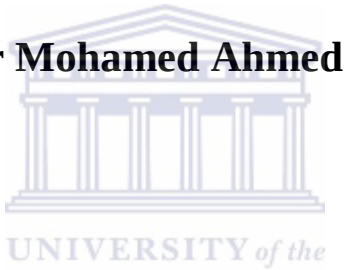
Assessment of infection control in public dental clinics in Khartoum State, Sudan

Dr. Modather Mohamed Ahmed Sheikh Idris



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Supervisor

Professor Sudeshni Naidoo, PhD

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Abstract

The unique nature of dental procedures, instrumentation and patient care settings require specific strategies directed at the prevention of transmission of diseases among oral health care workers and their patients.

Aim: The aim of the present study was to assess the knowledge, attitude and practice of infection control among dentists and dental auxiliaries in public dental clinics in Khartoum State, Sudan.

Materials and Methods: A cross-sectional survey using a structured administered questionnaire was carried out. The questionnaire consisted of 38 closed-ended questions that included the key areas of infection control including hand hygiene, personal protection, sterilization and disinfection and environmental infection control. There were also questions to elicit perceptions regarding the treatment of HBV and HIV/AIDS patients.

Results: All except one (n=125) of the oral health personnel in Khartoum State participated in the study. 68 dentists and 57 dental assistants were interviewed. The majority were female (60.8%) and 31-40 year olds the predominant age group (44%) for both genders.

Hand washing before and after treating each patient was reported by 89.6%. Among dentists, 84.8% reported that they take the medical history of every patient. A quarter of the dentists and 36.8% of dental assistants reported using both hands to recap the used needles. 84%were vaccinated against hepatitis B. With regard to personal protection, the highest adherence was reported for glove use (99.2%), and the least for eye protection (45.6%). None of the study participants used plastic barriers to cover the clinical contact surfaces, 61.6% did not high vacuum suction and 97.6% did not use the rubber dam. All respondents used autoclaves for sterilization, but only 7.2%sterilized hand pieces. 72.8%reported that they did not mind treating HIV/AIDS and hepatitis B patients; however, dental assistants were more willing to treat them than the dentists.

Declaration

I, the undersigned, hereby declare that the work contained in this dissertation is my original work and that it has not been previously in its entirety or in part submitted at any university for a degree.

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Dr. Modather Sheikh Idris

Dedication

Dedicated to

My beloved parents for their constant love, support and prayers

My brother Dr Isam Mohamed Ahmed for making it all possible and lastly, but not least,

My son Eyad for keeping me sane through it all

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LIST OF ABBREVIATIONS

AAMI	Association for the Advancement of Medical Instrumentation
ADA	American Dental Association
ANSI	American National Standards Institute
BDA	British Dental Association
BI	Biological Indicators
CDC	Centers for Disease control and prevention
CPD	Continuous Professional Development
DUWL	Dental Unit Water Lines
EMRO	Eastern Mediterranean Regional Office of the WHO
HBV	Hepatitis B Virus
HCV	Hepatitis C Virus
HCW	Health Care Worker
HIV	Human Immunodeficiency Virus
OHCW	Oral Health Care Worker
OHD	Oral Health Directorate, Khartoum, Sudan
OPIM	Other Potentially Infectious Material
OSHA	Occupational Safety and Health Administration
PPE	Personal Protective Equipment
WHO	World Health Organization

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Chapter 1: Introduction

The Republic of Sudan is an Afro-Arab country located in the eastern region of Africa. It is one of the largest African and Arab countries covering an area of 1,881,000 million square kilometers. It was the largest country in Africa before the splitting of South Sudan in 2011. Sudan shares borders with seven African countries: Egypt and Libya at the north, Chad and the Central Africa at the west, South Sudan in the south, and Ethiopia and Eritrea in the east. It also neighbours Saudi Arabia across the Red Sea at the east. Sudan belongs to the EMRO region of the World Health Organization. The total population is 33,419,625 according to the 2008 census (CBS, 2008). Sudan was a British colony that gained its independence on the 1st of January 1956. The official language is Arabic and Khartoum is the capital city.

Figure 1: Republic of Sudan

Khartoum State is the capital state located in the eastern part of the middle of the country at the confluence of the Blue Nile and White Nile and comprises seven localities. It covers an area of 20,000 square miles. The total population is 5,706,507 making it the most populous state that comprises 17.1% of total population (CBS, 2008).Health care services in Khartoum State are provided by different providers in both public and private sectors. The Ministry of Health Khartoum State is the main public service provider. The others are Federal Ministry of Health, universities, armed forces, private sector, and governmental and non-governmental organizations. The dentist-to-population ratio according to a 2009 report is approximately 1:17,034 (OHD, 2012). There are 58 State dental clinics located in different hospitals and healthcare centers in Khartoum State providing oral healthcare services for about 150,000 people per annum. The school-based oral health programme provides preventive services for around 70,000 primary school children annually.

Autoclaves were first introduced in 2005 and gradually replaced the hot air ovens and now they are available in each clinic. Autoclaves are a pre-requisite for private dental clinics to acquire a license from the Oral Health Directorate to practice. Not all State clinics are equipped with water-resistant dental cabinets that contain two basins and drawers for storing instruments and materials and provide adequate working surface. Sterilization is monitored by mechanical and chemical indicators for every sterilization cycle and with biological indicators once a month (OHD, 2012).

Problem Statement

Oral Health Care Workers (OHCW) and patients are at risk for possible occupational exposure to infectious materials, including body substances and contaminated supplies, equipment and environmental surfaces. The unique nature of dental procedures, instrumentation and patient care settings require specific strategies directed to the prevention of transmission of diseases among OHCW and their patient. It is therefore necessary to have in place and implement a well-designed infection control programme with recommendations that are based on a strong theoretical rationale to prevent work-related injuries and to reduce the risk of disease transmission in oral health care settings.

Hepatitis B virus (HBV) is a blood-borne virus of major concern in dental infection. Epidemiology of hepatitis B infection in the Middle East in 2001 showed that the prevalence in Sudan was between 16–20% and for HCV a lower prevalence of 2.2%–4.8%. The HIV prevalence in Sudan is 0.67% (Mudawi, 2008).

Although control of infection is of paramount importance in oral healthcare settings and to health care providers, there are no national guidelines for infection control in dental practice in Sudan. Guidelines are a necessary requirement to OHCWs to enable and support them to provide safe oral healthcare.

Khartoum State is the most populous State in Sudan in which the majority of health facilities and health providers in both public and private sectors are located. In the absence of national guidelines it is has become the responsibility of the Oral Health Directorate, Ministry of Health-Khartoum State to develop a regional infection control programme to support dental clinics in reducing the risk of healthcare-associated infections. One of the goals of the Oral Health Directorate is to promote a healthy and safe environment by preventing transmission of infectious agents among patients, staff and visitors. It was anticipated that an assessment of infection control in public dental clinics in Khartoum State will provide baseline data for planning oral health services not only for Khartoum State, but for the country and that guidelines can be developed that are relevant and appropriate.

Chapter 2: Literature Review

In 1986, the Centers for Disease Control and Prevention (CDC) published its first infection control recommendations for dentistry as a journal article (CDC, 1986). Later in 1993 the CDC published "Recommended Infection Control Practices for Dentistry" which focused on prevention of transmission of blood-borne pathogens (CDC, 1993). Ten years later the previous recommendations were revised and updated to "Guidelines for Infection Control in Dental Healthcare Settings" (CDC, 2003a). These guidelines emphasized the use of Standard Precautions (described below) to prevent the transmission of blood-borne pathogens as well as other pathogens encountered in dental clinics (Kohn et al. 2004). To date this is the most widely accepted set of guidelines used in dental practice. There are other infection control guidelines and regulations for example the Occupational Safety and Health Administration (OSHA) in the United State published guidelines regulating the occupational exposure to blood borne pathogens (OSHA, 1991). In the United Kingdom, the British Dental Association had also published guidelines entitled "Infection Control in Dentistry" (BDA, 2003). In addition guidelines for specific aspects of infection control have also been developed. For hand hygiene, for instance, there are "Guidelines for Hand Hygiene in Health Care Settings" (CDC, 2002) and "WHO Guidelines on Hand Hygiene in Health Care (WHO, 2009). Despite these efforts and the fact that infection control guidelines are being developed and continually revised and updated in different institutions around the world, adherence to these guidelines varies from country to country and in different parts within the same country (Myers et al,2008). Infection control practice is lagging behind the knowledge available (Freire, Pordeus and Paixão, 2000).

2.1 Disease transmission in oral healthcare settings

Oral Health Care Workers (OHCW) and their patients are exposed to different types of microorganisms, for example: Hepatitis B Virus (HBV), Hepatitis C Virus (HCV), Human Immunodeficiency Virus (HIV), and mycobacterium tuberculosis (TB). Microorganisms can be transmitted from patient to OHCW, from OHCW to patient and from patient to patient through the following:

- *Contact: direct contact* with blood, saliva or other body material or *indirect contact* through contaminated object.
- *Droplet* contamination of mucous membranes as a result of, for example, coughing or sneezing.
- *Inhalation* of air-borne microorganism

(Bolyard et al, 1998)

Transmission of infection through these routes requires the presence of three factors: a susceptible host, a portal of entry and pathogenic microorganisms. These factors are collectively referred to as the "chain of infection". Infection control practice must be designed to break one or more links of this chain (Greene, 1969). Strategies to accomplish this will be discussed in more details below.

2.1.1 Universal and Standard Precautions

Since it is impossible to identify all patients with infectious diseases by a history or clinical examination alone, the concept of ***Universal Precautions*** was developed. These are a "set of practices and procedures based on the concept that all blood and body fluids that might be contaminated with blood should be treated as infectious" (CDC, 1985). This concept applies to all patients regardless of their infection status.

The term Universal Precaution was changed to ***Standard Precautions*** which expanded the previous concept into standards of care designed to protect healthcare personnel and their patients. Standard Precautions apply to contact with:

- Blood.
- All body fluids, secretions, and excretions (except sweat) whether they contain blood or not.
- Non intact skin.
- Mucous membranes

(Bednarsh, Eklund and Molinari, 2010)

Elements of Standard Precautions include, but are not limited to: adherence to hand hygiene, use of Personal Protective Equipment (PPE), use of engineering and work practice controls, and careful handling of materials and equipment to prevent cross contamination (Siegel et al, 2007).

2.1.2 Transmission-Based Precautions

In some cases when patients have confirmed or suspected infections with highly transmissible pathogens to which Standard Precautions will not provide a complete protection, a second line of precautions, known as Transmission-Based Precautions, is required to prevent the spread of these pathogens. These precautions are in three categories: contact, droplet and airborne precautions (Siegel et al, 2007). They are designed to reduce the transmission of specifically highly transmissible pathogens through these routes. Since some diseases can be transmitted through more than one route, more than one category can be used at a time. Transmission-Based Precautions are always used in addition to Standard Precautions (Harte, 2010).

2.1.3 Prevention of exposure

Avoiding exposure to blood and Other Potentially Infectious Material (OPIM) and immunization are the primary strategies to avoid occupationally acquired infections. Most of the exposures in dental practice are preventable. The best way to reduce exposure is through a combination of Standard Precautions as well as the use of engineering, work-practice and administrative controls. The use of Personal Protective Equipment, which are elements of Standard Precautions, will protect the skin and mucous membranes of OHCW against exposure (CDC, 2003a).

