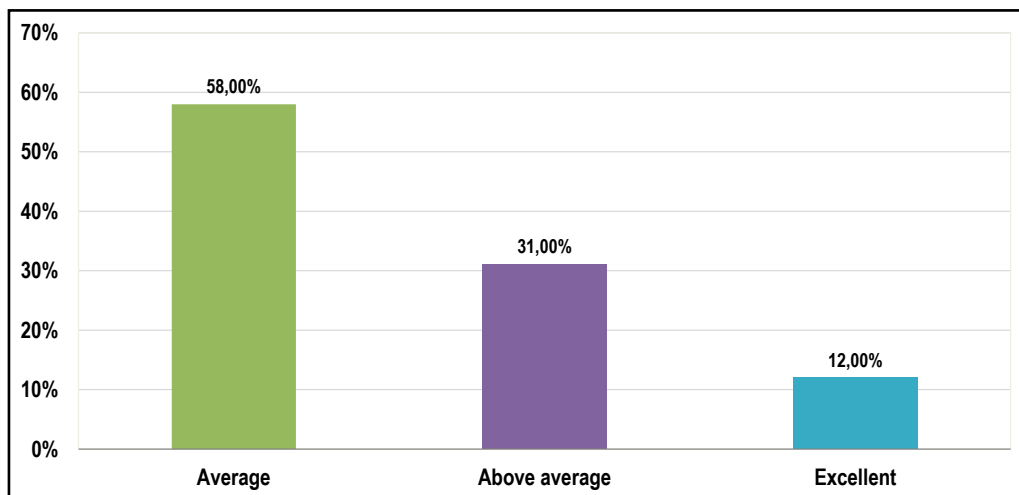


Figure 5.6: Respondents' personal rating of dental HCWM knowledge

5.4.3 Knowledge of HCRW categories (Q21)

The majority of the respondents (n=48) knew that there are different categories of dental HCRW, only one was unaware of this fact, while three respondents indicated that they were not sure about this (Fig. 5.7).

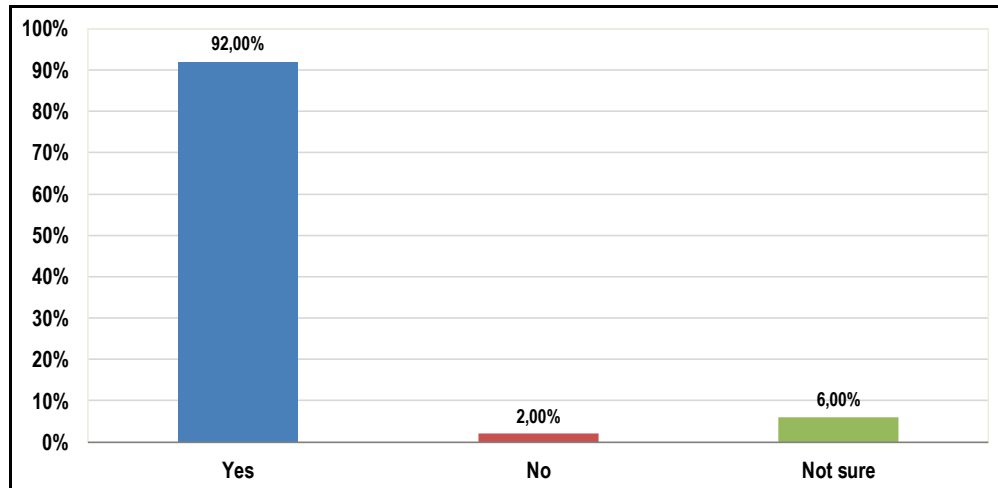


Figure 5.7: Knowledge of the different categories of dental healthcare risk waste

5.4.4 Knowledge of HCRW disposal colour coding (Q23)

The majority of respondents (n=49) knew that different colour coding is used to dispose of HCRW. However, one respondent did not know and two were not sure of the HCRW disposal colour coding system (Fig. 5.8).

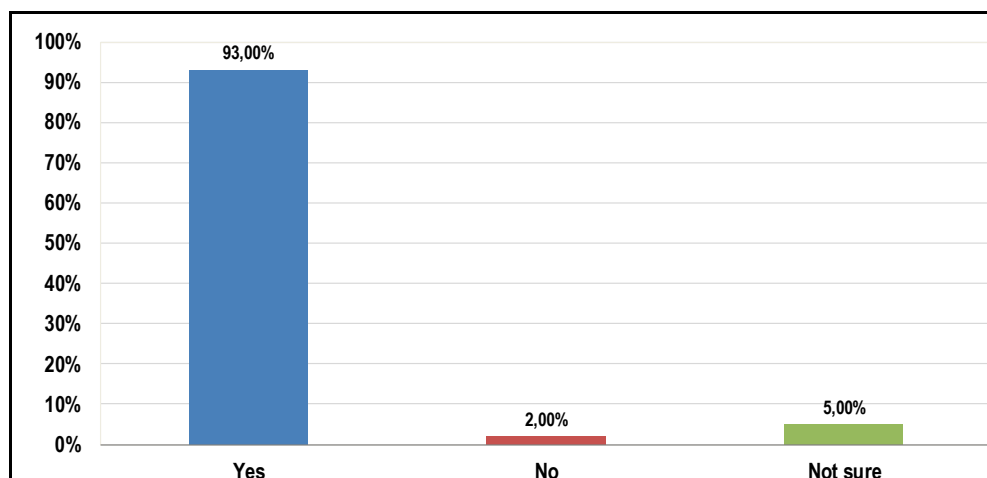


Figure 5.8: Knowledge of specific colour coding used when disposing different types of dental healthcare risk waste

5.4.5 Knowledge of types of HCRW (Q24 – 29)

The majority of respondents (83.31%) said paper was an example of general waste. However, seven respondents (13.73%) incorrectly identified used gauze as general waste and one respondent named used gloves as general waste (Fig. 5.9).

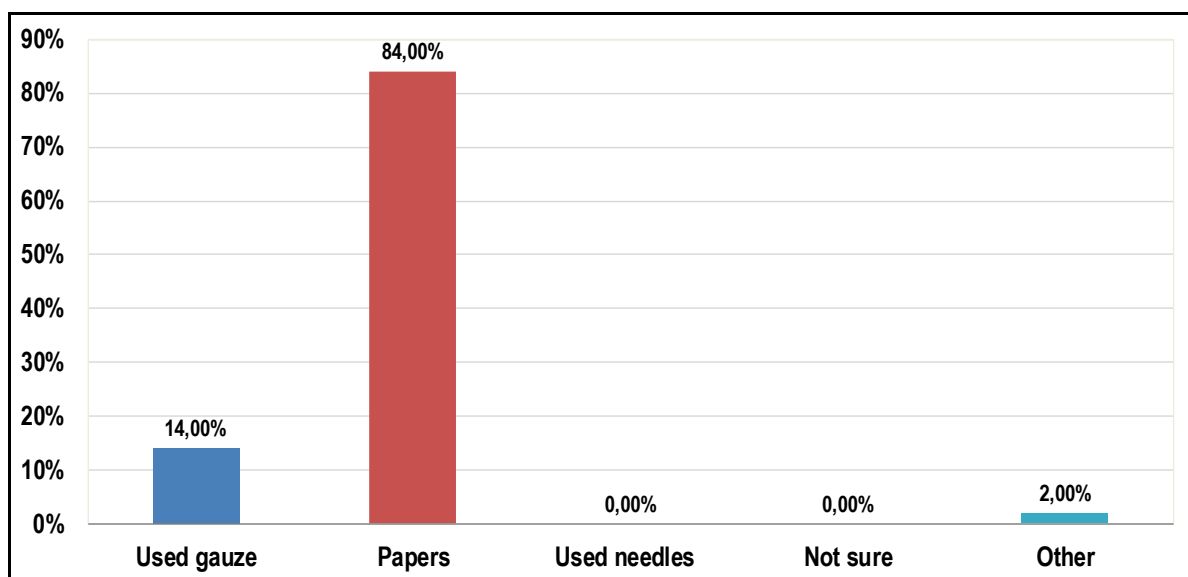


Figure 5.9: Knowledge of general waste

All respondents were familiar with the example of sharps waste that included used needles (Fig. 5.10).

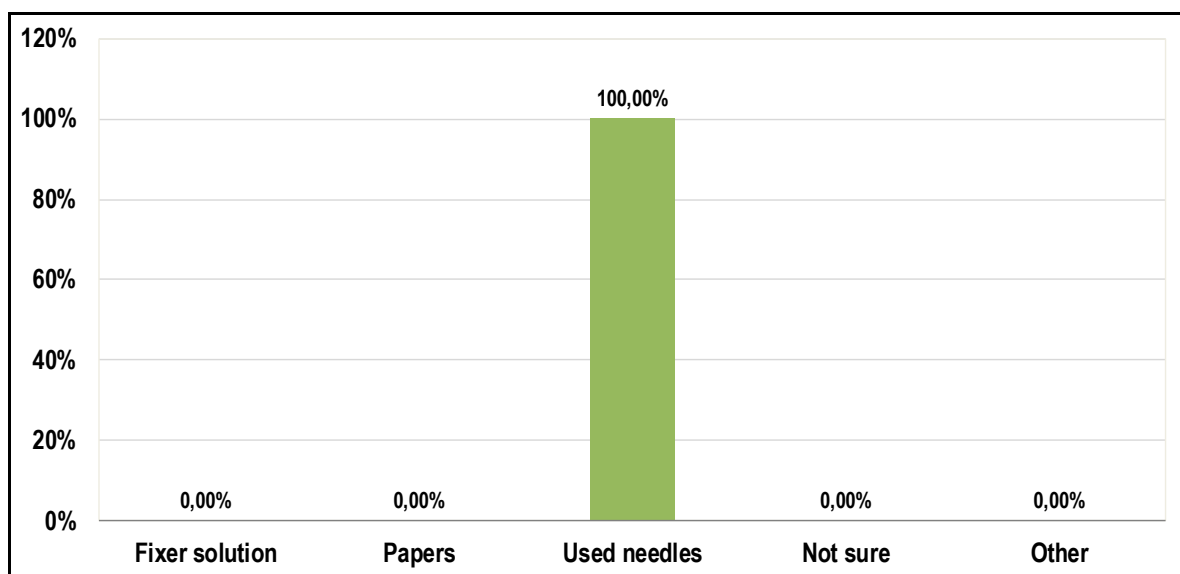


Figure 5.10: Knowledge of sharps waste

The majority of respondents (88.46%) identified the example of infectious anatomical waste as an extracted tooth, but four (7.69%) included cotton used for patient care and two (3.85%) included cotton under other (Fig. 5.11). Thus, it is safe to say all respondents correctly identified infectious waste, however, some incorrectly included cotton used for patient care as anatomical waste.

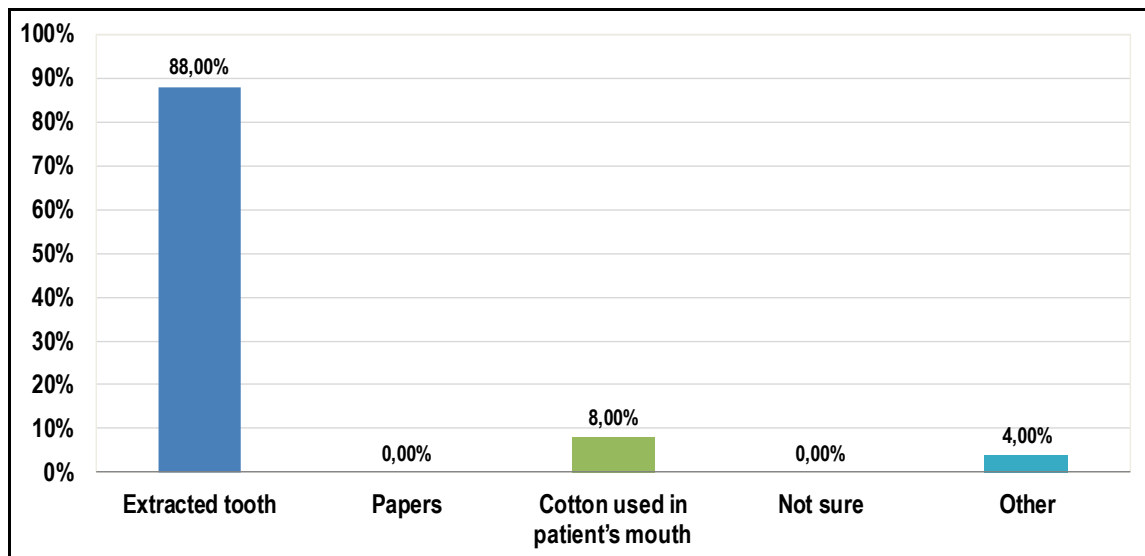


Figure 5.11: Knowledge of infectious anatomical waste

Of the respondents, 27 (51.92%) identified an example of pathological infectious waste as the extracted tooth, 23 (44.23%) included gauze used for patient care and two respondents (3.85%) included the extracted tooth under other (Fig. 5.12).

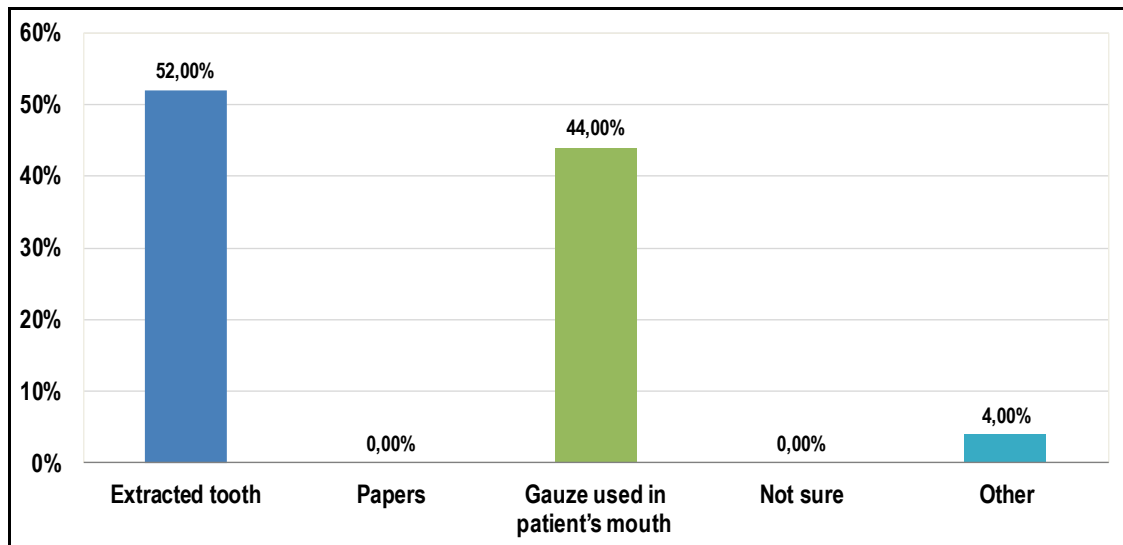


Figure 5.12: Knowledge of pathological infectious waste

The majority of the respondents (98%) said an example of chemical waste at the dental healthcare facility is fixer solution, while 2% thought it was the extracted tooth (Fig. 5.13).

