# INFECTION PREVENTION AND CONTROL AUDIT-FEEDBACK INSTRUMENT FOR ORAL HEALTH CARE IN SOUTH AFRICA

by

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## D Tech in Biomedical Technology

in the Faculty of Health- and Environmental Sciences
Central University of Technology, Free State

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Bloemfontein

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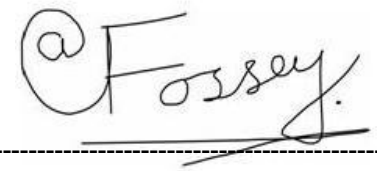
# PREFACE

The work described in this thesis was carried out in the Faculty of Health- and Environmental Sciences; Central University of Technology, Free State, under the supervision of Professor Annabel Fossey and the co-supervision of Doctor Elsa Potgieter.

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

Professor Annabel Fossey

Supervisor



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Doctor Elsa Potgieter

Co-supervisor

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# DECLARATION

I **Jeanné Oosthuysen** declare that:

(i) The research reported in this thesis, except where otherwise indicated, is my original work.

(ii) This thesis has not been submitted for any degree or examination at any other university.

(iii) This thesis does not contain other persons' data, pictures, graphs or other information, unless specifically acknowledged as being sourced from other researchers.

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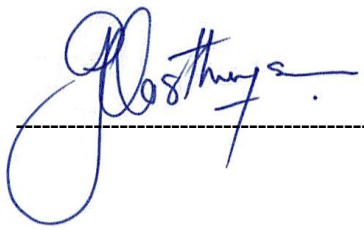
Signed: 

# DEDICATION

*To my children - Van Wyk, Jacques and Elle-Jean*

*"I remember my mother's prayers*
*and they have always followed me.*
*They have clung to me all my life."*

*~ Abraham Lincoln (1809 – 1865)*

*To my mother and father*
*Miss Ellie, this was my promise to you – coram Deo!*

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- Van Wyk, Jacques and Elle-Jean, thank you for putting up with your mother every day and thank you for being patient with me for the past 12 years. If I can teach you one thing from this thesis, that would be to never ever ever ever give up!

**Soli Deo Gloria!**

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# ABSTRACT

*This study reviewed national and international literature to develop an audit-feedback instrument (AFI) to monitor adherence of South African oral health care facilities with compliance to infection prevention and control precautions. In a multi-phased literature search, existing infection prevention and control recommendations, guidelines and audit-feedback instruments were reviewed and broadened to include "dental audit tools", as well as audit tools from other health care disciplines. Audit-feedback instruments were scrutinised for user friendliness, the use of simple language, electronic calculations and feedback possibilities. A new South African AFI was proposed, considering the differences between public and private oral health care facilities and also the diversity of training levels of oral health care personnel employed. Eleven focus areas supporting all aspects of infection prevention and control in oral health care facilities, including administrative controls; personnel protection controls; environmental- and work controls; surface contamination management; equipment maintenance, service or repair; air- and waterline management; personal protective equipment usage; personal and hand hygiene practices; sterilisation practices; safe sharps handling and waste management were included. The AFI was tested in a sample of 50 oral health care facilities. None of the participating facilities demonstrated 100% compliance. Personal- and hand hygiene practices and waste management performed the best, at respectively 75% and 63%, while administrative controls and air- and waterline management scored the lowest mean values; 31% and 36% respectively The general lack of compliance with infection prevention and control precautions in the participating oral health care facilities clearly poses a safety hazard to both patients and oral health care workers.*

*Results indicate that adherence of South African oral health care facilities with compliance to infection prevention and control precautions need to be improved. The AFI should go a long way towards improving safety and the high expectations about providing quality infection prevention and control outcomes in oral health care.*

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# LIST OF ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| ADA: | American Dental Association |
| AIDS: | Acquired Immune Deficiency Syndrome |
| AFI: | Audit-Feedback Instrument |
| AS / NZS: | Australian / New Zealand |
| BDA: | British Dental Association |
| CDC: | Centers for Disease Control and Prevention |
| CPD: | Continuous Professional Development |
| COHSASA: | Council of Health Services Accreditation of South Africa |
| DoH: | Department of Health |
| FDI: | Fédération Dentaire Internationale |
| HBV: | Hepatitis B Virus |
| HCV: | Hepatitis C Virus |
| HHV | Human Herpes Virus |
| HIV: | Human Immunodeficiency Virus |
| HSV | Herpes Simplex Virus |
| IPS: | Infection Prevention Society |
| MSDSs: | Material Safety Data Sheets |
| OHCW(s): | Oral health care worker(s) |
| OHS: | Occupational Health and Safety |
| OSAP: | Organization for Safety and Asepsis Procedures |
| PPE: | Personal Protective Equipment |
| SADA: | South African Dental Association |
| TB: | Tuberculosis |
| WHO: | World Health Organization |

# CHAPTER 1

# Introduction to the study

## 1.1 Introduction

Throughout the lives of people of all ages tooth decay, periodontal disease, oral trauma and oral cancer have contributed to a tremendous disease burden. When working in, or visiting health care facilities, people from infancy through old age are exposed to the potential of a variety of infections and injury related risks (Miller and Palenik, 2010).

In oral health care facilities, disease transmission may occur when microbial pathogenic agents are transmitted to patients, oral health care workers or the public (National Health and Medical Research Council, 2010). The prevention or reduction of the risk of disease transmission is conventionally accomplished by breaking the chain of infection through the application of standard precautions (Republic of South Africa, 2001; Parkhurst and Coulter, 2009).

South Africa has a substantial and unique burden of disease (Jentsch, 1997; Connelly*, et al.*, 2007; Department of Health Republic of South Africa, 2010; Sissolak*, et al.*, 2011). Human immunodeficiency virus (HIV) and acquired immune deficiency syndrome (AIDS), Hepatitis B and C, tuberculosis infection, preventable conditions arising from poor sanitation, nutrition and other conditions of poverty, and a growing burden of non-communicable disease, for example obesity and diabetes, all affect the lives and lifestyles of South Africans. Although vaccines have became available for many diseases; to date there is no curative treatment or vaccine available for HIV infection (Lee and Bishop, 1997).

It is every South African citizen's constitutional right to receive health care in an environment that is not harmful to his / her well-being (Republic of South Africa, 1996). In the National Core Standards of quality health care in South Africa, infection prevention and control has been identified as a fast track priority for improvement (Department of Health Republic of South Africa, 2011, 2012). Detailed infection prevention and control recommendations and guidelines pertaining to the oral health care profession are presently sadly lacking in South Africa. The National Infection Prevention and Control Policy and Strategy sets minimum national standards for the effective prevention and management of health care associated infections (National Department of Health, 2007). However, these standards do not specifically address the oral health care environment. The Norms, Standards and Practice Guidelines for Primary Oral

Health Care provides a few pages listing succinct guidelines for infection control in primary oral health care facilities (National Department of Health, 2005), without any detailed instructions regarding the limitless variety of oral health care problems / procedures found in rural and urban facilities on the one hand, and public and private oral health care facilities on the other hand, or the diversity of training levels of personnel and the vast differences in available resources that exist between these two extremes. These unique conditions, including the burden of disease in South Africa, necessitates the development and application of consistent mechanisms or instruments to measure and monitor compliance to infection prevention and control in oral health care facilities, as well as set guidelines to regulate service delivery.

## 1.2 Aim and objectives

The main aim of this study is to develop an audit-feedback instrument to measure compliance to infection prevention and control guidelines for oral health care professionals and facilities in South Africa.

The development of an infection prevention and control audit-feedback instrument and application thereof in oral health care facilities will contribute to a safer health care environment in South Africa. This instrument will provide a means for oral health care facilities to assess their compliance with best practices in infection prevention and control in South Africa.

The objectives that have been formulated to achieve this aim include:

1. Reviewing national and international infection prevention and control literature.
2. Devising infection prevention and control guidelines to support the development of an audit-feedback instrument.
3. Creating an audit-feedback instrument that can be used in oral health care facilities in South Africa.
4. Testing and refining the application of the developed audit-feedback instrument in a sample of oral health care facilities in South Africa.

## 1.3 Ethical clearance and limitations of the study

Ethical clearance was obtained from the Medical University of South Africa (MEDUNSA), where the study originated. The ethical clearance certificate has been included in Appendix A.

The specifications and the audit-feedback instrument generated during this study are aimed at the oral health care fraternity specifically. The audit-feedback instrument has been tested in a sample of oral health care facilities in South Africa.

## 1.4 Layout of the thesis

This thesis has been arranged into eight chapters:

Chapter 1: Introduction

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

Chapter 2: Introduction to infection prevention and control in oral health care

Chapter 2 provides a historical perspective of infection prevention and control, as well as an overview of infectious agents and risks in oral health care.

Chapter 3: Compliance with infection prevention and control in oral health care facilities: A national perspective

Chapter 3 provides a review of the literature (1990 to 2013), addressing compliance with infection prevention and control in South African oral health care facilities. A review of the literature spanning 1990 to 2007 was published in 2010 (Oosthuysen, J., Potgieter, E., and Blignaut, E. Compliance with infection control recommendations in South African dental practices: A review of studies published between 1990 and 2007. *International Dental Journal,* **60**(3), 181–189). An update of literature since the first publication has been included. A copy of the original .pdf document of the publication appears in Appendix A.

Chapter 4: Compliance with infection prevention and control in oral health care facilities: A global perspective

Chapter 4 provides a review of global literature (2008 to 2013), addressing compliance with infection prevention and control in oral health care facilities. A review of the literature was published in 2014 (Oosthuysen, J., Potgieter, E., and Fossey, A. Compliance with infection prevention and control in oral health-care facilities: a global perspective. *International Dental Journal, September 2014.* Article ID 12134 http://dx.doi.org/10.1111/idj.12134). A copy of the original .pdf document of the publication appears in Appendix B.

Chapter 5: Theoretical framework that underpins the development of the audit-feedback instrument for oral health care facilities in South Africa

Chapter 5 provides the theoretical framework that underpins the development of the audit-feedback instrument for oral health care facilities in South Africa.

This chapter has also been submitted for publication in the *South African Dental Journal.*

Chapter 6: Audit-feedback instrument for oral health care in South Africa

Chapter 6 provides the guidelines that support the development of the audit-feedback instrument and the details regarding the audit-feedback instrument.

This chapter has also been submitted for publication in the *South African Dental Journal.*

Chapter 7: Assessment of the audit-feedback instrument for oral health care facilities in South Africa

Chapter 7 provides the results of the application of the audit-feedback instrument in 50 oral health care facilities in South Africa.

This chapter has also been submitted and approved for publication in the *South African Dental Journal* – paper in press.

Chapter 8: Conclusions and recommendations

Chapter 8 provides overall conclusions of the study and recommendations.

Appendix A: A copy of the original .pdf document of the publication Oosthuysen, J., Potgieter, E., and Blignaut, E. Compliance with infection control recommendations in South African

dental practices: A review of studies published between 1990 and 2007. *International Dental Journal,* **60**(3), 181–189.

Appendix B: A copy of the original .pdf document of the publication Oosthuysen, J., Potgieter, E., and Fossey, A. Compliance with infection prevention and control in oral health-care facilities: a global perspective. *International Dental Journal, September 2014*. Article ID 12134 (http://dx.doi.org/10.1111/idj.12134).

Appendix C: Copy of ethical clearance certificate.

Appendix D: Infection prevention and control guidelines supporting the development of the audit-feedback instrument.

Appendix E: Certificate of language editing.

## 1.5 References

Connelly, D., Veriava, Y., and Roberts, S. (2007). Prevalence of HIV infection and median CD4 counts among health care workers in South Africa. *South African Medical Journal,* **97**, 108-109.

Department of Health Republic of South Africa (2010). *Department of Health Strategic Plan 2010/11-2012/13 South Africa*. from http://www.doh.gov.za.

Department of Health Republic of South Africa (2011). *National Core Standards for Health Establishments in South Africa; "Towards quality care for patients".* Retrieved 6 October 2012. from http://www.sarrahsouthafrica.org/DOCUMENTS/NationalQualityAssuranceDocuments.aspx.

Department of Health Republic of South Africa (2012). National Core Standards for Health Establishments: 7 domains of quality healthcare. *86E84d01 National Core Standards for Health Establishments.pdf*. Retrieved from www.doh.gov.za/docs/posters/2012/domainsposter.pdf.

Jentsch, U. (1997). A review of opportunistic infections in Africa: current topics. *South African Journal of Epidemiology and Infection,* **12**, 28-32.

Lee, M., and Bishop, P. (1997). *Microbiology and infection control for health professionals*. Australia: Prentice Hall.

Miller, C. H., and Palenik, C. J. (Eds.). (2010). *Infection Control and Management of Hazardous Materials for the Dental Team* (Fourth ed.). St. Louis, Missouri: Elsevier Mosby.

National Department of Health (2005). *Department of Health National norms, standards and practice guidelines for primary oral health care. South Africa: 24 June 2005. Directorate Oral Health*.

National Department of Health (2007). The National Infection Prevention and Control Policy and Strategy, Department of Health, Republic of South Africa.

National Health and Medical Research Council (2010). *Australian Government: Guidelines for the Prevention and Control of Infection in Healthcare. Commonwealth of Australia*. from http://www.nhmrc.gov.au.

Parkhurst, C. L., and Coulter, W. A. (2009). *Basic guide to infection prevention and control in dentistry* (First ed.). West Sussex, United Kingdom: John Wiley and Sons Ltd.

Republic of South Africa (1996). *The Constitution of the Republic of South Africa Act, Number 108*.

Republic of South Africa (2001). *Regulations for hazardous biological agents. Government Notice R1390 of 27 December 2001 under section 43 of the Occupational Health and Safety Act of the Republic of South Africa; Act 85 of 1993*. from http://www.labour.gov.za.

Sissolak, D., Marais, F., and Mehtar, S. (2011). TB infection prevention and control experiences of South African nurses - a phenomenological study. *Biomedcentral Public Health,* **11**(262), 1-10.

# CHAPTER 2

# Background to infection prevention and control in oral health care

**Summary**

*This study is a systematic review and general perspective of the historic background on infection prevention and control in oral health care facilities. Many researchers brought about the prevention of disease through the use of infection control procedures during the golden age of microbiology. They provided evidence on contagious diseases, but Ignaz Semmelweis (Vienna) and Oliver Wendell Holmes (USA) were the first to recognise the importance of hand washing in preventing the spread of disease. Today, this important precaution, including some others, is still applied as standard precautions to safeguard patients and personnel providing health care.*

*In the sphere of oral health care itself, the electric dental engine was introduced in the 1920s, and with that came the discovery that oral health care personnel and patients are more exposed to aerosol contamination than with the previous foot-driven models. Today, oral health care facilities and personnel have to face numerous challenges in providing safe care for patients. As a result of intense media coverage, many patients have become concerned with the possibility of disease transmission in health care facilities in general. Infection prevention and control precautions have rapidly evolved in past three decades, particularly after the emergence of high risk diseases such as HIV infection. In South Africa, with its distinctive burden of disease, such as the high incidence of HIV/AIDS, hepatitis B and C, as well as tuberculosis, infection prevention and control in oral health care facilities is of particular significance.*

***Keywords:*** *Dentistry; dental; oral health care; infection prevention and control*

## 2.1 Historical perspective of infection control

*"The first requirement of a hospital is that it should do the sick no harm."*

~ Florence Nightingale (1820-1910)

In 1675, Antony van Leeuwenhoek constructed the first, simple microscope and observed "animalcules" in saliva, scrapings from teeth and gutter water (bacteria, yeasts, and protozoa) (Miller and Palenik, 2010; Molinari and Harte, 2010). At that time, the relationship between microbes and disease had not been defined. It was only during the mid- to late 1800s, during the "Golden Age of Microbiology", that the relationship between these "little animals" and disease was established by researchers such as Louis Pasteur (France), Robert Koch (Germany) and Lord John Lister (England). The American researcher, Willoby D. Miller, became known as the "Father of Oral Microbiology" because of his contributions to the understanding of oral microbes and disease (Miller and Palenik, 2010). By the 1900s, bacteria had been described as being the cause of numerous diseases, including dental caries (Miller and Palenik, 2005).

The prevention of disease, through the use of *Infection Control Procedures,* was brought about during the *Golden Age of Microbiology* (Miller and Palenik, 2010). As stated, it was during the mid- to late 1800s that Ignaz Semmelweis (Vienna) and Oliver Wendell Holmes (USA) provided first hand evidence that puerperal fever was a contagious disease (Miller and Palenik, 2005). Both researchers outlined measures to minimise the spread of illness, especially considering the relationship between disease and the practice of health care professionals (Molinari and Harte, 2010). They were also the first to specifically recognise the importance of hand washing in preventing the spread of disease (Miller and Palenik, 2005). During 1846, Semmelweis observed that women whose babies were delivered by students and physicians in the First Clinic at the General Hospital of Vienna consistently had a higher mortality rate than those whose babies were delivered by midwives in the Second Clinic (CDC, 2002). From May 1847, Semmelweis insisted that students and physicians clean their hands with a chlorine solution, after which the maternal mortality rate in the First Clinic dropped dramatically and remained low (CDC, 2002).

Louis Pasteur and John Tindall discovered that heat destroys bacteria and resistant bacterial spores (Miller and Palenik, 2005). Their technique of using boiling water to destroy bacteria (called pasteurisation) is still in use today. The surgeon, Lord John Lister, further reduced post-operative infections by the use of phenols (Miller and Palenik, 2005). Because of Lister's contribution to the study of post-operative infections and hygiene practices, he became known as the "father of clean and decent

surgery" (Molinari and Harte, 2010). At that time his proposal to spray the air around patients before surgery was considered both bold and shocking. The practice of spraying the air around patients before surgery paved the way for the sterile and aseptic techniques practised worldwide today (Miller and Palenik, 2005).

The scientific study of hospital cross-infection began during the 18th century. In 1858 Florence Nightingale promoted hospital reform, and her memorable motto: "The first requirement of a hospital is that it should do the sick no harm", is still applicable today (Forder, 2007; Molinari and Harte, 2010).

In oral health care, the electric dental engine was introduced in the 1920s, after which it was discovered that dental personnel and patients were more exposed to aerosol contamination than previously with foot-driven engines. A report from 1931 revealed that oral health care workers (OHCWs) were more prone to airborne infections than workers in any other profession (Registrar-General of Great Britain, 1931). In 1951 the introduction of the high-speed turbine machine and ultrasonic cleaner further increased bacteria-laden aerosol contamination in oral health care facilities. It was only during the 1970s, and early 1980s, that it was realised that the incidence of certain diseases among oral health care professionals was much higher than observed in the general public, and that this was a result of the continuous exposure to saliva and blood (Molinari and Harte, 2010). In 1981 the human immunodeficiency virus (HIV) that is responsible for acquired immune deficiency syndrome (AIDS), was identified. Although vaccines have become available for many diseases, to date there is no curative treatment available for HIV infection (Lee and Bishop, 1997).

New and improved infection control procedures emerged from the late 1980s to 1992, owing to a better understanding of the variety of hazards health care workers are exposed to. It was during the late 1980s and early 1990s that authorities such as the American Dental Association (ADA), the Occupational Safety and Health Administration (OSHA) and the Centers for Disease Control (CDC), increasingly urged oral health care professionals to improve their infection control practices (Hazelkorn*, et al.*, 1996; Eklund*, et al.*, 2002).

In the past, infection control procedures in oral health care facilities mainly only involved frequent hand washing. Structured infection control practice was the exception rather than the rule. During the 21st century, the emergence and re-emergence of infection challenges have confronted health practitioners (Miller and Palenik, 2010). One of the most important of these includes the first epidemic of the century, namely the Severe Acute Respiratory Syndrome (SARS) outbreak of late 2002 and early 2003. In addition shortly afterwards, avian influenza outbreaks among domesticated birds in Asia

became the focus of investigations into the potential for human-to-human transmission (Samaranayake, 2012).

Today it is imperative for health care facilities and personnel to face the challenges of providing care for patients potentially infected with new viruses, among others the pandemic of the new influenza A (H1N1) virus that has gained prominence since 2009. It is, therefore, critical that OHCWs follow appropriate infection prevention and control precautions to protect themselves, other personnel, patients and the community in order to minimise or prevent the possibility of disease transmission (World Health Organization, 2009).

## 2.2 Microorganisms and infectious agents in oral health care

It has only been since the 1980s that the concern about the HIV pandemic and the consequent risks of cross contamination and infection has resulted in the increased awareness of infection prevention and control in oral health care (Samaranayake, 2002). In addition, as a result of intense media coverage, many patients have become concerned about the possibility of disease transmission in health care facilities (Samaranayake, 2002). If however, proper infection prevention and control precaution measures are applied, patients can be treated safely and with confidence, whether the patient's infectious status is known or not (Scarlett, 2006).

There are five groups of microorganisms and infectious agents that may cause diseases that are of importance in oral health care. Understanding the characteristics of these microorganisms, how they are transferred and how they cause specific diseases forms the basis of how to prevent the microorganisms causing harm to OHCWs and patients (Table 2.1).

## TABLE 2.1: Classification, characteristics and diseases of infectious agents in oral health care

| Vector of disease | Characteristics | Examples of diseases |
|---|---|---|
| **Prions** | • Proteinaceous infectious particles that are unique elements to nature.<br>• Very long incubation periods (up to 20 years) in humans.<br>• Transmission of prion disease by neurosurgical instruments has been reported.<br>• It is suggested to use disposable instruments or autoclaving for a minimum of 18 minutes at 134°C in a vacuum autoclave to achieve sterility.<br>• There is no vaccine or treatment against prion induced diseases. | Creutzfeldt-Jakob disease (CJD), including variant CJD, fatal familial insomnia, Kuru fever, Gerstmann-Straussler-Scheinker syndrome (Samaranayake, 2012). |
| **Viruses** | • Viruses cause many diseases in humans.<br>• A virus is a very small microorganism, 1/100th of the size of one bacterium, requiring an electron microscope to observe it.<br>• Viruses require a living cell to reproduce - thus must live inside a host cell to multiply.<br>• Because viruses live within cells they are often protected against chemicals.<br>• To survive, viruses change constantly.<br>• Viruses outside the body can be deactivated by heat and chemicals.<br>• Controlling the parasitic viral growth inside host cells using chemicals is very difficult.<br>• Most viral diseases can only be prevented through immunisation and infection control.<br>• Viral diseases cannot be treated with antibiotics. | Hepatitis, AIDS, herpetic gingivostomatitis, recurrent herpes (e.g. herpes labialis), hand-foot-and-mouth disease, herpangia, hairy leukoplakia, varicella, common cold, influenza, bronchitis, pneumonia, cytomegalovirus (CMV) disease, infectious mononucleosis, measles, mumps, rubella (Miller and Palenik, 2005; Molinari and Harte, 2010). |
| **Bacteria** | • Bacteria include the vast majority of human pathogens that are only visible under a light microscope.<br>• Different bacteria have different metabolic properties, e.g. nutrients used to grow, requirements for oxygen, excretion of waste materials such as acids and enzymes, which must be present in a particular habitat for growth. These metabolic properties determine where bacteria will grow and the damage that will be caused.<br>• Under adverse environmental conditions, some bacteria form a dense, thick walled structure called a spore or endospore - extremely resistant to heat, drying and chemicals.<br>• Bacteria multiply at a high rate, e.g. one *Escherichia coli* can multiply under optimal conditions to 3 trillion billion cells within 24 hours.<br>• Controlling bacteria is accomplished through preventing their multiplication or by destroying them by means of procedures, such as sterilisation and disinfection.<br>• In humans, bacterial diseases can be successfully treated with antibiotics. | Dental decay, periodontal disease, tuberculosis, gonococcal pharyngitis, streptococcal pharyngitis, scarlet fever, syphilis, diphtheria, pneumonia, meningitis, sinusitis, conjunctivitis, bronchitis (Miller and Palenik, 2005). |
| **Fungi** | • Yeast cells can be killed outside the body by exposure to heat or antiseptics / disinfectants that can be used on living tissue, with minimal damage.<br>• *Candida* is an opportunistic pathogen in people with depressed immune systems, trauma to tissues (e.g. poor-fitting dentures), or on long term antibiotic treatment.<br>• *Candida albicans* is a member of the normal oral flora in about 30% of adults.<br>• *C. albicans* infections are easily treated with topical antifungal agents. | Candidiasis, denture stomatitis (Miller and Palenik, 2005), and a number of fungal infections of the lower respiratory tract, especially in those who are immuno-compromised (Samaranayake, 2012). |
| **Protozoa** | • Protozoa are microscopic single-celled 'animals'.<br>• They live in fluids in the oral cavity and in polluted water.<br>• Protozoa can also cause periodontal disease.<br>• Examples of pathogenic protozoa include *Cryptosporidium* and *Giardia*, occurring in countries where the public water supply is contaminated with faecal matter. | Amoebiasis (amoebic dysentery), cryptosporidiosis and giardiasis. Protozoa can also cause periodontal disease (Samaranayake, 2012). |

Given the specific nature of oral health care procedures, some diseases are of particular interest to OHCWs due to the occupational risk they carry. Cross infection may occur when disease causing pathogens are transferred from one person to another in an oral health care facility, e.g. through contact or spatter. It is therefore important to consider the cumulative risk of infection, which is largely determined by:

1. The prevalence or frequency of the disease in the patient population;
2. the risk of transmission amongst OHCWs and / or patients after exposure (varies due to type of microorganism / agent and the immune status of OHCWs and / or patients);
3. the type and frequency of contact with potentially infectious materials;
4. lack of knowledge and understanding of diseases and their causative agents; and
5. inadequacy of organisation and equipment in oral health care facilities.

The diseases and risks that are of particular interest to OHCWs and patients are listed in Table 2.2.

**TABLE 2.2: Infectious disease risks in oral health care (Molinari and Harte, 2010)**

| Disease | Ethiologic agent | Incubation time |
|---|---|---|
| **Viral** | | |
| Influenza | Influenza viruses | 1 to 4 days |
| Common cold | Rhinoviruses (most common) | Few days |
| Recurrent herpetic lesion | Herpes simplex, types 1 and 2 | Up to 2 weeks |
| Rubella | Rubella virus | 9 to 11 days |
| Hepatitis B | Hepatitis B virus | 6 weeks to 6 months |
| Hepatitis C | Hepatitis C virus | Weeks to months |
| Delta hepatitis (hepatitis D) | Hepatitis D virus | Weeks to months |
| Infectious mononucleosis | Epstein-Barr virus | 4 to 7 weeks |
| Hand-foot-and-mouth disease | Primarily coxsackievirus A16 | 2 days to 3 weeks |
| Herpangina | Coxsackieviruses group A | 5 days |
| AIDS | HIV | Months to years |
| **Bacterial** | | |
| Staphylococcal infections | *Staphylococcus aureus* | 4 to 10 days |
| Tuberculosis | *Mycobacterium tuberculosis* | Up to 6 months |
| Streptococcal infections | *Streptococcus pyogenes* | One to 3 days |
| **Fungal** | | |
| Dermatomycoses (superficial skin infections) | *Trichophyton, Microsporum, Epidermophyton* and *Candida genera* | Days to weeks |
| Candidiasis | *Candida albicans* | Days to weeks |
| **Miscellaneous** | | |
| Infections of fingers, hands and eyes from dental plaque and calculus | Variety of microorganisms | 1 to 8 days |

Fundamental infection prevention and control is based upon the principle that disease transmission will be prevented when any of the steps or links in the chain of infection is broken or interrupted (Figure 2.1). The first attempt in preventing microorganisms and infectious agents from causing harm is

to keep them from becoming a potential source of infection. Reservoirs or sources of the pathogens should be eliminated through procedures such as cleaning, disinfection / pasteurisation, sterilisation, growth inhibition, immunisation or antimicrobial therapy. Contamination of susceptible hosts by infectious agents may be prevented by limiting or avoiding exposure to the reservoirs or sources of the agents, by application of precautions such as barrier protection or use of pre-procedural mouth rinses (Miller and Palenik, 2005).