Engineering controls are controls that isolate or remove the hazard of blood borne pathogens from the workplace. They are often technology-based methods to reduce exposures, for example safer design of instruments and equipment to minimize the chances of percutaneous injuries and puncture resistant containers for sharps disposal.

Work practice control means reducing the likelihood of exposure by altering the manner in which a task is performed in every day practice. They are behaviour-based and include any practice that is adopted by OHCW to protect against exposure, for example, removing burs before removing the hand piece from the dental unit, using the one handed scoop technique or recapping devices to recap needles (OSHA, 1991; Harte and Molinari, 2010).

Administrative control represents policies and procedures within a dental facility to reduce the risk of disease transmission (Bednarsh, Eklund and Molinari, 2010)

2.1.4 Hepatitis B immunization

All OHCW should be immunized before they are placed in risk situations where they may become susceptible to transmission of infections (CDC, 2003a). All staff must be vaccinated against the common diseases and those who are involved in clinical care should be vaccinated against the Hepatitis B Virus (BDA, 2003). Vaccination of all dentists and staff members who come in contact with patient is a policy of the American Dental Association (ADA, 1996). Hepatitis B vaccine consists of three doses of intramuscular injections. The second and third doses should be introduced one and six months after the first dose respectively (Molinary and Terezhalmy, 2010). The vaccine is effective in individuals who produce >100mIU/mL level of antibodies to hepatitis B surface antigen (anti-HBs). If an inoculation injury occurs before completing the course of the vaccine close medical follow-up is necessary. The antibody level (anti-HBs) should be measured 2 – 4 months after completion of the course of vaccination. A single booster dose five years after completion of vaccine course is recommended for OHCW who have contact with blood or OPIM. The CDC, however, does not recommend a booster dose for vaccine responders. Individuals who do not respond to the vaccine are either true non-responders or they carry the virus. True non-responders will remain susceptible to hepatitis B infection (BDA, 2003).

2.2 Personal Protective Equipment

Personal Protective Equipment (PPE) includes masks, gloves, eye protection and protective clothing (CDC, 2003a; BDA, 2003). They are designed to protect the skin and mucous membranes of OHCW that may be exposed to blood or OPIM during dental treatment (CDC, 2003a). The technique of providing a physical barrier between the body and source of contamination is called barrier precautions. Its implementation and appropriate use in healthcare serves to reduce exposure to pathogens and thereby assist immune system of the host to resist infections (Molinari and Harte, 2010)

2.2.1 Gloves

OHCW may come in contact with mucous membranes, blood or OPIM during patient care, therefore gloves are used to protect their hands as well as prevent microorganisms present in their hands from being transmitted to their patients (CDC, 1986; CDC, 1993). Based on their use there are two types of medical gloves: non-sterile examination gloves and sterile surgeon's gloves.

The former are used, as their name indicates, for examination and other non-surgical procedures. Sterile surgeon's gloves are used when performing invasive surgical procedures, for example, incision, excision, flap reflection. They are more comfortable and well-fitting than examination gloves and provide additional barrier protection (Molinari and Harte, 2010). Both types are manufactured for single use, thus, a new pair of gloves must be worn for every patient (CDC, 2003a). Gloves must be worn immediately prior to starting the patient care and removed immediately after finishing (BDA, 2003).Non-medical gloves also referred to as general-purpose or utility gloves are also used in dental practice. Their thick texture and puncture resistance make them appropriate for handling sharp contaminated instruments and for cleaning purposes. They can be reused after washing or disinfecting and must be changed when damaged or punctured (Molinari and Harte, 2010).

2.2.2 Surgical masks

OHCW should wear a surgical mask to protect their mouth and nose from blood or other body fluids that may spatter during dental treatment (CDC, 2003a; BDA, 2003). Masks are also used to protect the patients from microorganisms generated by the mask wearer (CDC, 2003a). While some authors prefer that a new mask must be used for every patients (BDA, 2003), others recommend that mask must be changed between patients only if it becomes wet. Air will not pass easily through the mask when the outer surface is wet and may flow around the sides resulting in the loss of proper seal (CDC, 1993; CDC, 2003a).

2.2.3 Eye protection

Protective eye wear is used to prevent both physical injury and microbial contamination with possible consequent infection to the eyes (Molinari and Harte, 2010). It must be worn to protect the eyes of OHCW from sprays or splashes of blood or saliva or debris that may be generated during dental treatment (CDC, 2003a; BDA, 2003). Either a face shield or protective glasses with solid side shield will be appropriate. Protective eye wear must be cleaned between patients using soap and water and, if visibly soiled, disinfected according to the manufacturer instructions (CDC, 1993). Eye protection should also be provided for patients when injury to or contamination of the eye is anticipated. Tinted glasses are appropriate for protection against dental curing lights (BDA, 2003).

2.2.4 Protective clothing

Protective clothing, for example lab coats and gowns, are used to protect the skin and the ordinary clothes of the OHCW from any possible contamination. Long sleeved gowns will protect the forearm from spatters but they might be contaminated themselves. Forearms may be exposed when short sleeves are used, but will allow the forearms to be cleaned together with hands between patients. For these reasons there is no consensus on whether to wear long or short sleeved protective clothing (BDA, 2003). However, OSHA recommends the use of long sleeved protective clothing (OSHA, 1991).

2.3 Hand Hygiene

Hand hygiene is referred to any action of hand cleansing. It is considered the most important method to reduce the risk of transmission of microorganisms (CDC, 2002; WHO, 2009). It may be defined as "a general term that applies to either hand washing, antiseptic hand wash, antiseptic hand rub or surgical hand antisepsis" (CDC, 2002).The normal flora of the skin consists of two types of microorganisms: the *transient* flora that colonizes the superficial layer of the skin and the *resident* flora that colonizes the deeper layer. The transient flora is usually acquired by direct contact with contaminated object. Although they are easy to remove with hand washing they are commonly involved in healthcare associated infections. Resident flora are more difficult to remove but are not commonly associated with infections (CDC, 2003a).

2.3.1 Indications and recommendations

Hand hygiene is indicated when hands are visibly soiled, after touching an object that is likely to be contaminated with blood or OPIM, before and after treating each patient, before and after gloving, if the integrity of the glove is compromised (CDC, 2002) and after using the toilet (WHO, 2009).There are four different methods for hand hygiene (Table 1). For routine dental examination and non-surgical procedures hand washing with ordinary or antiseptic soap and water is adequate. Alcohol-based hand rubs are used when hands are not visibly soiled. For surgical procedures hand antisepsis is performed to destroy transient flora and reduce resident flora. Antiseptic soap or alcohol-based surgical hand rub with prolonged effects should be used (CDC, 2003a).

2.3.2 Important issues related to hand hygiene

The majority of microorganisms are found beneath and around the finger nails, therefore nails should be kept short to allow proper cleaning. Jewelry that may interfere with glove wearing or adversely affect their integrity should be avoided.

Repeated hand washing may result in dry broken skin which may lead to development of chronic irritant contact dermatitis (CDC, 2003a). Moreover the cracked skin provides a portal of entry for microorganisms (BDA, 2003). This can be avoided by the use of lotions to keep the skin soft and intact (Berndt et al 2000; McCormick, Buchman and Maki, 2000). Lotions are recommended for use after every clinical session (BDA, 2003). However petroleum-based lotions adversely affect the latex gloves by weakening them and reducing their permeability, therefore they should only be used at the end of the day (Larson, 1995).

Table 1: Methods of Hand Hygiene

Method	Agent	Purpose	Minimum Duration
Routine hand wash	Water and non-antimicrobial soap	Removal of soil and transient microorganisms	15 seconds
Antiseptic hand wash	Water and antimicrobial soap	Remove or destroy transient microorganisms and reduce resident flora	15 seconds
Antiseptic hand rub	Alcohol-based hand rub	Remove or destroy transient microorganisms and reduce resident flora	Rub the hands until the agent is dry
Surgical hand antisepsis	Water and antimicrobial soap	Remove or destroy transient microorganisms and reduce resident flora (persistent effect)	2 – 6 minutes
	Water and non-antimicrobial soap followed by alcohol-based surgical hand-scrub with persistent activity		Follow manufacturer instructions for surgical hand-scrub product.

(Adapted from CDC, 2003a)

2.4 Sterilization and disinfection

In 1968 Spaulding classified patient care items according to the risk of infection associated with their use into critical, semi critical and non-critical items (CDC, 2008; Molinari and Harte, 2010). Critical items are those penetrate soft tissue and bone and have greater risk of transmission of infection.

Semi critical items come in contact with mucous membranes and non-intact skin and have lower risk of transmitting infection. Non critical items contact only the intact skin, the natural protective barrier, and have the lowest risk of disease transmission. Both critical and semi critical items must be sterilized. Cleaning or, if necessary, disinfection of non-critical items will be appropriate (CDC, 1993; CDC 2003b; CDC, 2008).

2.4.1 Disinfection

Disinfection is the process of destroying pathogenic and other microorganisms on inanimate objects by physical or chemical means. Disinfection does not ensure the higher safety margin of sterilization and therefore the golden role is "do not disinfect if sterilization is possible (Molinari and Harte, 2010). There are three levels of disinfectants: high, intermediate and low levels.

High level disinfectants are capable of destroying all microorganisms but not necessarily a high number of bacterial spores. They are used for disinfection of heat sensitive semi critical items. Some high level disinfectants may be used as sterilants as well provided that proper cleaning precedes their use and guidelines are strictly followed (CDC, 2008). Contact time is the most important variable distinguishing high level disinfection from the sterilization process (CDC, 2003a). It may be up to 12 – 24 hours depending on the type of compound used (Molinari and Harte, 2010).

Intermediate level disinfectants are capable of destroying vegetative bacteria and the majority of fungi and viruses but not necessarily bacterial spores. They are used for disinfection of noncritical items, and clinical contact and housekeeping surfaces contaminated with blood.

Low level disinfectants are capable of destroying the majority of vegetative bacteria and certain fungi and viruses. They are used to disinfect noncritical items without visible blood and both clinical contact and housekeeping surfaces. The manufacturer's instructions regarding the concentration of their products and the duration of exposure should be followed (CDC, 2003a). The properties of ideal disinfectant are shown in Table 2. It is worth mentioning that a product with all of these properties does not exist (Molinari and Harte, 2010).

Table 2: Properties of an ideal disinfectant

Broad spectrum	Should have the widest-possible antimicrobial spectrum
Fast acting	should produce rapid kill
Not affected by environmental factors	Active in the presence of organic matter (e.g. blood & sputum) and compatible with soap, detergent and other chemicals
Nontoxic and non-allergenic	Should not be harmful to the user or patient
Surface compatibility	Should not corrode instrument and metallic surfaces and should not deteriorate cloth, plastic and other materials
Residual effect	Should leave an antimicrobial film on the treated surfaces
Easy to use	With clear label directions
Odorless	Have a pleasant odor or no odor to facilitate its routine use
Environmental friendly	Do no damage the environment on disposal
Economical	Cost should not be prohibitively high

(Adapted from Molinari, Campbell and York, 1982; Molinari et al. 1987)

2.4.1.1 Disinfection of impressions, prosthodontic and orthodontic items

Dental impressions, prostheses and appliances have cross-contamination potential if not appropriately dealt with in both the dental clinic and the laboratory (CDC, 2003a).