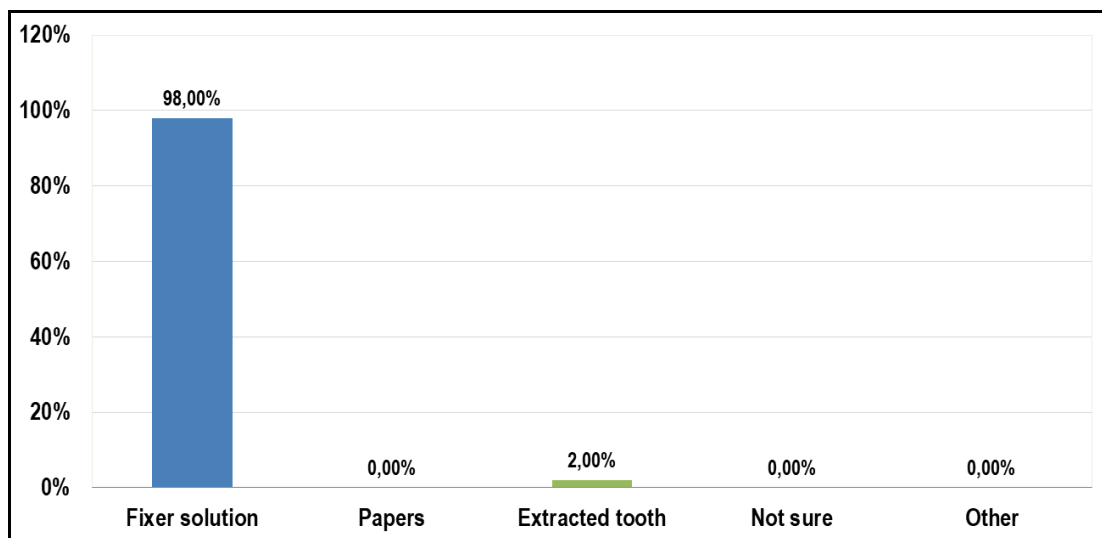


Figure 5.13: Knowledge of chemical waste

The same 98% of the respondents said an example of pharmaceutical waste was expired medication and 2% thought it was used needles (Fig. 5.14).

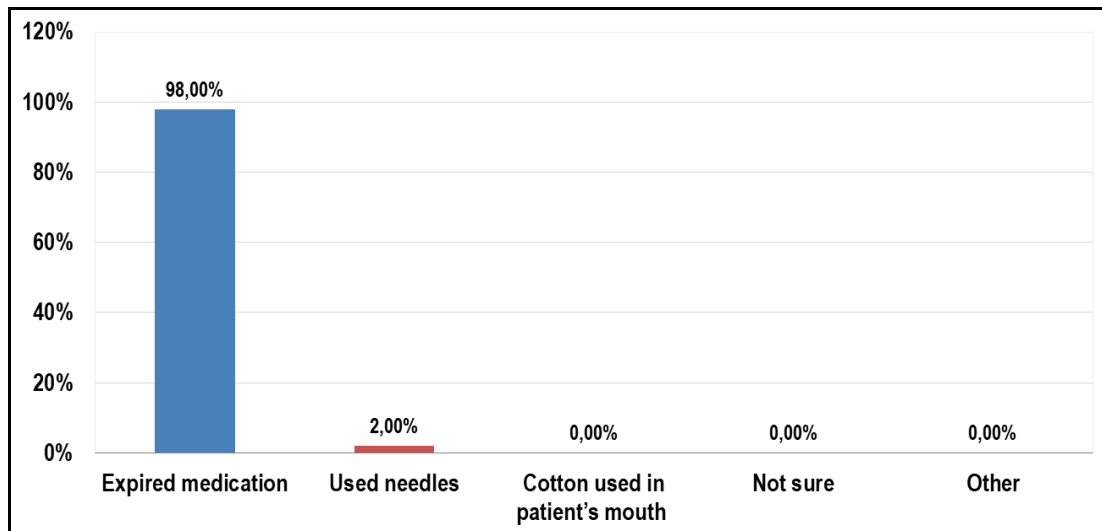


Figure 5.14: Knowledge of pharmaceutical waste

The majority of the respondents (81%) felt that the HCW generated at their workplace is hazardous, while the minority (17%) felt the contrary and 2% were not sure (Fig. 5.15).

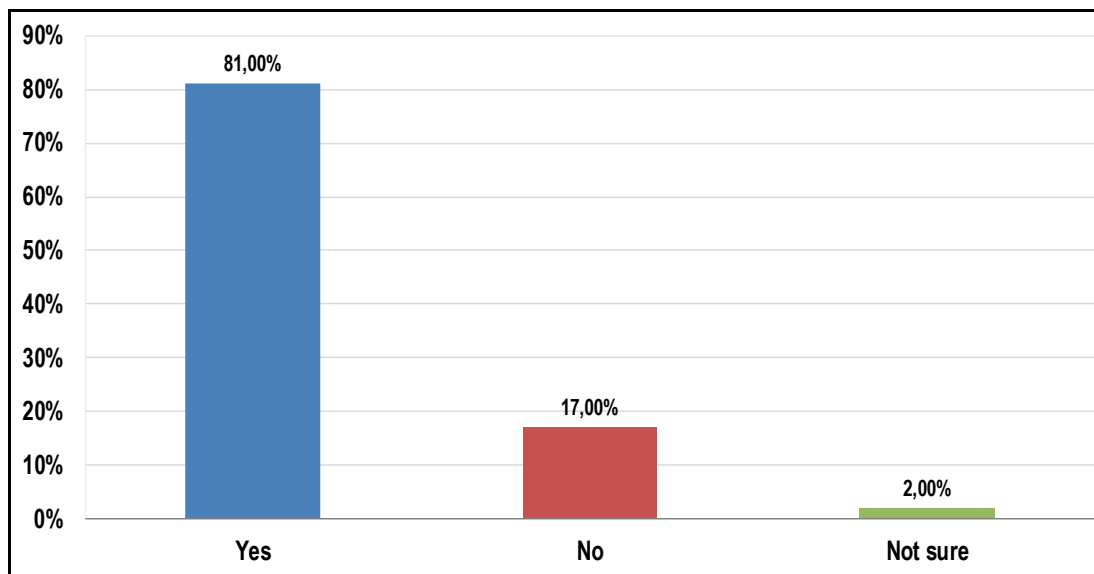


Figure 5.15: Knowledge that hazardous waste is generated at workplace

5.4.6 Knowledge of HCRW disposal and treatment (Q57 and 60)

The majority of respondents (85%) said HCRW should be disposed of in a specific prescribed manner, 4% said HCRW did not require a specific method of disposal and above 12% were not sure (Fig. 5.16).

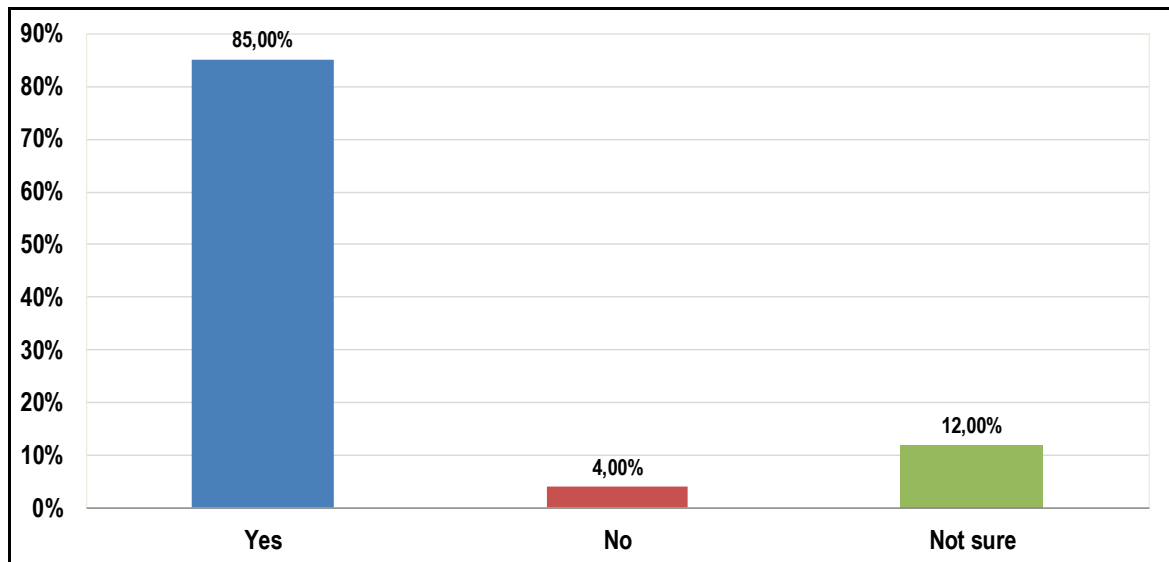


Figure 5.16: Knowledge of HCRW disposal

More than half (57%) of the respondents agreed that burning/incineration was a safe waste treatment method for HCRW, about a third (32%) of the respondents were not sure about the matter and 7% disagreed. This information is an indication that there is a lack of knowledge (Fig. 5.17).

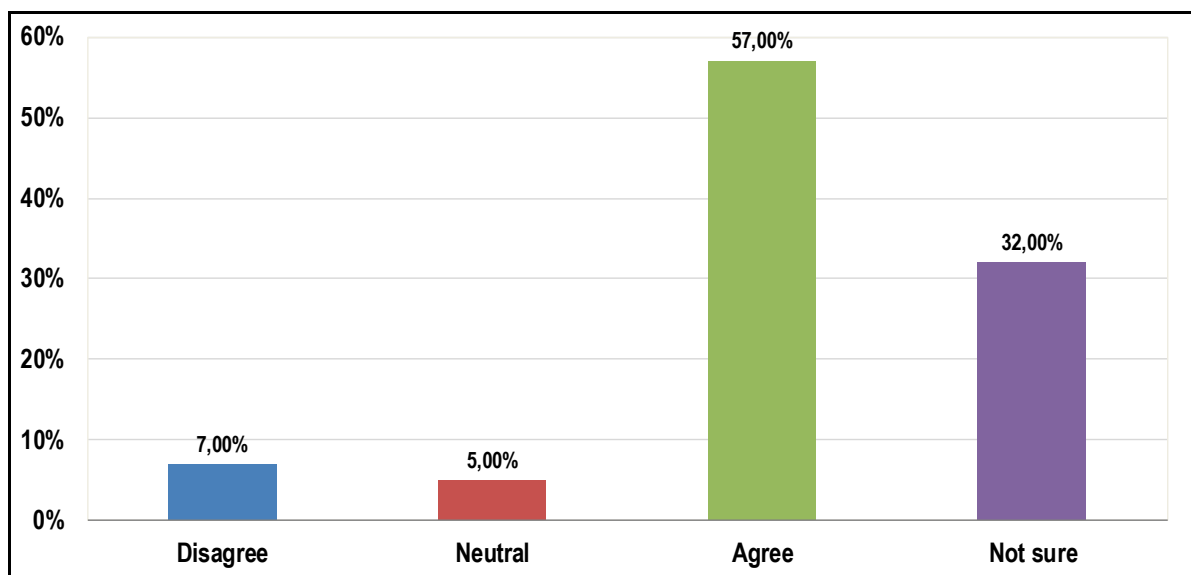


Figure 5.17: Knowledge of HCRW treatment

5.5 Attitudes towards healthcare waste management at dental healthcare facilities

Attitudes refer to the respondents' feelings towards the subject as well as any pre-conceived ideas that they may have towards it. Attitudes have an influence on practices and vice versa. From the results depicting the attitudes towards HCRW practices by respondents who participated in this study (Table 5.3), it was evident that there was uncertainty and confusion. Participants were not sure when training is needed and also whether effective healthcare waste management and control products are expensive, however they are paramount.

Table 5.3: Frequency distribution and attitudes towards healthcare risk waste practices

Question	Description	Options	Count (n)	Percentage (%)
Q18	Frequency of dental healthcare risk waste management training needed	Upon appointment as new staff member	38	43.68%
		When facility implements new dental healthcare waste management material and equipment	39	44.83%
		None of the above	8	9.20%
		Other	2	2.30%
Q22	Is it important to separate dental healthcare risk waste generated in dental healthcare facilities into different categories?	Yes	49	94.23%
		No	2	3.85%
		Not sure	1	1.92%
Q64	Dental healthcare waste management processes a waste of time	Disagree	50	96.15%
		Neutral	0	0.00%
		Agree	1	1.92%
		Not sure	1	1.92%
Q65	Dental healthcare waste management and control a waste of money	Disagree	48	92.31%
		Neutral	1	1.92%
		Agree	1	1.92%
		Not sure	2	3.85%
Q66	Effective waste management and control products expensive	Disagree	11	21.15%
		Neutral	14	26.92%
		Agree	12	23.08%
		Not applicable	0	0.00%
		Not sure	15	28.85%

Q69	Lack of guidance with regards to waste management and control procedures, makes it difficult to execute effective dental healthcare waste management and control procedures	Disagree	27	51.92%
		Neutral	8	15.38%
		Agree	12	23.08%
		Not applicable	0	0.00%
		Not sure	5	9.62%
Q71	Dental healthcare waste management is a team effort	Disagree	1	1.92%
		Neutral	1	1.92%
		Agree	49	94.23%
		Not sure	1	1.92%

5.5.1 Attitudes towards the need for HCRW training (Q18)

None of the respondents argued against the need for HCRW training. Most respondents felt HCRW training is important and that they needed to receive training on HCRW when initially appointed as well as when the facility implemented new HCWM material and equipment (Fig. 5.18). One of the respondents shared that their practice used to have a office manager who gave small lectures on products and equipment followed by a written test on products and how to handle waste. One respondent indicated there is always a need for HCRW training.

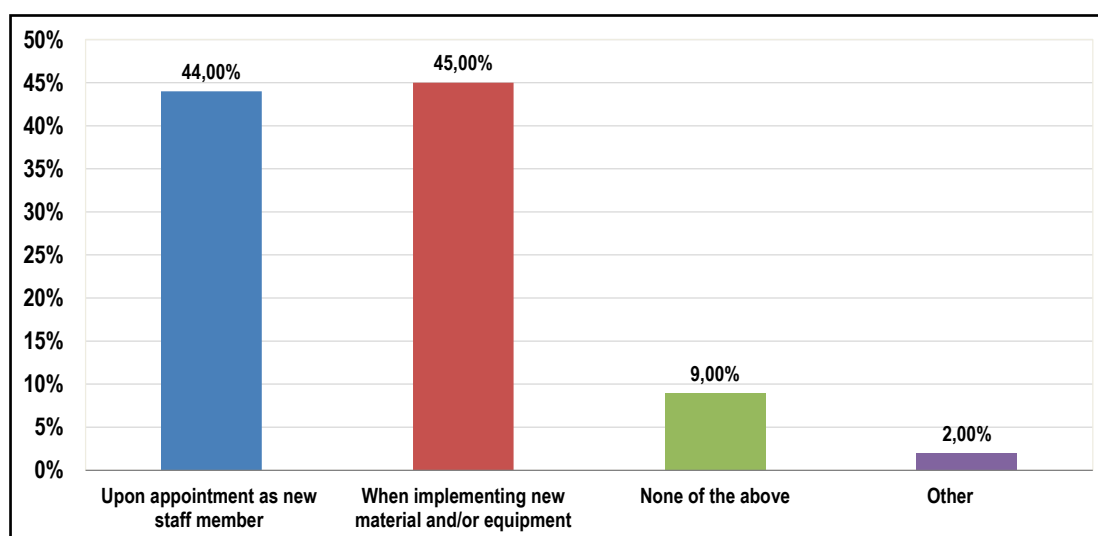


Figure 5.18: Attitudes towards the need for HCRW management training

5.5.2 Attitudes towards HCRW separation (Q22)

More than 90% of the respondents regarded it as being important to separate generated dental HCRW into different categories at the dental HCF, almost (4%) did not regard it as being important and less than 2% were not sure (Fig. 5.19).