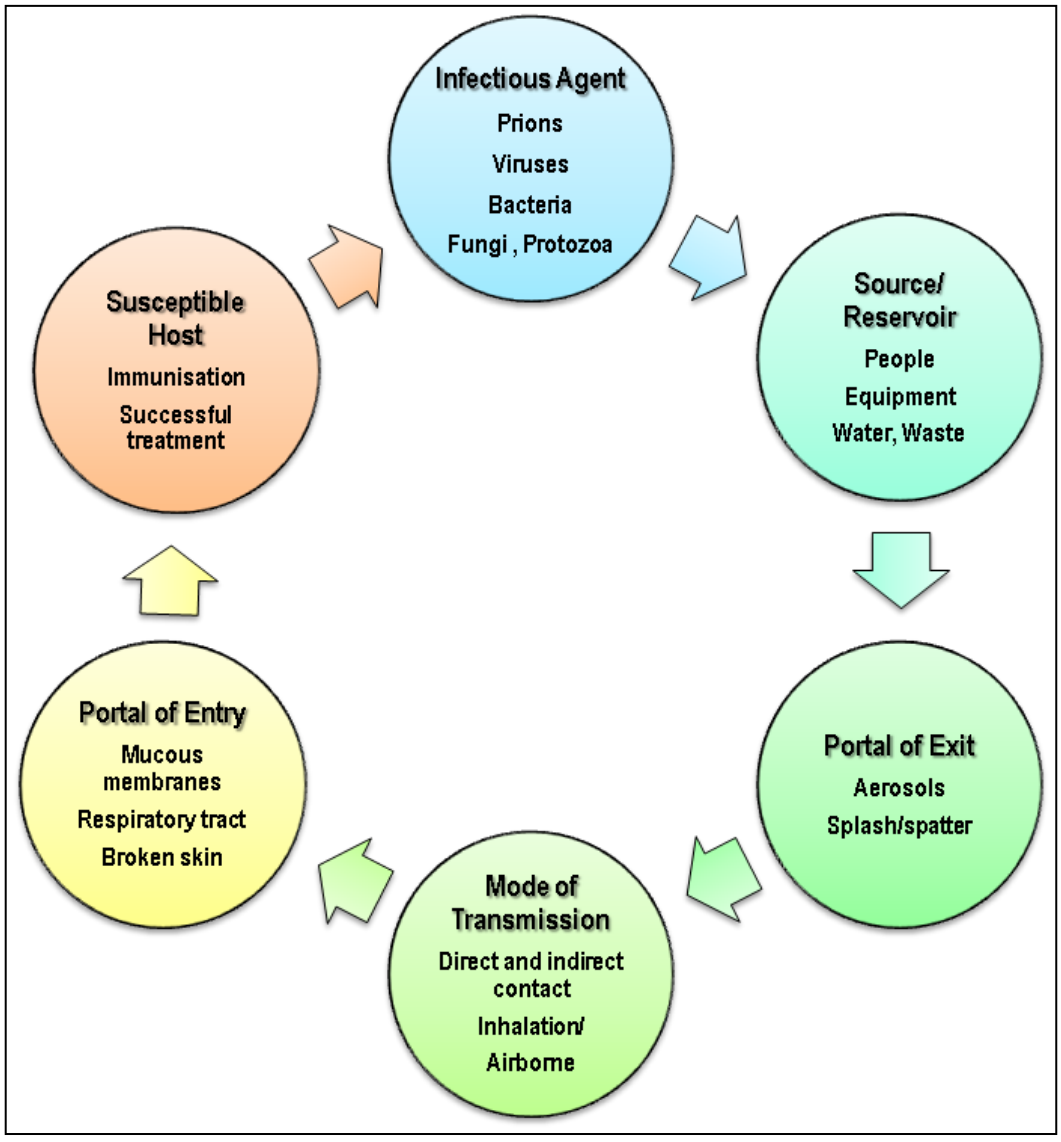


**FIGURE 2.1: Chain of infection**

The four pillars upon which all precautions or protection methods in oral health care rests include taking actions to ensure the health of OHCWs and that patients avoid contact with blood and body fluids, using instruments and supplies in a safe manner and limiting the spread of blood and body fluid contamination (Table 2.3).

**TABLE 2.3: Four pillars of infection prevention (**adapted from Eklund*, et al.*, 2002; OSAP, 2004)

| Pillars of infection prevention | Actions |
|---|---|
| **Actions to stay healthy** | Implement administrative controls that include standard operating procedures, written policies; periodic training of personnel; job orientation; various records (e.g. medical and vaccination records); actions to keep OHCWs healthy (e.g. routinely recommended vaccinations) and actions to encourage adherence to recommended precautions, e.g. using personal protective equipment such as masks. One of the most important precautions that should be emphasised continuously is that of hand hygiene. |
| **Avoidance of contact with blood and body fluids** | Standard precautions to avoid contact with blood and other potentially infectious materials (including hand washing; using personal protective equipment such as gloves, eyewear and face protection, protective clothing; safe handling of sharps and using controls to prevent injury, e.g. needle capping using the one handed technique and other safety devices). Each patient should be treated as if infectious. |
| **Safe use of objects** | The safe use of objects includes safe working habits, such as working with care when handling sharp objects and other methods; technology that isolates or removes hazards; cleaning and sterilisation of patient care items and instruments; protection, cleaning and disinfection of surfaces; and general environmental hygiene and housekeeping. |
| **Limiting the spread of blood and body fluid contamination** | Methods to limit the spread of blood and body fluid contamination include minimising the spatter and aerosols created during dental procedures; environmental control by covering or disinfecting surfaces that may become contaminated between patient contacts and proper health care risk waste disposal. |

## 2.3 Risk identification and assessment in oral health care

Risk is defined as the probability that a substance or situation will produce harm under specified conditions and have an effect on public health and / or on the environment (Omen*, et al.*, 1997). Risk is a combination of two factors, namely the probability that a harmful event will occur, e.g. specific disease or injury; and that the consequences of the event will be unsafe.

OHCWs have a duty and responsibility to themselves, colleagues and patients to take the necessary steps to prevent cross infection in an oral health care facility. The Occupational Health and Safety Act of 1993, which applies to all workplaces including oral health care facilities, has the requirement for oral health care providers or employees to perform risk assessments at intervals not exceeding two years embedded within its safety legislation (Republic of South Africa, 2001). The goal of risk management is to apply scientifically sound, cost-effective and integrated actions that reduce or prevent risk, while taking into account all appropriate social, cultural, ethical, political, and legal considerations (Omen*, et al.*, 1997).

Risk assessments are undertaken to identify hazards, determine who might be at risk of being harmed and to initiate appropriate and reasonable actions to minimise the risks (Republic of South Africa, 1993). A risk assessment is the systematic, scientific categorization of potential harmful effects of exposures to hazardous agents or activities. It is performed by considering the types of hazards, the extent of exposure to the hazards, and information about the relationship between exposures and responses, including variation in susceptibility. Harmful effects or responses can result from exposure to chemicals, microorganisms, radiation, or natural events (Omen*, et al.*, 1997).

Risk assessment involves five major stages (Parkhurst and Coulter, 2009):

1. Identifying the risk factors or looking for the hazards;
2. deciding who might be harmed and how;
3. evaluating the risk arising from the hazard and deciding whether existing precautions are adequate or if more should be done;
4. recording the findings of the risk assessment; and
5. reviewing the risk assessment on a periodic basis and revising if necessary.

The steps of the different stages that facilitates a risk assessment are shown in Table 2.4 (Parkhurst and Coulter, 2009).

**TABLE 2.4: Stages and their steps of a risk assessment**

| Stages of risk assessment | Steps within each stage |
|---|---|
| **1. Identify the risk factors or look for the hazards** | • Divide the work into manageable categories.<br>• Concentrate on significant hazards that could cause serious harm or affect several people.<br>• Give all employees opportunity to share their views and involve the whole team.<br>• Divide activities into operational stages to ensure there are no hidden hazards.<br>• Use the manufacturers' material safety data sheets (MSDS) to assist in the process to identify the risk and to put the risk into true perspective.<br>• Review previous accidents or incidents and work related illness records. |
| **2. Decide who might be harmed and how** | • Identify all members of personnel who may be at risk.<br>• Include persons who infrequently come into contact with the hazard, for example maintenance service people, visitors, general public and people sharing the workspace.<br>• Identify more vulnerable people and persons at particular risk, e.g. the very young or very old, people with disabilities, inexperienced or temporary workers. |
| **3. Evaluate the level of risk** | • Aim to reduce the risk to a low level.<br>• For each significant risk, *after all precautions have been applied,* determine whether the remaining risk is high, medium or low.<br>• Examine the actual process of the specific standard operating procedure.<br>• Confirm compliance with guidelines, requirements or standards.<br>• Confirm legal compliance to keep the workplace safe. |
| **4. Record the findings of the risk assessment** | • Keep records of assessment of significant findings, hazards and conclusions, including the following:<br>o Activities or work examined;<br>o hazards identified;<br>o persons exposed to hazards;<br>o evaluation of the risk and determination of priorities in these;<br>o effectiveness of existing control measures, and<br>o identification of additional precautions; persons who take action and when. |
| **5. Review the assessment and revise if necessary** | • This is a continuous process that must be kept up to date.<br>• Take into account all new activities and hazards, any changes in processes, methods of work and new personnel members.<br>• The likelihood of occurrence of the hazard determines when the review assessment must be executed: Yearly, quarterly, monthly or daily. |

Not all oral health care procedures carry an equal risk of disease transmission. It is therefore recommended that oral health care providers evaluate a task and the type of exposure expected for each treatment situation, prior to choosing the appropriate personal barrier precautions to implement. Blood is the most important transmitter of disease, but saliva has always been considered a risk in oral health care (CDC, 2003). Therefore, procedures involving blood, blooded body fluids, and non-intact tissues require maximum protection. On the other hand, procedures involving no anticipated exposure may not need stringent barrier precautions. Listed in Table 2.5 are examples of task levels and exposure types.

It is recommended that each oral health care facility implements a risk assessment action plan in order to identify, control or eliminate hazards. Such an action plan should involve the following (Parkhurst and Coulter, 2009):

1. Eliminate or remove the risk, e.g. by means of safer procedures, services or goods;
2. substitute the risk e.g. by using something less hazardous or risky;
3. contain or enclose the risk to remove the hazard from the worker or patient with improved environmental controls, e.g. by using closed, leak-proof puncture-resistant containers to carry contaminated instruments to a sterilisation area;
4. guard and / or segregate the hazard, e.g. exclude people from waste disposal- / storage areas and segregate health care risk waste at the point of generation in the clinical area;
5. modify procedures, protocols and work practices to reduce risk to an acceptable low level;
6. verbally communicate and provide written standard operating procedures for each facility to all persons affected and provide training in order to update / upgrade knowledge and understanding;
7. provide adequate supervision and monitor OHCW and patient compliance;
8. identify training needs and implementation of these;
9. provide information / instruction / training by means of signage, handouts, guidelines and policies; and
10. provide and supervise the use of personal protective equipment (PPE).

**TABLE 2.5: Categories of oral health care tasks for risk assessment** (adapted from Royal College of Dental Surgeons of Ontario, 2009)

| Task level | Exposure type | Personal barrier |
|---|---|---|
| **Surgery, periodontal procedures, etc.** | Involves the exposure to blood, blood-contaminated saliva, or non-intact tissue, especially when aerosol or spatter is likely to be produced. | Maximum necessary, including hand washing; using personal protective equipment such as gloves, eyewear and face protection, protective clothing; safe handling of sharps and using controls to prevent injury. |
| **Examinations, radiographs, etc.** | Involves contact with intact oral mucosa but no anticipated blood, aerosol or spatter. | Moderate (at minimum, gloves recommended) |
| **Consultations, etc.** | Involves no exposure to blood, other potentially infectious materials such as saliva, or tissues. | None required |

## 2.4 Conclusion

Infection prevention and control precautions have rapidly evolved in the past three decades, particular with the advent of emerging high risk diseases. In South Africa, with its unique burden of disease

including the high incidence of HIV/AIDS, hepatitis B and C, as well as tuberculosis, infection prevention and control in oral health care facilities is of particular significance.

## 2.5 References

CDC (2002). Guideline for hand hygiene in health-care settings. *Morbidity and Mortality Weekly Report,* **51**(RR-16).

CDC (2003). Guidelines for infection control in dental health-care settings - 2003. [Recommendations and reports]. *Morbidity and Mortality Weekly Report,* **52**(Number RR-17), 1-68.

Eklund, K. J., Bednarsh, H., and Haaland, C. O. (2002). *OSAP Interact infection control and safety training system* (Second ed.). Annapolis: OSAP.

Forder, A. A. (2007). A brief history of infection control - past and present South African Medical Journal November 2007. Retrieved 9 July, 2009, from http://findarticles.com/p/articles/mi_6869/is_11_97/ai_n28533881/.

Hazelkorn, H. M., Bloom, B. E., and Jovanovic, B. D. (1996). Infection Control in the dental office: has anything changed? *Journal of the American Dental Association,* **127**, 786-790.

Lee, M., and Bishop, P. (1997). *Microbiology and infection control for health professionals*. Australia: Prentice Hall.

Miller, C. H., and Palenik, C. J. (2005). *Infection Control and Management of Hazardous Materials for the Dental Team* (Third ed.). St. Louis, Missouri: Elsevier Mosby.

Miller, C. H., and Palenik, C. J. (Eds.). (2010). *Infection Control and Management of Hazardous Materials for the Dental Team* (Fourth ed.). St. Louis, Missouri: Elsevier Mosby.

Molinari, J. A., and Harte, J. A. (2010). *Cottone's Practical infection control in dentistry* (Third ed.). Baltimore, Philadelphia: Lippincott, Williams and Wilkens, a Wolters Kluwer business.

Omen, G. S., Chiu, P. Y., Kessler, A. C., Doull, J., Anderson, N. T., Goldstein, B., Leberberg, J., Rall, D., McGuire, S. M., Weldon, V. V., and Charney, G. (1997). *Risk assessment and risk management in regulatory decision-making* (No. Final report 1997). Washington, DC: The Presidential/Congressional Commission.

OSAP (2004). *From policy to practice: OSAP's Guide to the Guidelines*. Annapolis: Organization for Safety and Asepsis Procedures.

Parkhurst, C. L., and Coulter, W. A. (2009). *Basic guide to infection prevention and control in dentistry* (First ed.). West Sussex, United Kingdom: John Wiley and Sons Ltd.

Registrar-General of Great Britain (1931). *Death from Respiratory Tuberculosis: London*.

Republic of South Africa (1993). Occupational Health and Safety Act of the Republic of South Africa, Number 85.

Republic of South Africa (2001). *Regulations for hazardous biological agents. Government Notice R1390 of 27 December 2001 under section 43 of the Occupational Health and Safety Act of the Republic of South Africa; Act 85 of 1993*. from http://www.labour.gov.za.

Royal College of Dental Surgeons of Ontario (2009). The Guidelines of the Royal College of Dental Surgeons of Ontario Retrieved 5 July, 2009, from http://www.rcdso.org.

Samaranayake, L. (2012). *Essential microbiology for dentistry.* (4th ed.). Hong Kong: Churchill Livingstone Elsevier.

Samaranayake, L. P. (2002). *Essential Microbiology for Dentistry* (2nd ed.). Edinburgh /New York Churchill Livingstone.

Scarlett, M. I. (2006). Today's guidence for infection control in dental healthcare settings - 2006. *Dentaltown,* **6**, 62-68.

World Health Organization (2009, 25 June 2009). Infection prevention and control in health care for confirmed or suspected cases of pandemic (H1N1) 2009 and influenza-like illnesses: Interim guidance 25 June 2009 (originally published 29 April 2009) Retrieved 10 July, 2009, from http://www.who.int/csr/resources/publications/swineflu/swineinfinfcont/en/index.html.

# CHAPTER 3

# Compliance with infection prevention and control in oral health care facilities: A national perspective

## 3.1 Introduction

Compliance with infection prevention and control recommendations in South African oral health care facilities is low (Oosthuysen, 2003b; Nemutandani*, et al.*, 2007; Nemutandani, 2008; Oosthuysen*, et al.*, 2010; Chikte*, et al.*, 2011). South Africa, as a developing country, has limited resources which are the major determining factor when employers consider the application of infection prevention and control strategies. Contrary to the belief of many oral health care employers, Mehtar (2008) has confirmed that if the right approach is applied, infection prevention and control is not necessarily expensive.

For safe oral health care, specific challenges need to be addressed to ensure safe oral health care provision. However, in oral health care the ignorance regarding this "…fundamentally important professional obligation…" is questioned (Hartshorne, 2010). Hartshorne (2010) referred to the role of the four primary role players in the depiction of "dirty dentistry", namely national, provincial and local government; academic institutions; the South African Dental Association; and the oral health care workers.

Unique conditions exist in South Africa (Republic of South Africa, 2011b). Of these, the most important include:

- The fastest growing HIV and AIDS epidemic worldwide (Health, 2007; Shisana, 2007; Sissolak*, et al.*, 2011);
- the prevalence of hepatitis B virus (HBV) infection within selected communities, which remains high and will be so for the next few years (Karim*, et al.*, 1989; Voigt*, et al.*, 1996; Jentsch, 1997; Mayaphi*, et al.*, 2012);
- a tuberculosis infection rate that is among the highest in the world (Edginton and Naidoo, 2007; World Health Organization, 2008b; Reddy and Naidoo, 2010; Wood*, et al.*, 2010; Sissolak*, et al.*, 2011); and
- a violent society leading to trauma with open wounds as a regular feature in many patients (Gilbert, 1996; Department of Health Republic of South Africa, 2010, 2011b).

The South African Minister of Health has stated: *"South Africa faces a quadruple burden of diseases consisting of HIV and AIDS; communicable diseases; non-communicable diseases; and violence and injuries"* (Department of Health Republic of South Africa, 2011c). As a direct consequence, the South African government and Department of Health has promulgated and adopted a 10 Point Plan for 2009-2014, that is to be implemented in all health establishments (Department of Health Republic of South Africa, 2011c). This plan focuses on the following priorities:

1. Provision of strategic leadership and creation of a social compact for better health outcomes;
2. Implementation of a National Health Insurance Plan (NHI);
3. Improving the quality of all health services;
4. Overhauling the health care system and improve its management;
5. Improving human resource planning, development and management;
6. Revitalisation of physical infrastructure;
7. Accelerated implementation of HIV & AIDS and Sexually Transmitted Infections' National Strategic Plan 2007-11, with increased focus on TB and other communicable diseases;
8. Mass mobilisation for better health for the population;
9. Review of the Drug Policy; and
10. Strengthening research and development.

Many first world countries, including the United States of America, Great Britain, Australia and New Zealand, have specific policies, recommendations and guidelines for oral health care professionals. These inform the practitioners of the best practices to prevent and control disease transmission (British Dental Association, 2003; Centers for Disease Control and Prevention, 2003a; Organization for Safety and Asepsis Procedures, 2004; New South Wales Health Department, 2005; Australian / New Zealand Standard, 2006; World Health Organization, 2006; American Dental Association, 2007; Department of Health United Kingdom, 2008; Kohli and Puttaiah, 2008; Rutala*, et al.*, 2008; Parkhurst and Coulter, 2009; World Health Organization, 2009c; United States Air Force, 2012). In South Africa however, none of the infection prevention and control policies, regulations or guidelines sufficiently addresses the specific conditions or requirements for the provision of oral health care in particular.

A systematic literature review was published by Oosthuysen, *et al.*, (2010). "Compliance with infection control recommendations in South African dental practices: A review of studies published between 1990 and 2007. *International Dental Journal,* **60**(3), 181–189." A copy of this article (Article 1) is presented in section 3.2. Subsequently, in section 3.3, additional information with an update of those studies published between 2008 and 2013 that address compliance with infection control recommendations in South African dental practices is discussed. Following this update, in section 3.4, a discussion of the

past to present legal and ethical obligations under which infection prevention and control in South African oral health care facilities is conducted, is included.

## 3.2 Article 1: Compliance with infection control recommendations in South African dental practices: A review of studies published between 1990 and 2007

### *3.2.1 Summary*

*In a country where the prevalence of infectious diseases ranks among the highest in the world, infection control in health care facilities should not be debatable. This unfortunately does not seem to be the case in South African oral health care facilities. This study is a systematic review of available literature on the adherence of South African oral health care professionals to infection control recommendations. Nine focus areas were investigated with regard to infection control practices: knowledge of infectious occupational hazards; personal hygiene and care of hands; correct application of personal protective equipment; use of environmental barriers and disposable items; sterilisation (recirculation) of instruments and handpieces; disinfection (surfaces) and housekeeping; management of waste disposal; quality control of dental unit waterlines, biofilms and water; as well as other special considerations. Although South African studies are limited and most of them relied on self-reports, which could have resulted in a serious overestimation of compliance, even these studies indicate serious shortcomings with regard to infection control practices in oral health care facilities in this country. This review highlights opportunity for improvement. Furthermore, it identifies possibilities for future research in infection control and also opportunities to improve infection control education for all oral health care workers in the country.*

**Keywords:** Dentistry; South Africa, infection control; compliance with guidelines

### *3.2.2 Introduction*

Since 1993, it has been recommended that South African dental practitioners adhere to the infection control (IC) guidelines issued by the US Centers for Disease Control and Prevention (CDC) (CDC, 2003). In 1998, however, Edward-Miller reported that many health care facilities in South Africa lacked even basic infection control requirements such as water and electricity (Edward-Miller, 1998), therefore making it impossible to adhere to any form of recommendation.

It has been estimated that one drop of saliva may contain up to 600 000 bacteria (Hovius, 1992) and in no other profession are people in such continuous contact with traumatised tissue, saliva and blood, thus increasing the risk of disease transmission (Harfst, 1991). In South Africa, however, the term "high risk" takes on a new meaning should one consider the exceptionally high prevalence of infectious diseases in this country. Human immunodeficiency virus (HIV) infection among antenatal clinic attendees was 29.1% in 2006. (National Department of Health, 2007) The Hepatitis B carrier rate had previously been estimated at 10% to 15% for rural populations and at 1% to 10% for urban populations (Jentsch, 1997). Karim *et al.* (1989) reported that 81% of females and 86% of males in their study tested positive for at least one hepatitis B serological marker; indicating an infection at some stage of their lives (Karim*, et al.*, 1989). Although the hepatitis B infection rate should improve as a result of the fact that children born since 1995 (National Department of Health, 2007) are being immunised as part of the routine immunisation programme, most of the adult population in this country, however, is still not immunised. Furthermore, South Africa records a tuberculosis infection rate among the highest in the world (World Health Organization, 2008a). Oral health care professionals (OHCPs) should therefore be even more cautious of cross-infection and display a higher degree of compliance with current protective guidelines than many other medical colleagues. It is alarming, however, that in South Africa there are still many oral health care workers (OHCWs) who admit to not taking adequate steps to prevent cross-infection (Darling*, et al.*, 1992; Naidoo, 1994; Lapidus, 1995; Lapidus and Sandler, 1997; Naidoo, 1997a; Rudolph and Ogunbodede, 1999; de Kock and van Wyk, 2001a; Dreyer and Hauman, 2001; Yengopal*, et al.*, 2001b; Naidoo and Mahommed, 2002a; Ogunbodede and Rudolph, 2002a; Kopsala, 2003; Oosthuysen, 2003a; Yengopal, 2003; Shisana*, et al.*, 2005b; Mehtar*, et al.*, 2007).

In 2005, both public and professional concern were raised after a media release by the Nelson Mandela Foundation (McKay, 2005), confirming that infection control practices in oral health care facilities were inadequate. Visible as well as invisible blood was detected in the facilities and on dental instruments. It was concluded that this was the result of a breakdown in infection control processes that had occurred in South Africa over an extended period of time (Shisana*, et al.*, 2005a).

This review of published research aims to determine to what extent South African OHCPs adhere to national infection control recommendations, and thereby to identify possible shortcomings. Knowledge of the latter could indicate a strategy for the improvement of infection control in oral health care facilities.

### *3.2.3 Research materials and methods*

Various strategies were followed to identify information on IC research, published between 1990 and 2007, and applicable to South Africa only. This review of adherence to infection control practices included all OHCWs, namely dental practitioners, dental therapists, dental assistants, oral hygienists and students.

The outcome measures used as the baseline for infection control practices were selected according to international recommendations by the British Dental Association (British Dental Association, 2003), CDC (CDC, 2003), and the Australian and New Zealand Dental Associations (Australian / New Zealand Standard, 2006).

These outcomes focus on and include: knowledge of infectious hazards, personal hygiene and care of hands; wearing of personal protective equipment; environmental barriers; sterilisation (recirculation) of instruments and handpieces; disinfection (surfaces) and housekeeping; waste disposal; quality control and maintenance of dental unit waterlines, biofilms and water supply; and other special considerations.

Electronic databases were searched, including Medline (EBSCOhost), Academic Search Premier (EBSCOhost), Science Direct, SA ePublications, SACAT, ISAP by the National Library of South Africa, NEXUS current and completed research, UCTD (Theses and Dissertations at South African universities) and the South African Dental Association's publication library for the period 1990 till the end of September 2007. The search produced 77 publications of which 16 were selected. Publications containing quantitative data were selected, while those containing mere recommendations were excluded.

### *3.2.4 Results and discussion*

#### *3.2.4.1 Focus area one: Knowledge of infectious hazards*

As a standard precaution, infection control guidelines and recommendations stipulate that the blood and body fluids of all patients should be treated as potentially infectious (British Dental Association, 2003; CDC, 2003; Australian / New Zealand Standard, 2006). Lack of knowledge of hazards associated with infectious conditions was considered as the reason why oral health care providers took additional precautions when they treated confirmed HIV / AIDS patients as opposed to patients suffering from other infectious conditions (Lapidus, 1995; Lapidus and Sandler, 1997; Gordon*, et al.*, 2001). Interesting

to note was that respondents believed they could differentiate between infected and uninfected patients by just looking at them and that older dentists thought they were more at risk when working on a HIV-infected patient as compared to a hepatitis B-infected patient (Lapidus, 1995; Lapidus and Sandler, 1997). The majority of non-clinical personnel working in clinics thought that HIV infection could be transmitted through mosquito bites (Rudolph and Ogunbodede, 1999). De Kock and Van Wyk (2001) found that 26.8% of respondents did not know the difference between disinfection and sterilisation. Oosthuysen reported that 87% of respondents regarded each patient as a potential source of cross-infection (Oosthuysen, 2003b), yet only 27.6% possessed an infection control manual with detailed protocols for sterilisation, exposure control or infection control techniques. In the Free State public dental care facilities 57.1% of respondents indicated that they had not received any infection control training in the past two years and that none of the clinics had devised any official infection control policy (Mehtar*, et al.*, 2007). Only 30% of the respondents in this study knew that they had to wash their hands after removing gloves. Forty percent, 27% and 10% respectively, believed gluteraldehyde, Jik® and Dettol® possessed sterilising properties (Mehtar*, et al.*, 2007). Nemutandani *et al*. (2007) reported that 49.1% of the dental assistants in his study had been given no formal training in infection control (Nemutandani*, et al.*, 2007).