2.4.1.1.1 Impressions

These are one of the first laboratory items considered to be contaminated and need special considerations. Immersion, spraying and submersion (dipping) have been recommended for disinfection of impressions; however, immersion is the method of choice. Spraying is an alternative to immersion and submersion is the last choice. Because a wide range of disinfectants is available for different impression materials the exposure or immersion time should follow the manufacturer instructions. Owing to the porosity if impressions, the time needed for their disinfection is longer than that for hard surfaces. Rinsing under running water is necessary immediately after the impression is removed from the mouth, to remove any blood, saliva or bio-burden, and after disinfection to remove any residual disinfectant (Merchant, 2010).

2.4.1.1.2 Prosthodontic and orthodontic items

Heat tolerant items used for prosthodontic or orthodontic treatments should be sterilized. These include, for example, orthodontic pliers and metal impression trays. Other heat sensitive items should be disinfected.

This includes items used in both the dental clinic and dental laboratory. Disposable items should never be reused (Merchant, 2010).Any appliance delivered to the patient should be free of contamination. They should be disinfected prior to insertion into the patient's mouth and intermediate level disinfectants are generally appropriate. The best time for cleaning and disinfection of impressions and appliances is immediately after removal from the patient's mouth before blood or saliva have dried on the surface (CDC, 2003a).

2.4.1.2 Preparing contaminated items for sterilization

Contaminated items should be handled with care to minimize unnecessary percutaneous injury (OSHA, 1991). Used items must be cleaned thoroughly prior to sterilization (BDA, 2003). This involves the removal of debris either manually or with automated machine (ultrasonic cleaner/bath or washer/disinfector) (Rutala, Weber, 1998; CDC, 2003b). Use of work practice control is necessary when hand cleaning is performed. For example; reusable used instruments must be placed in a bath of water and detergent and scrubbed with brush under water to avoid splashing (BDA, 2003), use of long handled brush to avoid injury (OSHA, 1991; BDA, 2003), wearing puncture resistant utility gloves and keeping the sharp edges of instruments away from the body (BDA, 2003). OSHA mandates wearing of Personal Protective Equipment when performing hand cleaning (OSHA, 1991). The brush used for cleaning instruments must be cleaned and stored dry and autoclaved regularly (BDA, 2003).

If an ultrasonic cleaner, which is superior to hand cleaning, is used the manufacturer's instructions must be carefully followed. Detergent must be used because disinfectant can result in precipitation of proteins which are difficult to remove. At the end of the day the used liquid must be disposed of and the machine should be cleaned and kept dry (BDA, 2003). Washer/disinfector is preferred over the hand and ultrasonic cleaning (BDA, 2003; Miller et al. 2000). The use of automated machines does not necessitate presoaking of instruments to facilitate the removal of dried blood or other patient debris and therefore minimizes the risk of exposure to these materials as well as the risk of injury and safes time (Miller et al. 2000).

2.4.2 Sterilization

Sterilization is "the destruction or removal of all forms of life with particular reference to microbial organisms" (Harte and Molinari, 2010). It is a complex process requiring specialized equipment, qualified personnel and regular monitoring (ANSI/AAMI, 2002). Heat-tolerant items can be sterilized using; autoclaves (steam under pressure), dry heat sterilization or unsaturated chemical vapor (ANSI/AAMI, 2002; CDC, 2008). Whatever the method been selected the manufacturer's instructions must carefully be followed. This is of particular importance to loading, sterilization time and temperature, and compatible wraps and indicators (CDC, 2003a).

2.4.2.1 Steam sterilization

Steam sterilization or autoclaving is the method of choice for sterilizing dental instruments (BDA, 2003). It is the most widely used, reliable and economical method (Miller and Palenik, 2001). A temperature of 134 – 137 °C must be reached and continued for three minutes and is appropriate for sterilization of dental instruments (BDA, 2003). Air trapped in the sterilization chamber will interfere with the sterilization process and therefore must be removed either by downward displacement by steam (gravity displacement sterilizers) or evacuating the air to create vacuum before introducing the steam into the chamber (pre-vacuum sterilizers) (CDC, 2003a; BDA, 2003). Table 3 shows the minimum recommended timing of steam sterilization cycles.

2.4.2.2 Dry heat sterilization

This type of sterilization requires relatively longer operating time compared to autoclaves and require higher temperature which is not suitable for some dental instruments (Joslyn, 2001). It can be a useful method for sterilizing instruments that corrode by moist heat (Miller and Palenik, 2001).

2.4.2.3 Unsaturated chemical vapor

This method of sterilization requires heating of a chemical solution in closed pressurized chamber. Because of low level of water used during this process it causes less corrosion and therefore it is suitable for sterilizing carbon steel instruments e.g. burs (CDC, 2003a).

Table 3: Minimum cycle times for steam sterilization

Type of sterilizer	Item	Duration of exposure at 121°C (minutes)	Duration of exposure at 132°C (minutes)	Drying time (minutes)
Gravity displacement	Wrapped instruments	30	15	15 – 30
	Textile packs	30	25	15
	Wrapped utensils	30	15	15 – 30
Pre-vacuum	Wrapped instruments		4	20 – 30
	Textile packs		4	5 – 20
	Wrapped utensils		4	20

Adapted from CDC, 2008

2.4.2.4 Sterilization of unwrapped instruments

This type of sterilization, also known as flash sterilization, involves the sterilization of unwrapped instruments for immediate use. It requires thorough cleaning of instruments before the cycle, checking mechanical indicators and the use of chemical indicators for each cycle. This method is not suitable for dental implants (CDC, 2003a).

2.4.2.5 Sterilization of handpieces

There is no documented case of disease transmission associated with the use of high or slow speed handpieces in dentistry (ADA, 1996). However, sterilization of these pieces of equipment is recommended. Surface disinfection or immersion in chemical germicides are both unacceptable methods. Prior to sterilization the hand piece should be flushed with water for 20 – 30 seconds leaving bur in place to avoid contamination of the inner parts, then clean the outer surface with detergent and water. Never use disinfectants for cleaning or immersing the hand piece. Generally, autoclaves are preferred for sterilizing the handpiece. Some manufacturers recommend the use of cleaner/lubricant before and/or after sterilization. These instructions should carefully be followed (ADA, 1996; BDA, 2003; CDC, 2003a).

2.4.2.6 Monitoring of sterilization

Sterilization monitoring refers to the use of mechanical, chemical and biological indicators to evaluate the sterilizing condition and the effectiveness of the procedure (CDC, 2003a; Harte and Molinari, 2010).

2.4.2.6.1 Mechanical indicators

Mechanical indicators are used to evaluate time, temperature and pressure of each sterilization cycle by observing gauges and displays of sterilizer (CDC, 2008, ANSI/AAMI, 1998). Correct readings do not ensure perfect sterilization but incorrect readings indicate the possibility of a problem. In case of incorrect readings the processed instruments should not be used (CDC, 2003a).

2.4.2.6.2 Chemical indicators

These are sensitive chemicals used to assess the physical conditions of sterilization (e.g. time and temperature) during each cycle. The colour of the indicator is changed when certain parameters are reached. Chemical indicators do not ensure sterilization but they are used to identify any errors that may occur during the sterilization process. They are of two types: external and internal. External chemical indictors are located outside the instrument packaging and are used to indicate that the packaging has been processed through sterilization cycle. Internal chemical indicators are used to confirm that the sterilization agent has penetrated the wrap material and reached the instrument. According to the information they provide, internal chemical indicators are of two types: single-parameter internal chemical indicator which can read only a single sterilization parameter and multi-parameter internal chemical indicator which can read two or more parameters (AAMI, 1999). The latter is available only for autoclaves. If the chemical indicators indicate incorrect process the instruments should not be used (CDC, 2003a).

2.4.2.6.3 Biological indicators (BI)

This is the most reliable method for sterilization monitoring (Favero, 1998) as it directly assesses the killing of known highly resistant microorganisms rather than merely evaluating chemical and physical conditions required for sterilization (CDC, 2008). It is necessary to verify that the sterilizer is functioning correctly by the use of biological indicator (BI) at least once a week (CDC, 1993; Favero 1998; CDC, 2008).

Two BIs are used for this process: one is a control BI that is not processed through sterilization cycle and the other is a test BI which is processed through sterilization cycle according to manufacturer's instructions (CDC, 2003a). Both BIs should be incubated; the control one must show a positive test result for bacterial growth but the result of the test BI must be negative. In case of positive test result the mechanical and chemical indicators should be examined. If they show that the sterilizer is working perfectly, the single positive test result is probably not indicative of malfunction and therefore it is not necessary to recall instruments that have been processed through the sterilizer since the last negative test result. However, the sterilizer must be removed from service, the test must be repeated and the operating procedures must be reviewed with all personnel working with that device to detect any operating defect that may be responsible for the positive test result (ANSI/AAMI, 2002; CDC, 2008).

Another approach recommends that in case of a positive test result a sterilizer malfunction is assumed and instruments processed in that device should be recalled and re-sterilized or kept until the BI test is repeated (ANSI/AAMI, 2002). Because the marginal safety in autoclaves is enough to ensure that the risk of infection is minimal this approach is considered conservative and should be always used with methods other than steam sterilization (CDC, 2008). In both cases, if the repeated test is negative and mechanical and chemical indicators show adequate functioning, the sterilizer can be returned to service. If the repeated test is positive and other procedures (e.g. packaging and loading) were performed correctly the sterilizer must remain out of service until it has been repaired and rechecked with three consecutive empty chamber sterilization cycles (CDC, 2008). Instruments processed in the sterilizer since the last negative test result should be retrieved, whenever possible, and re-sterilized (CDC, 2003a).

2.4.2.7 Storage

Sterilized instruments should be kept dry and covered. This is achieved by use of closed containers, trays with lids or closed cabinets (BDA, 2003; CDC, 2003a). If sterilization pouches are used, the date of sterilization and sterilizer used (in case of more than one sterilizer) must be recorded to be able to retrieve instruments in case of sterilization failure (ANSI/AAMI, 2002). These recommendations for storage are also applied for single used dental supplies (BDA, 2003; CDC, 2003a).

2.5 Environmental infection control

The environment of healthcare facilities, though rarely implicated in disease transmission (CDC, 2003b), could be contaminated during patient care. In the dental operatory, environmental surfaces, air, dental unit water lines (DUWL) and waste disposal have to be considered ensure that clean and safe services is provided for patients.

2.5.1 Environmental surfaces

Surfaces that do not come in direct contact with patients are known as environmental surfaces. They are of two types: clinical contact surfaces (e.g. light handles, switches, radiograph equipment, pens etc.) and housekeeping surfaces (e.g. walls and floors). Some of these surfaces can act as a reservoir for bacterial contamination and can be indirectly associated with transmission of infections mainly through hand contact. This indicates that hand hygiene has an important role to play in reducing the transmission of infection through this route. Other methods are cleaning and disinfection of environmental surfaces and the use of barrier protection (CDC, 2003a).