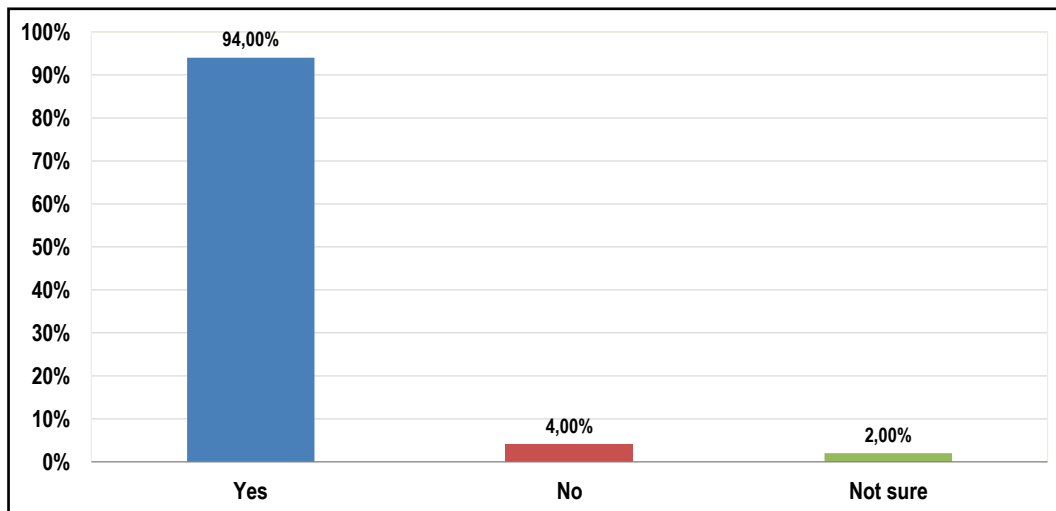


Figure 5.19: Attitudes towards HCRW separation

5.5.3 Attitudes towards time spent on HCRW (Q64)

Of the respondents, almost all disagreed that dental HCWM processes are a waste of time. One respondent agreed and another one was not sure (Fig. 5.20).

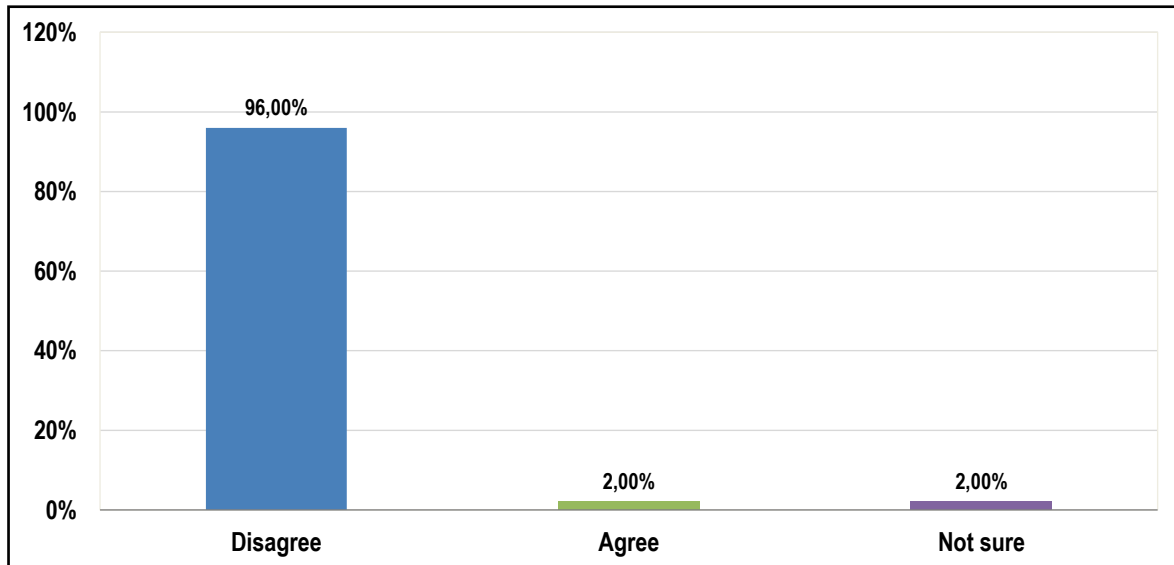


Figure 5.20: Attitudes towards HCRW management being a waste of time

5.5.4 Attitudes towards HCRW expenses (Q65 and Q66)

Respondents agreed that there is value in HCRW management because more than 90% of the respondents disagreed that dental HCRW management and control was a waste of money (Fig. 5.21). However, two respondents were not sure with the remainder being neutral on the expenses of HCRW management.

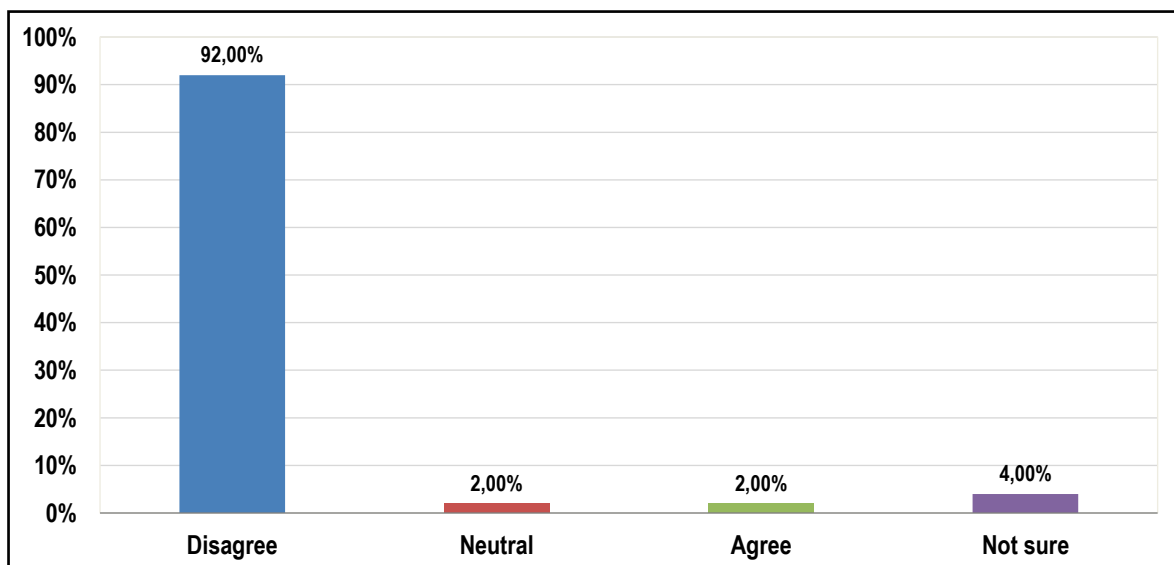


Figure 5.21: Attitudes towards HCRW management being a waste of money

Respondents were very uncertain about the price of effective healthcare waste management. More than a quarter of the respondents remained neutral or were not sure about pricing, while 23.08% agreed that it was expensive (Fig. 5.22).

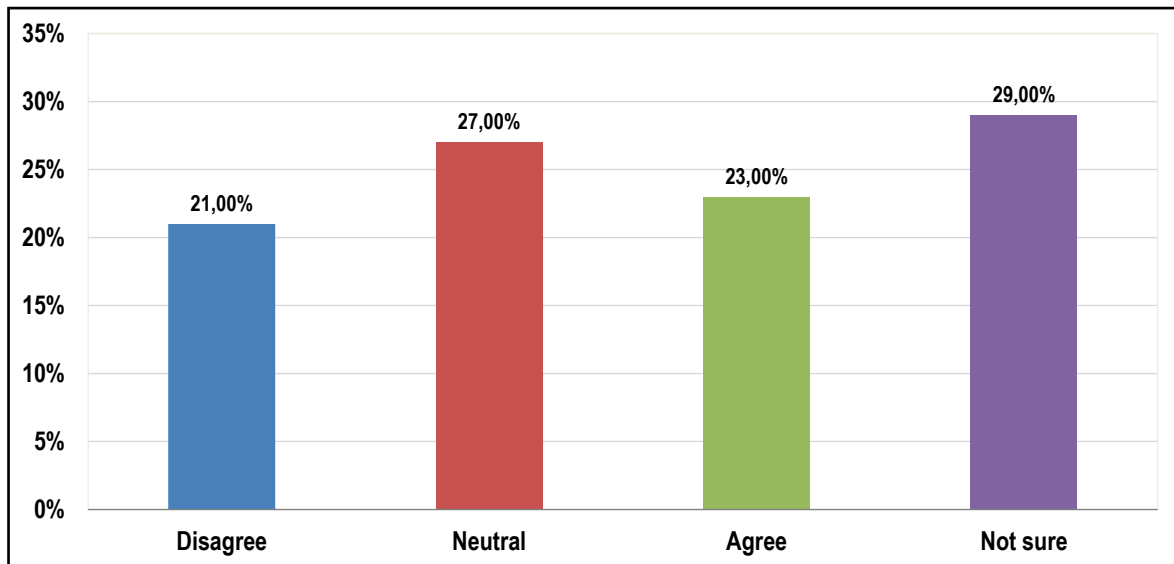


Figure 5.22: Attitudes towards effective healthcare waste management and control products being expensive

5.5.5 Guidance and HCRW management (Q69)

More than half of the respondents disagreed that the lack of guidance with regards to healthcare waste management and control procedures made it difficult to execute effective dental HCWM. Of the respondents, a quarter remained neutral or were not sure about it while more than 20% agreed with the guidance and HCRW management provided (Fig. 5.23).

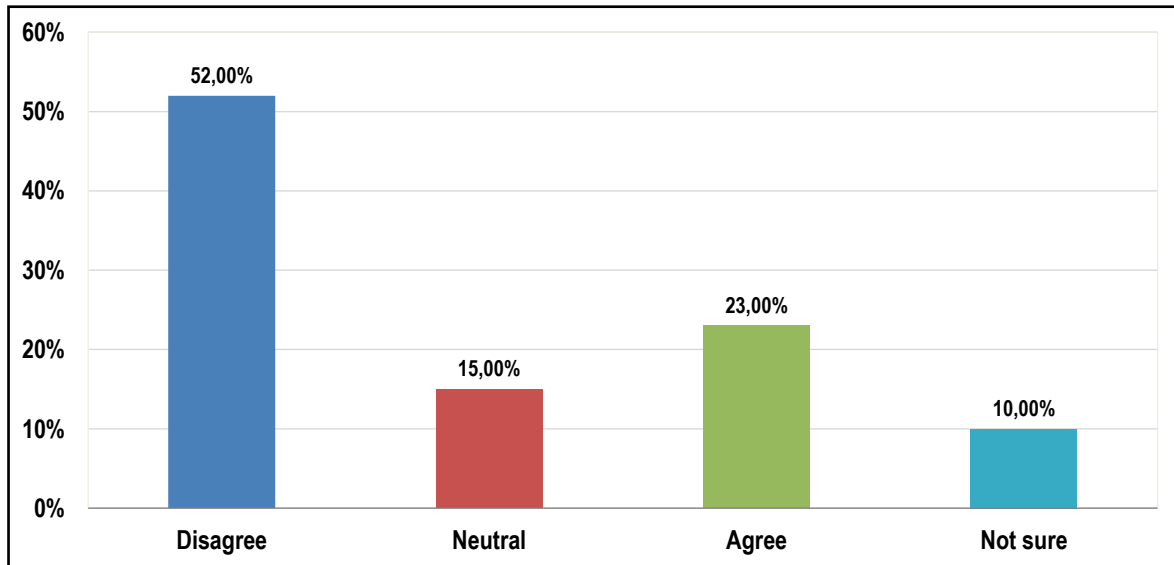


Figure 5.23: Attitudes towards guidance and HCRW management

5.5.6 Attitudes towards teamwork for the purpose of HCRW management (Q71)

The majority of the respondents, more than 90%, agreed on team effort to manage dental HCRW (Fig. 5.24).

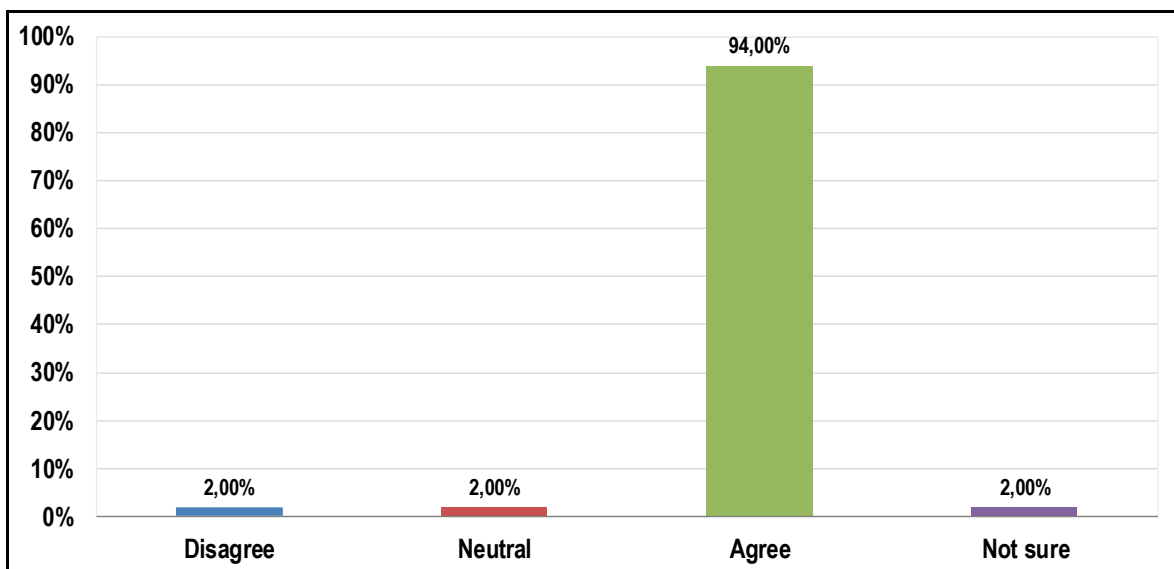


Figure 5.24: Attitudes towards HCRW team effort

5.6 Practices of healthcare waste management at dental healthcare facilities

Practices of healthcare risk waste management refers to the ways that knowledge and attitudes are demonstrated through actions at dental healthcare facilities. By capturing the practices of healthcare waste management among the participating dental healthcare facilities, it was evident from the results that although the practitioner was the person overseeing quality control and management of the dental HCRW at the facility, it was more often the dental assistant or cleaning personnel who executed these practices. It was thus concerning as most respondents indicated that they lacked training on disposal, treatment and transportation of healthcare risk waste (Table 5.4). According to the Occupational Health and Safety Act 85 of 1993, employers are responsible for providing adequate training and empowering employees, for personnel who have no formal training background, about the safe execution of all practices relating to HCRW management in line with the duties they need to perform routinely (South Africa, Occupational Health & Safety Act, 1993).