Several other studies on various aspects of infection control reported the need for further training in and knowledge about standard precautions and infection control in South Africa (Darling*, et al.*, 1992; Naidoo, 1994; Lapidus, 1995; Lapidus and Sandler, 1997; Naidoo, 1997b; Rudolph and Ogunbodede, 1999; De Kock and Van Wyk, 2001b; Dreyer and Hauman, 2001; Yengopal*, et al.*, 2001a; Naidoo and Mahommed, 2002b; Ogunbodede and Rudolph, 2002b; Oosthuysen, 2003b; Yengopal, 2003; Shisana*, et al.*, 2005a; Mehtar*, et al.*, 2007).

#### *3.2.4.2 Focus area two: Personal hygiene and care of hands*

Hand hygiene (e.g. hand washing, hand antisepsis, or surgical hand antisepsis) substantially reduces the numbers of potential pathogens on the hands and is considered the single most important procedure for reducing the risk of transmitting organisms to patients and OHCWs (CDC, 2003). In South Africa several reports of inadequate compliance to this important infection control procedure have been recorded. Taps were operated mainly by hand (84%) and only 12% by elbow or 4% by foot (Naidoo, 1997a). The water supply in public dental clinics was found to be inadequate (Rudolph and Ogunbodede, 1999). The majority of oral health care workers (83.2%) used an anti-bacterial liquid soap to wash their hands; however, a bar of soap was still the product of choice among 10.0% of respondents (Oosthuysen, 2003b). Although 86.6% of respondents acknowledged that hand washing is critical

before and after patient contact, only 21.7% were observed doing it, indicating a considerable gap between the knowledge of this procedure and the actual clinical practice (Mehtar*, et al.*, 2007). In a study conducted in the Limpopo province only 50% of dental assistants washed their hands before and after putting on gloves (Nemutandani*, et al.*, 2007). Hand basins were used not only for hand washing, but also for cleaning dental equipment and discarding body fluids, as well as being a supply of water for patients (Mehtar*, et al.*, 2007). It was found that 34.8% of oral health care workers wore jewellery while treating patients (Mehtar*, et al.*, 2007).

#### *3.2.4.3 Focus area three: Personal protective equipment*

From the results of the study conducted in 1992, it would seem that OHCPs realised the importance of the routine use of gloves, masks and protective eyewear, recording an increase of 87%, 80% and 63% to 98%, 94% and 92% respectively when they were treating a known HIV-positive patient (Darling*, et al.*, 1992). South African OHCPs cited high costs as reasons for not sustaining adherence to infection control measures (Rudolph and Ogunbodede, 1999; Ogunbodede and Rudolph, 2002a). Although private dental practitioners are charging patients for the use of barrier protection, not all were found to actually use these measures (Naidoo, 1994) or to change them between patients (Oosthuysen, 2003b).

Gloves were found not to be available at all, or in insufficient quantities, in 21.4% of clinics, to change after every patient (Rudolph and Ogunbodede, 1999). This was substantiated by Methar *et al.* (2007) where a shortage was reported in 30% of clinics (Mehtar*, et al.*, 2007).

Routine glove use was reported by 88.4%, 87% and 97.1% of respondents in three studies conducted among Durban OHCPs (Naidoo, 1994, 1997a; Yengopal*, et al.*, 2001b). Similarly Oosthuysen (2003) reported that most practitioners (88.4%) routinely wear gloves, as summarised in table 3.1. The use of gloves by the dental assistant (65.8%) did not compare favourably with that of the dental practitioner (88.4%) (Oosthuysen, 2003b). Ninety two percent of the dental assistants in the Limpopo study reported wearing gloves (Nemutandani*, et al.*, 2007).

**TABLE 3.1: Reported use of barrier protection (Oosthuysen, 2003b)**

| | Gloves % | Masks % | Protective eyewear % |
|---|---|---|---|
| **Practitioners** | | | |
| • Always | 88.4 | 83.5 | 55.0 |
| • Sometimes | 9.3 | 11.2 | 20.6 |
| • Never | 0.9 | 3.7 | 15.3 |
| • Other | 1.0 | 1.2 | 8.7 |
| • No response | 0.4 | 0.4 | 0.4 |
| **Assistants** | | | |
| • Always | 65.8 | 50.4 | 21.6 |
| • Sometimes | 28.7 | 29.0 | 23.7 |
| • Never | 3.2 | 15.4 | 50.6 |
| • Other | 1.9 | 4.3 | 3.4 |
| • No response | 0.4 | 0.9 | 0.7 |

Between 2.2% and 11.9% of OHCPs reported not changing their gloves between patients and, instead, merely washing their hands (De Kock and Van Wyk, 2001b; Oosthuysen, 2003b). Despite skin reactions to gloves being frequently reported by OHCPs (De Kock and Van Wyk, 2001b), only latex gloves were available in clinics, irrespective of the procedures to be performed or the infection control risk involved (Mehtar, *et al.*, 2007). Despite dental practitioners being aware of the necessity to wear gloves, masks and protective eyewear, the majority were found to only wear gloves (Lapidus, 1995; Lapidus and Sandler, 1997).

To maintain high filterability, masks should be replaced before they become moist, preferably every 20 minutes (Miller and Palenik, 2005). Oosthuysen (2003) found that 83.5% of practitioners wore masks, as opposed to only 50.4% of their assistants, during patient treatment. The reasons furnished for wearing masks were to prevent the transmission of respiratory infections, or in the event of patients or practitioners possibly suffering from halitosis. Only 30.4% of respondents changed their masks with every patient, meaning that masks were only replaced when visibly contaminated, soiled, wet, or stained. The frequency of changing masks varied from each patient, to every 2$^{nd}$, 3$^{rd}$, 4$^{th}$, 5$^{th}$ or 10$^{th}$ patient, morning and afternoon, daily, after four to five days or even once a week (Oosthuysen, 2003b). In 1994 Naidoo reported that 65% of practitioners wore masks (Naidoo, 1994), which is considerably less than the 83.5% reported by Oosthuysen in Table 3.2 (Oosthuysen, 2003b).

The fact that so few dental assistants are wearing masks is a cause for concern since they are exposed to the same occupational hazards as dentists and oral hygienists.

Protective eyewear not only prevents infection, but also physical injury from aerosols, spattering and accidental trauma caused by flying debris. It is therefore advisable that operators, practitioners, hygienists and assistants, as well as patients, use protective eyewear to prevent trauma and infections

(Davis and Young, 1993). Similar to the findings regarding masks, Oosthuysen (2003) reported that 15% of practitioners wore protective eyewear, while 50.6% of their assistants never did so (Table 3.1). Naidoo in 1994 reported that that 64% of dentists used protective eyewear, as opposed to the 52.9% found in a study by Yengopal *et al.* (Naidoo, 1994, 1997a; Yengopal*, et al.*, 2001b). In 2007 it was reported that 78.6% of OHCWs knew they have to wear eye protection, but observation revealed that only 17.4% were actually doing so (Mehtar*, et al.*, 2007). This does not compare well with international studies in which a 80.8% - 82% compliance was reported (Gershon*, et al.*, 1998; McCarthy*, et al.*, 1999).

**TABLE 3.2: A comparison of infection control procedures among dentists in South Africa (adapted from Yengopal, Naidoo and Chikte, 2001 (Yengopal, *et al.*, 2001a))**

| **ASPECTS SURVEYED** | Naidoo | Yengopal, Naidoo and Chikte | Oosthuysen |
|---|---|---|---|
| | (1994/5) | (1999/2000) | (2001) |
| | % | % | % |
| Routine glove use | 87 | 97.1 | 88.4 |
| Routine mask use | 65 | 82.0 | 83.5 |
| Routine eyewear use | 64 | 53.0 | 55.0 |
| Autoclave use | 68 | 89.7 | 84.5 |
| Slow speed handpiece autoclaving | 28 | 39.0 | 43.8 |
| High speed handpiece autoclaving | - | 45.6 | |
| Rubber dam use | 2 | 40.6 | 27.7 |
| Needlestick injury (previous 6 months) | 18 | 13.8 | - |
| Use of a post-exposure sharps protocol | 6 | 33.3 | - |
| Recapping needles (two-handed technique) | 74 | 84.1 | - |
| Hepatitis vaccine | 70 | 88.2 | - |
| Disinfect impressions | 4 | 53.7 | - |
| Disinfect appliances | - | 52.4 | - |
| Proper waste disposal | 75 | 95.4 | - |
| Cross-infection control for burs | 92 | 93.3 | - |
| Cross-infection control for curing light source | 76 | 91.0 | - |
| Decontaminate – | | | |
| work surfaces, | 90 | 98.5 | - |
| floor in surgery | 70 | 80.6 | - |
| Cross-infection control for 3-in-1 tips | 84 | 96.2 | - |
| Standard precautions, expensive but necessary | 68 | 52.9 | - |

Protective clothing or the wearing of a uniform has only been discussed in four studies (Rudolph and Ogunbodede, 1999; De Kock and Van Wyk, 2001b; Shisana, *et al.*, 2005a; Mehtar, *et al.*, 2007). Rudolph and Ogunbodede (1999) reported that “laundered” protective uniforms were rarely available in

dental clinics. De Kock and Van Wyk (2001) reported the use of disposable gowns to be very low (3.6%), while 42.8% of those who wore washable gowns did not remove these uniforms before leaving the surgery or clinic, thus exposing the community and family members to potentially infectious agents. Other studies support the fact that the wearing of protective clothing was inadequate (17.4%) and furthermore that these items were neither clean nor replaced regularly (Shisana*, et al.*, 2005a; Mehtar*, et al.*, 2007).

#### *3.2.4.4 Focus area four: Environmental barriers*

The constant touching of surfaces has been identified in dentistry as a special issue of concern (CDC, 2003). Furthermore, one needs to differentiate between clinical contact surfaces and general housekeeping surfaces. The clinical contact surfaces may often become contaminated with patient matter and thus present a risk for exposure and potential for disease transmission. Only one survey reported the use of protective barriers on equipment and it was found that only 23.3% of oral hygienists applied such barriers (De Kock and Van Wyk, 2001b). This could indicate a serious shortcoming to inform South African OHCWs concerning the effective and correct application of the recommended environmental barriers.

#### *3.2.4.5 Focus area five: Sterilisation*

Most instruments used during dental procedures are in contact with the oral mucosa and/or penetrate tissue. This requires that re-usable instruments be thoroughly cleaned and sterilised with standardised methods that can be routinely monitored and verified (Crawford, 1994). Dental practitioners (69%) reported that their patients expressed concerns about contracting AIDS through dental procedures and asked questions about sterilisation practices (Darling*, et al.*, 1992). Between 68% and 89.7% of respondents in three major studies reported that they autoclaved instruments (Naidoo, 1994, 1997a; Yengopal*, et al.*, 2001b; Oosthuysen, 2003a). Dry heat ovens or hot air sterilisers were used by 6%, 1% used chemical vapour and 4% used liquid sterilisation with chemicals only (Oosthuysen, 2003b). Boiling water was the method of choice among 22% of respondents (Naidoo, 1994, 1997b; Oosthuysen, 2003b). Alarming, however, is the fact that disinfection is still widely used to process critical instruments (Naidoo, 1994, 1997b; Oosthuysen, 2003b; Shisana*, et al.*, 2005a; Mehtar*, et al.*, 2007). More than 50% of respondents reported incorrect processing of equipment and instruments (De Kock and Van Wyk, 2001b); more than 10% reported not having autoclaves in public dental clinics (Rudolph and Ogunbodede, 1999); while 48.9% of respondents were not aware of the operational parameters (time, temperature and pressure) of their autoclaves (Oosthuysen, 2003b). Only 47.8% of items were

disassembled prior to disinfection and sterilisation; 24.64% of dental items were found to be contaminated with blood immediately prior to being used on patients, with 19.4% of instruments revealing visible blood and extraction forceps recording the highest counts (Shisana*, et al.*, 2005b; Mehtar*, et al.*, 2007).

Scrubbing instruments by hand has been indicated as the preferred method (55.6%) for pre-sterilisation debridement (Oosthuysen, 2003b). Although manual cleaning is simple and cheap, the time involved in cleaning instruments properly and the added risk of injury by contaminated instruments cannot be ignored. It may therefore be appropriate to encourage more practitioners to make use of automated cleaners in order to protect staff members and improve cross-infection control, as recommended by the CDC (CDC, 2003).

Sterilisation failure rates have been recorded in many countries, including the USA 15%, Norway 33%, Germany 23%, Canada 4%, Denmark 2.3% to 7.3%, and UK 2% (Burke*, et al.*, 1998), emphasising the need for regular testing of effectiveness of autoclaves. The CDC recommends that equipment should be monitored for its ability to attain all the physical parameters of the sterilisation process and should include a combination of mechanical, chemical, and biological indicators (CDC, 2003). Although the majority of respondents (70%) in the study by Oosthuysen indicated checking the effectiveness of their autoclaves, they do so by either observing gauges/lights on the autoclave only (31.2%), or by using commercially available colour changing strips/tapes (14.8%). Of the practitioners 90.9% indicated they never use biological or other tests to monitor autoclave effectiveness (Oosthuysen, 2003b). In the survey among oral hygienists only 1.8% of respondents confirmed using biological tests to monitor autoclave effectiveness (De Kock and Van Wyk, 2001b).

#### *3.2.4.6 Focus area six: Disinfection (surfaces) and housekeeping*

Environmental surfaces become contaminated with body fluids either directly or through aerosols generated by dental equipment. It is important to realise that the effectiveness of a disinfecting solution depends on various factors, including the concentration and nature of contaminating microorganisms, the concentration of the chemical, the exposure time and the amount of accumulated bioburden (Molinari*, et al.*, 1996). Although 93.8% and 83.0% of respondents indicated disinfection of working areas and handles of lights, the availability of chemicals have been indicated as a problem by 37% of respondents (Rudolph and Ogunbodede, 1999). Yengopal, *et al.* (2001) reported that rinsing with water only was the preferred method for the disinfection of appliances (60.6%) and impressions (66.7%).

Limited data are available on the use of disinfectants by South African OHCPs, which offers an opportunity for further investigation.

#### *3.2.4.7 Focus area seven: Waste management*

Knowledge of a waste management policy seems to be lacking amongst OHCWs in South Africa, as evidenced by the findings that only 26.7% of those questioned were aware that such a policy exists (Shisana*, et al.*, 2005b; Mehtar*, et al.*, 2007), 25% of respondents disposed of sharps in the normal waste (Naidoo, 1994, 1997a) and almost 50% of respondents did not have a waste disposal policy (Rudolph and Ogunbodede, 1999). Although 96% of respondents indicated immediate disposal of used needles, 15.2% employed no special waste disposal system for sharps and needles (Rudolph and Ogunbodede, 1999). Only one respondent indicated wearing gloves during handling of waste while in only 39% of cases waste was segregated according to the appropriate colour coding (Mehtar*, et al.*, 2007).

#### *3.2.4.8 Focus area eight: Dental unit waterlines, biofilms and water quality*

It was encouraging to note that 76% of respondents flushed their waterlines after treating a patient (Rudolph and Ogunbodede, 1999). In the survey of infection control procedures applied by oral hygienists, 50% reported flushing waterlines - 30 seconds after each patient and 3 minutes at the beginning and end of the working day (De Kock and Van Wyk, 2001b). Even with anti-retraction valves, flushing of devices for a minimum of 20 to 30 seconds after each patient is recommended (CDC, 2003). However, mechanical flushing alone cannot control contamination in waterlines (OSAP, 2004).

To date, no published scientific evidence confirms a serious health risk for patients or OHCPs from contact with contaminated dental water, but researchers have found pathogens such as *Pseudomonas aeruginosa*, *Legionella* and non-tuberculosis *Mycobacterium* in dental unit tubing (Szymanska, 2005). Exposing patients or personnel to water of poor microbiological quality is inconsistent with accepted infection control principles (ADA, 1999). A reason for concern is the increasing number of vulnerable patients, for example the elderly, those with chronic conditions such as diabetes, people being treated for cancer, and patients with compromised immune systems (Webber, 2000). No South African studies exist showing compliance with the various recommendations with regards to control of biofilms in the thin tubing and waterlines of the dental units and the quality of the water delivered through these systems (Mills, 2000). In addition no South African studies exist concerning the availability and use of

infection control policies and standard operating procedures in cases of "boil water alerts" (Potgieter*, et al.*, 2007) in South Africa.

#### *3.2.4.9 Special considerations*

Special considerations include: dental handpieces and other devices attached to air- and waterlines; single-use or disposable devices (including saliva ejectors; dental radiology; pre-procedural mouth rinses; the dental laboratory; *Mycobacterium tuberculosis*; Creutzfeldt-Jakob disease and other prior diseases; and vaccination of OHCPs.

Dental handpieces and other devices attached to air- and waterlines

A special area of concern in dentistry is bacterial contamination of dental handpieces and the methods applied to ensure safe application to patients after use (Bossmann, 1990; Dreyer and Hauman, 2001). The CDC recommends routine use of a heating process (after every patient) capable of sterilisation (i.e. steam under pressure or autoclaving, dry heat, or heat/chemical vapour) for all high-speed dental handpieces, low-speed handpiece components used intra-orally, and re-usable prophylaxis angles (CDC, 2003). More than half of respondents (53.0%) reported that their preferred method for recycling handpieces was wiping with or soaking in a liquid chemical disinfectant (Oosthuysen, 2003b), whereas between 28% and 39% autoclaved slow handpieces, and 43.8% and 45.6% the high speed handpieces (Naidoo, 1994, 1997a; Yengopal*, et al.*, 2001b; Oosthuysen, 2003a). Only 17% autoclaved their handpieces after every patient use (Oosthuysen, 2003b). Autoclaving handpieces is not a common procedure in South Africa and this indicates an urgent need for motivation to routinely follow this procedure (De Kock and Van Wyk, 2001b). These South African figures are extremely low when compared to international figures of 76.9% to 95% for routine heat sterilisation of handpieces (McCarthy*, et al.*, 1999). Lack of sufficient handpieces and fear of equipment failure resulting from the heat of the sterilisation process are reasons provided for a reluctance to comply (Yengopal*, et al.*, 2001a).

Dreyer and Hauman demonstrated that internal surfaces of dental handpieces become contaminated during normal dental procedures, with water-lines within the handpiece displaying the heaviest contamination, and concluded that autoclaving handpieces would possibly be the only effective way to sterilise both internal and external surfaces (Dreyer and Hauman, 2001).

In a study conducted among dentists regarding their awareness of tuberculosis (TB), Naidoo and Mahommed (2002) reported that two thirds of dentists sterilised suction and the air/water syringe tips.

This indicates a need to promote the disposal of these items as the effective sterilisation thereof is extremely difficult (Naidoo and Mahommed, 2002a).

Single-use or disposable devices (including saliva ejectors and 3-in-1 tips)

It was found that 1.5% of responding dentists re-used needles and 6.2% re-used cartridges and although these numbers are low:

*"These practices are totally unacceptable from a moral, ethical and infection control point of view".* (Yengopal*, et al.*, 2001a)

It is suggested that further observational studies and other methods be applied to assess incorrect use or compliance with the correct practices. The use of a rubber dam as an infection control practice should be promoted since it is recommended for controlling the generation of saliva contaminated aerosol (Eklund*, et al.*, 2002). Between 2% and 40.6% of dentists were found to use a rubber dam as an infection control practice (Naidoo, 1994; Yengopal*, et al.*, 2001b; Naidoo and Mahommed, 2002a).

Pre-procedural mouth rinses

The CDC lists the use of pre-procedural mouth rinses as part of standard precautions to reduce the risk of cross-infection (CDC, 2003). This can be most beneficial prior to a procedure that requires the use of a polishing cup/brush or ultrasonic scaler, because a rubber dam cannot be used in such cases to control aerosols and spatter. With the aid of a dental assistant, high volume evacuation can be utilised as an additional infection control procedure (Yengopal, 2004).

Dental radiology

No publications concerning infection control during dental radiographic procedures have been documented in South Africa.

Dental laboratory

Dentists did not disinfect impressions (46.3%) and appliances (47.6%) before sending them to the dental laboratory (Yengopal*, et al.*, 2001a). In an earlier study Niadoo reported that 96% of respondents did not disinfect impressions (Naidoo, 1994). However, rinsing with water as the preferred method for disinfection of appliances (60.6% ) and impressions (66.7%) (Yengopal*, et al.*, 2001a) does not comply with recommendations. (CDC, 2003). With regard to this aspect, in addition there seems to be a lack of effective communication and coordination between the laboratory and oral health care facility to ensure

that appropriate cleaning and disinfecting procedures are performed that appliances and prostheses delivered to the patient are free of contamination.

*Mycobacterium tuberculosis*

The prevalence rate of tuberculosis (TB) in South Africa is one of the highest in the world and accounts for 80% of all notifiable diseases in the country (Naidoo and Mahommed, 2002a). Only these authors have reported on this uniquely South African occupational hazard for OHCPs and the requirement to increase knowledge, alter attitudes and behaviour in order to prevent transmission and manage this infection in oral health care facilities.

Creutzfeldt-Jakob disease (CJD) and other prion diseases

No published data on the occurrence of this condition or presence of prions in South Africa could be found in the literature that was searched.

Sharps injuries and post-exposure management

With the particularly high prevalence rate of HIV/AIDS in South Africa (National Department of Health, 2007), the lack of use of antiretroviral agents as post exposure prophylaxis (PEP) after injuries caused by sharps is incomprehensible, complicated further by the lack of personnel capable of carrying out a proper risk assessment and counselling (Ogunbodede and Rudolph, 2002a). Many OHCPs work in remote rural areas and were only able to access PEP several days after an exposure incident - although the ideal time to start with PEP is within 2 hours of the exposure (Ogunbodede and Rudolph, 2002a). This state of affairs was confirmed in a survey in the Free State, in which only 6.7% of clinics had a sharps injury protocol at hand, although in 50% of cases staff was aware of such a protocol. Forty three percent of respondents said they were under the impression that they could receive PEP within 4 hours after a sharps incident (Shisana*, et al.*, 2005b; Mehtar*, et al.*, 2007). Of these respondents 26.6% reported a sharps injury in the past three years while administering local anaesthesia or while using two-handed re-capping of the needle (Shisana*, et al.*, 2005b; Mehtar*, et al.*, 2007). Yengopal (2001) reported that 13.8% of dentists had experienced a needle stick injury in the previous six months, with 84.1% of such dentists using the two-handed technique to recap needles. It is recommended that one never recaps a needle using both hands, nor points any sharp object at any part of the body (CDC, 2003). Two-thirds of the injured dentists did not follow any specific protocol subsequent to their injury (Yengopal*, et al.*, 2001a).

Hepatitis B vaccinations

The hepatitis B carrier rate in South Africa is very high. (Jentsch, 1997) All OHCPs and cleaners in the oral health care facility are constantly exposed to traumatised tissue, saliva and blood. Nevertheless, few studies have reported on hepatitis B immunisations among OHCPs in South Africa. Depending on antibody status, hepatitis B immunisations must be repeated every 5 years, yet Rudolph and Ogunbodede reported that almost 50% of dentists in their study had not received any hepatitis B vaccination in the previous 3 years (Rudolph and Ogunbodede, 1999). De Kock and Van Wyk (2001) reported that while only 7.1% of hygienists had never been immunised, 26.8% required a booster. Among dentists, 88% had been immunised, of which 59.1% had been given a booster. Only 38.8% of the rest of their staff were immunised (Yengopal*, et al.*, 2001a). In 2007 it was reported that 62.7% of dental assistants in the Limpopo province had not been immunised at all (Nemutandani*, et al.*, 2007). In none of the studies was the immunisation status of cleaning staff determined.

### *3.2.5 Conclusion*

Although studies on compliance with infection control guidelines exist, many aspects of this issue have not been studied. Of those which have been accorded attention to the following problem areas were identified in order to improve compliance to infection control recommendations in South Africa:

Although gloves are worn they are not replaced for every patient and hands are not washed before and after donning them. Masks are worn by most dentists, but not their assistants, and are not replaced after every patient. Protective eyewear and clothing are not worn and cleaning of uniforms seems to be a problem. Hand scrubbing of instruments is still widely used. Most practitioners use autoclaves, but 90% of them have never used a biological indicator and many still use disinfectants. Boiling water is still used to sterilise appliances and waste segregation is not undertaken correctly. Handpieces are not sterilised between all patients and single-use items are re-used. Most of the dental practitioners seem to be immunised against hepatitis B, but many do not maintain boosters and most of the dental assistants are not immunised, while no data is available regarding cleaners. Waterlines are flushed, but no data is available with regards to the quality of the water from dental units used in South Africa.

With two exceptions, all other studies among South African OHCPs relied on self-reports, and consequently these results may represent a serious overestimation of correct behaviour. Despite this possibility, even these results indicate that a considerable gap exists between what is expected and the actual clinical performance by South African oral health care providers concerning infection control recommendations. Controlling diseases and preventing infections from spreading are more crucial than

ever, and doing so is the responsibility of every member of the oral health care team. This review highlights opportunities for improvement and further research.

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### *3.2.6 References*

ADA (1999). Council on Scientific Affairs. Dental unit waterlines: approaching the year 2000. *J Am Dent Assoc,* **130**, 1653-1664.

Australian / New Zealand Standard (2006). *Office-based health care facilities - Reprocessing of reusable medical and surgical instruments and equipment, and maintenance of the associated environment*.

Bossmann, K. (1990). Hygienic maintenance of dental handpieces and turbines : clinical information. *The Journal of the Dental Association of South Africa,* **50**(9), 416-417.

British Dental Association (2003). *Infection control in dentistry. Advice sheet A12* (Vol. **Advice sheet A12**). London: BDA.

Burke, F. J. T., Coulter, W. A., Cheng, S. W., and Palenik, C. J. (1998). Autoclave performance and practitioner knowledge of autoclave use: a survey of selected UK practices. *Quintessence International,* **29**(4), 231-238.

CDC (2003). Guidelines for infection control in dental health-care settings - 2003. [Recommendations and reports]. *Morbidity and Mortality Weekly Report,* **52**(Number RR-17), 1-68.

Crawford, J. J. (1994). Infection control. In C. M. Sturdevant, T. M. Roberson, H. O. Heymann and J. R. Sturdevant (Eds.), *The art and science of operative dentistry. 3rd Edition*. St Louis: Mosby.