Housekeeping surfaces have lower risk of transmission of infection and they need to be cleaned with detergent and water or disinfection depending on the degree of contamination and the nature of the surface (CDC, 2003a). Cleaning is the process of removing organic matter, salts and visible soil from the environmental surfaces prior to disinfection. Failure to do this will compromise the success of disinfection procedure. Surfaces should be covered with barriers if they are difficult to clean. Care should be taken to avoid preparing disinfectant solutions in dirty containers or keeping them for long periods of time as they may become potential reservoirs for microorganisms and lose their efficiency (CDC, 2003b).

Direct contamination to clinical contact surfaces from the patient or the operator's hands may result during dental procedures. The use of barrier protection is preferred especially for those surfaces which are difficult to clean (Miller and Palenik, 2001). When barriers are not used, clinical contact surfaces should be disinfected between patients with low or intermediate level disinfectant. If the surface is contaminated with blood or OPIM intermediate level disinfectant must be used (CDC, 1993; CDC, 2003b). It is also recommended that clinical contact surfaces should be cleaned and disinfected at the end of each clinical day (OSHA, 1991)

2.5.2 Management of blood spills

Blood spills on clinical contact or housekeeping surfaces should be removed immediately to avoid the spread of contamination to other areas, OHCW or patients (CDC, 2003b). The spilled blood must be covered by disposable towel and the surface is then cleaned and disinfected with intermediate level disinfection. During this procedure the OHCW should wear the appropriate Personal Protective Equipment (BDA, 2003).

2.5.3 Dental unit water lines (DUWL)

It has been demonstrated that dental unit water lines (DUWL) can be contaminated by different types of microorganisms including bacteria, fungi and protozoa (Walker et al. 2000). These microorganisms colonize and replicate on the interior surface of water lines to form a microbial community known as biofilm. This serves as a reservoir for free floating microorganisms that contaminate the water used for dental procedures (Walker et al. 2000)

The Centre for Disease Control and Prevention (CDC) recommended in 2003 that water used for dental treatment should be as good as drinking water and contains ≤ 500 CFU/mL (CFU = Colony Forming Unit). Water which meets this standard is safe for most dental procedures for example restorative treatment and scaling. However, sterile irrigation solutions must be used for more invasive procedures which include excision, incision, flap reflection and bone cutting (Mills, 2010).

DUWL should be flushed for at least 20 to 30 seconds after each patient to eliminate any patient material that may have been retracted into the tubing system (Mills, 2010). This method will not affect the existence of biofilm and therefore the use of germicides is indicated to inactivate or eliminate the biofilm. Instructions provided by dental unit or germicide manufacturers should be followed (CDC, 2003a).

2.5.4 Air

The use of rotary and ultrasonic devices in dental clinic can generate airborne particles that may contain infectious microorganisms. These particles may be in the form of spatter, mists or aerosols.

Spatter consists of droplet more than 50 microns in diameter that generates during dental procedures and fall onto floor or other surfaces. Mixed with dust they can become airborne. Mist (5 – 50 microns in diameter) may remain suspended in air for longer time and subsequently transformed, due to evaporation, into smaller particles known as residual droplet nuclei. Aerosols particles are lesser than 10 um in diameter. Both aerosols and residual droplet nuclei can remain airborne for extended period of time and may be inhaled during this period. Tuberculosis and Sever Acute Respiratory Disease (SARS) are examples of infections that may spread through this scenario. Risk from contaminated air can be minimized by the use of high volume evacuator, rubber dam and pre-procedural month rinses (Mills, 2010).

2.5.5 Medical waste

Medical waste is defined as "any solid waste generated in the diagnosis, treatment or immunization of human beings" (Neveu, Harte and Molinari, 2010). General waste from healthcare facilities carries no more risk of infection than domestic (residential) waste (CDC, 1990). There are two main types of waste found in dental clinics: non-regulated and regulated medical waste.

Despite the fact that any item that comes in contact with blood or other body fluids may be infective, it is not necessary to treat all these items as infective waste (CDC, 2003b). Examples of such items are gloves, masks, lightly soiled gauze and cotton, and saliva ejectors. These items are regarded as non-regulated medical waste and could be disposed of with general waste (Palenik, 2003; Neveu, Harte and Molinari, 2010).

Regulated medical waste has greater potential of causing infections and therefore needs special and careful handling and disposal (CDC, 1990) examples of regulated medical waste in dental clinics are gauze or cotton saturated with blood, extracted teeth, surgically removed hard and soft tissues, and contaminated needles and scalpel blades. Single, sturdy and leak- resistant biohazard bags should be used for containment and disposal of non-sharp regulated medical waste. Puncture-resistant containers should be used for sharp regulated medical waste. The container should be placed close to the point of use and marked with biohazard label (OSHA, 1991). Final disposal and management of waste should comply with the national and local regulations (CDC, 2003a).

Chapter 3: Aim and Objectives

3.1 Aim

To assess the knowledge, attitudes and practices of infection control among dentists and dental auxiliaries in public dental clinics in Khartoum State.

3.2 Objectives

- To determine the knowledge of infection control methods among dentists and dental auxiliaries in public dental clinics in Khartoum state.
- To determine the attitudes of infection control methods among dentists and dental auxiliaries in public dental clinics in Khartoum state.
- To determine the practices of infection control methods among dentists and dental auxiliaries in public dental clinics in Khartoum state.
- To compare the findings between dentists and dental auxiliaries .
- To compare the findings among the clinics.

Chapter 4: Methodology

4.1 Study design

A descriptive, cross sectional survey was chosen for this study as it best suited the study aims and objectives.

4.2 Study site and study population

There are 48 public dental clinics in Khartoum state providing care for approximately 150,000 people per annum. These clinics are working either for one morning shift or for two morning and evening shifts. The lists of dentist and dental assistants working in these clinics were obtained from Directorate of Oral Health, Ministry of Health Khartoum State. The study sample included all dentists (n=69) and dental assistants (n=57) working in public dental clinics in Khartoum State.

4.3 Data collection tool

Researcher administered questionnaires were used for collecting the data (Appendix 1). This was written in English but administered in Arabic for ease of understanding to ensure that accurate information was obtained.

4.3.1 Development of questionnaire

This study was planned by the Directorate of Oral Health, Ministry of Health Khartoum State to obtain baseline information to assist with the planning of evidence-based oral health services. The Guidelines for infection control in dental health care settings published by the Centers for Disease Control and Prevention in 2003 was revised and a draft questionnaire, based on these guidelines was prepared. The principal investigator reworked the draft questionnaire with respect to the current recommendations of infection control in the literature to achieve the aim and objectives of the study.

It was decided in the early stages of the protocol development that two questionnaires with different content and language one in English for the dentists and the other in Arabic for dental assistants will be used. However, since both the dentist and the dental assistant work as a team in the dental clinic and share the responsibility of

maintaining adequate levels of infection control, it was felt that they should have the same knowledge to allow them to practice safe oral healthcare. For this reason it was decided to use a single questionnaire in English. Interviews were administered in Arabic for ease of understanding to ensure that accurate information is obtained.

The questionnaire was designed to test the knowledge, attitude and behavior of the study subjects. It consisted of 38 closed-ended questions that consisted of demographic details and the broad areas of infection control including the hand hygiene, personal protection, sterilization and disinfection and environmental infection control. A general section at the end of the questionnaire elicited perceptions regarding the treatment of HBV and HIV/AIDS patients.

4.4 Pilot study

A pilot study was carried out to:

(i) Test the suitability of the method of collecting the data.
(ii) Test how long each examination will take to complete.
(iii) Check the adequacy of the data capture sheet.
(iv) Check that all the parameter measurements are clear and unambiguous.
(v) Ensure that no major item has been omitted and
(vi) Remove any items that do not yield usable data.

The pilot study was carried out at Ribat National University – Faculty of Dentistry located in Khartoum State. After permission was obtained eight participants were interviewed. Participation was voluntary and informed consent was signed after information regarding the research aim and objectives were provided to the participants.

After the pilot study, two ambiguous questions were revealed and reformulated. Two further questions were added one regarding the DUWL and the other concerning the monitoring of sterilization. The pilot study also revealed that there was a question that was not applicable to dental assistants. This was reformulated by adding the option ‘not applicable’ to the options provided for this question.

Following the pilot study, the questionnaire was found to be clearer and easy to understand, ensured minimum participants' error, efficient interpretation of the data and evaluated knowledge, attitude and behaviour of the. A final draft of the questionnaire was then printed and used for the final study.

4.5 Data collection

Interviews with the study participants took place at the clinics site. The principle researcher and five dentists participated in data collection process. A standardisation and calibration meeting was called to ensure uniformity in the administration of the questionnaire and the interview procedure. The use of uniform wording of questions and nonverbal signals was emphasized. Three groups of data collectors made two and four day scheduled visits to the dental clinics. A number of clinics were assigned to each group on the basis of three to four visits per day on average. A second visit was arranged for those who could not be interviewed in the scheduled visit to complete the target. Putting two data collectors in each group was very useful. Interviewing the dentist and the dental assistant at the same time saved the time of the clinic staff, patients and data collectors. It also helped to reduce the number of days needed for the process and there for the use of other resources like vehicles and honoraria were kept to minimum.

4.6 Data analysis

The collected data was categorized, coded and entered into the computer. The data was captured in Excel. A basic descriptive analysis was done using the Excel environment. The database was imported into SPSS® to perform complex statistical analyses. Descriptive statistics was used to describe the demographic factors. The independent t-test was used to determine the correlation between scale variables of the sample. The Mann-Whitney test was used to determine the correlation between the nominal and the ordinal variables. Chi square tests were used for associations.

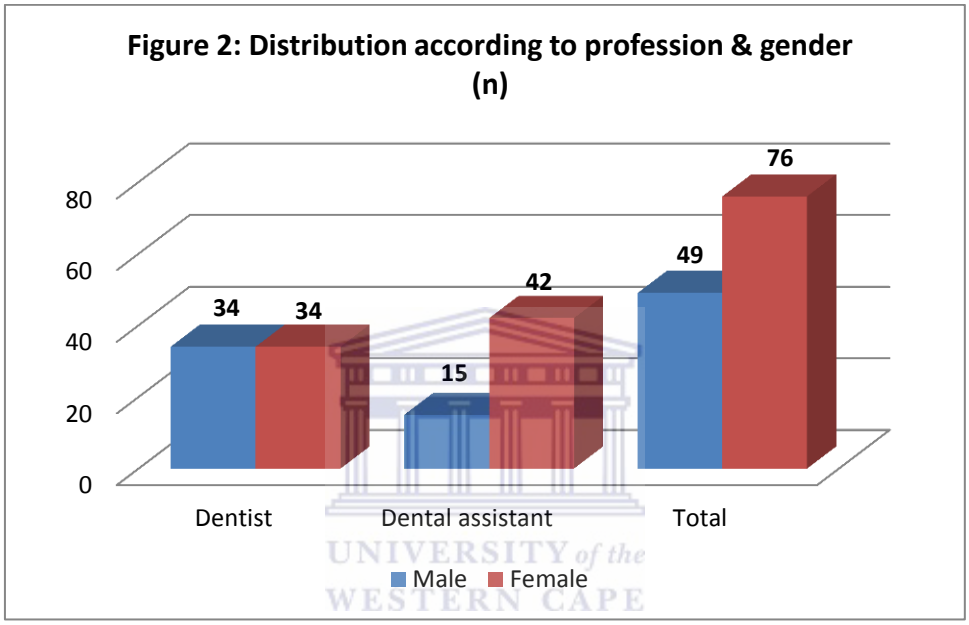
4.7 Ethical considerations

Permission to carry out the present study was obtained from the Senate Research Ethics Committee of the University of Western Cape and the Oral Health Directorate, Ministry of Health Khartoum State. Signed informed consent (Appendix 2) was obtained from each participant prior to interviews being conducted. Participation in this study was entirely voluntary and the participants were allowed to withdraw from the study at any time should they wish to do so without any penalties. It was emphasized that strict confidentiality would be maintained at all times and that none of their names or personal details will be mentioned in the write up of the study. Anonymity was achieved by not using the participant's names on the questionnaire and the questionnaire was recorded with serial numbers.