Table 5.4: Frequency distribution and practices of healthcare risk waste management

Question	Description	Options	Count (n)	Percentage (%)
Q10	Person overseeing quality control and management of the dental healthcare risk waste in facility	Owner/s	9	14.29%
		Dentist	18	28.57%
		Dental assistant	12	19.05%
		Cleaning personnel	4	6.35%
		Other	20	31.75%
Q11	Person executing actual procedures of dental healthcare risk waste in facility	Owner/s	2	3.17%
		Dentist	5	7.94%
		Dental assistant	26	41.27%
		Cleaning personnel	20	31.75%
		Other	10	15.87%
Q19	Written dental healthcare risk waste management plan/ guideline/ manual for dealing with accidents or incidents	Yes	26	50.00%
		No	20	38.46%
		Not sure	6	11.54%
		Not applicable	0	0.00%
		Other	0	0.00%

Q20	Use the dental healthcare risk waste management plan/ guidelines/ manual when the need arises	Yes	19	39.58%
		No	9	18.75%
		Not sure	5	10.42%
		Not applicable	15	31.25%
		Other	0	0.00%
Q42	Dental facility you work at, segregate waste at the place of creation	Yes	35	79.55%
		No	2	4.55%
		Not applicable	0	0.00%
		Not sure	3	6.82%
		Other	4	9.09%
Q43	Colour container for general waste	Black/clear	46	90.20%
		Green	0	0.00%
		Red	3	5.88%
		Yellow	1	1.96%
		Not sure	0	0.00%
		Not applicable	0	0.00%
		Other	1	1.96%
Q44	Colour container for sharps waste	Black/clear	1	2.00%
		Green	1	2.00%
		Red	6	12.00%
		Yellow	43	83.00%
		Not sure	0	0.00%
		Not applicable	0	0.00%
		Other	1	2.00%
Q45	Colour container for infectious anatomical waste	Black/clear	3	5.88%
		Green	0	0.00%
		Red	41	80.39%
		Yellow	2	3.92%
		Not sure	0	0.00%
		Not applicable	1	1.96%
		Other	4	7.84%
Q46	Colour container for extracted teeth with silver amalgam restorations	Black/clear	4	8.00%
		Green	1	2.00%
		Red	14	27.00%
		Yellow	1	2.00%
		Airtight container w/water	14	27.00%
		Not sure	2	4.00%
		Not applicable	10	19.00%
		Other	6	12.00%
Q47	Colour container for pharmaceutical waste	Black/clear	1	2.00%
		Green	6	12.00%
		Red	3	6.00%
		Yellow	1	2.00%
		Not sure	3	6.00%
		Not applicable	25	50.00%
		Other	11	22.00%
Q48		Down the drain with water	12	24.00%
		Chemical waste collection	11	22.00%

	How/where do you dispose of fixer solution?	Not sure	11	22.00%
		Not applicable	16	32.00%
		Other	0	0.00%
Q49	How/where do you dispose of developer solution?	Down the drain with water	11	22.00%
		Chemical waste collection	12	24.00%
		Not sure	9	18.00%
		Not applicable	19	37.00%
		Other	0	0.00%
Q51	Make use of the services of a registered and accredited healthcare waste removal company	Yes	47	90.00%
		No	1	2.00%
		Not sure	4	8.00%
Q52	Facility / practice keep records of different healthcare risk waste generated in facility	Yes	28	54.05%
		No	16	31.00%
		Other	8	15.00%
Q53	Facility / practice keep signed records of waste collected by a registered healthcare risk waste removal company	Yes	29	60.00%
		No	10	21.00%
		Other	9	19.00%
Q54	Formal training on transportation of healthcare risk waste	Yes	17	32.70%
		No	34	65.38%
		Other	1	1.92%
Q55	Staff transport healthcare risk waste e.g. containers with used sharps	Yes	22	42.00%
		No	28	54.00%
		Other	2	4.00%
Q56	Received formal training on healthcare risk waste disposal and treatment	Yes	44	84.61%
		No	2	3.85%
		Other	6	11.54%
Q58	Facility treat and dispose of their waste generated themselves	Yes	2	4.17%
		No	36	75.00%
		Not sure	10	20.83%
Q59	Know how and where healthcare risk waste generated is being treated and disposed of	Yes	4	7.69%
		No	11	21.15%
		Not applicable	33	63.46%
		Not sure	4	7.69%

5.6.1 Person overseeing quality control vs person actually executing healthcare waste management (Q10 and 11)

Quality control and management of dental HCRW was overseen by less than 15% of the owners of the healthcare facilities. A combination of dentists and other persons supervised the healthcare waste management at two-thirds of the dental facilities that took part in the study. These other persons included a manager, clinical manager, HCW officer/controller, and HCW manager at two facilities, oral hygienists, and they represented the majority in being responsible for overseeing healthcare waste management (Fig 5.25). Combined dental assistants and cleaning personnel represented approximately one-quarter of the respondents responsible for overseeing healthcare waste management. This substantial representation of the person overseeing quality control and management of dental HCRW is indicative of the important role these members play in the oral healthcare team at facilities.

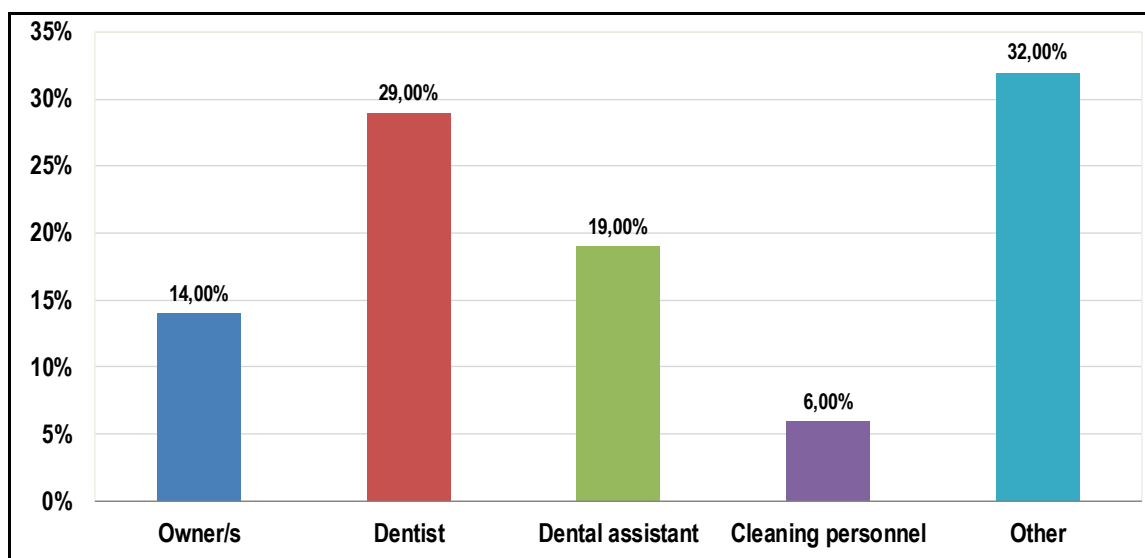


Figure 5.25: Person overseeing HCRW management and control

The personnel members responsible for executing the actual procedures of dental HCRW management and control at more than three-quarters of the dental healthcare facilities were the dental

assistants, followed by the cleaning personnel. Contrary to the previous section on the person overseeing the HCRW management and control, when it came to the actual execution of the practices of dental HCRW management, it was found that only at a few of the healthcare facilities did the dentists or owners of the facilities assume that responsibility. It is evident that at most facilities, the owner and/or dentist delegated this responsibility to the dental assistant, cleaner or other persons. These other persons executing the actual healthcare waste management included support personnel, waste management personnel, HCW manager/officer, nurse and oral hygienist (Fig 5.26).

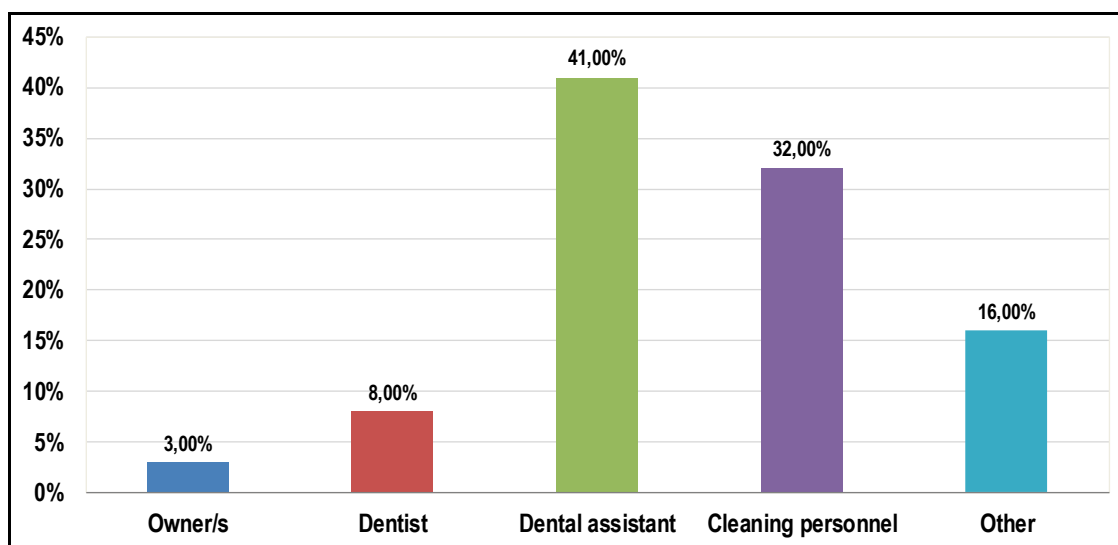


Figure 5.26: Person executing HCRW management and control

5.6.2 HCRW management plan/guidelines/manuals (Q19 and 20)

Written dental healthcare risk waste management plans/guidelines/manuals for dealing with accidents or incidents, including spillages, segregation and disposal, were available to half of the respondents at the participating healthcare facilities. However, it was alarming to note that the other half either indicated no to the question or they were unsure (Fig 5.27).

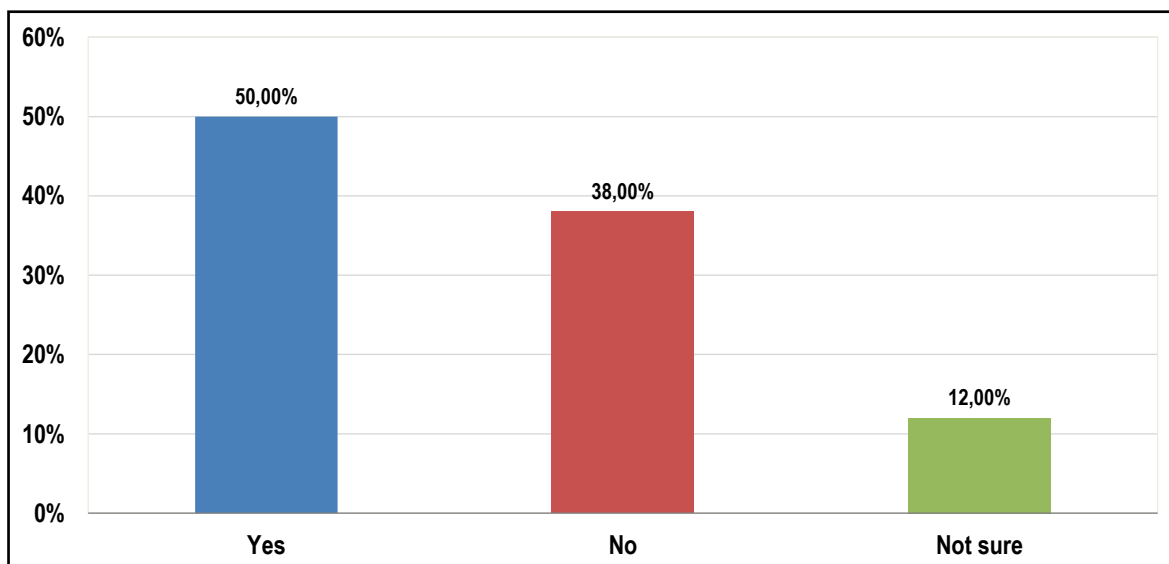


Figure 5.27: Availability of HCRW plans/guidelines/manuals

Less than half of the respondents (40%) confirmed that a written dental healthcare risk waste management plan/guidelines/manual was in use at the healthcare facility. It was alarming to note that 31% of the respondents felt that the written dental healthcare risk waste management plans, guidelines or manuals were not applicable to their facilities for dealing with accidents or incidents, including spillages, segregation and disposal of healthcare waste. The other 29% either did not use them or were unsure (Fig 5.28).

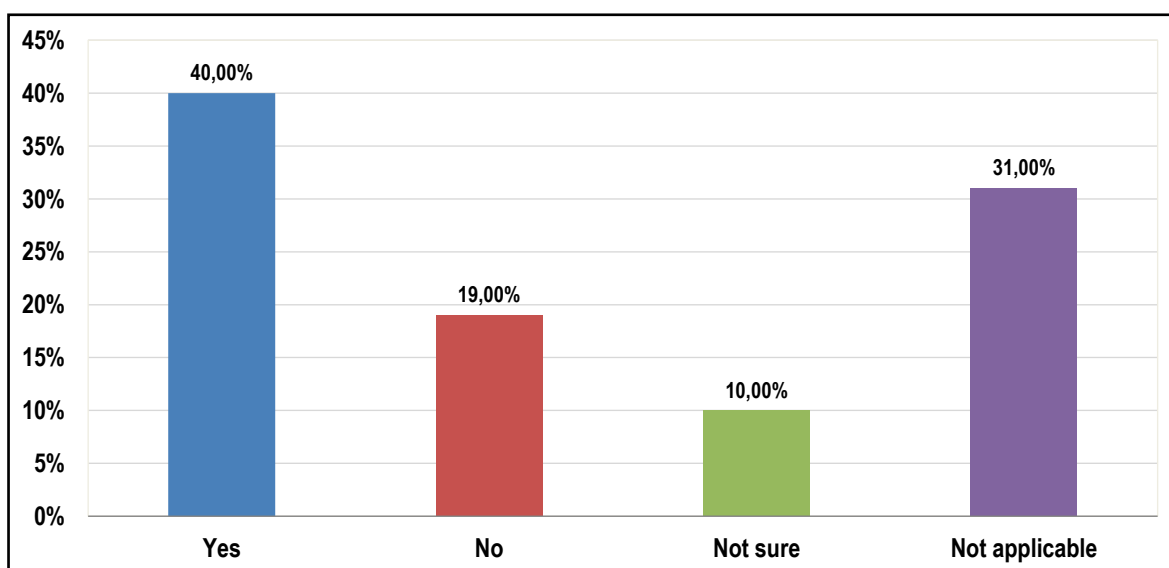


Figure 5.28: Use of HCRW plans/guidelines/manuals

5.6.3 Segregation of healthcare waste at place where created (Q42)

By far, the majority (80%) of respondents (n=42) indicated that they segregated healthcare waste at the place where it was created. However, two respondents indicated no to this question, while three respondents were not sure. Four of the respondents only segregate sharps, the other generated waste are segregated at other places (Fig 5.29).

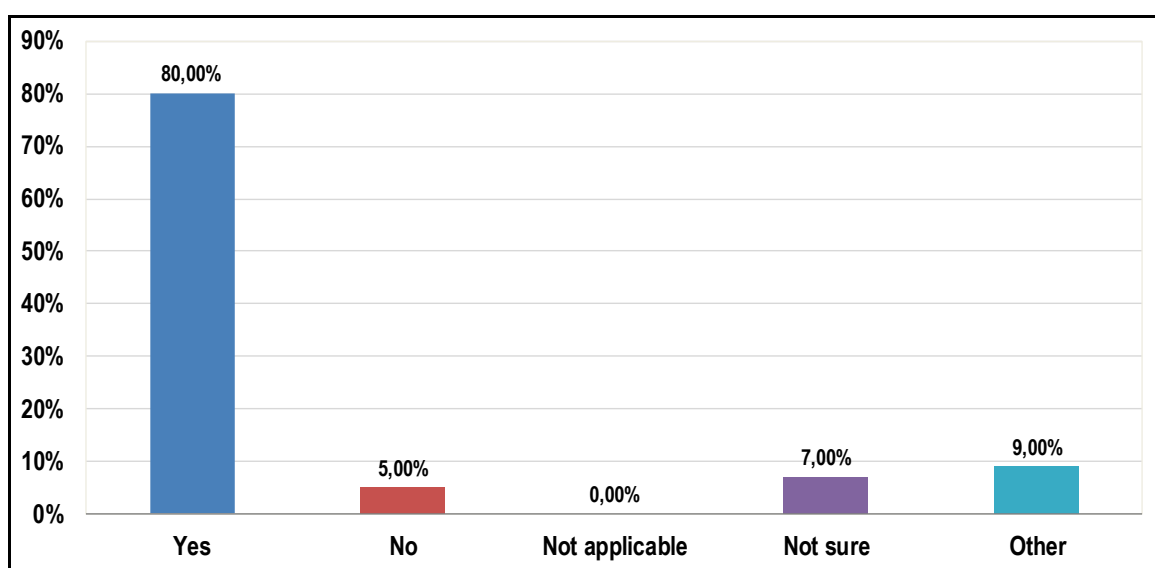


Figure 5.29: Segregation of HCRW

The majority, at 90%, of the respondents (n=46) said they disposed of general waste in the black container, less than 6% (n=3) disposed it in the red bag, 2% (n=1) said the yellow container while a further 2% (n=1) said other without disclosing what other meant.