Darling, M., Arendorf, T., and Samaranayake, L. P. (1992). Oral care of HIV-infected patients: the knowledge and attitudes of South African dentists. *Journal of the Dental Association of South Africa,* **47**(9), 399-402.

Davis, C., and Young, N. S. (1993). Disease transmission theory and control of contamination and bloodborne pathogens. In I. R. Woodall (Ed.), *Comprehensive dental hygiene care*. Missouri: Mosby.

De Kock, K., and van Wyk, C. W. (2001). Infection control in South African oral hygiene practice. *South African Dental Journal,* **56**(12), 584-587.

Dreyer, A. G., and Hauman, C. H. J. (2001). Bacterial contamination of dental handpieces. *South African Dental Journal,* **56**(11), 510-512.

Edward-Miller, J. (1998). Measuring quality of care in South African clinics and hospitals *South African Health Review* (Vol. 51, pp. Chapter 14). Durban: Health Systems Trust.

Eklund, K. J., Bednarsh, H., and Haaland, C. O. (2002). *OSAP Interact infection control and safety training system* (Second ed.). Annapolis: OSAP.

Gershon, R. M., Karkashian, C., Vlahov, D., Grimes, M., and Spannhake, E. (1998). Correlates of infection control practices in dentistry. *America Journal of Infection Control,* **26**(1), 29-34.

Gordon, B. L., Burke, F. J., Bagg, J., Marlborough, H. S., and McHugh, E. S. (2001). Systematic review of adherence to infection control guidelines in dentistry. *J Dent,* **29**(8), 509-516.

Harfst, S. A. (1991). Personal Barrier Protection. *Dental Clinics of North America,* **35**, 357-366.

Hovius, M. (1992). Disinfection and sterilisation: the duties and responsibilities of dentists and dental hygienists. *International Dental Journal,* **42**, 241-244.

Jentsch, U. (1997). A review of opportunistic infections in Africa: current topics. *South African Journal of Epidemiology and Infection,* **12**, 28-32.

Karim, S. S. A., Thejpal, R., and Singh, B. (1989). High prevalence of Hepatitis B virus infection in rural black adults in Mseleni, South Africa. *America Journal of Public Health,* **79**(7), 893-894.

Kopsala, J. T. (2003). *Infection control in public dental care settings.* Dissertation, University of the Witwatersrand, Johannesburg.

Lapidus, A., and Sandler, M. (1997). HIV and the dental profession. *Journal of the Dental Association of South Africa,* **52**(12), 721-726.

Lapidus, A. H. (1995). *HIV and the dental profession.* Dissertation, University of the Witwatersrand, Johannesburg.

McCarthy, G. M., Koval, J. J., and MacDonald, J. K. (1999). Compliance with recommended infection control procedures among Canadian dentists: Results of a national survey. *America Journal of Infect Control,* **27**(5), 377-384.

McKay, E. (2005). *Results of a research report into HIV risk exposure of young children (2-9) to HIV in the Free State province* (Media release): Nelson Mandela Foundation.

Mehtar, S., Shisana, O., Mosala, T., and Dunbar, R. (2007). Infection control practices in public dental care services: findings from one South African Province. *Journal of Hospital Infection,* **66**, 65-70.

Miller, C. H., and Palenik, C. J. (2005). *Infection Control and Management of Hazardous Materials for the Dental Team* (Third ed.). St. Louis, Missouri: Elsevier Mosby.

Mills, S. E. (2000). The dental unit waterline controversy: defusing the myths, defining the solutions. *J Am Dent Assoc,* **131**(10), 1427-1441.

Molinari, J. A., Rosen, S., and Runnels, R. R. (1996). Heat sterilization and monitoring. In J. A. Cottone, G. T. Terezhalmy and J. A. Molinari (Eds.), *Practical infection control in dentistry, 2nd Edition* (pp. 149-160). Baltimore: Williams & Wilkins.

Naidoo, S. (1994). *Dentists and cross-infection.* Dissertation, University of the Western Cape.

Naidoo, S. (1997). Dentists and cross-infection. *The Journal of the Dental Association of South Africa,* **52**(3), 165-167.

Naidoo, S., and Mahommed, A. (2002). Knowledge, attitudes, behaviour and prevalence of TB infection among dentists in the Western Cape. *South African Dental Journal,* **57**(11), 476-478.

National Department of Health (2007). *National HIV and syphilis prevalence survey South Africa 2006: Summary report*.

Nemutandani, M. S., Yengopal, V., Rudolph, M. J., and Tsotsi, N. M. (2007). Occupational exposures among dental assistants in public health care facilities, Limpopo Province. *South African Dental Journal,* **62**(8), 348-355.

Ogunbodede, E. O., and Rudolph, M. J. (2002). Policies and protocols for preventing transmission of HIV infection in oral health care in South Africa. *South African Dental Journal,* **57**(11), 469-475.

Oosthuysen, J. (2003). *Infection control techniques used in South African dental practices.* Dissertation, Central University of Technology, Free State, Bloemfontein.

OSAP (2004). *From policy to practice: OSAP's Guide to the Guidelines*. Annapolis: Organization for Safety and Asepsis Procedures.

Potgieter, E., Hiemstra, A. H., Barnes, B. J., Wagener, P. J. C., van Oudtshoorn, L. E. v. R., and Phooko, J. S. (2007, 20-22 August 2007). *Drinking water: Microbiological monitoring and management; a case study.* Paper presented at the The Second IASTED International Conference on Water Resources Management, Honolulu, Hawaii, USA.

Rudolph, M. J., and Ogunbodede, E. O. (1999). HIV infection and oral health care in South Africa. *South African Dental Journal,* **54**(12), 594-601.

Shisana, O., Mehtar, S., Mosala, T., Zungu-Dirwayi, M., Rehle, T., Dana, P., Colvin, M., Parker, W., Connolly, C., Dunbar, R., and Gxamza, F. (2005). *HIV risk exposure in children: A study of 2–9 year-olds served by public health facilities in the Free State, South Africa*. Cape Town: Human Sciences Research Council Press.

Szymanska, J. (2005). Microbiological risk factors in dentistry. Current status of knowledge. *Ann Agric Environ Med,* **12**, 157-163.

Webber, L. M. (2000). Bloodborne viruses and occupational exposure in the dental setting. *South African Dental Journal,* **55**(9), 494-496.

World Health Organization (2008). Global tuberculosis control: surveillance, planning, financing. WHO report 2008. **WHO/HTM/TB/2008.393**.

Yengopal, V. (2003). Evidence based dentistry - some updates to help in practice. How well do dental health care workers adhere to infection control guidelines for dentistry? *South African Dental Journal,* **58**(4).

Yengopal, V. (2004). The use of essential oil mouthwashes as preprocedural rinses for infection control. *South African Dental Journal,* **59**(6), 247-248,250.

Yengopal, V., Naidoo, S., and Chikte, U. M. (2001). Infection control among dentists in private practice in Durban. *South African Dental Journal,* **56**(12), 580-584.

## 3.3 An update of compliance with infection control recommendations in South African oral health care facilities: A review of studies published between 2008 and 2013

Various strategies were followed to review and update South African information on infection control compliance in oral health care facilities. In this section, only studies published between 2008 and 2013 that are applicable to South Africa were selected as the main focus. The search terms used were "infection control," "dentistry," "dental," "compliance," and "South Africa." This review of compliance with infection control practices included the complete sphere of oral health care workers (OHCWs), namely dental practitioners, dental therapists, dental assistants, oral hygienists, dental technicians and students.

The outcome measures and criteria used were the same as for the article (3.2), as previously mentioned (Oosthuysen*, et al.*, 2010), including international infection control guidelines and recommendations (British Dental Association, 2003; Centers for Disease Control and Prevention, 2003a; Organization for Safety and Asepsis Procedures, 2004; New South Wales Health Department, 2005; Australian / New Zealand Standard, 2006; World Health Organization, 2006; American Dental Association, 2007; Department of Health United Kingdom, 2008; Kohli and Puttaiah, 2008; Rutala*, et al.*, 2008; Parkhurst and Coulter, 2009; World Health Organization, 2009c; United States Air Force, 2012).

Various electronic databases were searched, including Medline (EBSCOhost), Academic Search Premier (EBSCOhost), Science Direct, SA ePublications, SACAT, ISAP by the National Library of South Africa, NEXUS current and completed research, UCTD (Theses and Dissertations at South African universities) and the South African Dental Association's publication library for the period January 2008 till December 2013. The search produced 68 publications, of which 9 were selected due to reporting on observed or self-reported infection control compliance. Further search refinement lead to the selection of publications containing quantitative data, while those containing mere recommendations were excluded.

### *3.3.1 Focus area one: Knowledge of infectious hazards*

South African strategies for infection prevention and control are often mainly based on the unmodified, well written and evidence-based information acquired from The US Centers for Disease Control and Prevention (CDC) (Mehtar, 2008). According to Mehtar, the CDC guidelines are appropriate in the countries for which they were written, but should be modified for implementation in South Africa, to

overcome the challenges and unique conditions found here. The target participants of the Mehtar study were health care workers with little previous formal training of infection prevention and control. In this study the following problems regarding the transfer of knowledge in infection prevention and control training programmes were identified (Mehtar, 2008):

1. English is not the first language of many of the personnel and the method of instruction had to be modified to be more practical than theoretical in order for them to understand the concepts.
2. Often personnel are not computer literate and have no access to the Internet.
3. The local culture of communication is mostly verbal and relies on practical, narrated workshops with simple, visual illustrations.
4. An established career path, with consequent financial benefit, may influence personnel to participate actively - or not, if it remains lacking.

South Africa is often referred to as a low- or limited resource country, but when appropriate principles of infection prevention and control are applied, guidelines and recommendations can be successfully applied and modified to the unique South African conditions (Mehtar, 2008).

In his study, Nemutandani ascertained that in South Africa the field of infectious hazards and occupational risks has received little attention and even less publication exposure (Nemutandani, 2008). The majority of the respondents (90%) in this study had no formal training as dental assistants. Half of the respondents had not received any health care training, 22% were auxiliary nurses and 18.6% had done a distance learning correspondence course, which excluded practical clinical training. Thus, only 10% of the respondents obtained their oral health care knowledge through formal training.

### *3.3.2 Focus area two: Personal hygiene and the care of hands*

Hand hygiene has been singled out as the most important procedure for preventing transmission of diseases (Centers for Disease Control and Prevention, 2002; World Health Organization, 2006). People tend to become relaxed about things they cannot see. This is the case regarding exposure to saliva in oral health care, which is clinically misleading, as the microbial load of human saliva is extremely high (Parkhurst and Coulter, 2009; Miller and Palenik, 2010; Molinari and Harte, 2010; Samaranayake, 2012). Global initiatives to improve the efficiency and methods of personal hygiene and care of hands in general health care have been extensively promoted since 2002, during 2006 and again in 2009 (Centers for Disease Control and Prevention, 2002; World Health Organization, 2006, 2009a, 2009c, 2009b). Many of these drives were published in other health related fields as well (World Health

Organization, 2009a), but no South African studies were published at all within the period of investigation for this study.

### *3.3.3 Focus area three: Personal protective equipment*

Personal protective equipment includes the wearing of barriers such as masks, caps, protective eyewear and gloves to safeguard the most vulnerable skin areas, as well as the face, eyes and hands of OHCWs (Martin*, et al.*, 2009). A study in the Limpopo Province of South Africa revealed that in some instances the incidence of wearing of protective gear in dental clinics was low. Nemutandani (2008) indicated that more than two thirds of the dental assistants routinely wore gloves during procedures. Alarming though, is the low compliance with wearing protective eyewear while assisting (32%), making the OHCWs vulnerable to infectious agents and flying debris or other material propelled from the patient's mouth and handpieces during dental procedures. In a study in KwaZulu-Natal clinics, the health care risk waste handlers also wore inappropriate personal protective equipment that did not provide adequate protection against the hazards and risks associated with the job (Gabela and Knight, 2010).

### *3.3.4 Focus area four: Environmental barriers*

The CDC and professional dental associations recommend the application of disposable environmental barriers whenever possible on difficult to clean clinical contact surfaces (Kohn*, et al.*, 2003; Petti*, et al.*, 2012). These areas include frequently touched areas such as light handles, switches, dental radiograph equipment, dental chairside computers, reusable containers of dental materials, drawer handles, faucet handles, countertops, pens, telephones and doorknobs, which can be covered by materials such as clear plastic wrap, foil, bags, sheets, tubing, plastic-backed paper or other moisture resistant materials (Centers for Disease Control and Prevention, 2003b). No publication concerning the application of environmental barriers in oral health care has been identified in South Africa. This shortcoming to inform South African OHCWs of the effective and correct application of environmental barriers is also indicated under point 3.2.

### *3.3.5 Focus area five: Sterilisation*

Today, the public in general are more knowledgeable and more inclined to question oral health care professionals' approach to aseptic procedures and sterile techniques (US Department of Veterans Affairs, 2011; Muscarella, 2012). Most modern instruments used for oral health care procedures are

heat resistant and are classified as critical and semi-critical instruments or devices. These instruments should therefore be sterilised in an autoclave – the gold standard for sterilisation (Centers for Disease Control and Prevention, 2003b; Rutala*, et al.*, 2008). Oral health care providers must ensure that these procedures are consistently executed; even more so where the 8109, 8110 and 8327 fees for infection control and sterile instrumentation are charged. In South Africa, Postma *et al.* (2011) reported about HPCSA complaints against various dental therapists who were charged and found guilty of misconduct regarding poor infection control, representing 8% of the cases against the profession (Postma*, et al.*, 2011). The implications of such cases can have far reaching consequences for any oral health care facility or individual involved. The costs involved in such charges can reach far beyond the fines and penalties. Where there is risk of disease transmission or injury involved, the costs and penalties could easily extend into millions.

### *3.3.6 Focus area six: Disinfection (surfaces) and housekeeping*

Limited data are available on the use of disinfectants by South African oral health care providers, which offers an opportunity for further investigation. The aerosols generated during oral health care procedures can stay suspended in the air for days and have the capacity to spread throughout the working environment (Bennett*, et al.*, 2000), thus posing a potential risk to both clinical and non-clinical personnel and patients. The first South African study conducted on housekeeping and the most important characteristics of oral health care facilities, reported high endotoxin exposure levels in the work environment (Singh and Mabe, 2009; Singh*, et al.*, 2010). Of particular concern in the Singh study were dental units and aging buildings, where endotoxin levels were measured in increased levels (Singh*, et al.*, 2010).

### *3.3.7 Focus area seven: Waste management*

The five categories of health care waste (HCW), namely general waste; infectious or sharps; pathological waste; and pharmaceutical waste was investigated in the clinics of a rural health district in KwaZulu-Natal during a health care waste management study (Gabela and Knight, 2010). The waste categories in this study correlate with the health care risk waste (HCRW) generated and associated with oral health care facilities in general (SABS, 2004; Republic of South Africa, 2012b). Similar to other heath care facilities,(Oosthuysen*, et al.*, 2009), the improper sorting or segregation, safe transporting and management of HCW are problems that were identified and occurred on most sites (Gabela and Knight, 2010). The personal protective equipment worn by the waste handlers were also inappropriate to the risk involved in executing their duties. This study also reported that health care personnel members transported

their HCRW with other goods and passengers in vehicles driven by people who were not trained, equipped or registered to deal with the hazardous waste, generated in health care facilities (Gabela and Knight, 2010). The study concluded that various elements, including waste segregation, the use of appropriate personal protective equipment as well as the safe transport and disposal of HCRW needs to be communicated and enforced more widely. Further investigation and education on HCRW management in oral health care facilities needs to be promoted in particular.

### *3.3.8 Focus area eight: Dental unit waterlines, biofilms and water quality*

After the release of the 2012 Blue Drop report during the Water Institute of Southern Africa Conference at the Cape Town International Convention, it was stated that the quality of South Africa's drinking water remains among the best in the world (BuaNews, 2012; Wright*, et al.*, 2012). Of concern grave though, are the reports of problems with municipal water quality system maintenance and high nitrate, coliforms and *Escherichia coli* (E. coli) counts (Potgieter*, et al.*, 2007; Esterhuizen*, et al.*, 2012). In the previous literature review (2.2), Oosthuysen *et.al.,* (2010) reported on the lack of South African infection control policies and standard operating procedures in cases of "boil water alerts" (Oosthuysen*, et al.*, 2010). These type of alerts may be applicable to all oral health care facilities in South Africa, that depend on a safe municipal water supply for dental units, hand washing, patient rinsing and instrument cleaning. Apart from these concerns, one published scientific case study of a dental receptionist diagnosed with Legionnaires' disease in South Africa confirms the serious health risk for patients and oral health care workers, posed by contaminated dental water (Chikte*, et al.*, 2011). The results of this study suggest that further research be conducted re dental unit waterlines, biofilms and water quality in South Africa.

### *3.3.9 Special considerations*

Special considerations include the hygiene of dental handpieces and other devices attached to air- and waterlines; the use of single-use or disposable devices (including saliva ejectors); pre-procedural mouth rinses; dental radiology; the practices conducted in the dental laboratory; the risk of *Mycobacterium tuberculosis*, Creutzfeldt-Jakob disease and other prior diseases; the possibility of sharps injuries and post-exposure management and vaccinations of OHCWs. In South Africa, since 2008, no new data has been reported regarding dental handpieces and other devices attached to air- and waterlines; the use of single-use or disposable devices; the incidence of Creutzfeldt-Jakob disease or any other prior diseases. There has been some new information made available on the following subjects, however.

Pre-procedural mouth rinses

An informative study discussed the antifungal effect of mouth rinses on oral Candida counts and salivary flow in treatment-naïve HIV-infected patients (Patel*, et al.*, 2008). Further research in the area of pre-procedural mouth rinses is suggested, as it can significantly contribute to the reduction in infection risks and the viable microbial content of aerosols produced during oral health care procedures (Reddy*, et al.*, 2012).

Dental laboratory

Dimensional instability and difficulty in disinfecting irreversible hydrocolloid impressions are some of the challenges oral health care workers and dental technicians have to overcome when handling saliva contaminated impressions and trays. The use of chlorite disinfectant products such as Presept® or Aseptrol®, have been investigated and are suggested as ideal for disinfection of alginate impressions, particularly because of its rapid action time (Rweyendela*, et al.*, 2009).

*Mycobacterium tuberculosis*

The prevalence rate of tuberculosis (TB) in South Africa is one of the highest in the world (Edginton and Naidoo, 2007; World Health Organization, 2008b; Reddy and Naidoo, 2010; Wood*, et al.*, 2010; Sissolak*, et al.*, 2011). In addition to that, health care providers in South Africa are challenged with the complex and difficult task of managing mono-and poly-resistant TB, multi-drug-resistant (MDR)- and extensively-drug-resistant (EDR)-TB patients. As previously stated, South African guidelines and policies need to be modified to accommodate the country's unique conditions and circumstances (Mehtar, 2008). Inconsistent methods of infection prevention and control have been reported as an added risk for transmission of these diseases, in particular in areas where there is a concentration of patients, such as in public health clinics or training institutions (Sissolak*, et al.*, 2010; Sissolak*, et al.*, 2011). The risk for transfer of these diseases to other patients, and to the health care workers who provide care to them, is high. Limitation in environmental- or engineering controls, and the shortage of other resources in South Africa are challenges that have to be overcome when applying infection prevention and control precautions, unlike in countries such as the USA or UK, (Mehtar, 2008). Further research on clinical practices in oral health care facilities is suggested.

Sharps injuries and post-exposure management

Nemutandani (2008) reported on the incidence of occupational exposure (78.4%) and sharp injuries (83%) among dental assistants in Limpopo dental clinics. The author stated that the lack of formal or other structured training of dental assistants increased their risk 9.9 times when compared to those of the semi-trained auxiliary nurses. This may be a leading cause of injury of dental assistants. It has also

been reported that two-thirds of the respondents were injured when removing and or cleaning instruments, while 65.3% had injuries resulting from direct punctures (Nemutandani, 2008). This study highlights additional contributing factors can be attributed to the injuries of dental assistants due to the fact that they were understaffed and had increased workloads.

When it comes to post-exposure management, many dental assistants (23%) failed to report exposures and injuries (Nemutandani, 2008). Of those who had reported the incidents, a significant high percentage were only provided with wound cleaning (83%), while a small percentage (23.8%) were placed on antiretroviral agents as post exposure prophylaxis (Nemutandani, 2008). Half of the responding group, who handled or transported health care risk waste, including sharps, were unaware of the possibility of any particular post exposure prophylaxis management or treatment (Gabela and Knight, 2010).

Hepatitis B vaccinations

In 2007 it was reported that 62.7% of dental assistants in the Limpopo province had not been immunised at all. (Nemutandani*, et al.*, 2007) In none of the studies the immunisation status of cleaning staff was determined.

## 3.4 Legal and ethical obligations for infection prevention and control under which oral health care is conducted in South Africa

The discussions and literature reviewed under point 3.1 and 3.2 excluded any legislative documentation regarding infection prevention and control. The South African political landscape has undergone many changes in the post-apartheid era, earmarked by an important period of transformation, that is also present in the South African health system (Department of Health Republic of South Africa, 2011a). In the context of infection prevention and control policy, the South African legislative framework is largely based on existing legislation, policies, guidelines and protocols.

In the following section, legal and ethical obligations for infection prevention and control practice, under which oral health care in South Africa is conducted, will be reviewed covering the period up to 2013.

Crucial changes to improve the critical health care outcomes and to meet the citizens' expectations of good quality care have been initiated by the South African government of the day (Department of Health Republic of South Africa, 2011c). Secondly, meeting global outcomes as linked to the Millennium Development Goals (United Nations, 2011) is another governmental goal.

The White Paper for the transformation of the Health System in South Africa and The White Paper on Transforming Public Service Delivery, also known as the Batho Pele paper, were both published in 1997 (Republic of South Africa, 1997). The White Paper for the transformation of the Health System contains 21 chapters and provides for the goals and objectives of the health sector, including infection control, in the minimum package for oral health. The White Paper on Transforming Public Service Delivery lists eight principles of Batho Pele, meaning *"People First",* that also has implications in the delivery of safe health care practices.

Currently on the forefront is the new initiative from parliament and the National Department of Health of a national drive to improve the quality of health care by way of National Core Standards. These new Standards call on leadership in the health sector to facilitate initiative and change to improve services in the health sector. The National Core Standards for health establishments are part of the development of a new regulatory framework within health care. This regulatory framework for health service, including governance and care, has been designed and tested to ensure that the health, safety and welfare of patients who use health care facilities and the personnel working in these facilities are protected. The legal context of the National Core Standards for the health sector is the National Health Act, 61 of 2003, which promotes good quality health services, health care standards, and authorises a new Office of Standards Compliance, which were scheduled to be established in 2013. It would be expected from all health care facilities in South Africa, including oral health care facilities, to ensure compliance with these standards.

### *3.4.1 Legislation applicable for infection prevention and control in oral health care*

Constitution of the Republic of South Africa Act, 108 of 1996

Pertinent sections in the South African Constitution provides for the right of free access to oral health care facilities (Republic of South Africa, 1996). Section 24 affords everyone the right to a daily living and working environment that is not harmful to his / her health or well-being. The Constitution provides the foundation for regulation and policy of environments for patients who are visiting oral health care facilities, or are in need of oral health care services, as well as for the occupational environments of workers providing these services in South Africa.

National Health Act, 61 of 2003 and the National Health Amendment Bill, 24 of 2011

This Act provides for a transformed national health system for the entire Republic of South Africa (Republic of South Africa, 2003). The National Health Act, 61 of 2003, emphasises the need to foster

good quality health services. It defines the role of advising on health standards, revising or setting standards, monitoring compliance, reporting non-compliance, and advising on strategies to improve quality.

Amendments to aspects of the National Health Act, the National Health Amendment Bill, 2008, relates to quality and compliance, and seeks to align the legislative framework of the National Health Act, 61 of 2003 in the direction of effective infection prevention and control policy (Republic of South Africa, 2011a). The Bill provides for the establishment of an Office of Health Standards Compliance, as dictated by the National Core Standards, including routine inspections and audits to determine compliance or non-compliance with policy. The inspections and audits are to be conducted in all health care settings, including oral health care facilities.

Health Professions Act, 56 of 1974, as amended

This Act provides for the regulation of health professions, including medical practitioners, dentists, dental therapists, oral hygienists, dental assistants and other related health professionals. It also regulates community service by the mentioned medical and dental professionals (Republic of South Africa, 1974).

National Environmental Management Waste Act, No. 59 of 2008

Environmental management involves people's quality of life and the safety of their daily living and working environments. The National Environmental Management Waste Act reforms law regulating waste management, and for the first time provides a legislative framework addressing all the steps in the waste hierarchy (Republic of South Africa, 2009). Oral health care facilities conform to the same categories of waste generated by other health care establishments. Provision is made for the regulations of Health Care Risk Waste Management in Notice 452 of 1 June 2012 (Republic of South Africa, 2012a). The categories of waste are classified in Waste Classification and Management Regulations No. 35572, Notice 614 of 2012 (Republic of South Africa, 2012b).

Environment Conservation Act, 73 of 1989

All wastes containing hazardous biological agents that can cause exposure to disease may only be disposed of on sites specifically designed for this purpose. This Act also provides for oral health care facilities, with the implication that everything that has been contaminated with saliva or blood must be disposed of in health care risk waste containers that must be incinerated. This includes all masks, gloves and other dental products that have been used during oral health care procedures.

Human Tissue Act, 65 of 1983

This Act provides for the administration of matters pertaining to human tissue. In oral health care it makes provision for the handling and disposal of extracted teeth, include extractions and disposal during institutional practical training sessions and demonstrations. A specific area of concern includes teeth containing amalgam restorations (Centers for Disease Control and Prevention, 2003b). These teeth should be disposed of in containers that must not be incinerated.

Compensation for Occupational injuries and Diseases Act, 130 of 1993

This Act provides for compensation when employees working in any oral health care facility, are disabled or injured as a result of occupational injuries or diseases sustained, or death resulting from these injuries or diseases. If an employee contracts an infectious disease and the origin can traced back to the oral health care facility, the employer can be held responsible under the stipulations of this Act (Republic of South Africa, 1993a).

Basic Conditions of Employment Act, 75 of 1997

This Act provides for the minimum conditions of employment that employers must comply with in workplaces. In oral health care facilities, it also relates to unfair discrimination against any employee infected or affected by disease.

Occupational Health and Safety Act, 85 of 1993 and the Occupational Health and Safety Amendment Act, 181 of 1993

This Act requires from employers to create a safe environment for employees in the workplace (Republic of South Africa, 1993b). In oral health care facilities, the Occupational Health and Safety Act, in itself, goes a long way towards ensuring effective implementation of infection prevention and control measures. Section 8.1 obliges the employer to provide, as far as is reasonably practicable, a safe working environment. This includes the provision of personal protective equipment that must be worn during oral health care procedures, and other duties in oral health care facilities. Appropriate personal protective equipment for the duties that are to be executed, must be provided free of charge to the employer. These would include, at a minimum, masks, protective eyewear, gloves and protective clothing. Section 13 of the act imposes a duty on every employer, as far as is reasonably practicable, to inform every employee about the hazards attached to his work that can impose on his health and safety. It is the duty of every employee to follow the instructions of the employer and familiarise themselves with the precautionary measures to be taken with respect to the hazards associated with oral health care.