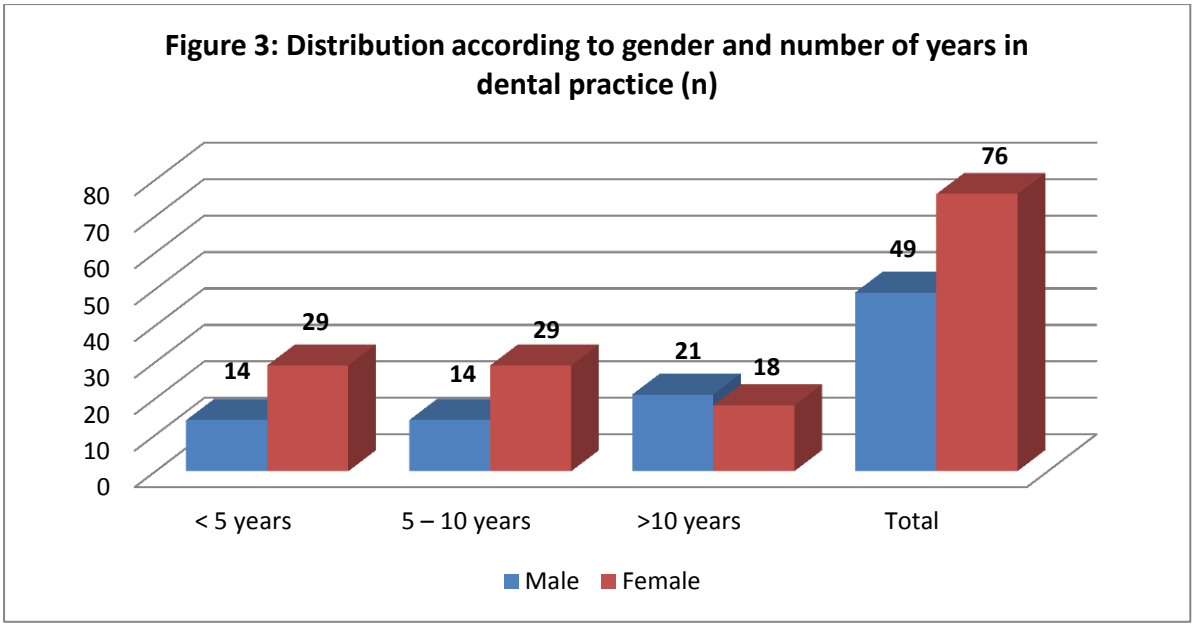
Chapter 5: Results

5.1 Demographic information

All dental personnel (n=125) except one dentist participated in this study. Just over half (54.4%) were dentists and 57 (45.6%) dental assistants. The majority were female (60.8%) and 31-40 year olds the predominant age group (44%) for both genders (Figure1).



Forty three (34.4%) were in dental practice for less than 5 years as were those who were in practice for between 5 – 10 years. A third (31.2%) was in practice for more than 10 years (Figure2).



5.2 Hand Hygiene

All respondents (100%) reported that they had knowledge of hand hygiene. Nearly all (89.6%) reported that they wash their hands before and after treating each patient, 88% wash their hand before donning gloves and 93.3% perform hand washing after gloves removal. 29 respondents (23.2%) reported that they do not wash their hand if the integrity of the gloves is compromised or deteriorated (Table 4).

Table 4: Occasions of hand washing

	Yes		No	
	Number	Percentage	Number	Percentage
Before and after each patient	112	89.6	13	10.4
Before putting gloves on	110	88	15	12
After removing gloves	117	93.6	8	6.4
If integrity of gloves is compromised	96	76.8	29	23.2
Mean	**109**	**87**	**16**	**13**

The most commonly reported cause of not adhering to hand hygiene is the perceived low risk of acquiring infection through hands. As depicted in Table 5, the dental assistants were more compliant than dentists with respect to hand hygiene before putting on the gloves. The association was statistically significant (Chi square $p < 0.05$).

Table 5: Occupation and hand washing (before putting on gloves)

	Wash	Don't wash -	Total
Dentist	55	13	**68**
	80.9%	19.1%	**100%**
Assistant	55	2	**57**
	96.5%	3.5%	**100%**
Total	**110**	**15**	**125**
	88%	**12%**	**100%**

** Chi square p value = 0.016, p value < 0.05*

Compliance with hand hygiene (before and after treating each patient) decreased as the number of years in practice increased (Table 6). This finding was not statistically significant (Chi square *p*> 0.05).

Table 6: Years in practice and hand washing (before and after treating patients)

	Wash	Don't wash	Total
<5 years	41	2	**43**
	95.3%	4.7%	**100%**
5-10 years	38	5	**43**
	88.4%	11.6%	**100%**
>10 years	33	6	**39**
	84.6%	15.4%	**100%**
Total	**112**	**13**	**125**
	89.6%	**10.4%**	**100%**

** Chi square p value = 0.268, p value > 0.05 (Not significant)*

The majority of the taps (94.4%) in the dental clinics were hand operated. The remaining taps were either elbow (4.8%) or foot (0.8%) controlled. More than three quarters of the study population (77.4%) used antiseptic soap and water for hand cleaning and 19.2% use ordinary soap and water. Paper towels were used by almost half of the respondents (48%) for hand drying and 37.6% used fabric towels. 13 participants (10.4%) reported that they do not dry their hands.

5.3 Personal protection

5.3.1 Standard Precautions

The question regarding the taking of the medical history was only applicable to the dentists. 56 (84.8%) reported that they take the medical history of every patient regularly and 10 (15.2%) only sometimes.

Only four respondents (3.2%) do not treat all patients as if they are potentially infectious. The remaining 121 (96.8%) reported that they treat their patients bearing this concept in mind. The younger-in-practice group (< 5 years) were 100% compliant with the concept of standard precaution. The middle group (5–10 years) showed 95.3% compliance and 94.9% of the older-in-practice group (> 10 years) reported compliance.

5.3.2 Prevention of exposure

Regarding the recapping of used dental needles, 38 (38%) reported using both hands, 85 (68%) reported that they use one hand and only 2 (1.6%) reported that they do not recap. All respondents used special containers for disposal of used sharps.

According to occupation, using both hands to recap dental needles was practiced by 25% of the dentists and 36.8% of dental assistants. According to the number of years in practice, it was shown that recapping with both hands increased with increasing years in practice. Those who use both hands for recapping were 23.3% among the younger-in-practice group (< 5 years), 30.2% among the middle group (5–10 years) and 38.5% among older-in-practice group (> 10 years). This association is illustrated in Table 7.

Table 7: Years in practice/ method of recapping used needles

	Use both hands	Use one hand	Do not recap	Total
<5 years	10	33	0	**43**
	23.3%	76.7%	0%	**100%**
5-10 years	13	30	0	**43**
	30.2%	69.8%	0%	**100%**
>10 years	15	22	2	**39**
	38.5%	56.4%	5.1%	**100%**
Total	**38**	**85**	**2**	**125**
	30.4%	**68%**	**1.6%**	**100%**

** Chi square p value = 0.124, p value > 0.05 (Not significant)*

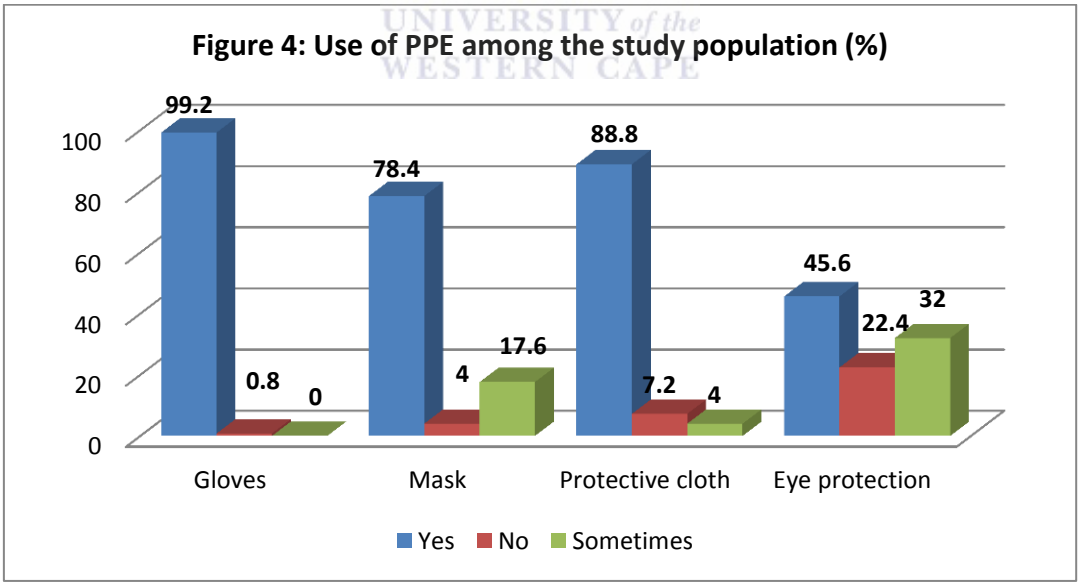
5.3.3Hepatitis B immunization

One hundred and five participants (84%) had been vaccinated against hepatitis B and 10 (8%) had only received the first or second dose of the vaccine and the remaining 10 (8%) were not vaccinated.

5.3.4Personal Protective Equipment (PPE)

As shown in Figure 3, differing levels of adherence to the use of PPE were reported in the present study. The highest adherence was with regard to the routine wearing of gloves (99.2%). Less than a fifth (17.6%) stated that they wear masks only sometimes while the remainder 82.4% wore them routinely. None of the participants stated that they do not use glove or masks.

Routine wearing of protective clothing was reported by 89.6%. The least adherence was with regard to eye protection. Slightly less than a quarter (22.4%) did not use the eye protection while almost a half reported their routine use. The routine use of all PPE together was significantly associated with the dentists ($p < 0.05$) as shown in Table 10.



In the present study the regular wearing of masks increased with the number of years in practice. The compliance was as follows: 79.1% the younger-in-practice group (< 5 years), 83.7% in the middle group (5–10 years) and 84.6% in the older-in-practice group (> 10 years).