When it came to sharps disposal, more than 80% of the respondents (n=43) said sharps were disposed of in a yellow container, less than 12% indicated the red bag and 6% said either black (n=1), green (n=1) or other (n=1).

The majority, 80%, of the respondents (n=42) said they disposed of infectious anatomical waste in a red container, 6% (n=3) said black, 4% (n=2) said yellow, 8% (n=4) indicated other, while 2% (n=1)

thought it was not applicable to their facility. Some of those who reported other that the waste was collected by the dentist, but was unsure as to where it was taken to.

With regard to the disposal of extracted teeth, it seemed to be handled differently and it appeared as if respondents were uncertain how to dispose of them. Respondents seemed to randomly pick the colour of the waste container for the disposal of extracted teeth (Fig 5.30). Less than a third of the respondents (n=14) said they would dispose of the extracted teeth in the red container, a further less than a third (n=14) place them in an airtight container with water, less than 8% said black bag and less than 4% indicated they were not sure. Of the respondents, 4% also picked the green and yellow containers.. Under other, the respondents indicated that any of the HCRW containers would be appropriate.

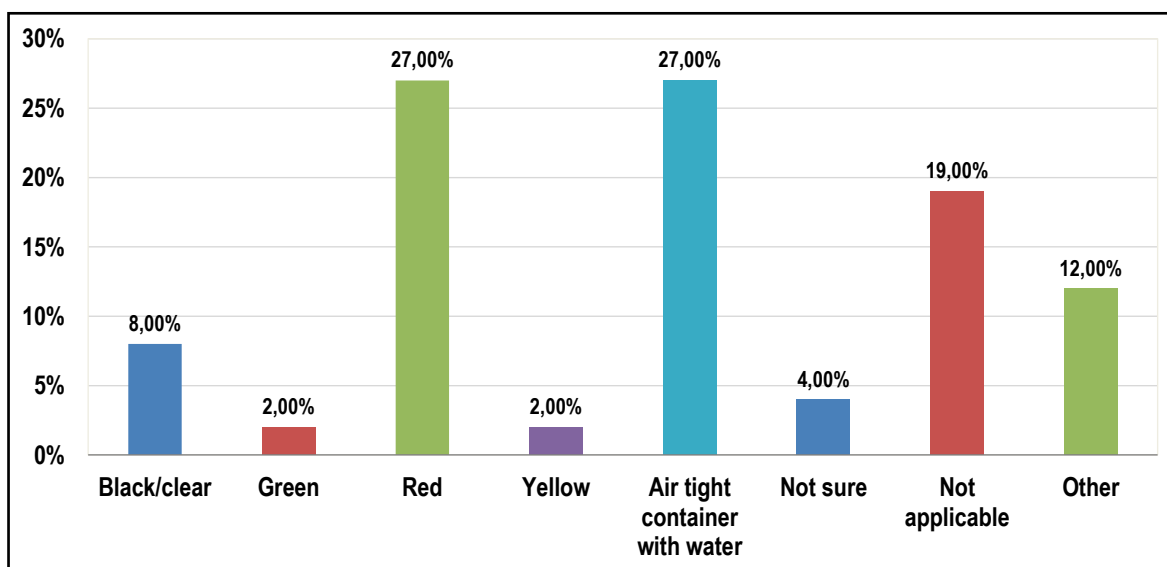


Figure 5.30: Selection of colour of waste container for disposal of extracted teeth

5.6.4 Pharmaceutical and chemical waste disposal (Q47, 48 and 49)

Half (n=25) of the respondents, the choices were not applicable because they do not dispense medication, while more than 20% (n=11) indicated other choices, such as collected by the pharmacy department within the same premises (Fig. 5.31). Of the respondents, 10% (n=6) indicated that

pharmaceutical waste is disposed of in green containers, red bag was picked by more than 5% ($n=3$), another 5% were not sure, 2% ($n=1$) black bag and a further 2% yellow container.

Concerning chemical waste disposal, more than a third of the respondents indicated that they no longer make use of manual x-ray processing. Less than a quarter of the respondents indicated that they disposed of fixer and developer solution down the drain with water. Another quarter of the respondents indicated that they make use of chemical waste collection, while more than 20% were not sure of how the chemical waste was disposed. This may be indicative that there is a need for additional education and training on pharmaceutical and chemical waste disposal, especially as many pharmaceutical and chemical products are used at dental healthcare facilities.

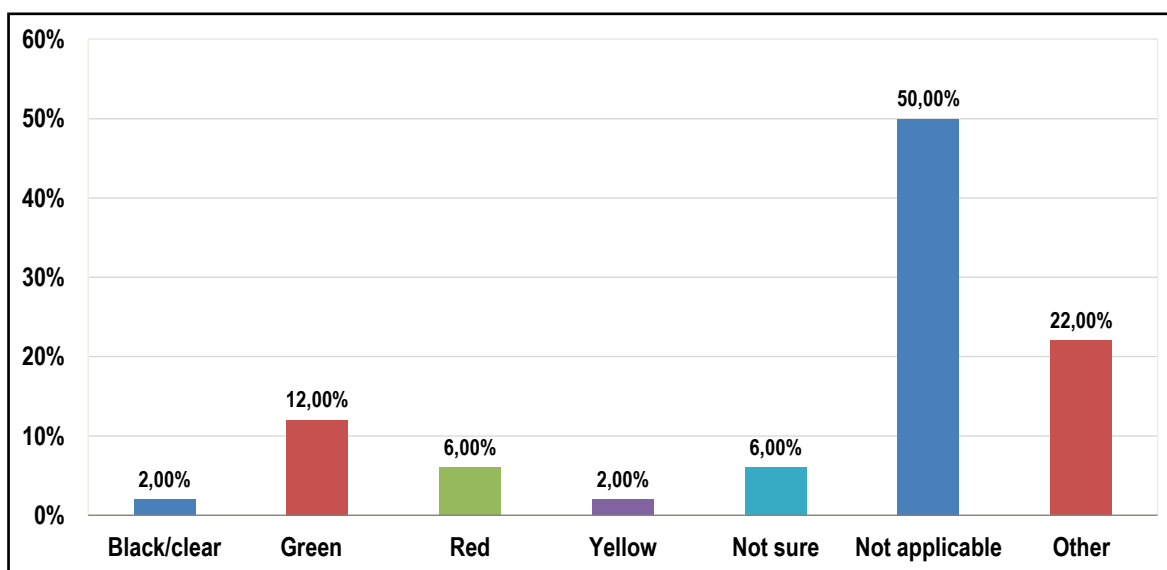


Figure 5.31: Selection of colour of waste container for disposal of pharmaceutical waste

5.6.5 Removal of healthcare risk waste (Q51 and 53)

More than 90% of the respondents indicated that they made use of the services of a registered and accredited HCW removal company for the removal of their HCRW. Only one (2%) respondent did not and less than 8% ($n=4$) were uncertain, as the healthcare waste was collected by the dentist and they were therefore unsure where it was disposed. Out of the 90% who said that they used registered and

accredited HCRW removal companies, more than 60% kept signed records of the HCRW collected. About a quarter of the respondents did not keep signed records of the HCRW collected by the accredited provider (Fig 5.32). This is very concerning, as those signed records are the only proof that the generator of the healthcare waste has disposed of the HCRW responsibly, as required by law. Of the respondents, 19% (n=9) indicated other because they did not perceive it as being part of their routine work duties. These facts highlight the importance of a personnel member being specifically assigned the responsibility for coordinating occupational health and safety as well as infection prevention and control within the oral healthcare team and facility, so oversights and adverse events are avoided as a consequence.

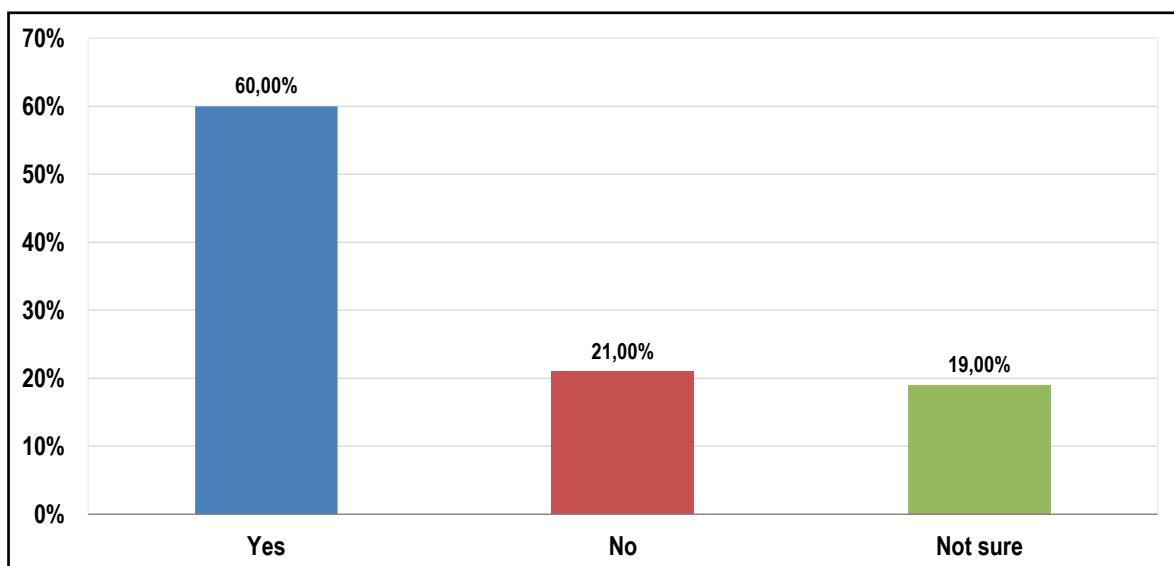


Figure 5.32: Keeping signed records of collected waste

5.6.6 Transportation of healthcare risk waste (Q54 and 55)

Of the respondents, more than 30% reported that they had received formal training on the transportation of HCRW. However, it was alarming that 65% did not receive training on transportation of HCRW. What is even more concerning was that, of these respondents, more than 40% of the staff transported HCRW themselves. Without adequate and appropriate training, this practice may expose the dental healthcare personnel to increased risks that could be avoided.

5.6.7 Disposal and treatment of healthcare risk waste (56 and 58)

More than 80% of the respondents confirmed that they had received formal training in HCRW disposal and treatment. More than 20% of the respondents were not sure how disposal and treatment of their HCRW happened. Fortunately, less than 5% of the respondents reported that they treated and disposed of the generated healthcare waste themselves.

5.6.8 Management and control of healthcare risk waste (Q67 and 68)

For question 67, most respondents (79%) indicated that limited time did not make it difficult to execute effective dental healthcare waste management. This was again confirmed in question 68, where most respondents (71%) indicated that the number of practitioners that the dental assistant had to assist did not make it difficult to execute effective dental healthcare waste management. The respondents agreed and regarded effective dental healthcare waste management as a team effort. All but two respondents confirmed that it was a priority at their workplaces (Fig. 5.33).

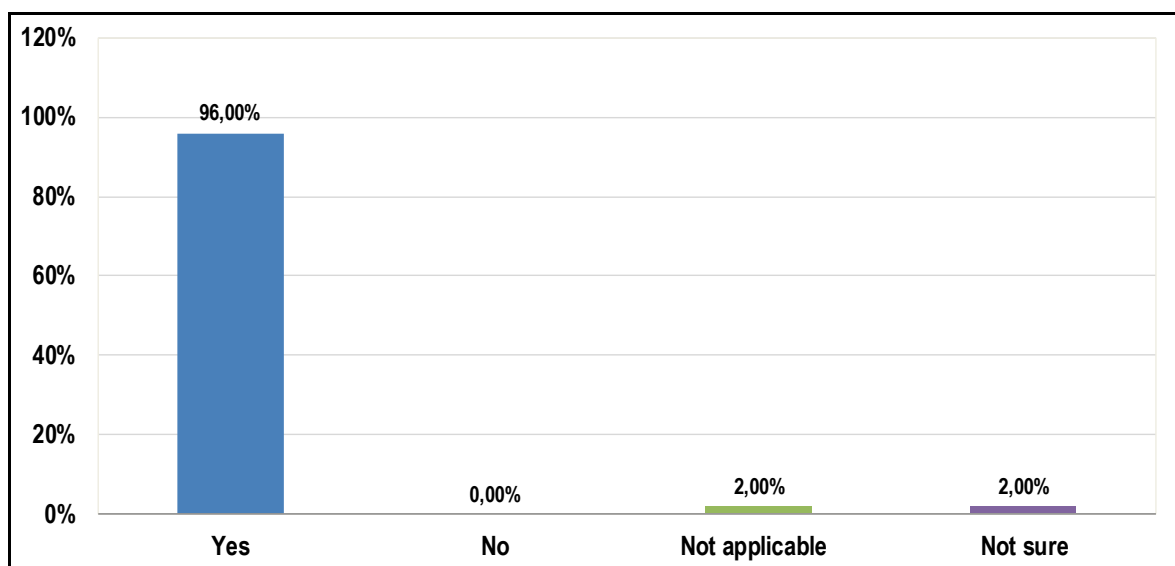


Figure 5.33: Effective dental healthcare waste management as a priority

5.7 Discussion

The results positively indicated that dental healthcare staff feel they have sufficient knowledge of healthcare waste management. Knowledge of HCWM scored 83.4% and that is regarded as sufficient. In general, participants picked the correct colour of the disposal bags for the different types of HCRW. However, participants seemed to be confused when they had to pick the correct container to dispose infectious anatomical waste and also where to dispose waste containing amalgam. Attitude has a direct impact on dental healthcare waste management practices. With a score of 75%, the healthcare professionals displayed good attitudes towards healthcare waste management and the need thereof.

Practices at 54% are a clear indicator of what is happening at healthcare facilities. It was interesting to note that public dental healthcare facilities were more compliant with HCWM than the private healthcare facilities. Results also indicated that there was no association between practices and the age or gender of the respondents, but rather that education and training are the determining factors for the appropriate execution of healthcare waste management. However, healthcare waste management practices are influenced by and affect staff, patients, community and environment in the long run.

The majority of respondents in this study, the dental assistants, indicated that they did not receive training at the start of their employment nor when new infection equipment was purchased. Participants relied on the in-house training they received from their employer, which may be subjective to his or her own understanding or perspective. The need to routinely educate all categories of dental healthcare staff members in order to ensure that the appropriate and standard execution of healthcare waste management practices is effected, is of greater importance than what participants perceived.

Disposal of dental healthcare waste should be the responsibility of all dental healthcare staff but they require knowledge to implement the healthcare waste management guidelines correctly. This would

further increase compliance with healthcare waste management practices. The results of this study provide a baseline of the knowledge, attitudes and practices of dental healthcare staff with regard to healthcare waste management of dental waste. It is suggested that this baseline be used by dental healthcare facilities to develop a plan to address and improve on the identified gaps.

Chapter 6

Discussion and Concluding Remarks

6.1 Introduction

This chapter provides a summary of the important findings from the study, the conclusion of the study and recommendations based on the objectives. It focuses on the HCW knowledge, attitudes and practices of dental healthcare staff at dental healthcare facilities in the Greater Tshwane region and aligns them to national and international guidelines with regards to HCWM. The conclusion maps out future review projects that can be undertaken to address the identified shortfalls that were found in the study, particular in the Greater Tshwane region.

6.2 Prospective recommendations

Proper disposal of dental healthcare waste is of great importance to protect the employees, the environment and the public against health risks. The recommendations include staff training at the start of their new employment and when new infection prevention and control equipment is purchased or taken in for use. The HPCSA accredited training on HCWM is to serve as a reminder. The results of this study provide a baseline for the knowledge, attitudes and practices of dental healthcare staff with regard to HCWM of dental waste. It is suggested that this baseline be used by dental healthcare facilities to develop a plan to improve and address the identified gaps. The need to routinely educate all categories of dental healthcare staff members in order to ensure that appropriate and standard execution of healthcare waste management practices is effected, is of greater importance than what participants perceived.