*R 1390: Regulations for hazardous biological agents*

Government Notice R1390 of 27 December 2001 on Hazardous Biological Agents Regulations, promulgated under Section 43 of the Occupational Health and Safety Act, No 85 of 1993, regulates the exposure of employees to hazardous biological agents in the workplace (Republic of South Africa, 2001). Every employee should familiarise themselves with the precautionary measures to be taken with respect to the specific biological hazards associated with providing oral health care in their facility.

*R 1591: Regulations for* vessels under pressure

Government Notice R1591 of 4 October 1996, Vessels under Pressure Regulations, promulgated under Section 43 of the Occupational Health and Safety Act, No 85 of 1993, regulates the exposure of employees to boilers or any other vessels, including autoclaves or other sterilisers. Every oral health care employee should familiarise themselves with the precautionary measures to be taken in respect of the specific vessels generating pressure in their workplace, for example autoclaves and pasteurisers.

Hazardous Substances Act, No. 15 of 1973

This Act provides for the control of substances which may cause injury or ill-health, resulting from toxic, corrosive, irritant, strong sensitising agents, e.g. disinfectants or chemical sterilants, or the flammable nature of products used in the oral health care facility, such as 70% alcohol.

*R 1179: Hazardous Chemical Substances Regulations of 1995*

This Regulation provides for the identification of risks, handling of hazardous chemical substances, wearing of appropriate protective equipment and control of exposure to these substances. During infection prevention and control practice in oral health care facilities, employees are often exposed to chemicals, including decontamination or cleaning products, disinfectants or sterilants. A product such as one that contains activated glutaraldehyde should be handled with caution to prevent inhalation and prevent subsequent respiratory problems.

Skills Development Act, 97 of 1998

This Act provides for the measures that employers need to take for training and the personal development of employees in the workplace. This aims to improve the levels of employee skill. The risks and hazards associated with infection prevention and control in oral health care facilities has been identified as an area in dire need of training and development. Application of this Act obliges the employer to provide at least annual training for all new personnel members, as well as when any new product or equipment is implemented.

Consumer Protection Act 68, 32186 of 2008

This Act provides for the relationship between a consumer on the one hand, and a supplier of goods or services on the other. Oral health care providers are considered to be suppliers of services (oral health care treatment) to patients, and suppliers of products, as they provide oral devices and / or materials in the course of, or for the purposes of patient treatment. Patients are considered to be consumers and this Act will thus apply to oral health care providers in its full context.

### *3.4.2 Published standards and guidance for infection prevention and control*

Policy on Quality in Health Care for South Africa

This policy provides strategic direction in health facilities, and thus can be applied in oral health care facilities to assure quality oral health care services. It furthermore advocates for the continuous improvement of the care being provided. Infection prevention and control is part and parcel of each intervention with any patient in the oral health care setting.

Occupational Health and Safety Policy for the National Department of Health, February 2008

The purpose of this policy is to, in accordance with the Occupational Health and Safety Act, establish minimum standards and requirements of occupational health and safety. It is relevant to oral health care facilities in identifying hazards and possible risks that can cause incidents and accidents, and for setting standards of practice, procedures and accountability, measuring performance against standards, evaluating compliance with standards, correcting deficiencies, and deviations. It also sets standards for procedures to be followed, creating and maintaining a healthy and a safe work environment. Unfortunately, no specific audit-feedback instrument is available for application of this policy in oral health care facilities.

Key aspects of HIV / AIDS and Employment Regulation

Employers should include the Code of Good Practice on key aspects of HIV / AIDS and Employment Regulation in their orientation and training programmes for new oral health care employees. The prevalence of HIV and AIDS among South African health care workers was already reported to be high in 2004, varying between 15.7% and 20.3%, depending on age (Shisana*, et al.*, 2004). This code sets out guidelines for employers, public and private oral health care faculties, and trade unions for the implementation and management of infected and affected workers. With this Code, any unfair discrimination against employees infected or affected by HIV and AIDS in the workplace can be prevented. The principles of the Code may further be generalised to other communicable and non-communicable diseases. Employment regulations with regard to absenteeism from work, exclusion from

duty and restriction from patient contact (Centers for Disease Control and Prevention, 2003b) should be communicated to all clinical and non-clinical oral care personnel.

## 3.5 Conclusion

From this review, it has become clear that infection prevention and control is not a priority at all in the oral health care fraternity in South Africa. Only a few publications on the topic of compliance with infection prevention and control guidelines are available, as are recommendations in South African oral health care facilities. Of those, only four were publicised in the South African Dental Journal (Hartshorne, 2010).

The limited number of formal research studies and reports provides indication that infection prevention and control in oral health care facilities needs to be prioritised and disseminated as policy documents and other regulations. The problem is complicated further in that compliance with existing infection prevention and control policy is not sufficiently high - many shortcomings still exist. These shortcomings will continue to exist until a method can be developed to measure compliance with well written infection prevention and control recommendations, forming guidelines for oral health care facilities. One way in which this can be achieved is by means of a structured audit- and feedback instrument. This will provide an opportunity to accept responsibility, through comparison and interpretation of audit-feedback results in South African oral health care facilities and to address shortcomings of compliance with infection prevention and control guidelines.

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## 3.6 References

ADA (1999). Council on Scientific Affairs. Dental unit waterlines: approaching the year 2000. *Journal of the American Dental Association,* **130**, 1653-1664.

American Dental Association (2007). New Guidelines from the American Dental Association and the American Heart Association: Evidence weighs against use of antibiotics before dental procedures to prevent infective endocarditis. *Dispatch*.

Australian/NewZealandStandard (2006). *Office-based health care facilities - Reprocessing of reusable medical and surgical instruments and equipment, and maintenance of the associated environment*.

Bennett, A. M., Fulford, M. R., Walker, J. T., Bradshaw, D. J., Martin, M. V., and Marsh, P. D. (2000). Microbial aerosols in general dental practice. *British Dental Journal,* **189**(12), 664-667.

Bossmann, K. (1990). Hygienic maintenance of dental handpieces and turbines: Clinical information. *The Journal of the Dental Association of South Africa,* **50**(9), 416-417.

British Dental Association (2003). *Infection control in dentistry. Advice sheet A12 of the British Dental Association*. London: British Dental Association.

BuaNews (2012). South Africa's tap water 'world-class'. Retrieved 12 January, 2013, from http://www.southafrica.info/services/health/water-080512.htm#.UPBr3awsbbg.

Burke, F. J. T., Coulter, W. A., Cheng, S. W., and Palenik, C. J. (1998). Autoclave performance and practitioner knowledge of autoclave use: a survey of selected UK practices. *Quintessence International,* **29**(4), 231-238.

CDC (2003). Guidelines for infection control in dental health-care settings - 2003. [Recommendations and reports]. *Morbidity and Mortality Weekly Report,* **52**(Number RR-17), 1-68.

Centers for Disease Control and Prevention (2002). Guideline for hand hygiene in health-care settings. *Morbidity and Mortality Weekly Report,* **51**(RR-16).

Centers for Disease Control and Prevention (2003a). Guidelines for environmental infection control in health-care facilities: recommendations of CDC and the Healthcare Infection Control Practices Advisory Committee (HICPAC). *Morbidity and Mortality Weekly Report,* **52**(No. RR-10).

Centers for Disease Control and Prevention (2003b). Guidelines for infection control in dental health-care settings - 2003. [Recommendations and reports]. *Morbidity and Mortality Weekly Report,* **52**(Number RR-17), 1-68.

Chikte, U. M., Khondowe, O., and Gildenhuys, I. (2011). A case study of a dental receptionist diagnosed with Legionnaires' disease. *South African Dental Journal,* **66**(6), 284-287.

Crawford, J. J. (1994). Infection control. In C. M. Sturdevant, T. M. Roberson, H. O. Heymann and J. R. Sturdevant (Eds.), *The art and science of operative dentistry. 3rd Edition*. St Louis: Mosby.

Darling, M., Arendorf, T., and Samaranayake, L. P. (1992). Oral care of HIV-infected patients: the knowledge and attitudes of South African dentists. *Journal of the Dental Association of South Africa,* **47**(9), 399-402.

Davis, C., and Young, N. S. (1993). Disease transmission theory and control of contamination and bloodborne pathogens. In I. R. Woodall (Ed.), *Comprehensive dental hygiene care*. Missouri: Mosby.

De Kock, K., and van Wyk, C. W. (2001a). Infection control in South African oral hygiene practice. *South African Dental Journal,* **56**(12), 584-587.

De Kock, K., and Van Wyk, C. W. (2001b). Infection control in South African oral hygiene practice. *South African Dental Journal,* **56**(12), 584-587.

Department of Health Republic of South Africa (2010). *Department of Health Strategic Plan 2010/11-2012/13 South Africa*. from http://www.doh.gov.za.

Department of Health Republic of South Africa (2011a). *The HRH Strategy for the Health Sector: Human Resources for Health South Africa, Department of Health*.

Department of Health Republic of South Africa (2011b). *Human resources for health South Africa. The HRH Strategy for the Health Sector: 2012/13 – 2016/17* from http://www.doh.gov.za/docs/stratdocs/2011/hrh_strategy.pdf.

Department of Health Republic of South Africa (2011c). *National Core Standards for Health Establishments in South Africa; "Towards quality care for patients".* Retrieved 6 October 2012. from http://www.sarrahsouthafrica.org/DOCUMENTS/NationalQualityAssuranceDocuments.aspx.

Department of Health United Kingdom (2008). Health Technical Memorandum 01-05 Decontamination in primary care dental practices. *Health Technical Memorandum 01-05*(Oct 2008), 1-60.

Dreyer, A. G., and Hauman, C. H. J. (2001). Bacterial contamination of dental handpieces. *South African Dental Journal,* **56**(11), 510-512.

Edginton, M., and Naidoo, S. (2007). Tuberculosis: a deepening crisis in South Africa. Editorial. *The South African Journal of Epidemiology and Infection,* **22**(2, 3), 37-38.

Edward-Miller, J. (1998). Measuring quality of care in South African clinics and hospitals *South African Health Review* (Vol. 51, pp. Chapter 14). Durban: Health Systems Trust.

Eklund, K. J., Bednarsh, H., and Haaland, C. O. (2002). *OSAP Interact infection control and safety training system* (Second ed.). Annapolis: OSAP.

Esterhuizen, L., Fossey, A., and Lues, J. F. R. (2012). Dairy farm borehole water quality in the greater Mangaung region of the Free State Province, South Africa. *Water SA,* **38**(5), 803-806.

Gabela, S. D., and Knight, S. E. (2010). Healthcare waste management in clinics in a rural health district in KwaZulu-Natal. *South African Journal of Epidemiological Infections,* **25**(1), 19-21.

Gershon, R. M., Karkashian, C., Vlahov, D., Grimes, M., and Spannhake, E. (1998). Correlates of infection control practices in dentistry. *American Journal of Infection Control,* **26**(1), 29-34.

Gilbert, L. (1996). Urban violence and health – South Africa. *Social Science and Medicine*, 873-886.

Gordon, B. L., Burke, F. J., Bagg, J., Marlborough, H. S., and McHugh, E. S. (2001). Systematic review of adherence to infection control guidelines in dentistry. *J Dent,* **29**(8), 509-516.

Harfst, S. A. (1991). Personal Barrier Protection. *Dental Clinics of North America,* **35**, 357-366.

Hartshorne, J. (2010). Contaminated dentistry and infection control standards of care. *International Dentistry South Africa,* **12**(6), 46-50.

Health, N. D. o. (2007). *National HIV and syphilis prevalence survey National Department of Health, South Africa 2006: Summary report*.

Hovius, M. (1992). Disinfection and sterilisation: the duties and responsibilities of dentists and dental hygienists. *International Dental Journal,* **42**, 241-244.

Jentsch, U. (1997). A review of opportunistic infections in Africa: current topics. *South African Journal of Epidemiology and Infection,* **12**, 28-32.

Karim, S. S. A., Thejpal, R., and Singh, B. (1989). High prevalence of Hepatitis B virus infection in rural black adults in Mseleni, South Africa. *American Journal of Public Health,* **79**(7), 893-894.

Kohli, A., and Puttaiah, R. (2008). *Dental infection control and occupational safety for oral health professionals*. New Delhi, India: Thompson Printers.

Kohn, W. G., Collins, A. S., Cleveland, J. L., Harte, J. A., Eklund, K. J., and Malvitz, D. M. (2003). Centers for Disease Control and Prevention (CDC). Guidelines for infection control in dental health-care settings - 2003. *Morbidity and Mortality Weekly Report,* **52**(RR-17), 1-61.

Kopsala, J. T. (2003). *Infection control in public dental care settings.* Dissertation, University of the Witwatersrand, Johannesburg.

Lapidus, A., and Sandler, M. (1997). HIV and the dental profession. *Journal of the Dental Association of South Africa,* **52**(12), 721-726.

Lapidus, A. H. (1995). *HIV and the dental profession.* Dissertation, University of the Witwatersrand, Johannesburg.

Martin, M. V., Fulford, M. R., and Preston, A. J. (2009). *Quintessentials of Dental Practice, Clinical Practice Number 3. Infection control for the dental team.* (Vol. **39**). London: Quintessence Publishing Co. Ltd.

Mayaphi, S. H., Rossouw, T. M., Masemola, D. P., Olorunju, S. A. S., Mphahlele, M. J., and Martin, D. J. (2012). HBV/HIV co-infection: The dynamics of HBV in South African patients with AIDS. *South African Medical Journal,* **102**(3), 157-162.

McCarthy, G. M., Koval, J. J., and MacDonald, J. K. (1999). Compliance with recommended infection control procedures among Canadian dentists: Results of a national survey. *American Journal of Infection Control,* **27**(5), 377-384.

McKay, E. (2005). *Results of a research report into HIV risk exposure of young children (2-9) to HIV in the Free State province* (Media release): Nelson Mandela Foundation.

Mehtar, S. (2008). Lowbury Lecture 2007: infection prevention and control strategies for tuberculosis in developing countries and lessons learnt from Africa. *Journal of Hospital Infection,* **69**(4), 321-327.

Mehtar, S., Shisana, O., Mosala, T., and Dunbar, R. (2007). Infection control practices in public dental care services: findings from one South African Province. *Journal of Hospital Infection,* **66**, 65-70.

Miller, C. H., and Palenik, C. J. (2005). *Infection Control and Management of Hazardous Materials for the Dental Team* (Third ed.). St. Louis, Missouri: Elsevier Mosby.

Miller, C. H., and Palenik, C. J. (Eds.). (2010). *Infection Control and Management of Hazardous Materials for the Dental Team* (Fourth ed.). St. Louis, Missouri: Elsevier Mosby.

Mills, S. E. (2000). The dental unit waterline controversy: defusing the myths, defining the solutions. *Journal of the America Dental Association,* **131**(10), 1427-1441.

Molinari, J. A., and Harte, J. A. (2010). *Cottone's Practical infection control in dentistry* (Third ed.). Baltimore, Philadelphia: Lippincott, Williams and Wilkens, a Wolters Kluwer business.

Molinari, J. A., Rosen, S., and Runnels, R. R. (1996). Heat sterilization and monitoring. In J. A. Cottone, G. T. Terezhalmy and J. A. Molinari (Eds.), *Practical infection control in dentistry, 2nd Edition* (pp. 149-160). Baltimore: Williams & Wilkins.

Muscarella, L. F. (2012). Medical errors, infection-control breaches and the use of adulterated and misbranded medical devices. *World Journal of Clinical Infectious Diseases,* **2**(2), 13-27.

Naidoo, S. (1994). *Dentists and cross-infection.* Dissertation, University of the Western Cape.

Naidoo, S. (1997a). Dentists and cross-infection. *The Journal of the Dental Association of South Africa,* **52**(3), 165-167.

Naidoo, S. (1997b). Dentists and cross-infection. *Journal of the Dental Association of South Africa,* **52**(3), 165-167.

Naidoo, S., and Mahommed, A. (2002a). Knowledge, attitudes, behaviour and prevalence of TB infection among dentists in the Western Cape. *South African Dental Journal,* **57**(11), 476-478.

Naidoo, S., and Mahommed, A. (2002b). Knowledge, attitudes, behaviour and prevalence of TB infection among dentists in the Western Cape. *Journal of the Dental Association of South Africa,* **57**, 476-478.

NationalDepartmentofHealth (2007). *National HIV and syphilis prevalence survey South Africa 2006: Summary report*.

Nemutandani, M. S. (2008). *Occupational exposures among dental assistants in Limpopo dental clinics.* University of Witwatersrand Johannesburg.

Nemutandani, M. S., Yengopal, V., Rudolph, M. J., and Tsotsi, N. M. (2007). Occupational exposures among dental assistants in public health care facilities, Limpopo Province. *South African Dental Journal,* **62**(8), 348-355.

New South Wales Health Department (2005). Infection control guidelines for oral health care settings. *Centre for Oral Health Strategy New South Wales Health Department Infection Control Policy*(October 2002).

Ogunbodede, E. O., and Rudolph, M. J. (2002a). Policies and protocols for preventing transmission of HIV infection in oral health care in South Africa. *South African Dental Journal,* **57**(11), 469-475.

Ogunbodede, E. O., and Rudolph, M. J. (2002b). Policies and protocols for preventing transmission of HIV infection in oral health care in South Africa. *South African Dental Journal,* **57**(11), 469-475.

Oosthuysen, J. (2003a). *Infection control techniques used in South African dental practices.* Dissertation, Central University of Technology, Free State, Bloemfontein.

Oosthuysen, J. (2003b). *Infection control techniques used in South African dental practices. Thesis MTech: Biomedical Technology.* Central University of Technology, Free State, Bloemfontein.

Oosthuysen, J., Potgieter, E., and Blignaut, E. (2009, 11-14 July 2009). *Compliance to infection control recommendations among South African Dentists.* Paper presented at the Organization for Safety & Asepsis Procedures (OSAP) 2009 Annual Symposium Plano, Dallas, Texas, USA.

Oosthuysen, J., Potgieter, E., and Blignaut, E. (2010). Compliance with infection control recommendations in South African dental practices: a review of studies published between 1990 and 2007. *International Dental Journal,* **60**(3), 181–189.

Organization for Safety and Asepsis Procedures (2004). *From policy to practice: OSAP's Guide to the Guidelines*. Annapolis: Organization for Safety and Asepsis Procedures.

OSAP (2004). *From policy to practice: OSAP's Guide to the Guidelines*: OSAP.

Parkhurst, C. L., and Coulter, W. A. (2009). *Basic guide to infection prevention and control in dentistry* (First ed.). West Sussex, United Kingdom: John Wiley and Sons Ltd.

Patel, M., Shackleton, J., Coogan, M. M., and Galpin, J. (2008). Antifungal effect of mouth rinses on oral Candida counts and salivary flow in treatment-naïve HIV-infected patients. *AIDS patient care and STDs,* **22**(8), 613-618.

Petti, S., Polimeni, A., and Dancer, S. J. (2012). Effect of disposable barriers, disinfection, and cleaning on controlling methicillin-resistant Staphylococcus aureus environmental contamination. *American Journal of Infection Control,* **21**(09), 1-5.

Postma, T. C., Van Wyk, P. J., Heymans, J. H. W., J.G., and Prinsloo, P. M. (2011). An analysis of complaints against oral health professionals charged with misconduct at the HPCSA : 2004-2009. *South African Dental Journal,* **66**(9), 420-425.

Potgieter, E., Hiemstra, A. H., Barnes, B. J., Wagener, P. J. C., van Oudtshoorn, L. E. v. R., and Phooko, J. S. (2007, 20-22 August 2007). *Drinking water: Microbiological monitoring and management; a case study.* Paper presented at the The Second IASTED International Conference on Water Resources Management, Honolulu, Hawaii, USA.

Reddy, M., and Naidoo, S. (2010). A review of the epidemiology and an update of infection control recommendations. *South African Dental Journal, 65*(10), 262-269. Retrieved from http://www.sada.co.za/modules.php?name=News&file=article&sid=1372.

Reddy, S., Prasad, M., Kaul, S., Satish, K., Kakarala, S., and Bhowmik, N. (2012). Efficacy of 0.2% tempered chlorhexidine as a pre-procedural mouth rinse: A clinical study. *Journal of the Indian Society of Periodontology,* **2012**(16), 213-217.

Republic of South Africa (1974). Health Professions Act of the Republic of South Africa Number 56.

Republic of South Africa (1993a). Compensation for Occupational Injuries and Diseases Act of the Republic of South Africa, Number 130.

Republic of South Africa (1993b). Occupational Health and Safety Act of the Republic of South Africa, Number 85.

Republic of South Africa (1996). *The Constitution of the Republic of South Africa Act, Number 108*.

Republic of South Africa (1997). *The White Paper for the transformation of the Health System in South Africa of 1 April 1997*. Retrieved 13 January 2013. from http://www.info.gov.za/whitepapers/1997/health.htm.

Republic of South Africa (2001). *Regulations for hazardous biological agents. Government Notice R1390 of 27 December 2001 under section 43 of the Occupational Health and Safety Act of the Republic of South Africa; Act 85 of 1993*. from http://www.labour.gov.za.

Republic of South Africa (2003). *National Health Act, No. 61 of 2003*. Retrieved 27 December 2012. from http://www.doh.gov.za.

Republic of South Africa (2009). *National Environmental Management: Waste Act of the Republic of South Africa, No. 59 of 2008*. Retrieved 12 October 2012. from http://www.info.gov.za/view/DownloadFileAction?id=97351.

Republic of South Africa (2011a). *National Health Amendment Bill, No 24 of 2011*. Retrieved 13 January 2013. from http://www.doh.gov.za.

Republic of South Africa (2011b). *National Health Insurance in South Africa Policy Paper, 12 August 2011*. Retrieved 13 January 2013. from http://www.info.gov.za/view/DownloadFileAction?id=148470.

Republic of South Africa (2012a). *National Environmental Management Waste Act 59 of 2008: Draft Health Care Risk Waste Management Regulations Notice 452 of 1 June 2012*. Retrieved 13 January 2013. from http://www.environment.gov.za/sites/default/files/gazetted_notices/healthcare_waste_regulations.pdf.

Republic of South Africa (2012b). *National environmental management: Waste Act No. 59 of 2008. Waste classification and management regulations No. 35572, Notice 614 of 2012*. Retrieved 13 January 2013. from http://www.info.gov.za/view/DownloadFileAction?id=172025.

Rudolph, M. J., and Ogunbodede, E. O. (1999). HIV infection and oral health care in South Africa. *South African Dental Journal,* **54**(12), 594-601.

Rutala, W. A., Weber, D. J., and HICPAC (2008). Guideline for disinfection and sterilization in healthcare facilities, 2008. [Guideline]. *Centers for Disease Control and Prevention, Department of Health and Human Services*.

Rweyendela, I. H., Patel, M., and Owen, C. P. (2009). Disinfection of irreversible hydrocolloid impression material with chlorinated compounds. *South African Dental Journal,* **64**(5), 208, 210-212.

SABS (2004). South African National Standard: Management of healthcare waste. Number SANS 10248:2004. Edition2.

Samaranayake, L. (2012). *Essential microbiology for dentistry.* (4th ed.). Hong Kong: Churchill Livingstone Elsevier.

Shisana, O. (2007). High HIV/AIDS prevalence among health workers requires urgent action: Editorial. *South African Medical Journal,* **97**(2), 108-109.

Shisana, O., Hall, E. J., Maluleke, R., Chauveau, J., and Schwabe, C. (2004). HIV/AIDS prevalence among South African health workers. *South African Medical Journal,* **94**(10), 846-850.

Shisana, O., Mehtar, S., Mosala, T., Zungu-Dirwayi, M., Rehle, T., Dana, P., Colvin, M., Parker, W., Connolly, C., Dunbar, R., and Gxamza, F. (2005a). *HIV risk exposure in children: A study of 2–9 year-olds served by public health facilities in the Free State, South Africa*. Cape Town: Human Sciences Research Council Press.

Shisana, O., Mehtar, S., Mosala, T., Zungu-Dirwayi, M., Rehle, T., Dana, P., Colvin, M., Parker, W., Connolly, C., Dunbar, R., and Gxamza, F. (2005b). *HIV risk exposure in children: A study of 2–9 year-olds served by public health facilities in the Free State, South Africa. Commissioned by the Nelson Mandela Foundation*. Cape Town: Human Sciences Research Council Press.

Singh, T. S., Bello, B., Mabe, O. D., Renton, K., and Jeebay, M. F. (2010). Workplace determinants of endotoxin exposure in dental healthcare facilities in South Africa. *Annals of Occupational Hygiene,* **54**(3), 299-308.

Singh, T. S., and Mabe, O. D. (2009). Review: Occupational exposure to endotoxin from contaminated dental unit waterlines. *South African Dental Journal,* **64**(1), 8-14.

Sissolak, D., Bamford, C. M., and Mehtar, S. (2010). The potential to transmit Mycobacterium tuberculosis at a South African tertiary teaching hospital. *International Journal of Infectious Diseases,* **14**(2010), e423–e428.

Sissolak, D., Marais, F., and Mehtar, S. (2011). TB infection prevention and control experiences of South African nurses - a phenomenological study. *Biomedcentral Public Health,* **11**(262), 1-10.

Szymanska, J. (2005). Microbiological risk factors in dentistry. Current status of knowledge. *Annals of Agricultural and Environmental Medicine,* **12**, 157-163.

United Nations (2011). Sustainability and Equity: A Better Future for All. *United Nations Human Development,* **Report 2011**.

United States Air Force (2012). Guidelines for infection prevention and control in dentistry *January 2012*. Retrieved from http://airforcemedicine.afms.mil/decs.

US Department of Veterans Affairs (2011). Report No. 10-03330-148 Healthcare inspection: Oversight Review of Dental Clinic Issues Dayton VA Medical Center Dayton, Ohio 25 April 2011. *Journal of the American Dental Association* Retrieved 11 January, 2013, from http://www.va.gov/oig/54/reports/VAOIG-10-03330-148.pdf.

Voigt, M. D., Bird, A. R., Kirsch, R. E., Kew, M. C., Aspinall, S., and Sims, J. (1996). National strategy for the prevention and management of transfusion-associated hepatitis. *South African Medical Journal,* **86**, 245-250.

Webber, L. M. (2000). Bloodborne viruses and occupational exposure in the dental setting. *South African Dental Journal,* **55**(9), 494-496.

Wood, R., Liang, H., Wu, H., Middelkoop, K., Oni, T., Rangaka, M. X., Wilkinson, R. J., Bekker, L. G., and Lawn, S. D. (2010). Changing prevalence of tuberculosis infection with increasing age in high-burden townships in South Africa. *International Journal of Tuberculosis and Lung Disease,* **14**(4), 406-412.

World Health Organization (2006, April 2007). World Health Organization Guidelines on Hand Hygiene in Healthcare (Advanced Draft) - Global patient safety challenge 2005 - 2006: “Clean care is safer care". *World Alliance for patient safety* Retrieved 21 August, 2007, from http://www.who.int/patientsafety.