Nearly all (94.4%) of the respondents reported that they change the gloves after each patient. The mask is changed after each patient by 28%, after few patients by 25% and if it becomes soiled by 22.4%. The protective wear is changed either daily or if it became soiled by 84.8%. Table 8shows how often each piece of personal protective equipment is changed.

Table 8: Frequency of changing PPE (n)

	Gloves	Mask	Protective clothing	Eye protection
1. After each patient	118	35	2	28
2. After few patients	3	32	5	2
3. Daily	0	21	71	20
4. More than once a day	1	6	3	2
5. If it becomes soiled	2	28	35	44
More than one answer	1 (1&5)	1 (2&5)	0	0

The most common reasons for not wearing the mask were ‘no need for it’ and ‘not comfortable’. Nearly a third (29.6%) stated that they do not wear the eye protection “because there is no need for it”. Table 9 shows the reasons for not wearing each of the Personal Protective Equipment.

Table 9: Reasons for not wearing the PPE (n)

	Gloves	Mask	Protective clothing	Eye protection
Time consuming	0	0	0	0
Not comfortable	0	10	1	14
Not available	0	1	9	15
No need for it	0	11	1	37
Other reasons	0	0	2	1

Table 10 is a depiction of the overall compliance with the PPE requirements in clinical practice. Significantly more dental assistants do not comply with the requirements.

Table 10: Occupation and adhering to overall PPE requirements

	Adhere to PPE	Do not adhere	Total
Dentist	34	34	**68**
	50%	50%	**100%**
Assistant	15	42	**57**
	26.3%	73.7%	**100%**
Total	**49**	**76**	**125**
	39.2%	**60.8%**	**100%**

** Chi square p value = 0.012, p value < 0.05 (significant)*

5.4 Environmental infection control

5.4.1 Air

Forty percent of the study population reported that they do not use saliva ejectors at all and the remaining either use them regularly (36%) or sometimes (24%). Just over two thirds (61.6%) do not use the high vacuum suction and 97.6% do not use rubber dam. The most reported reason for not using these pieces of equipment is that they are not available.

5.4.2 Environmental surfaces

None of the study participants used plastic barriers to cover any of the surfaces frequently touched by the dental personnel because they are not available.

5.4.3 Dental Unit Water Lines

The main findings on how often do the respondents flush waterlines are illustrated in Table 11.The vast majority of the respondents reported that they flush DUWL either regularly (86.4%) or sometimes (8.8%). Only 5 participants (4%) reported that they had no idea of DUWL flushing procedures.

Table 11: Flushing of DUWL

	Number	Percentage
1. At the beginning of the day	18	14.4
2. After each patient	35	28.0
3. At the end of the day	18	14.4
Answer 1 & 3	17	13.6
Answer 1, 2 & 3	22	17.6

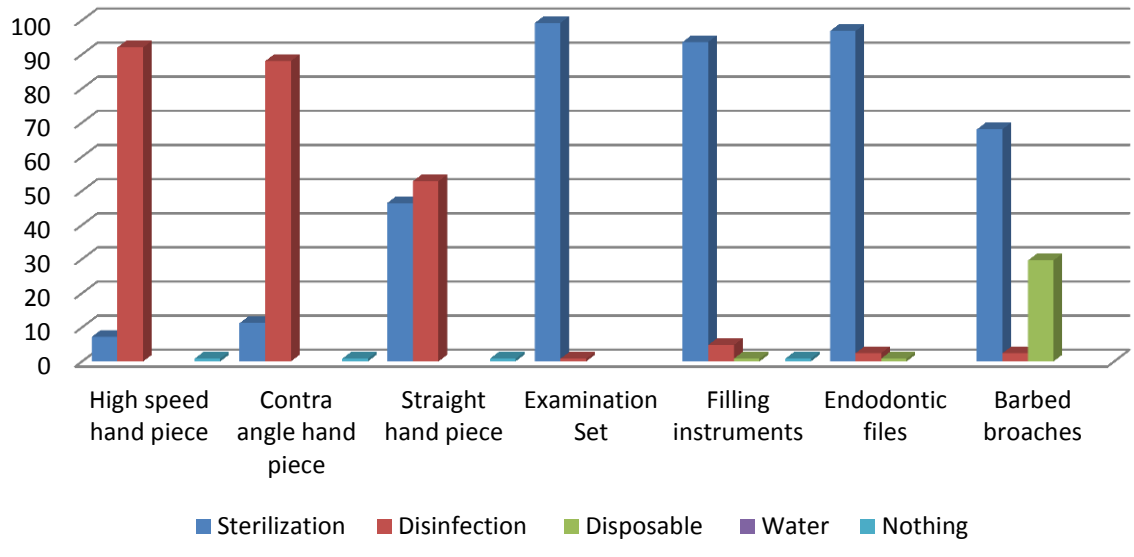
5.4.4 Waste

All the study respondents stated that they use special containers (safety boxes) to dispose of used sharps. Just over a half (51.2%) discarded the medical and domestic waste together.

5.5 Sterilization and disinfection

The respondents were questioned on how they disinfect floors, tray units and handles, chair side basins (spittoons), working surfaces, light handles and wash basins. Different materials were used for different surface including phenols, spirit, house hold bleaches, surface disinfectant sprays, detergents and water (Table 12). The use of combinations of two, or more, of these products for a single surface was also reported.

Figure 5: Methods used for different items in dental clinics (%)



Detergents are most commonly used for floors (35.5%) and basins (40.8%). The second most commonly used material is spirits. It is used for disinfecting the unit tray and handles (35.2%), for working surfaces (28.2%) and for light handles (39.5%). Household bleaches were used for the chair side basin by 27.2% of the study participants. The most commonly used combinations were that of spirits and house hold bleach. It is used by 24.8% for the floor and by 20.8% for the basin (Table 12).

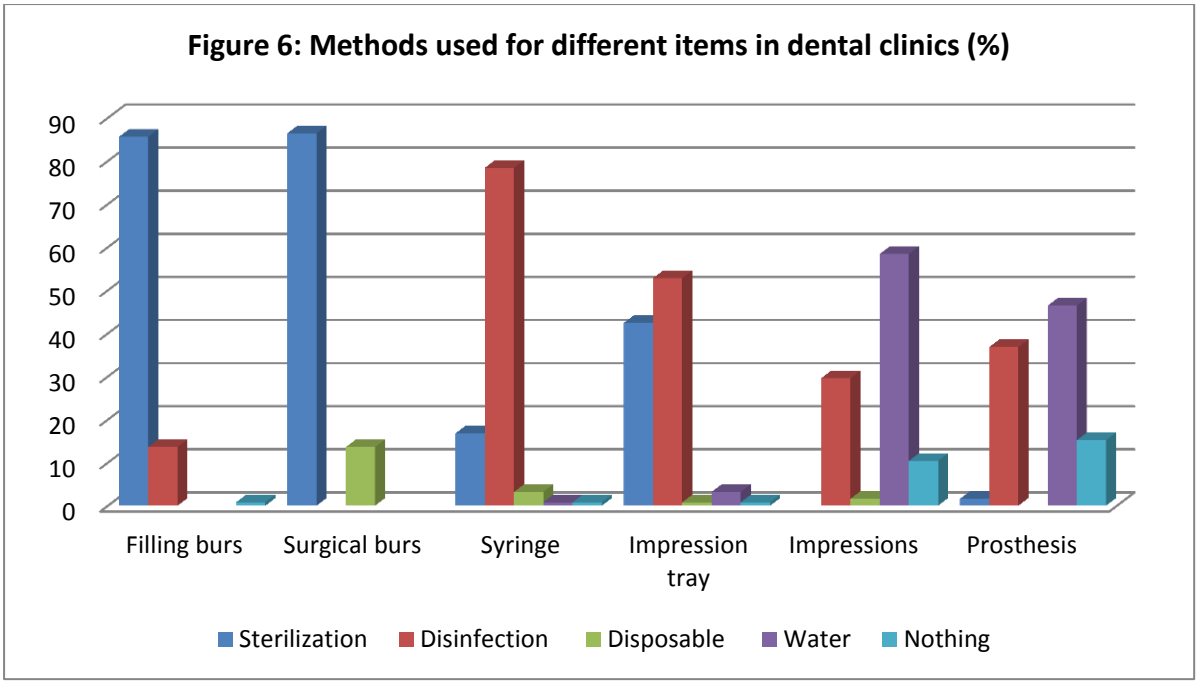
Table 12: Most commonly used disinfectants for different surfaces

Surfaces	Spirits	Bleach	Detergent	Combination of spirits & bleach
Floor			35.5%	24.8%
Unit tray & handle	35.2%	20.8%		
Spittoon		27.2%		18.4%
Working surface	28.2%	25.0%		
Light handle	39.5%	21.0%		
Basin			40.8%	20.8%

All respondents reported that they sterilize their instruments using autoclaves. 90 of them (72%) have a separate area for cleaning the instruments. They reported that monitoring of sterilization is either important (19.2%) or very important (80.8%).

Only 7.2% and 11.2% reported the sterilization if high and low speed handpieces respectively between patients. About half (46.4%) sterilized their straight (surgical) handpieces.

Sterilization was reported by 93.6% for filling instruments, 96.8% for endodontic files, 99.2% for examination sets and 85.6% for filling burs. Only 29.6% disposed of barbed broaches after single use. Figure 6 illustrates the different methods used for sterilizing various dental equipment, instruments and materials.



5.6 General

The participants were asked about their attitudes towards patients with HIV/AIDS, whether infection control is knowledge or practice, who is ultimately responsible for infection control, what they perceived to be as its most important component and how it could be improved. The results are given below.

5.6.1Attitudestowards treating HIV/AIDS and HBV patients

Nearly three quarters (72.8%) reported that they did not mind treating patients with HIV/AIDS or HBV, 16 (12.8%) do not want to and 18 (14.4%) are not sure about their feelings. The explanation given by the two latter groups was that 'it is not safe' (52.9 %).Table 13 shows that 89.5% of dental assistants do not mind treating patients with HIV/HBV versus 58.8% of the dentists. This association was statistically significant ($p< 0.05$).

Table 13: Occupation and attitudes towards treating HIV/HBV

	Don't mind	Don't want to	Not sure	Total
Dentist	40	13	15	**68**
	58.8%	19.1%	22.1%	**100%**
Assistant	51	3	3	**57**
	89.5%	5.3%	5.3%	**100%**
Total	**91**	**16**	**18**	**125**
	72.8%	**12.8%**	**14.4%**	**100%**

**p value = 0.001, p value < 0.05 (significant)*

5.6.2 Infection control: what is its most important component?

The vast majority (94.4%) believe that hand hygiene, the use of PPE, sterilization and disinfection and hepatitis B vaccination are equally important infection control measures. The remainder reported that either sterilization and disinfection (4%) or hand hygiene (1.6%) are the most important infection control measure.

5.6.3 Infection control: who is responsible?

Eighty four percent reported that infection control it is the collective responsibility of the ministries of health, medical and dental colleges, dentists and dental assistants.

5.6.4 Infection control: how to improve it?

The respondents were asked to choose from a list of what they believe necessary to improve infection control at their clinics. The list included five suggestions: more infection control readings and seminars, regular monitoring, obligatory training, standardization of equipment/materials and better supply of material. Forty of them (32%) suggested all of these to improve the infection control in dental practice. Further suggestions are summarized in Table 14.