6.3 Discussion

The study evaluated different aspects of HCWM in the Greater Tshwane region. The aspects included dental healthcare waste management training and continuous professional development, classification of dental healthcare waste (general, chemical, sharps and infectious & pathological), generation and minimisation, segregation and storage, waste administration, transport, waste disposal, waste treatment and general views of dental healthcare waste management under knowledge, attitudes and practices.

6.3.1 Demographic profile of healthcare workers

The majority of the respondents in the study were female dental assistants in the public sector between the ages of 36 and 45. Their working experience ranged between 6 months to 20 years with the majority being between 3 and 5 years. This population composition is comparable to other similar studies. According to the World Health Organization's (WHO) statistics for 2015, the majority of healthcare workers were women, comprising over 75% in the health sector work forces in many countries (WHO, 2015). A few years ago, an analysis of the demographic characteristics of the healthcare workers in England showed that the healthcare workers were predominantly females and the age profile of the work force ranged between 25 and 54 years (Yar *et al.*, 2006) (Makhura, 2016). This survey had more females, but the age nor the gender had a significant on the results outcome.

6.3.2 Knowledge of HCWM

More than a quarter of the respondents, who were dental assistants, had in-service training, while the majority of the respondents had been to University. However, it should be noted that the in-service training might be bias towards the trainer's knowledge or preferences. Research studies show that experience alone is not sufficient to effectively manage HCW (Vumase, 2009).

This study's results indicated that the majority of the dental healthcare staff felt that they have sufficient knowledge of healthcare waste management and the score on knowledge proved that. The percentage of healthcare workers who had knowledge on dental waste disposal was higher than the one for those who were not knowledgeable, which had the same results as this research study by Vumase (Vumase, 2009).

More than two third of the respondents were well aware of the different HCW categories with the examples and colour coding as well as treatment and disposal of HCW. The only concern is that 12% of the respondents were not sure of their knowledge on healthcare waste disposal. Meanwhile these respondents practice disposal of dental healthcare waste in their day-to-day activities and they also received instruction as part of their education and training.

Gaps can be identified in the HCWM knowledge and it is necessary to develop plans to close these gaps. It is expected that staff members possess the necessary knowledge for them to dispose of dental healthcare waste according to the national guidelines (Vumase, 2009).

6.3.3 Staff attitudes towards HCWM

Staff attitudes towards HCWM have a direct impact on the execution of the healthcare waste management. In this research study, the respondents displayed good attitudes towards HCWM with similar results as a research study done by Sanjeev R. on HCWM attitude (Sanjeev, 2014). The attitude of the respondents was good regarding to the cost and time spent on HCWM, the need for continuous training in HCWM, separation of healthcare waste and the need for HCWM at dental healthcare facilities. Of the respondents, 52% indicated that the lack of guidance or guidelines was not a reason for their challenges with HCWM, but for 20% it was the opposite.

6.3.4 HCWM practices at dental healthcare facilities

The HCWM practices' score was disappointing as it is indicative of what is really happening at the healthcare facilities. It may be because the person responsible for the management of healthcare waste is not always the same person who is executing the work. A third of the respondents confirmed that guidelines were available and being used in their practices, a further third indicated that it was not applicable to their healthcare facilities and the final third either denied that HCWM guidelines were being used or were unsure. The majority of the respondents (80%) indicated that there was segregation at the place of generation. Disposal of extracted teeth showed mixed responses, from utilising the red container, to an air tight container or other. Although half of the practices do not generate pharmaceutical waste, the other half had mixed responses that were divided between disposal of pharmaceutical waste in all colour of containers. The alarming part about waste removal is that in some practices, the healthcare waste was removed by the dentist and neither the dental assistant nor the cleaner had any idea where it was taken.

A higher percentage of respondents practiced adequate disposal of dental healthcare waste than those who did not, but this is still a concern. These results are similar to a study, which was conducted at the Johannesburg Hospital in 2008, that investigated the knowledge and practices of doctors and nurses on management of healthcare waste. The results in that study indicated that doctors and nurses engaged in good practices for the disposal of medical waste (Ramokate & Basu, 2009). This is in contrast with the study which was conducted in 2013 to assess knowledge and practice on medical waste disposal among health care workers working in primary health care centres of Bagepalli Taluk which showed that there was no significant association between professional category and practice (Makhura, 2016).

It was interesting to note that public dental healthcare facilities were more compliant with HCWM than the private facilities. Results also indicated that there was no association between practices and the

age or gender of the respondents, but rather that education and training were the determining factors for the appropriate execution of healthcare waste management. However, healthcare waste management practices are influenced by and affect staff, patients, community and environment in the long run.

6.4 Study limitation

The online survey did not have a platform for respondents to ask for clarity on questions and the survey used medical terminology in the questionnaire. This presented challenges that could have caused some of the respondents to be unsure when answering. Some were dental assistants who had no formal university training but only in-house training. The focus of this study was aimed at a representation of dental healthcare facilities in the Greater Tshwane region. Therefore, the results obtained may not represent the status quo at all dental healthcare facilities in Tshwane nor elsewhere in South Africa.

The responses were not observed nor validated in a physical work environment situation, so some aspects of the healthcare waste management may be worse than was reported. Even using walkthrough survey observations as the second research instrument has its own limitations, as this procedure does not require for prior notice to be given to those at the clinic being studied. As a result, the outcomes obtained could be negatively impacted due to the survey being conducted on a day that by chance was not representative of the actual practices or activities of the healthcare facility. This study would have been stronger if data had been collected on more than one occasion at each site.

6.5 Conclusion

The study provides evidence that dental healthcare staff demonstrated good knowledge and attitudes towards HCWM, but improvements can still be made. On the other hand, the HCWM practices were reason for concern considering that this is what is actually happening at the dental healthcare facilities.

Public dental healthcare facilities were found to be more compliant with HCWM policies and regulations than the private facilities.

The report recommends that regular training on HCWM be implemented and that HCWM policies are improved at the dental healthcare facilities in the Greater Tshwane region.

References

- Abhishek, K.N., Suryavanshi, H.N., Sam, G., Chaithanya, K.H., Punde P. and Singh, S.S. 2015. Management of Biomedical Waste: An Exploratory Study. *Journal of International Oral Health*, 7(9): 70–74. [Online] Available from: <<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4589724/>> [Accessed: 5 June 2017].
- Adedigba, M.A., Oke, I.O. and Arobieke R. 2013. Characterisation of Dental Waste in Tertiary Dental Hospitals: A Third World Example. In: Rodriguez-Morales, A.J. (ed). *Current Topics in Public Health*. IntechOpen. doi: <https://doi.org/10.5772/53194>. Available from: <<https://www.intechopen.com/books/current-topics-in-public-health/characterisation-of-dental-waste-in-tertiary-dental-hospitals-a-third-world-example>>
- Alagöz, A.Z. and Kocasoy, G. 2008. Determination of the best appropriate management methods for the health-care wastes in Istanbul. *Waste Management*, 28(7): 1227–1235. [Online] doi: <https://doi.org/10.1016/j.wasman.2007.05.018>. Available from: <<https://www.sciencedirect.com/science/article/abs/pii/S0956053X07001900>>[Accessed: 5 June 2017].
- Aliyu, S., Peter, E.S., Ochan, A.W., Mohiuddin, M. and Aleiro, A.A. 2017. Assessment of Healthcare Waste Management Practices Employed by Health Workers in Health Facilities in Bushenyi District Western Uganda. *International Journal of Scientific Research in Knowledge*, 5(1): 1–10. [Online] doi: <https://doi.org/10.12983/ijsrk-2017-p0001-0010>. Available from: <https://www.researchgate.net/publication/313063919_Assessment_of_Healthcare_Waste_Management_Practices_Employed_by_Health_Workers_in_Health_Facilities_in_Bushenyi_District_Western_Uganda>[Accessed: 5 June 2017].

- Ananth, A.P., Prashanthini, V. and Visvanathan, C. 2010. Healthcare waste management in Asia. *Waste Management*, 30(1): 154–161. [Online]
doi: <https://doi.org/10.1016/j.wasman.2009.07.018>. Available from:
<<https://pubmed.ncbi.nlm.nih.gov/19726174/>>[Accessed: 5 June 2017].
- Babanyara, Y.Y., Ibrahim D.B., Garba, T., Bogoro, A.G. and Abubakar, M.Y. 2013. Poor Medical Waste Management (MWM) Practices and Its Risks to Human Health and the Environment: A Literature Review. *International Journal of Environmental, Ecological, Geological and Mining Engineering*, 7(11): 757–764. [Online] Available from:
<https://www.researchgate.net/profile/Y_Babanyara/publication/285242270_Poor_Medical_Waste_Management_MWM_practices_and_its_risks_to_human_health_and_the_environment_a_literature_review/links/56660a6e08ae4931cd626842.pdf>[Accessed on: 14 January 2021].
- Battaglia, M., Passetti, E. and Frey, M. 2015. Occupational health and safety management in municipal waste companies: A note on the Italian sector. *Safety Science*, 72: 55–65. [Online]
doi: <https://doi.org/10.1016/j.ssci.2014.08.002>. Available from:
<<https://www.sciencedirect.com/science/article/abs/pii/S0925753514001830>>[Accessed: 5 June 2017].
- Centers for Disease Control and Prevention (CDC). 2003. *Guidelines for Environmental Infection Control in Health-Care Facilities*. Recommendations from CDC and the Healthcare Infection Control Practices Advisory Committee (HICPAC). Chicago. 1–241. [Online]
<<https://www.cdc.gov/infectioncontrol/guidelines/environmental/index.html>>
- Charania, Z. and Ingle, N.A. 2012. Awareness and Practices of Dental Care Waste Management Among Dental Practitioners In Chennai City. *Journal of Contemporary Dentistry*, 1(1): 15–21. [Online] Available from:

- <<https://www.semanticscholar.org/paper/Awareness-and-Practices-of-Dental-Care-Waste-Among-Charania-Ingle/2ae05111c28ed9f8e02b11780292d3c4ce7b3bf?p2df>> [Accessed: 5 June 2017].
- Diaz, L.F., Eggerth, L.L., Enkhtsetseg, Sh. and Savage, G.M. 2008. Characteristics of healthcare wastes. *Waste Management*, 28(7): 1219–1226. [Online] doi: <https://doi.org/10.1016/j.wasman.2007.04.010>. Available from: <<https://www.sciencedirect.com/science/article/abs/pii/S0956053X07001614>> [Accessed: 18 September 2015].
- Emmanuel, J. 2001. Non-incineration medical waste treatment technologies. Washington, DC, *Health Care Without Harm*, 1–105. [Online] Available from: <https://noharm-uscanada.org/sites/default/files/documents-files/2062/Non-Incineration_Technologies.pdf>
- Emmanuel, J. and Stringer, R. 2007. For Proper Disposal: A Global Inventory of Alternative Medical Waste Treatment Technologies. Arlington, *Health Care Without Harm*, 1–47. [Online] Available from: <https://noharm-uscanada.org/sites/default/files/documents-files/2046/For_Proper_Disposal.pdf>
- Gabela, S.D. and Knight, S.E. 2010. Healthcare waste management in clinics in a rural health district in KwaZulu-Natal. *South African Journal of Epidemiology and Infection*, 25(1): 19–21. [Online] doi: <https://doi.org/10.1080/10158782.2010.11441372>. Available from: <<https://www.tandfonline.com/doi/abs/10.1080/10158782.2010.11441372>> [Accessed on: 7 August 2020].

- Hasan, B., Olsen, B., Alam, A., Akter, L. and Melhus, A. 2015. Dissemination of the multidrug-resistant extended-spectrum β -lactamase-producing *Escherichia coli* O25b-ST131 clone and the role of house crow (*Corvus splendens*) foraging on hospital waste in Bangladesh. *Clinical Microbiology and Infection*, 21(11): 1000.e1–1000.e4. [Online] Available from: <<https://doi.org/10.1016/j.cmi.2015.06.016>> [Accessed: 7 August 2017].
- Hassan, M.M., Ahmed, S.A., Rahman, K.A. and Biswas, T.K. 2008. Pattern of medical waste management: existing scenario in Dhaka City, Bangladesh. *BMC Public Health*, 8(36). [Online] doi: <https://doi.org/10.1186/1471-2458-8-36>. Available from: <<https://bmcpublichealth.biomedcentral.com/articles/10.1186/1471-2458-8-36>>
- Health Professions Council of South Africa (HPCSA). 2016. *Guidelines for the Management of Healthcare Waste*, Booklet 12. Pretoria. 1–18. [Online] Available from: <https://www.sada.co.za/media/documents/HPCSA_Booklet_12_Guidelines_for_the_management_of_health_care_waste.pdf> [Accessed: 5 June 2017].
- Horrocks, S., Pollard, K., Duncan L., Petsoulas, C., Gibbard, E., Cook, J., McDonald, R., Wye, L., Allen, P., Husband, P., Harland, L., Cameron, A. and Salisbury, C. 2018. Measuring quality in community nursing: a mixed-methods study. *Health Services and Delivery Research*, 6(18). [Online] doi: <https://doi.org/10.3310/hsdr06180>. Available from: <<https://www.ncbi.nlm.nih.gov/books/NBK493833/>> [Accessed: 7 January 2021].
- International Organization for Standardization (ISO). 2004. *Plastics film and sheeting: Determination of impact resistance by the free-falling dart method. Suitcase methods*. Geneva, Switzerland. ICS: 83.140.10. Available from: <<https://www.iso.org/standard/14629.html>>
- Khandelwal, V., Khandelwal, S. and Thakur, J.S. 2013. Health care waste disposal among private

- dentist in an Indian city: it's time to act. *International Journal of Infection Control*, 9(2): 1–5.
[Online] doi: <https://doi.org/10.3396/ijic.v9i2.11112>. Available from:
<<http://www.ijic.info/article/view/11112>> [Accessed: 5 June 2017].
- Lesotho. Ministry of Development Planning. 2019. *Bureau of Statistics*. Maseru, Lesotho. Available from: <<https://www.bos.gov.ls>>
- Levin, K.A. 2006. Study Design III: cross-sectional studies. *Evidence-Based Dentistry*, 7(1): 24–25.
[Online] doi: <https://doi.org/10.1038/sj.ebd.6400375>. Available from:
<https://www.researchgate.net/publication/7222561_Study_Design_III_cross-sectional_studies> [Accessed: 29 November 2020].
- Maamari, O., Brandam, C., Lteif, R. and Salameh, D. 2015. Health Care Waste generation rates and patterns: The case of Lebanon. *Waste Management*, 43: 550–554. [Online]
doi: <https://doi.org/10.1016/j.wasman.2015.05.005>. Available from:
<<https://pubmed.ncbi.nlm.nih.gov/26049204/>> [Accessed: 4 June 2017].
- Mahasa, P.S. and Ruhiiga, T.M. 2014. Medical Waste Management Practices in North Eastern Free State, South Africa. *Journal of Human Ecology*, 48 (3): 439–450. [Online] Available from:
<https://doi.org/10.1080/09709274.2014.11906815>
[Accessed: 23 November 2020].
- Makhura, R.R. 2016. *Knowledge and Practices of Health Care Workers on Medical Waste Disposal in Mapulaneng Hospital in the Ehlanzeni District of South Africa*. Masters Mini-Dissertation. University of Limpopo, Polokwane. Available from:
<http://ulspace.ul.ac.za/bitstream/handle/10386/1639/makhura_rr_2016.pdf?sequence=1&isAllowed=y>