World Health Organization (2008a). Global tuberculosis control: surveillance, planning, financing. WHO report 2008. **WHO/HTM/TB/2008.393**.

World Health Organization (2008b). World Health Organization Global tuberculosis control: surveillance, planning, financing. WHO report 2008. **WHO/HTM/TB/2008.393**.

World Health Organization (2009a). Guide to implementation: A guide to the implementation of the WHO multimodal hand hygiene improvement strategy. Save lives clean your hands. *Patient safety: A world alliance for safer health care* Retrieved 3 August, 2012, from WHO_IER_PSP_2009.02_eng.pdf.

World Health Organization (2009b). The WHO Guidelines on Hand Hygiene in Health Care 2009. *First Global Patient Safety Challenge: Clean Care is Safer Care* Retrieved 3 August, 2012, from http://whqlibdoc.who.int/publications/2009/9789241597906_eng.pdf.

World Health Organization (2009c, 25 June 2009). World Health Organization Infection prevention and control in health care for confirmed or suspected cases of pandemic (H1N1) 2009 and influenza-like illnesses: Interim guidance 25 June 2009 (originally published 29 April 2009) Retrieved 10 July, 2009, from http://www.who.int/csr/resources/publications/swineflu/swineinfinfcont/en/index.html.

Wright, J. A., Yang, H., Rivett, U., and Gundry, S. W. (2012). Public perception of drinking water safety in South Africa 2002–2009: a repeated cross-sectional study. *Biomedcentral Public Health,* **556**(12), 1-9.

Yengopal, V. (2003). Evidence based dentistry - some updates to help in practice. How well do dental health care workers adhere to infection control guidelines for dentistry? *South African Dental Journal,* **58**(4).

Yengopal, V. (2004). The use of essential oil mouthwashes as preprocedural rinses for infection control. *South African Dental Journal,* **59**(6), 247-248,250.

Yengopal, V., Naidoo, S., and Chikte, U. M. (2001). Infection control among dentists in private practice in Durban. *South African Dental Journal,* **56**(12), 580-584.

# CHAPTER 4

# Compliance with infection prevention and control in oral health care facilities: a global perspective

**Summary**

*Many publications are available on the topic of compliance with infection prevention and control in oral health care facilities all over the world. The approaches between developing and developed countries vary completely, but the principles of infection prevention and control stay the same globally. This study is a systematic review and global perspective of available literature on infection prevention and control in oral health care facilities. Nine focus areas on compliance with infection control measures were investigated: knowledge of infectious occupational hazards; personal hygiene and care of hands; correct application of personal protective equipment; use of environmental barriers and disposable items; sterilisation (recirculation) of instruments and handpieces; disinfection (surfaces) and housekeeping; management of waste disposal; quality control of dental unit waterlines, biofilms and water; as well as some special considerations. Various international studies from developed countries have reported highly scientific evidence-based information. In developed countries, the resources for infection prevention and control are freely available, which, when compared to developing countries, is not the case. The studies in developing countries also indicate serious shortcomings with regard to infection prevention and control knowledge and education in oral health care facilities. This review highlights the fact that availability of resources will always be a challenge, but more so in developing countries. This presents unique challenges and opportunity for innovative thinking to promote infection prevention and control.*

***Keywords:*** *Dentistry; dental; oral health care; infection control; compliance with guidelines*

## 4.1 Introduction

During the early 1980s, most oral health care workers (OHCWs) practiced oral health care without wearing gloves, masks or eye protection (De Paola, 2012). The identification of infection with the human immunodeficiency virus (HIV) in 1981, which resulted in acquired immunodeficiency syndrome (AIDS), possibly had one of the most significant impacts on the oral health care profession (Kaste and Bednarsh, 2007 / 2008; Molinari and Harte, 2010). At that time, the routes of transmission and biology of HIV were poorly understood. As a direct result of the growing HIV / AIDS epidemic, infection control, especially in the clinical oral health care environment, changed almost overnight. More than three decades later, patient profiles have changed considerably, and treatment regimens have thus adapted towards early diagnosis and preventive approaches (Kaste and Bednarsh, 2007/2008). Today, there is generally a better understanding of disease transmission and prevention in oral health care, which has led to a greater focus on practicing infection prevention and control (Kuhar*, et al.*, 2013).

Oral health care facilities have led the way in implementing infection control practices by routinely incorporating hand hygiene and sterilisation procedures (Molinari and Harte, 2010). This has contributed positively to the reduction of various disease transmission challenges. Additionally, since the mid-1980s, prior to any of the other health professions, oral health care facilities rapidly incorporated hepatitis B vaccinations for personnel members (Molinari and Harte, 2010).

A systematic review of studies published from January 2008 till September 2013 that address compliance with infection control guidelines and recommendations in developed as well as in developing countries, was undertaken, and will be reflected in this chapter.

## 4.2 Research materials and methods

A systematic review of global literature addressing infection control compliance in oral health care was undertaken. Earlier, a similar review had been published, covering the same literature and applicable to South Africa only up to 2007 (Oosthuysen*, et al.*, 2010). Therefore, this review covers global studies published from January 2008, up to September 2013. The review focuses particularly on adherence to infection control practices and includes all the categories of oral health care workers (OHCWs), namely dental practitioners, dental therapists, dental assistants, oral hygienists and students.

International electronic databases were searched, including Medline (EBSCOhost), Academic Search Premier (EBSCOhost), Science Direct, SA ePublications, SACAT, ISAP by the National Library of

South Africa, as well as the theses and dissertations from universities for the period from January 2008. The search terms included, "infection control," "dentistry," "dental," "oral health" and "compliance". Responses to these search terms were then searched again, in more depth. The search produced 19 681 publications of which 176 were selected containing quantitative data, while those containing mere recommendations were excluded (Figure 4.1).

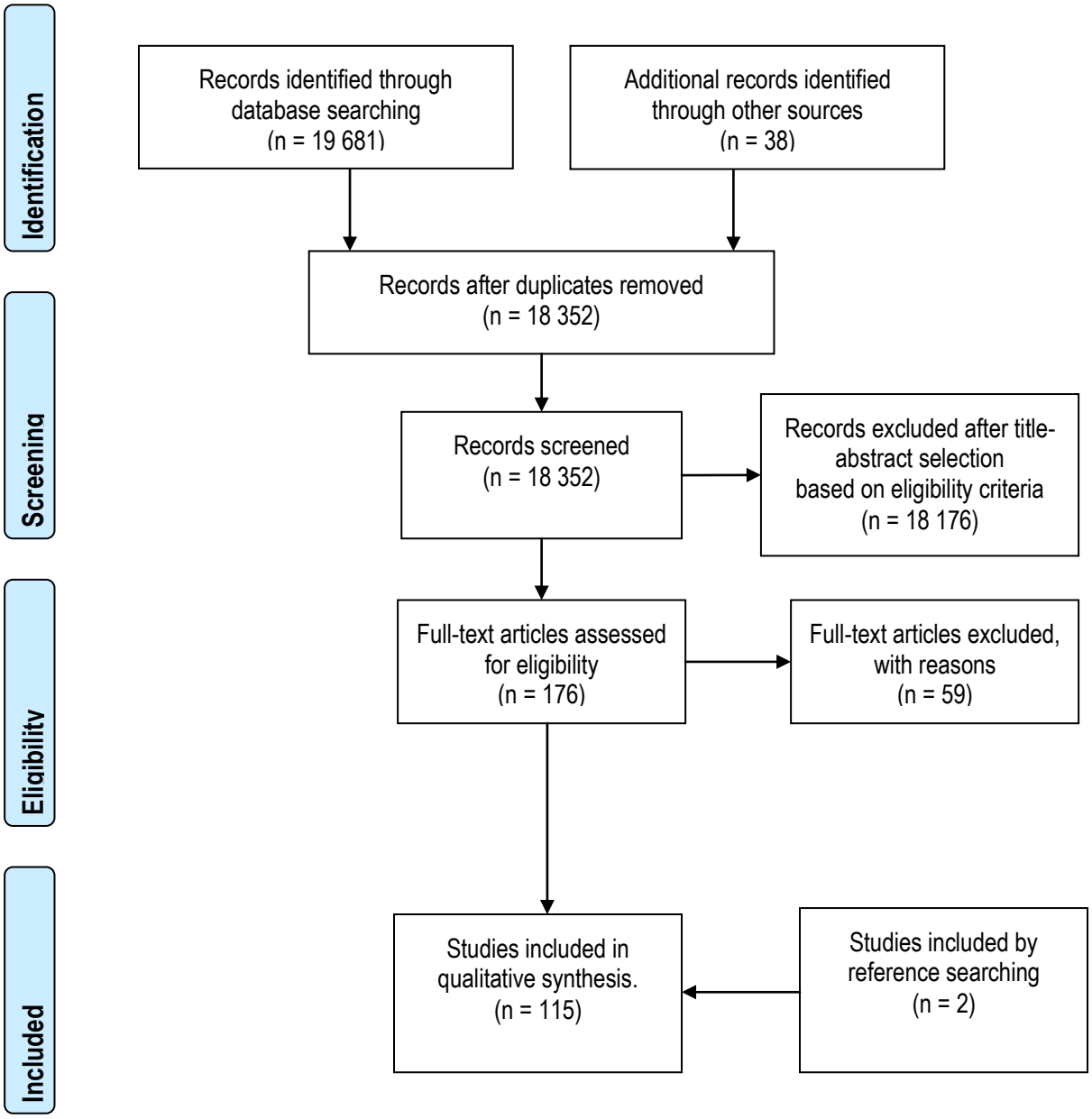



**FIGURE 4.1: PRISMA 2009 flow diagram (Moher*, et al.*, 2009)**

All selected literature were further scrutinised for adherence to the following questions:

- Does the literature provide details on infection control in oral health care?
- Can the contents of the selected literature be applied for compliance with infection control in oral health care facilities?

The outcome measures used as the baseline for infection control practices are similar to the earlier publication (Oosthuysen*, et al.*, 2010). These outcome measures were selected according to international recommendations by the British Dental Association, CDC and the Australian Dental Association (Centers for Disease Control, 2008; British Dental Association, 2011; Centers for Disease Control, 2011a, 2011b; Australian Dental Association, 2012). The outcomes focused on: knowledge of infectious hazards, personal hygiene and care of hands; wearing of personal protective equipment; environmental barriers; sterilisation (recirculation) of instruments and handpieces; disinfection (surfaces) and housekeeping; waste disposal; quality control and maintenance of dental unit waterlines, biofilms and water supply; and other special considerations.

## 4.3 Compliance with infection control in dentistry: A five year review of studies in developed and developing countries

### *4.3.1 Focus area one: Knowledge of infectious hazards*

Current epidemiological data outline the risk of exposure and possibility of transmitting diseases when providing oral health care treatment (Fédération Dentaire Internationale, 2009). The World Dental Federation (FDI) thus recommended that all oral health care professionals keep their knowledge and skills current. With the application of up to date knowledge and skills, transmission of infectious diseases could be managed in oral health care facilities (Fédération Dentaire Internationale, 2009). As stated, three decades ago it was the fear of the HIV / AIDS epidemic which motivated infection control preventive measures (Kaste and Bednarsh, 2007/2008; Amritraj*, et al.*, 2013). Today, recommendations, guidelines and policy statements assist oral health care professionals to prevent and control infectious risks by routinely following standard infection control precautions (British Dental Association, 2003; Australian / New Zealand Standard, 2006; Centers for Disease Control, 2008; Department of Health United Kingdom, 2008; Fédération Dentaire Internationale, 2009; British Dental Association, 2011; Australian Dental Association, 2012; Department of Health United Kingdom, 2013a, 2013b).

Recent media reports on breaches of infection control in USA oral health care facilities have increased public concern (Bradley*, et al.*, 2013; Eaton, 2013; Michmershuizen, 2013). Compliance with infection control and factors associated with the implementation of CDC infection control guidelines were investigated by Cleveland *et al*. (2012) from the USA. The authors linked compliance with infection control to continuous professional education through various modes / events of education (Cleveland*, et al.*, 2012). Examples of the modes of learning and education included workshops, journal articles and internet-based learning. Cleveland *et al*. (2012) furthermore reported that younger dental practitioners, who had been in their current practice for less than 30 years, were more likely to implement infection control guidelines. Exposure to more intensive and varying types of infection control education were highlighted as possible reasons for better compliance among younger oral health care practitioners (Cleveland*, et al.*, 2012). Apart from the age of practitioners, it was also reported that the size of facilities played a role in compliance with infection control. Results indicated that larger facilities, employing nine or more oral health care practitioners and other personnel, were more likely to have implemented guidelines and also have more knowledge to comply with infection control when compared to solo or smaller facilities (Cleveland*, et al.*, 2012).

Educational methods in infection control procedures were questioned in a study from the UK, where 77% of personnel confirmed to have received specific training in this field. However, it should be noted that training for instrument decontamination procedures was provided for mainly by demonstration (97%) or observed practice (88%) (Smith, Creanor*, et al.*, 2009). In addition to these results, the majority of dental assistant and dental practitioner responders from the same study were unfamiliar with the international indicator symbol for a single-use item (Smith, Creanor*, et al.*, 2009). This has highlighted the need for theoretical and practical education and training in infection control.

Cleveland *et al*. (2012) investigated the knowledge about surgical irrigation methods in the USA. They found that dental practitioners were aware of the use sterile water or saline during surgical procedures. However, only about half of the dental practitioners ever used sterile water or saline during surgical procedures, such as gingivectomy, extraction of an impacted third molar, soft tissue biopsy or bone recontouring.

The basic knowledge of infection prevention and control varies among countries. In a study investigating the education and knowledge of Turkish dental practitioners, only 43% of participants were able to define “cross-infection” correctly (Yüzbasioglu*, et al.*, 2009). In Brazil, authors agreed education and knowledge contribute to improved infection control attitudes and behaviour (Abreu*, et al.*, 2009). However, upon further investigation of the compliance with infection control, the results in practice were

worrying (De Abreu*, et al.*, 2009). Similarly, findings in India indicated that oral health care professionals have good knowledge of infection control (Jain*, et al.*, 2010). However, the authors admitted that the compliance levels with infection control were low. Singh *et al.* (2012) concluded that infection control guideline training among oral health care personnel and cooperation with local hazardous waste disposal authorities were identified as priorities.

An association was made between the knowledge of infection control and the injuries that occurred among Taiwanese dental practitioners (Cheng*, et al.*, 2012). The results from this study indicated that the overall knowledge of infection control procedures among dental practitioners was insufficient. Cheng *et al.* (2012) reported that, although younger dental practitioners had fewer needle stick and sharps injuries, those oral health care providers routinely exposed to injuries tended to be more concerned about knowledge of infectious hazards and compliance with infection prevention and safety measures. Studies among oral health care providers and dental students in the USA reported a lack of understanding of the basics of infection prevention and control (Kanjirath*, et al.*, 2009).

### *4.3.2 Focus area two: Personal hygiene and care of hands*

Hygiene and care of hands have been identified as the most important infection control precaution to prevent transmission of diseases (World Health Organization, 2009a; De Amorim-Finzi*, et al.*, 2010). Transfer of health care associated cross infections have been linked to the hands of health care workers in an estimated 20 to 40% of cases (Weber*, et al.*, 2010). To enable oral health care workers to execute routine hand hygiene before and after each patient contact session, the minimum requirements to facilitate this precautionary measure include the availability of clean water, adequate hand washing facilities, patient placement facilities, correct storage of sterile supplies and other conditions relevant to the physical working environment (World Health Organization, 2009b). Fixed hand hygiene facilities, including separate basins for instrument cleaning, hand hygiene and patient rinsing are some of the routine challenges for providing patient care (Omogbai*, et al.*, 2011). These challenges are doubly experienced when community oral health care procedures are executed in mobile dental units or community centres, such as schools or other venues (Radcliffe*, et al.*, 2013). These facilities are usually not specifically designed or equipped for oral health care procedures.

In 2002, new evidence-based practices for hand hygiene in health care were published by the CDC (Centers for Disease Control and Prevention, 2002). This guideline promotes the use of alcohol-based hand-sanitizers or hand rubs to be utilised as replacement for routine washing with soap and water, particularly when hand wash basins are not available. The use of these products is contraindicated when hands are visibly contaminated (Centers for Disease Control and Prevention, 2002). During 2009, the WHO endorsed these guidelines to improve hand hygiene practices throughout all health care facilities (World Health Organization, 2009b).

In addition, findings from Europe indicate that oral health care professionals there do not wash their hands according to the CDC recommendations for oral health care facilities either (Centers for Disease Control and Prevention, 2003; De Amorim-Finzi*, et al.*, 2010). However, as a result of the implementation of the Protection Against Infection Act in Germany, a decrease of errors in hand hygiene, and an increase in the use of skin antiseptics and surface disinfection were reported (Heudorf*, et al.*, 2013).

Adequate hand hygiene practices, such as frequent use of soap and water and sometimes alcohol-based hand sanitizers, were maintained by more than 75% of oral health care practitioners investigated in the USA (Myers*, et al.*, 2008). From the UK, it was reported that compliance with hand hygiene was not high enough, and when applied, the methods used were outdated (Smith, Creanor*, et al.*, 2009). Results of hand hygiene practices in this UK study point out that bar soaps were still used and nail brushes were present in 22% of facilities (Smith, Creanor*, et al.*, 2009). In actual fact, the use of bar soaps and nail brushes is discouraged in current UK guidelines / recommendations (Department of Health United Kingdom, 2013a).

Studies on personal hygiene and the care of hands in oral health care facilities in developing countries are limited. In a study, Nigerian respondents strongly agreed that the transmission of diseases to patients can be prevented through application of appropriate hand hygiene (Omogbai*, et al.*, 2011). In Brazil, the use of soap and paper towels in public oral health care facilities was found to be significantly less than in private practices ($p < 0.001$) (Bellissimo-Rodrigues*, et al.*, 2009). Bar soaps used in oral health care facilities in India were found to be contaminated with organisms such as *Pseudomonas aeruginosa, Acinetobacter, Enterobacter spp, Staphylococcus aureus and Staphylococcus epidermidis* in more than 90% of the samples taken (Pradeep*, et al.*, 2011). This supports the use of automated soap dispensers and liquid hand hygiene products, as recommended in the 2003 CDC guidelines for oral health care, actively discouraging the use of bar soaps.

The use of mobile devices in oral health care facilities, especially while busy with patient care procedures, are also a concern. The results of a study in India revealed that mobile phones may act as an infectious risk in oral health care facilities, as frequent touching heavily contaminates these devices with pathogens (Singh*, et al.*, 2010). Therefore, it is important for educators to instruct oral health care workers to limit touching personal mobile devices, and to avoid interruptions during contaminating treatment procedures. Higher compliance with hand hygiene practices and routine surface disinfection of mobile devices should further be advocated.

### *4.3.3 Focus area three: Personal protective equipment*

Areas most vulnerable and at risk for transmission of diseases include the eyes, face, and hands of OHCWs (Martin*, et al.*, 2009). Personal protective equipment (PPE), including protective clothing, masks, protective eyewear and disposable gloves should be worn during any clinical contact. PPE act as an important safety barrier to prevent exposures to the skin and mucous membranes of the OHCW (Kohn*, et al.*, 2003). This theory embraces the broader concept of "standard precautions", as incorporated in current infection control recommendations (Centers for Disease Control and Prevention, 2003).

At the foundation of any infection control programme is the use of standard precautions, which includes wearing of PPE, that should be applied at all times in oral health care procedures, regardless of a patient's suspected or confirmed medical history of infection (Harte, 2010). When used appropriately and in combination with other protective measures, PPE forms an effective barrier against transmission of any infection (Centers for Disease Control and Prevention, 2003; Department of Health United Kingdom, 2013a).

Studies found that the use of PPE among Lithuanian dentists, particularly the use of gloves and changing of gloves after each patient, was relatively high (85%) (Rimkuvienė*, et al.*, 2011). In contrast, although the general level of use of masks was high, changing of those masks was low (28%). In this study, the use of protective eyewear / face shields was less than 50% (Rimkuvienė*, et al.*, 2011). Furthermore, in a Russian study results indicated that many dental practitioners used double gloving after being informed of patients' infectious conditions (Budnyak*, et al.*, 2012). Similarly, in India, most dental practitioners added additional precautions when patients indicated a medical history of infection. However, in some cases, treatment was refused (21%) (Puttaiah*, et al.*, 2010).

In Brazil, the wearing of PPE was evaluated over a 10-year time period. In 1995, more that 95% of students wore protective clothing, face masks and rubber gloves during all patient procedures (De Abreu*, et al.*, 2009). However, the wearing of protective eyewear was considerably less (66.1%). After reassessing the use of PPE in 2005, similar results were obtained for the wearing of protective clothing, face masks and rubber gloves. However, a decline of 11% in the use of protective eyewear is of particular concern (De Abreu*, et al.*, 2009).

In a USA study, a large percentage of respondents, including students and professional OHCWs, incorrectly indicated that gloves provided full protection (Kanjirath*, et al.*, 2009). Furthermore, some students and professional OHCWs also mistakenly believed that gloves provide adequate protection as long as they are not visibly torn. Some respondents also stated that they never changed gloves in lengthy procedures, some lasting up to three hours (Kanjirath*, et al.*, 2009).

Research has shown that the unpredictable perforation rate of gloves present specific challenges, particularly during high exposure procedures such as oral and maxillofacial surgery (Kuroyanagi*, et al.*, 2012). Results from a Japanese study suggested that double gloving may offer a protection rate of up to 95% (Kuroyanagi*, et al.*, 2012). In a study in Iran, improved compliance was reported for the use double gloving while performing intra-venous procedures and working in emergency areas (Askarian*, et al.*, 2012).

Constant use of gloves also has health implications. Presently an increase in allergic reactions, due to the continuous contact with the latex content of gloves and other protective products, has been noted among many oral health care workers and patients (Kanjirath*, et al.*, 2009). As result, products manufactured from new materials, such as vinyl and nitrile have been introduced to avoid these allergic reactions (Coplen*, et al.*, 2008).

Contrary to the case in developed countries, in developing countries affordability, unavailability, limited resources and shortage of equipment have been put forward as reasons for low compliance with PPE guidelines (Uti*, et al.*, 2009; Puttaiah*, et al.*, 2010; Rimkuvienė*, et al.*, 2011).

### *4.3.4 Focus area four: Environmental barriers*

The production of aerosols and spatters during oral health care procedures, such as while operating high-speed dental handpieces and ultrasonic scalers, has been well documented (Larato*, et al.*, 1966; Micik*, et al.*, 1969; Miller*, et al.*, 1971; Miller, 1976; Holbrook*, et al.*, 1978; Gross*, et al.*, 1992). These aerosols, as well as spatters, have been identified as potentially hazardous, as they may contain infectious agents originating from the patient's oral cavity or the dental unit waterlines (Larato*, et al.*, 1966; Gross*, et al.*, 1992; Harrel and Molinari, 2004). As preventive measure against infectious material from the oral health care environment, and to minimise contamination of surfaces and equipment from the hands of oral health care workers, protective environmental barriers should be applied on frequently touched areas.

The changing of environmental barriers for every patient can be costly and impractical in some clinical environments, such as during screenings or orthodontic follow-up appointments. Costs are determined by the number and amount of clinical contact surfaces to be covered, as well as the number of patients treated during a working day (Petti*, et al.*, 2012). The relative risk for exposure, effectiveness of the barrier, time and costs will ultimately determine the choice of protection applied. For example, it was determined that, when compared to some expensive commercially available environmental barrier products, cheaper food wrap material can be applied as an equally effective environmental barrier (Dunne, 2011).

However, the effects of environmental barriers to the power output results from dental light curing units after application, is one area that presents challenges. The physical changes to the output of light curing tips should be monitored. The thickness and translucency of the barrier may have a negative effect on curing depth of light-activated resin composite procedures (Dunne, 2011).

The National Dental Practice-Based Research Network Collaborative Group in the USA reported on the use of a rubber dam during root canal treatment, and suggested that improved infection control, patient protection and treatment efficacy were some of the advantages offered by the rubber dam (Anabtawi*, et al.*, 2013). A significant reduction of spatter during treatments with the application of a combination of rubber dam with high-volume evacuation was reported (Dahlke*, et al.*, 2012).

### *4.3.5 Focus area five: Sterilisation*

Sterilisation includes the safe and effective instrument recycling as key element of any infection prevention and control programme (Rutala*, et al.*, 2008). The Spaulding Classification Scheme is a rational approach to disinfection and sterilisation that is used by all health care professionals as a guide for the decontamination and reprocessing of items (Rutala*, et al.*, 2008). The gold standard recommended for sterilisation of heat tolerant instruments or devices, is vacuum autoclaving (Rutala*, et al.*, 2008; Rutala and Weber, 2010). It is also recommended that dental handpieces be steam autoclaved (Centers for Disease Control and Prevention, 2003; Department of Health United Kingdom, 2008, 2013a). Most instruments used in oral health care facilities today are heat tolerant, and can thus be heat sterilised (Scarlett, 2007). Application of liquid chemical sterilants is only intended for the processing of heat sensitive instruments and instruments with acute cutting edges (Centers for Disease Control and Prevention, 2003; Kohn*, et al.*, 2003; Centers for Disease Control, 2008; Rutala*, et al.*, 2008; Rutala and Weber, 2010).

Effective instrument processing depends on systematic processes, involving a sequence of specific steps. These processes should ideally be executed in a specific, separate area, designed to promote routine workflow from “dirty” towards “clean” areas (British Dental Association, 2003). During these processes, occupational health and safety issues; the processing of different instrument types, equipment and supplies; sterilisation verification, as well as stock control should be considered as equally important aspects as well (Centers for Disease Control and Prevention, 2003; Department of Health United Kingdom, 2008; Rutala*, et al.*, 2008).

Current global recommendations suggest that automated cleaning devices and ultrasonic baths be utilised to facilitate a thorough cleaning process prior to sterilisation (Centers for Disease Control and Prevention, 2003; Department of Health United Kingdom, 2008; Rutala*, et al.*, 2008; Department of Health United Kingdom, 2013a). In Germany however, contradictory results indicated that some dental materials, such as cement, can only be removed manually or with an ultrasonic bath (Franz*, et al.*, 2012). These results are thus contrary to current regulations as enforced in the UK, where the use of a washer-disinfector is compulsory (Department of Health United Kingdom, 2013a).

Various studies have reported on the effectiveness of cleaning, disinfection and sterilisation of instruments. In a study among 30 oral health care facilities in South West England, processed instruments such as matrix bands with retainers, diamond and stainless steel burs, extraction forceps and hand scalers were investigated (Bagg, 2011). The best dental instrument cleaning result was

obtained after automated washer-disinfector cleaning. A study in Poland investigated cleaning methods in 43 oral health care facilities. The results indicated that manual cleaning and ultrasonic baths were applied in more that 50% of the facilities, while only 23% used washer-disinfectors (Röhm-Rodowald*, et al.*, 2012).