Table 14: Suggestions on how to improve the infection control

Suggestions	Frequency
1. **Regular monitoring**	**1**
2. **Standardization of equipment and/or materials**	**3**
3. **Better supply of material**	**4**
4. **More infection control readings and/or seminars**	**8**
5. **Obligatory training**	**11**
All of the above	**40**
Two or more suggestions	**57**

Chapter 6: Discussion

This study examined the current infection control in public dental clinics in Khartoum State. All dentists and dental assistants working for the Oral Health Directorate, Ministry of Health in Khartoum State, Sudan were approached to participate in the present study. All except one refused to participate giving a response rate of nearly a hundred percent. The dental assistants who participated in this study had varying levels of education including, but not limited to, registered dental assistants, certified nurses without university qualification, non-certified nurses and individuals from other disciplines joined the dental clinics as a job opportunity.

6.1 Hand Hygiene

The CDC recommends that hand hygiene should be performed when hands are visibly soiled, after touching an object which is likely to be contaminated with blood or OPIM, before and after treating each patient, before and after gloving or if the integrity of the glove is compromised (CDC, 2002). Very low rates of compliance to hand hygiene have been reported in both developed and developing countries. Variable adherence has been reported with baseline rates ranging from 5% – 89% and an overall average of 38.7% (WHO, 2009). The findings of the present study were much higher than the overall average of the 2009 World Health Organisation report.

In the present study, despite the fact that all respondents reported having knowledge on hand hygiene, this finding was not corroborated with their practice. Different levels of adherence to hand hygiene recommendations were observed that were similar when compared with a US study of Myers et al. (2008), but different to Sofola and Savage, in their assessment of the compliance of Nigerian dentists with infection control. They reported less compliance with hand hygiene recommendations before gloving and after gloves removal (Sofola and Savage, 2003).

6.2 Personal protection

6.2.1 Universal and Standard Precautions

It is impossible to identify all patients with infectious diseases by their medical history or clinical examination alone. Nearly all participants reported practicing Universal Precautions, however, years in practice had an influence on behavior. The younger-in-practice group (<5years) showed good compliance, but that decreased with increasing years in practice. It has been suggested that compliance with infection control which is enforced at dental colleges does not extend into practice life (Gordon et. al, 2001).

In a recent study carried out in eight countries, Puttaiah et.al (2009) compared the standard methods of infection control of the US dentists with those of dentists from seven Asian countries collectively. Comparing their findings with the present study, the practice of treating all patients as potentially infectious was very high among Sudanese dentists. Al-Omari and Al-Dawairi (2005) in Jordan and Sofola and Savage (2003) in Nigeria all reported moderately high to high adherence to taking of a medical history for every patient.

6.2.2 Prevention of exposure

Work practice controls are an important measure to ensure that daily procedures are performed in a manner that minimizes the risk of exposure (OSHA, 1991). Therefore, the use of both hands to recap dental needles that is practiced by a considerable percentage of the dentists (25%) and dental assistants (36.8%) is a risk behavior that is not recommended. Furthermore, the practice of recapping needles with both hands increased with increasing time in practice. This could attributed to the argument that adherence to infection control guidelines which is maintained by the students during education time starts to fade gradually after they commence the practical life (Gordon et. al, 2001).

All respondents used special containers for disposal of used sharps. This complies favourably with OSHA (1991) recommendation as an engineering control for prevention of exposure, but differs from the study of Al-Omari and Al-Dawairi (2005) who reported very much lower adherence (31.8%) to this recommendation.

6.2.3 Hepatitis B immunization

In this study 84% were vaccinated against hepatitis B and 8% had received the first or second dose of the vaccine. Although this reflects a relatively high percentage, immunization of OHCWs before they are placed in at risk positions is the most effective use of vaccine (CDC, 2003a). Moreover vaccination of all dentists and all staff members who come in contact with patient is the policy of ADA (ADA, 1996).The findings of the present study, are similar to the findings of South African dentists (Naidoo, 1997) but higher than that of Jordanian (Al-Omari and Al-Dawairi, 2005) and Asian dentists, but lower than that of American dentists (Puttaiah et al. 2009).

6.2.4 Personal Protective Equipment

Implementation and appropriate use of barrier protection techniques in healthcare serves to reduce exposure to pathogens and thereby boost the host's immune system to resist infections (Molinari and Harte, 2010). The use of PPE has increased globally over the years because guidelines have become more explicit (Gordon et al. 2001).

With regard to the findings of PPE compliance in the present study, different practices were reported for the different PPE recommendations. The use of PPE, except gloves, is below the current recommendations. The high adherence (99.2%) to the use of gloves alone may be due to perceived minimum or no risk of transmission of infection through other routes for example the mucous membranes of the eyes or nose. This is supported by the fact that the most reported reason for not wearing the mask or eye protection was "no need for them". The reason reported by Sofola and Savage (2003) was that "they were not available". The present study concurs with Elkarim et al. (2004) in that the highest adherence was to the gloves wearing (92%) and the lowest to eye protection (14.7%). When compared with findings of the systematic review Gordon et al (2001) and Sofola and Savage (2003) a similar pattern exists i.e. the highest compliance was for gloves wearing and the lowest for eye protection. A very high adherence (98%) to eye protection was observed among the American dentists (Puttaiah et al. 2009) when compared to the present study. The finding of wearing of protective clothes in the present study showed greater adherence than that reported by Sofola and Savage (2003).

6.3 Environmental infection control

6.3.1 Air

Both aerosols and residual droplet nuclei can remain airborne for extended periods of time and may be inhaled and subsequently result in infections. The risk from contaminated air can be minimized by the use of high volume suction evacuators and rubber dam (Mills, 2010). In the present study, just over two thirds reported not using high vacuum suction and the vast majority (97%) did not use the rubber dam. This low compliance that is far below current recommendations needs to be greatly improved. Similar levels of compliance were reported by Puttaiah et.al (2009) among the Asian dentists but differed from American dentists who showed a very high compliance.

6.3.2 Environmental surfaces

The use of barrier protection is preferred especially for those surfaces which are difficult to clean (Miller and Palenik, 2001). In the literature different levels of adherence to this recommendation have been reported. All were better than the present study since for example none of the current study participants reported the use of plastic barriers to cover any of the surfaces frequently touched by the dental personnel – the reason given was that they were not available.

6.3.3 Dental Unit Water Lines (DUWL)

It is recommended that DUWL be flushed for at least 20 to 30 seconds after each patient to eliminate any patient material that may have been retracted into the tubing system (Mills, 2010). High levels of compliance with this recommendation have been reported in the present study. Improving the quality of DUWL was the preferred method to prevent cross-infection found among 14.1% of Turkish dentists (Yüzbaşioglu et al. 2009).

6.3.4 Waste

Puncture-resistant containers should be used for sharp regulated medical waste. Leak-resistant biohazard bags should be used for containment and disposal of non-sharp regulated medical waste (OSHA, 1991). All respondents of the present study comply with this recommendation, a finding which is slightly higher than the finding of Puttaiah et.al (2009) reported among American dentists (98%) and much more than that reported among Asian dentists (38%).

6.4 Sterilization and disinfection

Different materials were used by the respondents for disinfection of environmental surfaces. The use of combinations of two or more for a single surface was also reported. There was no consensus as to a preferred method among the study respondents.

Steam under pressure (autoclaving) was the method of sterilization used by all respondents. This is the most widely used, reliable and economical method (Miller and Palenik, 2001) and is the method of choice as recommended by the BDA (BDA, 2003). In 2004, more than two thirds of dentists in Khartoum used dry heat as their method of sterilization and only 22% used autoclaves (Elkarimet al. 2004) and the present study thus shows a huge shiftto the use of autoclaves. This is due to mandate from the Oral Health Directorate that autoclaves must be used as the method of sterilization in both public and private dental practice.

When compared to similar studies from other countries, conflicting findings were observed. For example, Gachigo and Naidoo (2001) reported the use of autoclaves by the majority of dentists (85%) in Nairobi, Kenya. In a very recent study in Sao Paulo, Brazil slightly more than two thirds (69.38%) of the dentists were using autoclaves, just over a tenth were using ovens and the remainder group were using both devices (Matsuda, Grinbaum and Davidowicz, 2011).

6.4.1 Disinfection of impressions

Dental impressions, prostheses and appliances have cross-contamination potential if not appropriately dealt with in both the dental clinic and the laboratory (CDC, 2003a).The respondents of the present study showed weak compliance with this

practice especially for impressions (29.6%). This concurs with the results of the systematic review of Gordon et al. (2001) and with the findings of Al-Omari and Al-Dawairi (2005).

6.4.2 Sterilization of handpieces

Sterilization of handpieces is strongly recommended and autoclaving is the preferred method. Surface disinfection and/or immersion in chemical germicides are both unacceptable methods (ADA, 1996; BDA, 2003; CDC, 2003a). The most common method used for handpiece sterilization in the present study was surface disinfection. This is far below the current recommendation. These finding concurred with that of a recent study carried out in Turkey in which the majority of dentists also reported using surface disinfection for sterilizing handpieces (Yüzbaşioglu et al. 2009). Better compliance with autoclaving of handpieces was reported by Matsuda, Grinbaum and Davidowicz (2011) and Al-Omari and Al-Dawairi (2005).

6.5 Perception of treating HIV/AIDS and HBV patients

The prevalence of HIV in Sudan is low and according to 2006 figures, the HIV prevalence among youth (15 – 24 years) was estimated at 0.23% in the North and at 3.8% in the South (UNAIDS, 2009). Interestingly, significantly more dental assistants than dentists were happy to treat patients with HBV or HIV/AIDS. It could be speculated that this confidence is due to the perceived minimum or low risk rather than on sound knowledge and practice, and also that the dental assistants who participated in the present study had varying levels of education and some were not from the medical field.

The fact that there is no need to modify dental care for HIV infected patients (Chikte and Naidoo, 2000) and the reluctance of dentists towards treating these patients could be attributed to their lack of knowledge of transmission of infectious diseases and how to prevent cross infection as one of the reasons given for the reluctance to treat was that “it is not safe”. Gachigo and Naidoo (2001) reported that nearly half of their respondents reported that they perceived the risk of HIV transmission in the dental clinic as high. OHCWs are professionally and ethically responsible to provide quality care to patients with HIV/AIDS. HIV-positive patients should always receive treatment at the same standard as HIV-negative patients (Chikte and Naidoo, 2000).

About 90% of HIV infections among healthcare workers in developing countries were due to negligence of occupational safety (Kermode et al. 2005). It has been recognized that healthcare workers lack appropriate skills for managing and counseling HIV/AIDS patients and lack sufficient knowledge of how to diagnose and treat infected patients appropriately (Shaikh et al. 2007; Khandwalla, Luby and Rahman, 2000).

Inadequate knowledge of HIV/AIDS among Tanzanian healthcare workers resulted in their reluctance to treat HIV patients (Marchal, De Brouwere and Kegels, 2005). Medical students, in a study in Pakistan, expressed their need for further education on HIV/AIDS and its mode of transmission (Shaikh et al. 2007).