- Manga, V.E., Forton, O.T., Mofor, L.A. and Woodard, R. 2011. Health care waste management in Cameroon: A case study from the Southwestern Region. *Resources, Conservation and Recycling*, 57: 108–116. [Online] doi: <https://doi.org/10.1016/j.resconrec.2011.10.002>. Available from: <https://www.researchgate.net/publication/241099197_Health_care_waste_management_in_Cameroon_A_case_study_from_the_Southwestern_Region> [Accessed: 5 June 2017].
- Manti, S. and Licari, A. 2018. How to obtain informed consent for research. *Breathe (Sheff)*, 14(2): 145–152. [Online] doi: <https://doi.org/10.1183/20734735.001918>. Available from: <<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5980471/>> [Accessed: 29 November 2020].
- Mbongwe, B., Mmerekhi, B.T. and Magashula, A. 2008. Healthcare waste management: current practices in selected healthcare facilities, Botswana. *Waste Management*, 28(1): 226–233. [Online] doi: <https://doi.org/10.1016/j.wasman.2006.12.019>. Available from: <<https://www.pubmed.ncbi.nlm.nih.gov/17350817/>> [Accessed: 5 June 2017].
- Mulder, R. and Mulder-van Staden, S. 2018. South African statutory regulations for dental practices – ethics. *South African Dental Journal*, 73(4): 300–301. [Online] Available from: <<https://journals.co.za/content/journal/10520/EJC-100f58baa2>> [Accessed 5 June 2017].
- Municipalities of South Africa. n.d. City of Tshwane Metropolitan Municipality (TSH) Map. Available from: <<https://municipalities.co.za/map/3/city-of-tshwane-metropolitan-municipality>>
- Nemathaga, F., Maringa, S. and Chimuka, L. 2008. Hospital solid waste management practices in Limpopo Province, South Africa: a case study of two hospitals. *Waste Management*, 28(7);

- 1236–1245. [Online] doi: <https://doi.org/10.1016/j.wasman.2007.03.033>. Available from: <<https://pubmed.ncbi.nlm.nih.gov/18060760/>> [Accessed: 5 June 2017].
- Nemutandani, M.S. 2008. *Occupational exposures among dental assistants in Limpopo dental clinics*. Research Report. University of Witwatersrand, Johannesburg. Available from: <<http://hdl.handle.net/10539/5798>>
- Olaifa, A., Govender, R.D. and Ross, A.J. 2018. Knowledge, attitudes and practices of healthcare workers about healthcare waste management at a district hospital in KwaZulu-Natal. *South African Family Practice*, 60(5). [Online] doi: <https://doi.org/10.4102/safp.v60i5.4919>. Available from: <<https://www.ajol.info/index.php/safp/article/view/183763>> [Accessed: 24 April 2019].
- Olaniyi, F.C., Ogola J.S. and Tshitangano T.G. 2019. Efficiency of Health Care Risk Waste Management in Rural Healthcare Facilities of South Africa: An Assessment of Selected Facilities in Vhembe District, Limpopo Province. *International Journal of Environmental Research and Public Health*, 16(12): 2199. [Online] Available from: <<https://doi.org/10.3390/ijerph16122199>> [Accessed: 24 April 2020].
- Oosthuysen J. 2015. *Infection Prevention and Control Audit-Feedback Instrument for Oral Health Care in South Africa*. D Tech thesis. Central University of Technology, Free State. Available from: <<http://ir.cut.ac.za>>
- Oosthuysen J., Potgieter E. and Blignaut E. 2010. Compliance with infection control recommendations in South African dental practices: a review of studies published between 1990 and 2007. *International Dental Journal*, 60(3): 181–189. [Online] Available from: <https://onlinelibrary.wiley.com/doi/abs/10.1922/IDJ_2371Oosthuysen09> [Accessed: 5 June 2017].

- Priyaranjan, Mago, H.S., Pandey, S. and Mishra, A. 2019. Awareness of Dental Health Care Waste Management among Dentists – A Cross Sectional Study. *Journal of Advanced Medical and Dental Sciences Research*, 7(10): 73–76. [Online] doi: <https://doi.org/10.21276/jamdsr>.
- Prüss-Üstün. A., Rapiti, E. and Hutin, Y. 2005. Estimation of the global burden of disease attributable to contaminated sharps injuries among health-care workers. *American Journal of Industrial Medicine*, 46(6): 482–490. [Online] Available from: <https://onlinelibrary.wiley.com/doi/abs/10.1002/ajim.20230> [Accessed: 15 December 2020].
- Ramodipa, M.P. 2018. *Evaluation of an integrated health care waste management plan for major generators in public health care facilities*. M Thesis, Tshwane University of Technology, Tshwane.
- Ramokate, T. and Basu, D. 2009. Health care waste management at an academic hospital: knowledge and practices of doctors and nurses. *South African Medical Journal*, 99(6): 444–445. [Online] Available from: http://www.scielo.org.za/scielo.php?script=sci_arttext&pid=S0256-95742009000600016
- Sanjeev R, Suneesh Kuruvilla, Subramaniam R, Prashant PS1, Meera Gopalakrishnan2. 2014. Knowledge, attitude, and practices about biomedical waste management among dental healthcare personnel in dental colleges in Kothamangalam: a cross-sectional study. *Health Sciences Journal*, 1(3): 1-12.
- Singh, H., Bhaskar, D.J., Dalai, D.R., Rehman, R. and Khan M. 2014. Dental Biomedical Waste Management. *International Journal of Scientific Study*, 2(4): 66–68. [Online] Available from: http://asnanportal.com/images/managment/Dental_Biomedical_Waste_Management.pdf

[Accessed: 5 June 2017].

Smith, A., Creanor, S., Hurrell, D., Bagg, J. and McCowan, M. 2009. Management of infection

control in dental practice. *Journal of Hospital Infection*, 74(1): 353–358. [Online] doi:

<https://doi.org/10.1016/j.jhin.2008.11.026>. Available from:

<<https://pubmed.ncbi.nlm.nih.gov/19162375/>> [Accessed: 5 June 2017].

South Africa. 1996. The Constitution of the Republic of South Africa, Section 27. Available from:

<https://section27.org.za/wp-content/uploads/2010/04/Chapter2.pdf>

[Accessed: 29 November 2020].

South Africa. 1993. Occupational Health and Safety Act 85 of 1993. Cape Town: Government

Gazette No. 14918, Vol 337. [Online] Available from:

<https://www.gov.za/sites/default/files/gcis_document/201409/act85of1993.pdf>

South Africa. 2004. National Environmental Management: Air Quality Act 39 of 2004. Cape Town:

Government Gazette No. 27318, Vol 476. [Online] Available from:

<https://www.environment.gov.za/sites/default/files/legislations/nema_amendment_act39.pdf>

South Africa. 2008. National Environmental Management: Waste Act 59 of 2008. Cape Town:

Government Gazette No. 32000, Vol 525. [Online] Available from:

<https://www.environment.gov.za/sites/default/files/legislations/nema_amendment_act59.pdf>

[Accessed: 5 June 2017].

South Africa. Department of Environmental Affairs (DEA). 2011. *National Waste Management*

Strategy. Pretoria. 1–75. [Online] Available from:

<https://www.environment.gov.za/sites/default/files/docs/nationalwaste_management_strategy.

pdf> [Accessed: 5 June 2017].

South Africa. Department of Environmental Affairs and Tourism (DEAT). 2008. *Survey of Generation Rates, Treatment Capacities and Minimal Costs of Health Care Waste in the 9 Provinces of RSA*. Pretoria. 1–139 [Online] Available from:
<<http://sawic.environment.gov.za/documents/1067.PDF>> [Accessed: 15 December 2020].

South Africa. Department of Environment, Forestry and Fisheries (DEFF). 2016. *Approach to waste in South Africa*. South African Waste Information Centre (SAWIC), DEA: Pretoria. [Online]
Available from: <<http://sawic.environment.gov.za/?menu=60>>
[Accessed: 5 June 2017].

South Africa. Department of Statistics (Stats SA). 2019. *Mid-year population estimates*. Pretoria:
Statistical Release P0302. 1–30. [Online] Available from:
<<http://www.statssa.gov.za/publications/P0302/P03022019.pdf>>
[Accessed: 15 December 2020].

South Africa. National Department of Health (NDoH). 2015. *National Health Act: National Environmental Health Norms and Standards for Premises and Acceptable Monitoring Standards for Environmental Health Practitioners*. Department of Health Notice 1229 of 2015. Pretoria. Government Gazette No. 39561. 1–165. [Online] Available from:
<https://www.gov.za/sites/default/files/gcis_document/201512/39561gon1229.pdf> [Accessed: 5 June 2017].

South Africa. National Department of Health (NDoH). 2020. *Practical Manual for Implementation of the National Infection Prevention and Control Strategic Framework*. Pretoria. 1–214. [Online]
Available from: <https://www.idealhealthfacility.org.za/docs/Manuals-and->

Handbooks/Practical%20Manual%20for%20implementation%20of%20the%20National%20IPC
%20Strategic%20Framework%20March%202020.pdf
[Accessed 2 March 2020].

Srinivasan, K. 2018. Dental Perspective on Biomedical Waste and Management – A Knowledge,
Attitude and Practice Survey: A Cross-sectional Study. *International Journal of Dental and
Medical Specialty*, 5(1): 3–12. [Online] Available from:
<<http://rep.nacd.in/ijda/11/01/11.01.10001.pdf>> [Accessed: 7 August 2020].

Thakur, V. and Ramesh, A. 2015. Healthcare waste management research: A structured analysis
and review (2005–2014). *Waste Management and Research*, 33(10): 855–870. [Online] doi:
<https://doi.org/10.1177/0734242X15594248>. Available from:
<<https://pubmed.ncbi.nlm.nih.gov/26268601/>> [Accessed: 5 June 2017].

Trochim, M.K. 2007. *The Research Methods Knowledge Base*. Sydney: Conjoint.ly. [Online].
Available from: <[researchgate.net/publication/243783609_The
Research_Methods_Knowledge_Base](https://researchgate.net/publication/243783609_The_Research_Methods_Knowledge_Base)> [Accessed: 29 November 2020].

United Nations Environment Programme (UNEP). 1992. *Basel Convention on the Control of
Transboundary Movements of Hazardous Wastes and their Disposal*. Geneva, Secretariat of
the Basel Convention. [Online] Available from:
<[https://www.unenvironment.org/resources/report/basel-convention-control-transboundary-
movements-hazardous-wastes#:~:text=Events-
,Basel%20Convention%20on%20the%20Control%20of%20Transboundary%20Movements%20
Of%20Hazardous,came%20into%20force%20in%201992](https://www.unenvironment.org/resources/report/basel-convention-control-transboundary-movements-hazardous-wastes#:~:text=Events-,Basel%20Convention%20on%20the%20Control%20of%20Transboundary%20Movements%20of%20Hazardous,came%20into%20force%20in%201992)> [Accessed: 15 December 2020].

United States of America. Environmental Protection Agency (US EPA). 2017. Medical Waste

- Resource Conservation and Recovery Act. United States Congress. [Online] Available from:
<<https://www.epa.gov/rcra/medical-waste>> [Accessed: 5 June 2017].
- United States of America (USA). 1988. Medical Waste Tracking Act of 1988. Washington, United States House and Senate. [Online] Available from:
<<https://archive.epa.gov/epawaste/nonhaz/industrial/medical/web/html/tracking.html>>
[Accessed: 5 June 2017].
- Vieira, C.D., de Carvalho, M.A.R., de Menezes Cussiol, N.A., Alvarez-Leite, M.E., Dos Santos, S.G., da Fonseca Gomes, R.M., Silva, M.X. and de Macêdo Farias, L. 2009. Composition analysis of dental solid waste in Brazil. *Waste Management*, 29(4): 1388–1391. [Online] Available from: doi:10.1016/j.wasman.2008.11.026 [Accessed: 6 July 2016].
- Vumase, S.B. 2009. *An Evaluation of Operational and Administrative Procedures for Health Care Waste Management in Public District Hospitals of South Africa*. Doctors Degree of Technology: Business Administration. Durban University of Technology. Durban. Available from:
<https://ir.dut.ac.za/bitstream/10321/530/3/Vumase_2009.pdf>
- Yar, M., Dix, D. and Bajekal, M. 2006. Socio-demographic characteristics of the healthcare workforce in England and Wales – Results from the 2001 Census. *Health Statistics Quarterly/Office of National Statistics*, 32(32): 44–56. [Online] Available from:
<https://www.researchgate.net/publication/6635385_Socio-demographic_characteristics_of_the_healthcare_workforce_in_England_and_Wales-_Results_from_the_2001_Census>
- Windfeld, E.S. and Brooks, M.S. 2015. Medical waste management- A Review. *Journal of Environmental Management*, 163: 98–108. [Online] Available from:

<<https://doi.org/10.1016/j.jenvman.2015.08.013>> [Accessed: 28 October 2018].

World Health Organisation (WHO). 2014. *Safe management of wastes from health-care activities*,

2nd ed. Geneva, WHO Press. [Online]. Available from:

<http://www.euro.who.int/_data/assests/pdf_file /0012/268779/Safe-management-of-wastes-from-health-care-activities-Eng.pdf> [Accessed: 5 June 2017].

World Health Organisation (WHO). 2015. *Ethics and Health. Ethical Standards and Procedures for*

Research with Human Beings. Geneva, WHO Press. [Online]. Available from:

<<http://www.who.int/ethics/research/en/>> [Accessed: 29 November 2020].

Zafar, S. 2020. Medical Waste Management in Developing Countries. *Bioenergy Consult*. [Online]

Available from: <<https://www.bioenergyconsult.com/medical-waste-management/>> [Accessed: 15 December 2020].

LIST OF APPENDIXES

Appendix A: Copy of ethical clearance certificate - University of Free State

Appendix B: Copy of ethical clearance certificate – Gauteng Department of `health

Appendix C: Copy of questionnaire

Appendix D: Consent letter

Appendix E: Certificate of language editing

Appendix A: Ethical clearance certificate from the University of Free State



Health Sciences Research Ethics Committee

09-Nov-2018

Dear Tebatso Mutlhi

Ethics Clearance: Dental healthcare waste management practices in the Tlokweng region

Principal Investigator: Tebatso Mutlhi

Department: CUT - Central University of Technology

APPLICATION APPROVED

Please ensure that you read the whole document

With reference to your application for ethical clearance with the Faculty of Health Sciences, I am pleased to inform you on behalf of the Health Sciences Research Ethics Committee that you have been granted ethical clearance for your project.

Your ethical clearance number, to be used in all correspondence is: **UFS-HSD2018/0782/2711**

The ethical clearance number is valid for research conducted for one year from issuance. Should you require more time to complete this research, please apply for an extension.

We request that any changes that may take place during the course of your research project be submitted to the HSREC for approval to ensure we are kept up to date with your progress and any ethical implications that may arise. This includes any serious adverse events and/or termination of the study.

A progress report should be submitted within one year of approval, and annually for long term studies. A final report should be submitted at the completion of the study.

The HSREC functions in compliance with, but not limited to, the following documents and guidelines: The SA National Health Act, No. 61 of 2003; Ethics in Health Research: Principles, Structures and Processes (2015); SA GCP(2006); Declaration of Helsinki; The Belmont Report; The US Office of Human Research Protections 45 CFR 461 (for non-exempt research with human participants conducted or supported by the US Department of Health and Human Services- (HHS), 21 CFR 50, 21 CFR 56; CIOMS; ICH-GCP-E6 Sections 1-4; The International Conference on Harmonization and Technical Requirements for Registration of Pharmaceuticals for Human Use (ICH Tripartite); Guidelines of the SA Medicines Control Council as well as Laws and Regulations with regard to the Control of Medicines, Constitution of the HSREC of the Faculty of Health Sciences.

For any questions or concerns, please feel free to contact HSREC Administration: 051-4017794/5 or email EthicsFHS@ufs.ac.za.

Thank you for submitting this proposal for ethical clearance and we wish you every success with your research.