Studies on the sterilisation methods used for critical instruments have revealed varying results. A Russian study revealed dental practitioners had a poor understanding of Spaulding's classification (Budnyak*, et al.*, 2012). In spite of that, most Russian practitioners indicated that they always pre-packed instruments and applied sterilisation for critical instruments. This study also revealed that many practitioners used autoclaves (72%) and dry heat sterilisers (64%), while glass-bead sterilisers was still in use in more than a third of the investigated practices. Alcohol is still widely used for disinfection (83%).

Findings from India indicated that many practitioners used autoclaves (Puttaiah*, et al.*, 2010). However, results from this study revealed the majority used locally manufactured pressure cookers for sterilisation, and thus never packed instruments for sterilisation and storage (Puttaiah*, et al.*, 2010). Further reports from India also indicated that many dentists (71%) used boiling water as sterilising medium (Singh*, et al.*, 2012). In Turkey, the majority of dental practitioners used dry heat sterilisation, while autoclave (47%) and other sterilisation methods, such as chemical solutions (35%) and boiling water (2%), were also applied (Yüzbasioglu*, et al.*, 2009). A study from Brazil revealed that autoclaves were used by more than 60% of the dental practitioners (Matsuda*, et al.*, 2011). However, many practitioners (83%) did not use chemical and biological indicators to verify sterilisation (Matsuda*, et al.*, 2011). Similarly, Indian practitioners never used biological indicators to verify steriliser efficiency (Puttaiah*, et al.*, 2010). Results from Poland indicated that all sterilisation processes were performed in steam autoclaves and a third verified sterilisation with chemical indicators. Biological verification was rarely done (Röhm-Rodowald*, et al.*, 2012). These reports confirmed earlier reports from Poland, identifying the need for improving monitoring and documentation of sterilisation processes (Podgórska*, et al.*, 2009).

In Africa and Asia, procedures by traditional healers, including tooth extractions, have been performed for centuries, often without any Western technologies such as radiographs, pharmaceuticals or surgical instruments available (Willis*, et al.*, 2008). World Health Organization (WHO) reports stated more than 80% of some Asian and African countries rely on traditional healers and indigenous knowledge for their primary health care (World Health Organization, 2008). It has been reported that patients prefer treatment by traditional healers, because of inexpensive treatment with a 93% satisfaction rate with the

treatment provided (Agbor, *et al.*, 2011). In Cameroon however, cases of extraction of teeth by traditional healers, using crude and dirty instruments without any sterilisation, has been reported (Agbor, *et al.*, 2011). It is of concern that many traditional medicine practices often have been adopted in different cultures and regions without international standards or guidelines. Tooth extractions without infection prevention and control could be potentially life-threatening for both oral care workers and patients.

### *4.3.6 Focus area six: Disinfection (surfaces) and housekeeping*

Disinfection is defined as the physical or chemical destruction of microorganisms, including pathogens (Kohn, *et al.*, 2003). Disinfection is a less lethal process than sterilisation, because it destroys most, but not necessarily all pathogens, e.g. it does not destroy bacterial spores (Kohn, *et al.*, 2003). Effective use of disinfectants firstly requires an effective dilution of the chemical product, and secondly, that the product be applied for an adequate period of contact time, as indicated by the manufacturer (Centers for Disease Control and Prevention, 2003; Centers for Disease Control, 2008). These instructions need to be followed meticulously to prevent incorrect use or ineffective application.

In different oral health care facilities, different intra-oral and extra-oral surfaces present different challenges to decontaminate or clean effectively (British Dental Association, 2011). The most difficult surface to clean is textured vinyl, followed by smooth vinyl, enamelled metal, service line rubber hosing and brushed aluminium (Palenik 2012). In a study in Italy it was demonstrated that, when applying disinfection and cleaning with a sodium-lauryl-sulphate-based detergent (wipe-rinse method), the application was cost effective and practical (Petti, *et al.*, 2012). This study also illustrated equivalence with placement of disposable barriers to reduce Methicillin-resistant *S. aureus* (MRSA) contamination on dental chairs (Petti, *et al.*, 2012). Patel *et al.* (2010) identified computers, keyboards and other components positioned near the patient treatment areas as a potential risk for cross-infection from and to patients and operators. However, findings from the study indicated that routine cleaning, followed by disinfection with 70% isopropanol wipes reduced the microbial load on computer keys by at least 96% (Patel, *et al.*, 2010). Another challenge for cleaning has been identified in orthodontic facilities, where decontamination of photographic retractors, often manufactured from heat sensitive material, have been reported as being technique sensitive (Walker, 2010). The findings indicate that the application of a washer-disinfector for the retractors is most effective (Walker, 2010).

In a Brazilian study, surface contamination with *S. aureus* was investigated around patients, dental students and in the oral health care environment (Negrini*, et al.*, 2009). By far, the majority of microbial colonies (74%) were obtained from the nose, tongue and hands of patients. The results also clearly indicated that dental students were already contaminated before commencement of the clinical appointment, with the highest colony counts found on gloved hands, followed by the tongue, and ungloved hands (Negrini*, et al.*, 2009). Upon investigation of the clinical oral health care environment during this study, the count of *S. aureus* colonies significantly increased to 10.3% after the appointment ($p < 0.05$), and that the store room and auxiliary table were the most contaminated (Negrini*, et al.*, 2009). These results could be due to the intense circulation of people in the clinical dental area, as well as the use of high-speed dental handpieces during dental appointments. It is speculated that much of the *S. aureus* contamination detected in the clinical environment came from direct contact, skin exfoliation or improper handling of equipment (Negrini*, et al.*, 2009).

A record of evidence of work relating to decontamination or general housekeeping should be maintained for audit purposes (Department of Health United Kingdom, 2013a). Results from Poland revealed incorrect documentation of instrument and surface decontamination in oral health care facilities (Röhm-Rodowald*, et al.*, 2012). Further findings from Poland also indicated three common failures during disinfection, namely multiple re-use of disinfectant by topping up disinfectant instead of using freshly prepared mixture, continuously adding additional instruments to the disinfectant and not following manufactures' instructions (Podgórska*, et al.*, 2009). No specific data are available on housekeeping in oral health care facilities, which offers an opportunity for further investigation.

### *4.3.7 Focus area seven: Waste management*

Waste generated in oral health care facilities, including sharps and other infectious waste, is classified as hazardous and poses a serious risk to human health and the general environment (Eberle*, et al.*, 2009). Most countries have their own classification of hazardous or health care risk waste, which often includes infectious waste, pathological waste, sharps, chemical waste, and radio-active waste. To reduce the risk of hazardous waste to human health and the general environment, the WHO has defined eight steps to manage health care waste, including waste minimisation, waste generation, waste segregation, intermediate storage, centralised storage, external transport, treatment and disposal (World Health Organization, 2005). By segregating waste, oral health care facilities can reduce the hazardous waste that requires special treatment and safe disposal.

From the UK it was reported that the segregation and disposal of health care risk waste in oral health care facilities happened according to waste management guidelines (Smith, Creanor*, et al.*, 2009). However, one exception was noted in this study, namely, that disposal of anaesthetic cartridges was done in plastic bags instead of rigid puncture-proof sharps containers (Smith, Creanor*, et al.*, 2009). Furthermore, studies from the UK also reported that all orthodontic facilities used 'yellow bags' to dispose of clinical waste and had puncture-proof sharps containers, which were in accord with waste management recommendations (Shah*, et al.*, 2009).

Waste from oral health care facilities poses an infectious risk. In Malaysia various types of bacterial agents, including *Enterobacter* spp., *Salmonella* spp., *Klebsiella* spp., *Pseudomonas* spp., *Serratia* spp., *Proteus mirabilis*, *Escherichia* spp., *Staphylococcus* spp., *Enterococcus* spp. and *Streptococcus* spp. were detected in waste collected from oral health care facilities (Vieira*, et al.*, 2011; Hossain*, et al.*, 2013). Results from a specific Indian study are particularly worrying, as the majority of general dentists included (67%) had disposed of hazardous waste such as syringes, blades and ampoules in normal dustbins, emptied in domestic municipal waste (Singh*, et al.*, 2012).

### *4.3.8 Focus area eight: Dental unit waterlines, biofilms and water quality*

The water in dental unit waterlines is often contaminated with high concentrations of bacterial agents. Bacteria multiply and cling to the inner walls of the waterline plastic tubing, which continues to accumulate into biofilms (Miller and Palenik, 2010; Schmidtke, 2011). Biofilm formation in waterlines can be removed by breaking the biofilm into individual bacteria through a cleaning and decontamination process, such as flushing or purging the air- and water lines routinely (Schmidtke, 2011). Results from Germany indicated that when the water quality is tested in addition, this may be helpful, as mould contamination can provide a sign of biofilm formation prior to a high total colony count (Kramer*, et al.*, 2012).

Contaminated dental unit water, used during oral health care treatment, could be potentially life-threatening to vulnerable people such as the immune compromised, the elderly, and people with chronic conditions such as diabetes, cancer, AIDS or TB (Samaranayake, 2012). In February 2011, an 82-year-old woman, with no underlying disease, was admitted to an intensive care unit in Italy with fever and respiratory distress (Ricci*, et al.*, 2012). Two days later she died as a result of Legionnaires' disease. Her death was attributed to the presence of *Legionella pneumophila* in dental unit waterlines, a high-speed handpiece and the oral health care facility's taps (Ricci*, et al.*, 2012). Pathogenic bacterial agents, such as *Legionella* and *Pseudomonas species*, have been the reason for increasing concern

and a topic of discussion over the past four decades (Kohn*, et al.*, 2003; Coleman*, et al.*, 2009; Singh and Mabe, 2009; Garg*, et al.*, 2012; Department of Health United Kingdom, 2013a).

### *4.3.9 Special considerations*

Special considerations include aspects directed at dental handpieces and other devices attached to air and waterlines; single-use or disposable devices, including saliva ejectors; pre-procedural mouth rinses; dental radiology; the dental laboratory; *Mycobacterium tuberculosis*; the risk of contracting Creutzfeldt-Jakob and other prion diseases; sharps injuries and post-exposure management; and the vaccination of OHCWs.

Dental handpieces and other devices attached to air and waterlines

Oral health care workers involved with clinical procedures are exposed to the sprays and spatters generated during oral health care procedures. The sprays and spatters produced by dental unit handpieces have the potential to transmit pathogenic agents through air borne or water borne modes (Cristina*, et al.*, 2008; Laheij*, et al.*, 2012). The CDC states that "handpieces that cannot be heat sterilised should not be used" during oral health care procedures (Centers for Disease Control, 2008). According to the UK Department of Health (2008) and Rutala *et al.* (2008), it is recommended to apply vacuum autoclaving to achieve sterility of instruments, such as dental handpieces with lumens, cavities or indentations. A Polish study revealed that a third of the dental practitioners questioned used non-vacuum autoclaving (type B) for dental handpieces (Röhm-Rodowald*, et al.*, 2012). In Scotland, decontamination and autoclaving of handpieces between patients were investigated in a study involving 179 oral health care facilities (Smith, Smith*, et al.*, 2009). The results indicated that most of the practitioners (97%) autoclaved their handpieces between patient treatments. However, the majority of respondents manually decontaminated their dental handpieces externally with a disinfectant wipe rather than washing them, and then processed them in type N bench top steam sterilisers (Smith, Smith*, et al.*, 2009). In a study among dentists in Beijing, autoclaving of dental handpieces between patients increased from 41% to 96% in a 10-year survey (Su*, et al.*, 2012).

The use of non-water soluble lubricants in handpieces may be problematic. Such lubricants may cause blockage of the narrow lumen and also prevent effective cleaning of the inner parts of the handpieces prior to sterilisation. Furthermore, processed handpieces are re-contaminated if lubricated after sterilisation. A Scottish study showed that most handpieces were lubricated with non-water soluble lubricants after cleaning and before sterilisation (91%), although a number (24%) of participants also lubricated handpieces after sterilisation (Smith, Smith*, et al.*, 2009).

Single-use or disposable devices

Applications of single-use or disposable devices have become a common in oral health care (Martin*, et al.*, 2009). Examples of single-use or disposable devices include prophylaxis cups and brushes, saliva ejectors, high-volume evacuator tips, hypodermic syringes, needles, blades, endodontic irrigation tips / needles, plastic impression trays, air / water syringe tips, gloves and masks among others. These items are not designed by their manufacturers to be cleaned and re-used, and are thus classified as single-use or disposable items.

A study in the UK revealed that 23% of oral health care facilities gave guidance on when to choose single-use as opposed to re-usable instruments when both were commercially available. For 47% of facilities there was an internal policy on the re-use of devices labelled as single use, of which only 37% specified that re-use was never allowed (Smith, Creanor*, et al.*, 2009).

Pre-procedural mouth rinses

The major source of pathogens in oral health care facilities originates from the oral cavities of patients, each laden with high concentrations of oral microbial flora (Aravind*, et al.*, 2012). Having patients rinse with a pre-procedural mouth rinse has been proven as an effective precautionary infection control measure to reduce the microbial counts in the oral cavity (Kohn*, et al.*, 2003). It has been shown in an Indian study that bacterial cross-infection from dental aerosols can be reduced with chlorhexidine used as a simple, non-expensive and effective pre-procedural rinsing, prior to procedures with ultrasonic scalers and high-speed handpieces (Purohit*, et al.*, 2009). A Brazilian study confirmed this, and showed that rinses containing 0.05% cetylpyridinium chloride (CPC), 0.12% chlorhexidine (CHX) and water were equally effective in lowering the bacterial counts (Feres*, et al.*, 2010). Because CPC has fewer side effects than CHX, it could be considered good choice for pre-procedural rinsing (Feres*, et al.*, 2010).

Dental radiology

Sensors used during digital intra-oral radiography are heat sensitive and cannot be autoclaved. Thus, to prevent cross contamination, protective barrier envelopes that cover the sensors are used while capturing the radiographs (MacDonald and Waterfield, 2011). The sensors, contained inside the plastic barrier envelopes, always remain a potential source of contamination with saliva. Recommendations suggest disinfection of the digital intra-oral radiography sensors and equipment upon removal of the contaminated outer envelope, and the aseptic re-placement of a new protective envelope (Centers for Disease Control and Prevention, 2003). A Canadian study revealed that contamination of digital sensors can still take place due to the compromised integrity of the protective envelopes, and the techniques applied during placement and removal of the envelopes, despite various precautions to prevent cross-

infection (MacDonald and Waterfield, 2011). An Iran study indicated significant differences between the bacterial counts on radiographic equipment and surrounding surfaces before and after disinfection (Ardakani*, et al.*, 2008). In a comparison of four disinfectant products, Deconex demonstrated the highest disinfectant efficacy on radiographic equipment and surrounding surfaces (Ardakani*, et al.*, 2008).

Dental laboratory

Materials or instruments / equipment transferred to and received from the dental laboratory, such as impression materials, impression trays and dispensers have the potential for the transmission of disease (Westergard*, et al.*, 2011). It has been reported that impression material cartridges and handgun dispensers are easily and heavily contaminated with pathogenic agents, such as Methicillin-resistant *S. aureus* (MRSA), during clinical prosthetic procedures (Westergard*, et al.*, 2011). This places oral health care workers, as well as dental laboratory personnel, at risk for acquiring infections that are difficult to treat or possibly life-limiting. All standard precautions, such as careful handling of sharp instruments, hand washing, use of protective barriers and wearing of PPE such as gloves, masks, protective eyewear, and protective clothing for infection prevention and control should therefore also be extended to the dental laboratory (Centers for Disease Control and Prevention, 2003).

For optimum consumer protection, clear communication between oral health care facilities and dental laboratories is crucial. It is generally recommended that the responsibility of the cleaning and disinfection of impressions, before despatching to dental laboratories, should lie with the dental practitioner (British Dental Association, 2011). The same applies to dental technicians when sending completed products and dispensers back to the oral health care facility, such as prosthetic or orthodontic appliances and impression trays, among others (British Dental Association, 2011).

In a number of studies, impression decontamination and disinfection practices among oral health care practitioners and dental technicians were investigated. Results from the UK indicated that 37% of participants rinsed impressions with water and 3% brushed debris away before disinfection (Almortadi and Chadwick, 2010). Although 75% of the participating practitioners had claimed that they informed dental laboratories of impression disinfection, the large majority (95%) of participating dental technicians still received blood-contaminated impressions (Almortadi and Chadwick, 2010).

Approximately 61% of dental practitioner participants in studies in Russia indicated that they disinfected impressions (Budnyak*, et al.*, 2012). A study in Saudi-Arabia to evaluate the efficacy of sodium hypochlorite (1:10) and iodophor disinfectants, found sodium hypochlorite to be highly effective when

applied to alginate impressions (Haralur*, et al.*, 2012). The results furthermore indicated that gypsum does not have any inherent antibacterial properties. The presence of opportunistic pathogenic organisms such as Streptococci (100%), Staphylococci (65.4%), *Candida* (46.2%), Methicillin-resistant *Staphylococcus aureus* (15.4%), and *Pseudomonas aeruginosa* (7.7%), which could be life-threatening to immune-compromised persons, was demonstrated on selective agar cultures from impressions and gypsum casts in a study among Japanese dentists (Egusa*, et al.*, 2010). Upon investigating different Japanese disinfecting methods on alginate impressions, the findings suggested that applying a 0.5% sodium hypochlorite solution for 15 minutes was a feasible disinfection method (Hiraguchi*, et al.*, 2012).

Proper impression disinfection thus provides adequate cross contamination protection between the oral health care facility and the dental laboratory (Haralur*, et al.*, 2012). A study of Iranian dental laboratories revealed that the most popular chemical materials dental technicians used for disinfection included household bleach, glutaraldehyde, and alcohol (Hashemipour*, et al.*, 2008). Alarming results from this study also indicated that dental technicians rarely wore gloves (14%) and protective eyewear (8%) while handling used equipment. Only half of the technicians in this study had been vaccinated against HBV.

*Mycobacterium tuberculosis*

Transmission of *Mycobacterium tuberculosis* occurs through aerosols generated by coughing, sneezing and speaking (Jensen*, et al.*, 2005). *M. tuberculosis* can remain air borne within small droplets for several hours and susceptible individuals can still become infected (Kohn*, et al.*, 2003). Some countries have policies or recommendations that oral health care workers should avoid treating patients with suspicious symptoms of TB until it is confirmed the patient does not have TB, or is not infectious (Cleveland*, et al.*, 2009). If emergency oral health care treatment needs to be executed on suspected TB patients, respiratory protection such as N95, N99 or N100 respirators should be worn (Cleveland*, et al.*, 2009).

The incidence of *M. tuberculosis* infection among oral health care patients was assessed at a large tertiary hospital in Nigeria. Ten out of 78 sputum samples tested positive for *M. tuberculosis* (Cadmus*, et al.*, 2010). These findings emphasises the risk of active TB cases among patients and need to implement specific infection prevention precautions and policies for TB in oral health care facilities. Particular challenges identified in training institutions, hospitals and public health care facilities include a lack of TB specific infection control training, and a need for infrastructure improvement and better ventilation systems in existing and new facilities (Mphahlele*, et al.*, 2012).

Creutzfeldt-Jakob and other prion diseases

Creutzfeldt-Jakob disease (CJD) is caused by a proteinaceous infectious agent, or prion, which has an unusual resistance to standard methods of decontamination (Azarpazhooh and Leake, 2006). A variant form of CJD (vCJD), acquired from cattle, has recently been identified as a hazard for all health care professions, especially those exposed to blood and nerve tissue. The potential risk of further human-to-human transmission of the disease through contaminated instruments is a further concern (Rutala and Weber, 2010). Recently a study in the UK indicated the risk of vCJD transmission during oral health care procedures was higher than previously expected (Kirby*, et al.*, 2012). This study also revealed vCJD transmission after exposure of a patient's gingival tissues to a contaminated endodontic file, and not just from nerve tissue exposure as previously suggested.

A study in South England compared the different cleaning methods applied in oral health care facilities (Bagg, 2011). The study measured protein levels left on different types of instruments after manual cleaning, manual plus with ultrasonic bath cleaning and use of the automated washer-disinfector. Several shortcomings were observed in all three methods, which could be indicative of the potential risk of transmitting Creutzfeldt-Jakob disease between patients (Bagg, 2011). Although current evidence suggested that the possibility of prion contamination from dental instruments may be low, it may not be the case should endodontic instruments and reamers be applied (Department of Health United Kingdom, 2013a). When a strict and reliable cleaning regime cannot be executed for endodontic instruments and reamers, the application of a single-use, disposable policy may be the safer alternative (Department of Health United Kingdom, 2013a).

Sharps injuries and post-exposure management

The highest risk of infection is associated with accidental punctures with used and / or contaminated needles, or injuries with sharp instruments (Laheij*, et al.*, 2012). The most common occupational risks oral health care workers and dental patients are exposed to include exposure to blood borne pathogens, in particular including hepatitis B, hepatitis C and HIV (Kohn*, et al.*, 2003; Kohli and Puttaiah, 2008; Centers for Disease Control and Prevention, 2013).

The nature of oral health care easily results in exposure incidents. In 2012, Cleveland *et al.* from the CDC reported that 6% of dental practitioners and 14% of other oral health care personnel had experienced at least one or more percutaneous injuries in the 12 months prior to the study. In a second study amongst dental students in the USA, percutaneous injuries had occurred in 88% of the respondents (Myers*, et al.*, 2012). In a nationwide survey among dental practitioners in Taiwan, the results indicated that the risk of occupational needle stick and sharps injuries increased in correlation to

practitioner age (Cheng*, et al.*, 2012). In a study conducted with dental students in Shiraz, Iran, 73% of the participants experienced needle stick and sharps injuries in the 12 months prior to the study (Askarian*, et al.*, 2012). More than half of the injuries occurred during patient treatment procedures, of which needle re-capping was the most frequent problem. More alarming however, is the fact that 85% of the respondents did not report their injuries after it happened (Askarian*, et al.*, 2012). The reasons indicated for non-reporting included not knowing the mechanism of reporting, not realising that all needle stick injuries required reporting and evaluation, as well as not knowing who to report to (Askarian*, et al.*, 2012). In a study of oral health care facilities in Brazil, occupational accidents caused by cutting and piercing objects were reported by half of the participating facilities (Matsuda*, et al.*, 2011). Of all the respondents, only 26% had had specialised follow-up medical appointments after the accidents (Matsuda*, et al.*, 2011).

Vaccination of OHCWs

Hepatitis B virus (HBV) transmission is the greatest infectious risk dental patients or members of the oral health care team can be exposed to (Laheij*, et al.*, 2012). In Brazil, hepatitis B vaccination and post-vaccination tests among oral health care practitioners raised concerns (Resende*, et al.*, 2010). The results of the study revealed that, although 74% of the respondents had received all three required doses of the vaccine, only 15% had performed the follow-up post-vaccination test (Resende*, et al.*, 2010). In Nigeria, compliance with the recommended hepatitis B immunisations was poor (Azodo*, et al.*, 2012). Out of all the respondents, 20.0% had received three doses of the hepatitis-B vaccine, 49% either two or a single dose, while 31.4% were not vaccinated. The reasons reported by the respondents who were not vaccinated as recommended, included lack of opportunity for vaccination and the fear of side effects of the vaccines (Azodo*, et al.*, 2012).

## 4.4 Conclusion

Many publications are available on the topic of compliance with infection prevention and control practices in oral health care facilities all over the world. The approaches between developing and developed countries vary completely, though the principles of infection prevention and control stay the same globally. The availability of resources is, and will always be a challenge, maybe more so in developing countries. This review has indicated serious deviations in the compliance with infection control guidelines and recommendations internationally. Although there often was good knowledge and high compliance with infection control guidelines in developed countries, the lack of knowledge and compliance with infection control guidelines in developing countries is low and particularly disturbing.

In both developed and developing countries, hand hygiene and the care of hands were not consistently done according to international recommendations The fact of frequent touch in oral health care has been identified as an area of specific concern, and should, similarly to all other health care professions, be addressed as one of the most important infection control areas. The use and common application of modern technology, including digital devices, mobile devices and cell phones in oral health care facilities, and the potential of cross contamination from the patient's oral cavity to these appliances presents a further challenge, as frequent touching may heavily contaminate these devices with pathogens. The younger generation of oral health care professionals seem to comply better with the wearing of personal protective equipment, but areas of some concern are not replacing these between every patient. Affordability, unavailability, limited resources and shortage of equipment / supplies have been indicated as reasons for non-compliance with the routine use of personal protective equipment in developing countries.

The application of protective environmental barriers is widely promoted and applied in developed countries, but the lack of studies in developing countries could conceal serious shortcomings. In spite of guidelines promoting safety of workers and many studies indicating that the best instrument cleaning results are obtained in an automated washer-disinfector, manual cleaning is still widely used. Most participant practitioners used autoclaves, but the majority in developing countries had never used biological indicators, while many still use chemical solutions for reprocessing of critical instruments. In many developing countries, boiling water is widely used to "sterilise" appliances and alcohol is still utilised for disinfection, while used handpieces are not sterilised between all patients, and single-use items are re-used.

Additionally, wide ranging research has indicated that waste segregation and disposal is undertaken incorrectly. While immunisation against hepatitis B has improved among oral health care personnel, many do not maintain immunity with boosters or carry out post vaccine testing. The hygiene and maintenance of waterlines and the use of sterile water or saline during surgical procedures are areas of notable concern. No data is available with regard to the quality of the water from dental units that are used in developing countries. In dental laboratories, poor compliance with clinical infection control and prevention practices, and inadequate knowledge about the topic among technicians is a serious problem.

Finally, although developed countries obviously have more resources, there are some areas where specific reports on compliance with their infection prevention and control precautions show functional short comings. The more significant areas identified as such include the application of environmental

barriers, quality control and maintenance of dental unit waterlines and water supply; the development of biofilms and some special considerations. The special considerations that require further investigation include pre-procedural rinses, radiology, the treatment or protection against TB suffering patients, the risk of Creutzfeldt-Jakob and other prion diseases, as well as the timely vaccination of OHCWs. In most developing countries at present the application of infection prevention and control measures, or the lack thereof in oral health care facilities, is nothing short of a nightmare and in many instances an outright health and safety hazard to both patients and OHCWs.

## 4.5 References

Abreu, M. H., Lopes-Terra, M. C., Braz, L. F., Rímulo, A. L., Paiva, S. M., and Pordeus, I. A. (2009). Attitudes and behavior of dental students concerning infection control rules: a study with a 10-year interval. *Brazilian Dental Journal,* **20**(3), 221-225.

Agbor, A. M., Singh, S., and Mbia, A. M. (2011). The role of traditional healers in tooth extractions in Lekie Division, Cameroon. *Journal of Ethnobiology and Ethnomedicine,* 7(15). Retrieved from http://www.ethnobiomed.com/content/7/1/15.

Almortadi, N., and Chadwick, R. G. (2010). Disinfection of dental impressions - compliance to accepted standards. *British Dental Journal,* **209**(12), 607-611.

Amritraj, A., Rajan, P. S., Shenoy, N., Poojary, D., and Shetty, S. (2013). Awareness among young dentists about transmission of HIV and preventive measures. *International Journal of Bioassays,* 2(4), 701-704. Retrieved from http://ebioscholar.com/ojs/index.php/ijb/article/view/283.