Appropriate knowledge on and skills for the management of HIV/AIDS should enable OHCWs to provide quality oral healthcare with confidence. In a recent study in Sudan, dental students expressed a great need for education on basic HIV/AIDS issues, patient management, treatment recommendations and advice on referral (Nasir et al. 2008). Utilization of dental care in Sudan in the context of HIV epidemic is generally poorly understood (Nasir et al, 2009) and there is a dire need for a concerted effort to reduce stigma on people living with HIV and OHCWs have a role to play.

6.6 Infection control: its most important component

The vast majority of the participants had good knowledge on the importance of the components of infection control since they rated hand hygiene, use of PPE, sterilization and disinfection, and hepatitis B vaccination as all equally important infection control measures. The primary strategies to avoid infections acquired during provision of healthcare are avoiding exposure to blood and OPIM and immunization. All of these measures are designed to break the chain of infection in one or more links and they are in accordance with the principles of Universal Precautions.

The vast majority of the dentists examined in the study of Yüzbaşioglu et al. (2009) reported the use of Universal Precautions (the components of which described in this study as the PPE) as their preferred method to prevent the transmission of infections. The other measures were reported (in descending order) as follows: the use of barrier protection or disinfection, keeping instruments sterile until usage and avoiding exposure to sharp and contaminated instruments.

6.7 Infection control: who is responsible?

Infection control is a shared responsibility that includes all health care workers in different health settings. The appropriate knowledge and skills should be taught and enforced in all health institutions, retained and updated through continuous professional development CPD. In the present study the majority reported that the responsibility of infection control is a collective one by the ministry of health, medical and dental colleges, dentist and dental assistants. The WHO (2004) however, argues that infection control is a key responsibility of governments to provide quality health services achieved through collaboration with the public and private sectors. Health care facilities must implement infection prevention and control policies supported by their institutional management.

6.8 Infection control: how to improve?

To improve the infection control, the respondents suggested that more infection control readings and seminars, regular monitoring, obligatory training, standardization of equipment and materials, and better supply of materials. It has been reported previously that compliance with infection control recommendations was improved following educational training programmes, but it is unclear whether it had any permanent or long-term benefits or has any correlation with increased compliance. In the present study, despite reported knowledge of infection control measures, the majority of the practitioners were selective in their compliance with the different measures. To ensure a more permanent behavioural change, behavioural change models have been advocated that may positively influence compliance affect change in the attitudes, beliefs and self-efficacy of health care workers (Gammon, Morgan-Samuel and Gould, 2008).

Chapter 7: Recommendations

A lack of compliance towards infection control was a general feature of the findings of this research. It highlights the need of infection control education that starts at dental training colleges and is followed through after graduation with Continuing Professional Development (CPD).

The curricula of dental schools should include the detailed knowledge and practice of infection control. Curricula should be standardized to ensure that no contradictory messages are passed on to students. This will allow them to work in harmony with colleagues from other institutes when they begin their professional careers.

This uniformity, in turn, requires national infection control guidelines to be developed using current international standards that are adapted to State and Regional needs of the country. In this regard, it is anticipated that the findings of the current study will provide some of the baseline information required to develop such national guidelines.

It is recommended that the Oral Health Directorate (OHD) undertake periodic surveys to ensure that the knowledge and skills of OHCWs are maintained and to identify any weaknesses and modify the training accordingly. This may also go a long way to raise the awareness of the importance of infection control among OHCWs.

Qualitative research is needed to elucidate why there are differences between dentists and dental assistants with regard to compliance with certain infection control practices and towards the treatment of patients infected with HIV and HBV.

It is recommended that the OHD establish an Infection Control Committee that will be responsible for planning, monitoring and control, and evaluation of infection control in all clinics. This proposed committee will also be responsible for developing and updating infection control polices and guidelines, identifying training needs, and designing and approval of training modules.

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Appendix1: Questionnaire

Assessment of infection control in public dental clinics in Khartoum State, Sudan

Day Month Year	Clinic No.	Data collector	Record No.	Dentist	Assistant
☐☐☐	☐☐	☐	☐☐☐	☐	☐

Please tick or write in the appropriate response

1) **Age:**
   a. 20 – 30 years. ☐
   b. 31 – 40 years. ☐
   c. > 40 years. ☐

2) **Gender: Male** ☐ **Female** ☐

3) **Number of years of practice in Dental clinics.**
   a. <5 years. ☐
   b. 5 – 10 years. ☐
   c. > 10 years. ☐

	Y	N
4) **Do you have knowledge of hand hygiene?**	☐	☐

5) **When do you wash your hands?**	Y	N
a. Before and after each patient	☐	☐
b. Before putting on your gloves	☐	☐
c. After removing your gloves	☐	☐
d. If integrity of gloves is compromised	☐	☐

6) **If one answer is 'no', why?**
   a. Lack of hand washing materials. ☐
   b. Causes irritation and dryness. ☐
   c. Low risk of acquiring infection. ☐
   d. No time - busy practice. ☐
   e. I forget to do so. ☐
   f. Other (specify)……

7) **How do you operate your taps?**
   a. By hand. ☐
   b. With my elbows. ☐
   c. With foot pedal. ☐

8) What do you use to clean your hands?

a. Soap and water. ☐
b. Antiseptic soap and water. ☐
c. Alcohol. ☐
d. Other (specify)…….....

9) What do you use to dry your hands?

a. Towel. ☐
b. Paper towel. ☐
c. Other (specify).....
d. I don't dry my hands. ☐

10) Do you wear the following?

	Yes	No	Sometimes
Gloves			
Mask			
Protective clothing			
Eye protection			

11) If 'yes', how often do you change each one?

	Gloves	Mask	Protective clothing	Eye protection
After each patient				
After few patients				
Daily				
More than once a day				
If it becomes soiled				

12) If one or more answers to Q 10 are 'no' or sometimes, why?

	Gloves	Mask	Protective clothing	Eye protection
Time consuming				
Not comfortable				
Not available				
No need for it				
Other (specify)				

13) Do you use the following items:

Item	Yes	No	Sometimes
High vacuum Suction			
Saliva ejector			
Rubber dam			

14) If one or more answers are 'no' or sometimes, why?

Reason	High vacuum Suction	Saliva ejector	Rubber dam
Time consuming			
Not available			
No need for it			
Other (specify)			

15) Do you use plastic covers for the following items?

Item	Yes	No	Sometimes
Chair hand rest			
Light handle			
Tray handle			
Light cure handle			
Air/water syringe			
Ultrasonic scaler handle			

16) If one or more answer is 'no' or sometimes, why?

Reason	Chair hands rest	Light handle	Tray handle	Light cure handle	Air/water syringe	Ultrasonic scaler handle
Time consuming						
Not available						
No need for it						
Other (specify)						

17) Do you flush air and water lines?

a. Yes ☐
b. No. ☐
c. Sometimes. ☐

18) If you flush air and water lines when do you do that?

a. At the beginning of the day. ☐
b. After each patient. ☐
c. At the end of the day. ☐
d. Every week. ☐

19) If you don't flush air and water lines, why not?

a. I have no idea about this procedure. ☐
b. Time consuming. ☐
c. No need for it. ☐

20) How do you disinfect the following surfaces?

Surface	Phenol	Spirits	Bleach	Meutine	Water	Detergent	Other (specify)	Never
Floor								
Unit tray & handle								
Spittoon								
Working surface								
Light handle								
Basin								

Y N

21) Do you use a special container for disposal of used sharps? ☐ ☐

22) If no, what do you do with them?

a. Throw them with domestic waste. ☐
b. Throw them with medical waste. ☐
c. Other (specify) ……...

23) How do you dispose of medical waste?

a. Collected with domestic waste. ☐
b. Collected by medical waste personnel. ☐
c. Other (specify)……

24) How do you recap used needles?

a. Use both hands. ☐
b. Use one hand. ☐
c. Use special device. ☐
d. You do not recap. ☐

YN

25) Do you have separate area for cleaning used instruments? ☐ ☐

Y N

26) Do you sterilize your instruments? ☐ ☐

27) If yes, what do you use for sterilization?

a. Hot air oven. ☐
b. Autoclave. ☐
c. Other (specify) ……

28) Do you think that monitoring of sterilization is:

a. Important? ☐
b. Very important for every cycle? ☐
c. Not very important? ☐

29) Which method do you use for the following items?

	Method				
Items	**Sterilization**	**Disinfection**	**Disposable**	**Water**	**Nothing**
High speed hand piece					
Contra angle hand piece					
Straight hand piece					
Filling instruments					
Endodontic files					
Barbed broaches					
Examination Set					
Filling burs					
Surgical burs					
Syringe					
Impression tray					
Impressions					
Prosthesis					

30) Infection Control is something that every:

a. Dentist/ assistant must have knowledge on. ☐
b. Dentist/assistant must practice. ☐

Y N On going

31) Are you vaccinated against hepatitis B? ☐ ☐ ☐

32) Which one of the following is the most important infection control measure:

a. Hand hygiene. ☐
b. Personal protective equipment. ☐
c. Hepatitis B vaccination. ☐
d. Sterilization and disinfection. ☐
e. All are equally important. ☐

33) Who do you think is responsible for infection control?

a. Ministry of Health. ☐
b. Universities/ Faculties. ☐
c. Yourself. ☐
d. Dental assistants. ☐
e. All of the above ☐
f. Other (specify)……..

YN

34) Do you treat all patients as if they are potentially infectious? ☐ ☐

	Y	**N**	**Sometimes**	**Not applicable**
35) Do you take a medical history of every patient?	☐	☐	☐	☐

36) How do you feel about treating HIV/AIDS and HBV patients at your clinic?

a. You don't mind. ☐
b. You don't want to. ☐
c. You are not sure. ☐

37) If your answer to the above is b or c, please explain why?

a. It is not safe. ☐
b. You don't take enough precautions usually. ☐
c. Your clinic is not well equipped. ☐
d. You don't have enough training. ☐
e. It is not your responsibility for that. ☐
f. Other(specify)……
……
……

38) What do you suggest to improve the infection control issue?

a. More infection control readings/seminars. ☐
b. Regular monitoring. ☐
c. Obligatory training. ☐
d. Standardization of equipment/materials. ☐
e. Better supply of material. ☐
f. Other
(specify)……

Thank you very much for your time!

Appendix1: Informed consent

I am Dr. Modather M A Seikh Idris, working at Oral Health Directorate, Ministry of Health, Khartoum State. I am presently a Master's Degree student in Dental Public Health at University of the Western Cape, South Africa. I am carrying out research on the assessment of infection control in public dental clinics in Khartoum State.

Infection control is an important aspect of dental practice and I am carrying out this study to assess the current practice of infection control in dentistry in Khartoum State to obtain baseline data that may assist with the development of relevant and appropriate guidelines for the country.

I would like to ask you a few questions and this will take about 15 minutes of your time. All information obtained will be treated with utmost confidentiality.

Your participation in this research is completely voluntary, you may decline to participate in the study or withdraw from the study at any time without giving any reason and this will have no adverse effects or penalties.

If you need any further information regarding the study, please do not hesitate to contact me (Tel: 0912386282).

Thanking you in anticipation.

Dr. Modather

I understand the information that has been provided to me and agree to participate in the study.

Name: ……..Signature:…….

Date:…….

Name of Witness: ….……. Signature: ……..