Yours Sincerely



Dr. SM Le Grange

Chair : Health Sciences Research Ethics Committee

Health Sciences Research Ethics Committee

Office of the Dean: Health Sciences

T: +27 (0)51 401 7795/7794 | E: ethicsfhs@ufs.ac.za

IRB 00000240; RDC 210408-011; ICHG0005107; FWA00012704

Block D, Dean's Division, Room D004 | P.O. Box/Postbus 339 (Internal Post Box 040) | Bloemfontein 9300 | South Africa
www.ufs.ac.za



Appendix B: Ethical clearance certificate from Gauteng DoH



GAUTENG PROVINCE
REPUBLIC OF SOUTH AFRICA

Enquiries: Mpho Moshime-Shabangu
Tel: +27 12 451 9036
E-mail: Mpho.Moshime@gauteng.gov.za

TSHWANE RESEARCH COMMITTEE: CLEARANCE CERTIFICATE

DATE ISSUED: 29/11/2018
PROJECT NUMBER: 82/2018
NHRD REFERENCE NUMBER: GP_ 201810_054

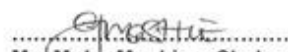
TOPIC: Dental healthcare waste management practices in the Tshwane region

Name of the Researcher: Ms. Tebatso Mutibi
Name of Supervisor: Dr J Oosthuysen
Prof A Fossey
Facility: Mamelodi West Clinic
Saulsville Clinic
KT Motubatse Clinic
Pretoria West District Hospital
Kalafong Provincial Tertiary Hospital
Name of the Department: University of Free State
(Central University of Technology)

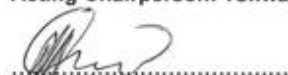
NB: THIS OFFICE REQUEST A FULL REPORT ON THE OUTCOME OF THE RESEARCH DONE AND

NOTE THAT RESUBMISSION OF THE PROTOCOL BY RESEARCHER(S) IS REQUIRED IF THERE IS DEPARTURE FROM THE PROTOCOL PROCEDURES AS APPROVED BY THE COMMITTEE.

DECISION OF THE COMMITTEE: APPROVED


Ms. Mpho Moshime-Shabangu
Acting Chairperson: Tshwane Research Committee

Date: 10/12/2018


Mr. Mothomone Pitsi
Chief Director: Tshwane District Health

Date: 2018.12.11

Appendix C: Copy of questionnaire

You are invited to participate in our survey Dental Healthcare waste management practices. In this survey, approximately 40 people will be asked to complete a survey that asks questions about [General Survey Process]. It will take approximately 15 minutes to complete the questionnaire. Your participation in this study is completely voluntary. There is no payment for participation and no foreseeable risks associated with this project. However, if you feel uncomfortable answering any questions, you can withdraw from the survey at any point. It is very important for us to learn your opinions. By participating in the survey, you are voluntarily consenting. Your survey responses will be regarded as strictly confidential and data from this research will be reported only in the aggregate. Your information will be coded and will remain confidential. If you have questions at any time about the survey or the procedures, you may contact: Mutibi T at 073 525 4049 or Mutibit@gmail.com. Thank you very much for your time and support. Please start with the survey now by clicking on the Continue button below:

Are you male or female?

1. Female
2. Male
3. Other _____

How old are you?

1. 18-25 yrs
2. 26-35 yrs
3. 36-45 yrs
4. 46-55 yrs
5. 56-65 yrs
6. 65+ yrs

Do you understand English?

1. Yes
2. No

Currently practicing as?

1. Dentist
2. Dental therapist
3. Oral hygienist
4. Dental assistant
5. Practice manager
6. Other _____

How long have you been practicing in this profession?

1. 0-2 yrs
2. 3-5 yrs
3. 6-10 yrs
4. 11-15 yrs
5. 16-20 yrs
6. 20+ yrs

Which sector are you working in?

1. Public dental clinic
2. Public dental hospital
3. Mobile clinic
4. Dental health training institution
5. Private sector: solo practice
6. Private sector: multi-practitioner practice
7. Private clinic
8. Other _____

The location of the main dental facility/ practice where you are working is in a:

1. City
2. Suburb
3. Rural area
4. Township
5. Other _____

Indicate the number of years you have been practicing in the above-mentioned dental healthcare facility.

1. 0-2 yrs
2. 3-5 yrs
3. 6-10 yrs
4. 11-15 yrs
5. 16-20 yrs
6. 20+ yrs

The person overseeing quality control and management of the dental healthcare risk waste in this facility?

1. Owner/s
2. Dentist
3. Dental assistant
4. Cleaning personnel
5. Other _____

The person executing the actual procedures of dental healthcare risk waste in this facility.

1. Owner/s
2. Dentist
3. Dental assistant
4. Cleaning personnel
5. Other _____

Training and Continuous Professional Development (CPD) activities

Indicate the type of Educational training you received.

1. In-service training
2. University
3. Other _____

Do you attend Continuous Professional Development (CPD) activities?

1. Yes
2. No
3. Use other methods _____

What do you recon is your current knowledge on dental healthcare risk waste management?

1. None
2. Below average
3. Average
4. Above average
5. Excellent

Where do you refresh your knowledge on dental healthcare risk waste management? Tick all applicable to you.

1. Formal training at University
2. Employment place
3. Other colleagues
4. Reading books and journals
5. Doing internet research
6. Attending CPD events
7. None
8. Other _____

Did you receive training on dental healthcare risk waste management during the following occasions?

1. Upon appointment as new staff member
2. When implementing new material and/or equipment
3. None of the above
4. Other _____

In your opinion, do you recon dental healthcare risk waste management training is needed during the following occasions?

1. Upon appointment as new staff member
2. When implementing new material and/or equipment
3. None of the above
4. Other _____

Does the dental healthcare facility / practice where you work for have a written dental healthcare risk waste management plan / guideline / manual for dealing with accidents or incidents, including spillages, segregation and disposal?

1. Yes
2. No
3. Not sure
4. Not applicable
5. Other _____

If yes to previous question, do you use the dental healthcare risk waste management plan/ guidelines/ manual when the need arise.

1. Yes
2. No
3. Not sure
4. Not applicable
5. Other _____

To your knowledge, are there different categories of dental healthcare risk waste generated in your dental healthcare facilities?

1. Yes
2. No
3. Not sure

In your opinion, is it important to separate dental healthcare risk waste generated in dental healthcare facilities into different categories?

1. Yes
2. No
3. Not sure

In your opinion, are there specific colour coding used to dispose of different types dental healthcare risk waste?

1. Yes
2. No
3. Not sure

In your opinion, which of the following is an example of general waste?

1. Used gauze
2. Papers
3. Used needles
4. Not sure
5. Other _____

In your opinion, which of the following is an example of sharps waste?

1. Fixer solution
2. Papers
3. Used needles
4. Not sure
5. Other _____

In your opinion, which of the following is an example of infectious anatomical waste?

1. Extracted tooth
2. Papers
3. Cotton used in patient's mouth
4. Not sure
5. Other _____

In your opinion, which of the following is an example of pathological infectious waste?

1. Extracted tooth
2. Papers
3. Gauze used in patient's mouth
4. Not sure
5. Other _____

In your opinion, which of the following is an example of chemical waste in dental healthcare facilities?

1. Fixer solution
2. Papers
3. Extracted tooth
4. Not sure
5. Other _____

In your opinion, which of the following is an example of pharmaceutical waste?

1. Expired medication
2. Used needles
3. Cotton used in patient's mouth
4. Not sure
5. Other _____

In your opinion, do you recon all healthcare risk waste generated in your facility is hazardous?

1. Yes
2. No
3. Not sure

Is the waste generated in your facility segregated in the area / room of generation?

1. Yes
2. No
3. Not sure

Do you wear specific hand protection equipment when handling healthcare waste?

1. Yes
2. No
3. Not sure

Do you change to clean hand protection equipment to handle healthcare waste after every patient treatment procedure?

1. Yes
2. No
3. Not sure

Do you regard examination gloves as sufficient hand protective equipment when handling healthcare risk waste?

1. Yes
2. No
3. Not sure

Do you re-use examination gloves on patients?

1. Yes
2. No
3. Not sure

If yes, to previous question: how often do you change the examination gloves?

1. After 2-3 patients
2. End of the day
3. Not applicable
4. Not sure
5. Other _____

Do you re-use saliva ejectors tips?

1. Yes
2. No
3. Not sure

If yes, to previous question. How do you clean/ disinfect/ sterilise the saliva ejectors?

1. Wash under cold running water
2. In cold chemical liquid
3. Not applicable
4. Other _____

If you re-use saliva-ejectors, when do you dispose of them?

1. When worn out
2. After several weeks
3. After a week
4. Not applicable
5. Not sure
6. Other _____

Do you re-use face masks?

1. Yes
2. No
3. Not sure

If, yes to previous question. How often do you change the face mask?

1. After 2-3 patients
2. At the end of the day
3. Once a week
4. After several weeks of use
5. Not applicable
6. Not sure
7. Other _____

Does the main dental facility you work at, segregate waste at the place of creation?

1. Yes
2. No
3. Not applicable
4. Not sure
5. Other _____

In which colour waste container do you place your general waste?

1. Black/clear
2. Green
3. Red
4. Yellow
5. Not sure
6. Not applicable
7. Other _____

In which colour waste container do you place your sharps waste?

1. Black/clear
2. Green
3. Red
4. Yellow
5. Not sure
6. Not applicable
7. Other _____

In which colour waste container do you place your infectious anatomical waste?

1. Black/clear
2. Green
3. Red
4. Yellow
5. Not sure
6. Not applicable
7. Other _____

In which colour waste container do you place extracted teeth with silver amalgam restorations?

1. Black/clear
2. Green
3. Red
4. Yellow
5. Air tight container with water
6. Not sure
7. Not applicable
8. Other _____

In which colour waste container do you dispose of pharmaceutical waste?

1. Black/clear
2. Green
3. Red
4. Yellow
5. Not sure
6. Not applicable
7. Other _____

How/where do you dispose of fixer solution?

1. Down the drain with water
2. Chemical waste collection
3. Not sure
4. Not applicable
5. Other _____

How/where do you dispose of developer solution?

1. Down the drain with water
2. Chemical waste collection
3. Not sure
4. Not applicable
5. Other _____

How/where do you store/dispose excess silver amalgam?

1. Dispose in common bin
2. Store in an air tight container with water
3. Pour down the drain with water
4. Not applicable
5. Other _____

Does the main dental healthcare facility / practice you work for make use of the services of a registered and accredited healthcare waste removal company?

1. Yes
2. No
3. Not sure

Does the main dental healthcare facility / practice you work for keep records of the different healthcare risk waste generated in the facility?

1. Yes
2. No
3. Not sure

Does the main dental healthcare facility / practice you work for keep signed records of waste collected by a registered healthcare risk waste removal company?

1. Yes
2. No
3. Not sure

Have you received any formal training on the transportation of Healthcare Risk Waste?

1. Yes
2. No
3. Not sure

Does the staff working in your facility ever transport Healthcare Risk Waste e.g. containers with used sharps?

1. Yes
2. No
3. Not sure

Have you received any formal training on Healthcare Risk Waste Disposal and treatment?

1. Yes
2. No
3. Not sure

According to your knowledge, should Healthcare Risk Waste be disposed of in a specific prescribed manner?

1. Yes
2. No
3. Not sure

Does your facility treat and dispose of the waste generated themselves?

1. Yes
2. No
3. Not sure
4. Other _____

If yes, to previous question: Do you know how and where the Healthcare Risk Waste generated in your dental healthcare facility is being disposed of and treated?

1. Yes
2. No
3. Not applicable
4. Not sure

In your opinion, is burning/ incinerating healthcare risk waste is a safe treatment method?

1. Disagree
2. Neutral
3. Agree
4. Not sure

According to your knowledge, do you think staff who need to handle, dispose of or treat Healthcare Risk Waste should be vaccinated against hepatitis B?

1. Yes
2. No
3. Not sure

According to your knowledge, should staff who handle, dispose of or treat Healthcare Risk Waste should wear appropriate protective equipment?

1. Yes
2. No
3. Not sure

According to your knowledge, is it the employer's responsible to provide appropriate personal protective equipment to staff?

1. Yes
2. No
3. Not sure

According to your knowledge, is Dental Healthcare Waste Management processes a waste of time?

1. Disagree
2. Neutral
3. Agree
4. Not sure

According to your knowledge, is Dental Healthcare Waste Management and control a waste of money?

1. Disagree
2. Neutral
3. Agree
4. Not sure

According to your knowledge, is effective waste management and control products expensive?

1. Disagree
2. Neutral
3. Agree
4. Not sure

Limited time makes it difficult to execute effective Dental Healthcare Waste Management and control procedures.

1. Disagree
2. Neutral
3. Agree
4. Not Applicable
5. Not sure

Number of practitioners whom the dental assistant needs to assist, makes it difficult to execute effective Dental Healthcare Waste Management and control procedures.

1. Disagree
2. Neutral
3. Agree
4. Not sure

Lack of guidance with regards to waste management and control procedures, makes it difficult to execute effective Dental Healthcare Waste Management and control procedures.

1. Disagree
2. Neutral
3. Agree
4. Not applicable
5. Not sure

Standard precautions should be used for all patients irrespective of their health status.

1. Disagree
2. Neutral
3. Agree

4. Not sure

Dental Healthcare Waste Management is a team effort.

1. Disagree
2. Neutral
3. Agree
4. Not sure

Dental Healthcare Waste Management is a priority at your work place.

1. Yes
2. No
3. Not applicable
4. Not sure

Appendix D: Consent letter



Central University of
Technology, Free State

FACULTY OF HEALTH AND ENVIRONMENTAL SCIENCES

Dear Dental Practice Owner,

I am a junior lecturer in the Dental Assisting program at the Tshwane University of Technology. I intend to complete a research project in order to obtain a Masters Degree in Environmental Health under the supervision of Prof A. Fossey and Dr J. Oosthuysen.

The target audience for this research project are Dental Practices Owners, Clinicians and Dental Assistants in the Tshwane District. The aim of the research is to probe into the management practices of dental healthcare waste in the Tshwane area.

As owners or employers of Clinicians and Dental Assistants, I herewith I request your approval to approach dentists and dental assistants, which are currently in your employment, to participate in this research project. Personal permission from the clinicians and dental assistants will also form part of the consent procedure before any part of the research would be undertaken. The participation of the Clinicians and Dental Assistants is voluntary and they have the right to withdraw at any time. All participants will be anonymous and all information received will be treated with outmost confidentiality. There will be no direct reference made to your specific practice.

The questionnaire will be available for your scrutiny if requested.

The advantage of your clinicians and dental assistants' participation in this research project will be:

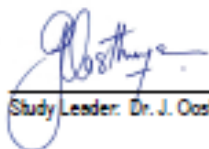
- 1) Clinicians and Dental assistants will become more aware of their role as professionals in the delivery of quality Dental Healthcare to patients and environment;
- 2) Clinicians and Dental Assistants will develop a higher sense of awareness of Dental Healthcare Waste Management;
- 3) Clinicians and Dental Assistants will develop confidence as they deliver the best possible means of Dental Healthcare Waste Management.

I trust that you will see the importance of this research project and support the research by giving consent that the Clinicians and Dental Assistants may participate in the research project. Together, we all can build to advance dentistry as a whole.

Yours sincerely



Researcher: Tebato Mutibi



Study Leader: Dr. J. Oosthuysen

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Appendix E: Certificate of language editing

10 February 2021

Att: Ms T Mutibi
Faculty of Health & Environmental Sciences
Central University of Technology
Private Bag X20539
Bloemfontein 9300

Per email to mutibit@gmail.com

CERTIFICATION OF PROOFREADING & EDITING

Thesis Title: Dental Healthcare Waste Management Practices in the Greater Tshwane Region

Author: Tebatso Mutibi

Length: 147 pages, 28901 words

This confirms that the above thesis to be submitted in partial fulfilment for the degree of Master of Health: Environmental Health to the Central University of Technology, Free State, South Africa was proofread and edited for proper English language, grammar, punctuation and spelling.

This was executed by an experienced academic proficient in the English language. Neither the research content nor the author's intended meaning was altered in any way during the review. All references and citations were checked online.

All amendments were tracked with the Microsoft Word *Track Changes* feature. Therefore, the author has the option to reject or accept each change individually. For this reason, the edited work described here may not be identical to that submitted.

Yours faithfully



B.Sc (Hons) HED