Anabtawi, M. F., Gilbert, G. H., Bauer, M. R., Reams, G., Makhija, S. K., Benjamin, P. L., and Williams, O. D. (2013). Rubber dam use during root canal treatment. Findings from the Dental Practice-Based Research Network. *Journal of the America Dental Association,* **144**(2), 179-186.

Aravind, N. K. S., Reddy, S., Manjunath, C., and Reddy, S. B. (2012). Complete care to cure: an update of the current knowledge of infection control in dental practice. *Annals and Essences of Dentistry,* **4**(4), 49-43.

Ardakani, F. E., Zandi, H., Mohammadi, Z., Ayatollahi, J., Ayatollahi, F., and Behniafar, B. (2008). Comparing the disinfecting efficacies of Micro 10, Deconex, Alprocid and Microzid AF on the microorganisms on radiographic equipments. *Journal of Dental Research, Dental Clinics, Dental Prospects,* **2**(2).

Askarian, M., Malekmakan, L., Memish, Z. A., and Assadian, O. (2012). Prevalence of needle stick injuries among dental, nursing and midwifery students in Shiraz, Iran. *GMS Krankenhaushygiene Interdisziplinär, 7*(1). Retrieved from http://www.egms.de/pdf/journals/dgkh/2012-7/dgkh000189.pdf. doi:10.3205/dgkh000189.

Australian / New Zealand Standard (2006). *Office-based health care facilities - Reprocessing of reusable medical and surgical instruments and equipment, and maintenance of the associated environment*.

Australian Dental Association (2012). *Australian Dental Association Guidelines for Infection Control* (2 ed.). St Leonards NSW 1590 Australia Australian Dental Association Inc.

Azarpazhooh, A., and Leake, J. L. (2006). Prions in dentistry--what are they, should we be concerned, and what can we do? *J Can Dent Assoc,* **72**(1), 53-60.

Azodo, C. C., Ehizele, A. O., Uche, I., and Erhabo, P. (2012). Hepatitis-B vaccination status among dental surgeons in Benin City, Nigeria. *Annals of Medical and Health Sciences Research,* **2**(1), 24-28.

Bagg, J. (2011). Summary of: A quantitative assessment of residual protein levels on dental instruments reprocessed by manual, ultrasonic and automated cleaning methods. *British Dental Journal,* **210**, 418 - 419.

Bellissimo-Rodrigues, W. T., Bellissimo-Rodrigues, F., and Machado, A. A. (2009). Infection control practices among a cohort of Brazilian dentists. *International Dental Journal,* **59**(1), 53-58.

Bradley, K., Fox, J., Wilson, J., Harris, T., Van Buskirk, K., and Schaefli, N. (2013). *Investigation of Healthcare-Associated Hepatitis C Virus Transmission in a Dental Surgical Clinic -- Oklahoma, 2013*. Paper presented at the 2013 Annual CSTE Conference - Epi on the Edge. from https://cste.confex.com/cste/2013/webprogram/Paper2450.html.

British Dental Association (2003). *Infection control in dentistry. Advice sheet A12 of the British Dental Association*. London: British Dental Association.

British Dental Association (2011). *Advice sheet A12 Infection control in dentistry (England).* (Vol. **April**). London: British Dental Association.

Budnyak, M. A., Gurevich, K. G., Fabrikant, K. G., Miller, K., and Puttaiah, R. (2012). Dental infection control and occupational safety in the Russian Federation. *The Journal of Contemporary Dental Practice,* **13**(5), 703-712.

Cadmus, S. I., Okoje, V. N., Taiwo, B. O., and Van Soolingen, D. (2010). Exposure of dentists to *Mycobacterium tuberculosis*, Ibadan, Nigeria. *Emerging Infectious Diseases,* **2010**(16), 1479-1481.

Centers for Disease Control (2008). Guideline for Disinfection and Sterilization in Healthcare Facilities, 2008 Retrieved 3 April, 2013, from http://www.cdc.gov/ncidod/dhqp/pdf/guidelines/Disinfection_Nov_2008.pdf.

Centers for Disease Control (2011a). Guide to Infection Prevention for Outpatient Settings: Minimum Expectations for Safe Care. Retrieved 2013-04-03, from Centers for Disease Control and Prevention: http://www.cdc.gov/HAI/pdfs/guidelines/standatds-of-ambulatory-care-7-2011.pdf.

Centers for Disease Control (2011b). Infection Prevention Checklist for Outpatient Settings: Minimum Expectations for Safe Care. Retrieved 2013-04-03, from Centers for Disease Control and Prevention: http://www.cdc.gov/HAI/pdfs/guidelines/ambulatory-care-checklist-07-2011.pdf.

Centers for Disease Control and Prevention (2002). Guideline for hand hygiene in health-care settings. *Morbidity and Mortality Weekly Report,* **51**(RR-16).

Centers for Disease Control and Prevention (2003). Guidelines for infection control in dental health-care settings - 2003. [Recommendations and reports]. *Morbidity and Mortality Weekly Report,* **52**(Number RR-17), 1-68.

Centers for Disease Control and Prevention (2013). Healthcare-associated hepatitis B and C outbreaks reported to the Centers for Disease Control and Prevention (CDC) in 2008-2011. Retrieved 10 February 2013, from CDC: http://www.cdc.gov/hepatitis/Outbreaks/HealthcareHepOutbreakTable.htm.

Cheng, H. C., Su, C. Y., Yen, A. M., and Huang, C. F. (2012). Factors affecting occupational exposure to needlestick and sharps injuries among dentists in Taiwan: a nationwide survey. *PLoS One* Retrieved 25 January, 2013, from http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3318009/.

Cleveland, J., Foster, M., Barker, L., Brown, G., Lenfestey, N., Lux, L., Corley, T., and Bonito, A. (2012). Advancing infection control in dental care settings: Factors associated with dentists' implementation of guidelines from the Centers for Disease Control and Prevention. *Journal of the American Dental Association,* **143**(10), 1127-1138.

Cleveland, J. L., Robison, V. A., and Panlilio, A. L. (2009). Tuberculosis Epidemiology, Diagnosis and Infection Control Recommendations for Dental Settings: An Update on the Centers for Disease Control and Prevention Guidelines. *Journal of the America Dental Association,* **140**(9), 1092-1099.

Coleman, D. C., O'Donnell, M. J., Shore, A. C., and Russell, R. J. (2009). Biofilm problems in dental unit water systems and its practical control. *Journal of Applied Microbiology,* **106**(5), 1424-1437.

Coplen, A., Chapman, J., Kanjirath, P., Gu, F., Fenno, C., and Peters, M. (2008). *Nitrile, latex, and vinyl gloves permeabiliy testing using serratia marcescens. Presentation at the Clinical Research Symposium on Clinical Research to Clinical Practice: September 11-13, 2008.* . Paper presented at the Managing Challenges at the Cutting Edge, University of Michigan.

Cristina, M. L., Spagnolo, A. M., Sartini, M., Dallera, M., Ottria, G., Lombardi, R., and Perdelli, F. (2008). Evaluation of the risk of infection through exposure to aerosols and spatters in dentistry. *American Journal of Infection Control, 36*(4), 304-307. Retrieved from http://www.ajicjournal.org/article/S0196-6553%2807%2900807-3/pdf.

Dahlke, W. O., Cottam, M. R., Herring, M. C., Leavitt, J. M., Ditmyer, M. M., and R.S., W. (2012). Evaluation of the spatter-reduction effectiveness of two dry-field isolation techniques. *Journal of the America Dental Association,* **143**(11), 1199-1204.

De Abreu, M. H. N. G., Lopes-Terre, M. C., Braz, L. F., Rimolo, A. L., Paiva, S. M., and Pordeus, I. A. (2009). Attitudes and behavior of dental students concerning infection control rules: a study with a 10-year interval. *Brazilian Dental Journal,* **20**(3), 221-225.

De Amorim-Finzi, M. B., Cury, M. V. C., Costa, C. R. R., Dos Santos, A. C., and De Melo, G. B. (2010). Rate of compliance with hand hygiene by dental healthcare personnel (DHCP) within a dentistry healthcare first aid facility. *European Journal of Dentistry,* **4**(3), 233-237.

De Paola, L. G. (2012). Infectious diseases in the oral healthcare environment. *Inside Dental Assisting, November / December*. Retrieved from http://ida.cdeworld.com/courses/4636.

Department of Health United Kingdom (2008). Health Technical Memorandum 01-05 Decontamination in primary care dental practices. *Health Technical Memorandum 01-05*(Oct 2008), 1-60.

Department of Health United Kingdom (2013a). Health Technical Memorandum 01-05: Decontamination in primary care dental practices. *Health Technical Memoranda*, 1-98. Retrieved from https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/170689/HTM_01-05_2013.pdf.

Department of Health United Kingdom (2013b). Health Technical Memorandum 07-01: Safe management of healthcare waste. *Health Technical Memoranda, 2013*, 1-187. Retrieved from https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/167976/HTM_07-01_Final.pdf.

Dunne, S. (2011). Summary of: The effect of disposable infection control barriers and physical damage on the power output of light curing units and light curing tips. *British Dental Journal,* **210**, 358 - 359.

Eaton, K. (2013). Tulsa oral surgeon accused in health scare sued. *San Francisco Cronicle* Retrieved 7 September, 2013, from http://www.sfgate.com/news/article/Tulsa-oral-surgeon-accused-in-health-scare-sued-4786971.php.

Eberle, J., Allain, L., and Nersesian, P. (2009). Logistics of health care waste management: information and approaches for developing country settings. *USAID Deliver Project, Task Order 1 from the U.S. Agency for International Development*.

Egusa, H., Watamoto, T., Abe, K., Kobayashi, M., Kaneda, Y., Ashida, S., Matsumoto, T., and Yatani, H. (2010). An analysis of the persistent presence of opportunistic pathogens on patient-derived dental impressions and gypsum casts. *The International Journal of Prosthetics,* **21**(1), 62-68.

Fédération Dentaire Internationale (2009). FDI Policy Statement on infection control in dental practice: Merging of 'Human Immunodeficiency Virus Infection and Other Blood Borne Infections (2000)', 'Infection Control in Dentistry' (2007), and 'Sterilization and Cross Infection Control in the Dental Practice' (2005). Revised version adopted by the General Assembly: 4th September 2009, Singapore. Retrieved 9 February, 2013, from http://www.fdiworldental.org/media/11259/Infection-control-in-dental-practice-2009.pdf.

Feres, M., Figueiredo, L. C., Faveri, M., Stewart, B., and De Vizio, W. (2010). The effectiveness of a preprocedural mouthrinse containing cetylpyridinium chloride in reducing bacteria in the dental office. *Journal of the America Dental Association,* **141**(4), 415-422.

Franz, A., Bristela, M., and Stauffer, F. (2012). Reprocessing of dental instruments in washer-disinfectors: does a representative test soil exist in dentistry? *GMS Krankenhaushygiene Interdisziplinär,* *7*(1). Retrieved from http://www.egms.de/pdf/journals/dgkh/2012-7/dgkh000197.pdf. doi:10.3205/dgkh000197.

Garg, S. K., Mittal, S., and Kaur, P. (2012). Dental unit waterline management: historical perspectives and current trends. *Journal of Investigative and Clinical Dentistry, 3*(4), 247–252. Retrieved from /doi/10.1111/j.2041-1626.2012.00135.x/pdf. doi:10.1111/j.2041-1626.2012.00135.x.

Gross, K. B., Overman, P. R., Cobb, C., and Brockmann, S. (1992). Aerosol generation by two ultrasonic scalers and one sonic scaler: a comparative study. *Journal of Dental Hygiene,* **66**(7), 314-318.

Haralur, S. B., Al-Dowah, O. S., Gana, N. S., and Al-Hytham, A. (2012). Effect of alginate chemical disinfection on bacterial count over gypsum cast. *Journal of Advanced Prosthetics,* **2012**(4), 84-88.

Harrel, S. K., and Molinari, J. (2004). Aerosols and splatter in dentistry: A brief review of the literature and infection control implications. *Journal of the America Dental Association,* **135**(April), 429-437.

Harte, J. A. (2010). Standard and transmission-based precautions: An update for dentistry. *Journal of the America Dental Association,* **141**(5), 572-581.

Hashemipour, M., Mosharafian, S., Mohammadalizadeh, S., and Ravaei, H. (2008). Evaluation of infection control situation among dental laboratories in Kerman. *Journal of Isfahan Dental School,* **4**(1), 18-24.

Heudorf, U., Eikmann, T., and Exner, M. (2013). Ten years' German Protection against Infection Act: Evaluation of the implementation of infection control visits in the ambulatory medical setting. *Bundesgesundheitsblatt Gesundheitsforschung Gesundheitsschutz*.

Hiraguchi, H., Kaketani, M., Hirose, H., and Yoneyama, T. (2012). Effect of immersion disinfection of alginate impressions in sodium hypochlorite solution on the dimensional changes of stone models. *Dental Materials Journal,* **31**(2), 280-286.

Holbrook, W. P., Muir, K. F., Macphee, I. T., and Ross, P. W. (1978). Bacteriological investigation of the aerosol from ultrasonic scalers. *British Dental Journal,* **144**(8), 245-247.

Hossain, S., Rahman, N. N. N. A., Balakrishnan, V., Puvanesuaran, V. R., Sarker, Z. I., and Kadir, M. O. (2013). Infectious risk assessment of unsafe handling practices and management of clinical solid waste. *International Journal of Environmental Research and Public Health, 10*, 556-567. Retrieved from www.mdpi.com/journal/ijerph. doi:10.3390/ijerph10020556.

Jain, M., Sawla, L., Mathur, A., Nihlani, T., Ayair, U., Prabu, D., and Kulkarni, S. (2010). Knowledge, attitude and practice towards droplet and airborne isolation precautions amongs dental health care professionals in India. *Medicina Oral Patologia Oral y Cirugia Bucal,* **15**(6), e957-961.

Jensen, P. A., Lambert, L. A., Iademarco, M. F., and Ridzon, R. (2005). Centers for Disease Control and Prevention. Guidelines for preventing the transmission of Mycobacterium tuberculosis in health-care settings, 2005. *Morbidity and Mortality Weekly Report,* **54**(RR-17), 1-142.

Kanjirath, P. P., Coplen, A. E., Chapman, J. C., Peters, M. C., and Inglehart, M. R. (2009). Effectiveness of gloves and infection control in dentistry: student and provider perspectives. *Journal of Dental Education,* **73**(5), 571-580.

Kaste, L. M., and Bednarsh, H. (2007/2008). The third decade of HIV / AIDS: A brief epidemiologic update for dentistry. *Journal of the Canadian Dental Association,* **73**(10), 941-944.

Kirby, E., Dickinson, J., Vassey, M., Dennis, M., Cornwall, M., McLeod, N., Smith, A., Marsh, P. D., Walker, J. T., Sutton, J. M., and Raven, N. D. H. (2012). Bioassay studies support the potential for iatrogenic transmission of variant Creutzfeldt Jakob Disease through dental procedures. *PLoS One,* 7(11), e49850. Retrieved from http://www.plosone.org. doi:10.1371/journal.pone.0049850.

Kohli, A., and Puttaiah, R. (2008). *Dental infection control and occupational safety for oral health professionals*. New Delhi, India: Thompson Printers.

Kohn, W. G., Collins, A. S., Cleveland, J. L., Harte, J. A., Eklund, K. J., and Malvitz, D. M. (2003). Centers for Disease Control and Prevention (CDC). Guidelines for infection control in dental health-care settings - 2003. *Morbidity and Mortality Weekly Report,* **52**(RR-17), 1-61.

Kramer, A., Assadian, O., Bachfeld, D., and Meyer, G. (2012). Purge- and intensive-purge decontamination of dental units contaminated with biofilm. *GMS Krankenhaushygiene Interdisziplinär,* 7(1). Retrieved from http://www.egms.de/pdf/journals/dgkh/2012-7/dgkh000195.pdf. doi:10.3205/dgkh000195.

Kuhar, D. T., Henderson, D. K., Struble, K. A., Heneine, W., Thomas, V., Cheever, L. W., Gomaa, A., and Panlilio, A. L. (2013). US Public Health Service Working Group: Updated US public health service guidelines for the management of occupational exposures to human immunodeficiency virus and recommendations for postexposure prophylaxis. *Infection Control and Hospital Epidemiology, 34*(9), 875-892. Retrieved from http://www.jstor.org/stable/10.1086/672271. doi:10.1086/672271.

Kuroyanagi, N., Nagao, T., Sakuma, H., Miyachi, H., Ochiai, S., Kimura, Y., Fukano, H., and Shimozato, K. (2012). Risk of surgical glove perforation in oral and maxillofacial surgery. *International Journal of Oral and Maxillofacial Surgery,* **41**, 1014-1019.

Laheij, A. M. G. A., Kistler, J. O., Belibasakis, G. N., Välimaa, H., and De Soet, J. J. (2012). Healthcare-associated viral and bacterial infections in dentistry. *Journal of Oral Microbiology* Retrieved 20 April, 2013, from http://dx.doi.org/10.3402/jom.v4i0.17659.

Larato, D. C., Ruskin, P. F., Martin, A., and Delanko, R. (1966). Effect of a dental air turbine drill on the bacterial counts in air. *Journal of Prosthetic Dentistry,* **16**(4), 758-765.

MacDonald, D. S., and Waterfield, J. D. (2011). Infection control in digital intraoral radiography: Evaluation of microbiological contamination of photostimulable phosphor plates in barrier envelopes. *Journal of the Canadian Dental Association,* **77**(b93), 1-5.

Martin, M. V., Fulford, M. R., and Preston, A. J. (2009). *Quintessentials of Dental Practice, Clinical Practice Number 3. Infection control for the dental team.* (Vol. **39**). London: Quintessence Publishing Co. Ltd.

Matsuda, J. K., Grinbaum, R. S., and Davidowicz, H. (2011). The assessment of infection control in dental practices in the municipality of São Paulo. *The Brazilian Journal of Infectious Diseases,* **15**(1), 45-51.

Michmershuizen, F. (2013, 4 April). Dental associations respond to infection control breach in Oklahoma. *Dental Tribune - The World's Dental Newspaper*, from http://www.dental-tribune.com/articles/news/usa/12548_dental_associations_respond_to_infection_control_breach_in_oklahoma.html.

Micik, R. E., Miller, R. L., Mazzarella, M. A., and Ryge, G. (1969). Studies on dental aerobiology, part I: bacterial aerosols generated during dental procedures. *Journal of Dental Research,* **48**(1), 49-56.

Miller, C. H., and Palenik, C. J. (Eds.). (2010). *Infection Control and Management of Hazardous Materials for the Dental Team* (Fourth ed.). St. Louis, Missouri: Elsevier Mosby.

Miller, R. L. (1976). Generation of airborne infection by high speed dental equipment. *Journal of the America Society for Preventive Dentistry,* **6**(3), 14-17.

Miller, R. L., Micik, R. E., Abel, C., and Ryge, G. (1971). Studies on dental aerobiology, part II: microbial splatter discharged from the oral cavity of dental patients. *Journal of Dental Research,* **50**(3), 621-625.

Moher, D., Liberati, A., Tetzlaff, J., and D., A. (2009). Preferred reporting items for systematic reviews and meta-analyses: The PRISMA Statement. PLoS Med 6(6): e1000097. doi:10.1371/journal.pmed1000097. *British Medical Journal,* **2009**(339), 332-336.

Molinari, J. A., and Harte, J. A. (2010). *Cottone's Practical infection control in dentistry* (Third ed.). Baltimore, Philadelphia: Lippincott, Williams and Wilkens, a Wolters Kluwer business.

Mphahlele, M. T., Tudor, C., Van der Walt, M., and Farley, J. (2012). An infection control audit in 10 primary health-care facilities in the Western Cape Province of South Africa. *International Journal of Infection Control,* **8**(3), 1-5.

Myers, J. E., Myers, R., Wheat, M. E., and Yin, M. T. (2012). Dental students and bloodborne pathogens: occupational exposures, knowledge, and attitudes. *Journal of Dental Education,* **76**(4), 479-486.

Myers, R., Larson, E., Cheng, B., Schwartz, A., Da Silva, K., and Kunzel, C. (2008). Hand hygiene among general practice dentists: a survey of knowledge, attitudes and practices. *Journal of the America Dental Association, 139*(7), 948-957.

Negrini, T., Duque, C., De Oliveira, A. C. M., Hebling, J., Spolidorio, L. C., and Spolidorio, D. M. P. (2009). *Staphylococcus Aureus* contamination in a pediatric dental clinic. *Journal of Clinical Pediatric Dentistry,* **34**(1), 13-18.

Omogbai, J. J., Azodo, C. C., Ehizele, A. O., and Umoh, A. (2011). Hand hygiene amongst dental professionals in a tertiary dental clinic. *African Journal of Clinical and Experimental Microbiology,* **12**(1), 9-14.

Oosthuysen, J., Potgieter, E., and Blignaut, E. (2010). Compliance with infection control recommendations in South African dental practices: a review of studies published between 1990 and 2007. *International Dental Journal,* **60**(3), 181–189.

Palenik , C. J. (2012). The effect of long-term disinfection on clinical contact surfaces. *Journal of the America Dental Association,* **143**(5), 472-477.

Patel, S., Porter, K., and Sammons, R. L. (2010). Are computer keyboards a cross-infection risk in a dental clinic? *Journal of Infection Prevention, 11*(6), 206-211. Retrieved from http://bji.sagepub.com/content/11/6/206.full.pdf+html. doi:10.1177/1757177410384892.

Petti, S., Polimeni, A., and Dancer, S. J. (2012). Effect of disposable barriers, disinfection, and cleaning on controlling methicillin-resistant Staphylococcus aureus environmental contamination. *American Journal of Infection Control,* **21**(09), 1-5.

Podgórska, M., Jakimiak, B., Röhm-Rodowald, E., and Chojecka, A. (2009). Assessment of disinfection and sterilization processes in dental practice as an important factors in prevention of infections. *Przegląd Epidemiologiczny,* **63**(4), 545-550.

Pradeep, S., Aravindhan, T. R., Chinnaiah, R., Anupma, K. J., and Suresh, R. (2011). Bar soaps in dental clinic might be a bacterial reservoir. *International Journal of Contemporary Dentistry,* **2**(5), 115-120.

Purohit, B., Priya, H., Acharya, S., Bhat , M., and Ballal, M. (2009). Efficacy of pre-procedural rinsing in reducing aerosol contamination during dental procedures. *Journal of Infection Prevention,* **10**(6), 90.

Puttaiah, R., Shetty, S., Bedi, R., and Verma, M. (2010). Dental infection control in India at the turn of the century. *World Journal of Dentistry,* **1**(1), 1-6.

Radcliffe, R. A., Bixler, D., Moorman, A., Hogan, V. A., Greenfield, V. S., Gaviria, D. M., Patel, P. R., Schaefer, M. K., Collins, A. S., Khudyakov, Y. E., Drobeniuc, J., Gooch, B. F., and Cleveland, J. L. (2013). Hepatitis B virus transmissions associated with a portable dental clinic, West Virginia, 2009. *Journal of the America Dental Association,* **144**(10), 1110-1118.

Resende, V. L. S., Abreu, M. H. G., Paiva, S. M., Teixeira, R., and Pordeus, I. A. (2010). Research concerns regarding hepatitis B vaccination and post-vaccination test among Brazilian dentists. *Virology Journal, 7*, 154. Retrieved from http://www.virologyj.com/content/7/1/154.

Ricci, M. L., Fontana, S., Pinci, F., Fiumana, E., Pedna, M. F., Farolfi, P., Sabattini, M. A., and Scaturro, M. (2012). Pneumonia associated with a dental unit waterline. *The Lancet,* **379**(9816), 684.

Rimkuvienë, J., Pûrienë, A., Peèiulienë, V., and Zaleckas, L. (2011). Use of personal protective equipment among Lithuanian dentists. *Sveikatos Mokslai,* **21**(2), 29-36.

Röhm-Rodowald, E., Jakimiak, B., Chojecka, A., Zmuda-Baranowska, M., and Kanclerski, K. (2012). Assessment of decontamination processes: cleaning, disinfection and sterilization in dental practice in Poland in the years 2011-2012. *Przegląd Epidemiologiczny,* **66**(4), 635-641.

Rutala, W. A., and Weber, D. J. (2010). Guideline for disinfection and sterilization of prion-contaminated medical instruments. *Infection Control Hospital Epidemiology,* **31**(2), 107-117.

Rutala, W. A., Weber, D. J., and HICPAC (2008). Guideline for disinfection and sterilization in healthcare facilities, 2008. [Guideline]. *Centers for Disease Control and Prevention, Department of Health and Human Services*.

Samaranayake, L. (2012). *Essential microbiology for dentistry.* (4th ed.). Hong Kong: Churchill Livingstone Elsevier.

Scarlett, M. I. (2007). Disinfection and sterilization: a primer. *Dentaltown,* **7**, 52-60.

Schmidtke, D. W. (2011). *Efficacy of Sterisil in the treatment of dental unit waterlines. Thesis: Master of Science.* The University of Alabama at Birmingham, Birmingham, Alabama.

Shah, R., Collins, J. M., Hodge, T. M., and Laing, E. R. (2009). A national study of cross infection control: 'are we clean enough?'. *British Dental Journal,* **207**, 267 - 274.

Singh, B. P., Khan, S. A., Agrawal, N., Siddharth, R., and Kumar, L. (2012). Current biomedical waste management practices and cross-infection control procedures of dentists in India. *International Dental Journal,* **62**(3), 111-116.

Singh, S., Acharya, S., Bhat, M., Rao, S. K., and Pentapati, K. C. (2010). Mobile phone hygiene: potential risks posed by use in the clinics of an Indian dental school. *Journal of Dental Education,* **74**(10), 1153-1158.

Singh, T. S., and Mabe, O. D. (2009). Review: Occupational exposure to endotoxin from contaminated dental unit waterlines. *South African Dental Journal,* **64**(1), 8-14.

Smith, A., Creanor, S., Hurrell, D., Bagg, J., and McCowan, M. (2009). Management of infection control in dental practice. *Journal of Hospital Infection,* **71**(4), 353-358.

Smith, G. W., Smith, A. J., Creanor, S., Hurrell, D., Bagg, J., and Lappin, D. F. (2009). Survey of the decontamination and maintenance of dental handpieces in general dental practice. *British Dental Journal,* **207**(4), E7; discussion 160-161.

Su, J., Deng, X.-H., and Sun, Z. (2012). A 10-year survey of compliance with recommended procedures for infection control by dentists in Beijing. *International Dental Journal,* **62**, 148-153.

Uti, O. G., Agbelusi, G. A., Jeboda, S. O., and Ogunbodede, E. (2009). Infection control knowledge and practices related to HIV among Nigerian dentists. . *The Journal of Infection in Developing Countries,* **3**(8), 604-610

Vieira, C. D., De Carvalho, M. A. R., De Menezes Cussiol, N. A., Alvarez-Leite, M. E., Dos Santos, S. G., Da Fonseca Gomes, R. M., Silva, M. X., Nicoli, J. R., and De Macêdo Farias, L. (2011). Count, identification and antimicrobial susceptibility of bacteria recovered from dental solid waste in Brazil. *Waste Management,* **31**, 1327-1332.

Walker, J. (2010). Summary of: The cleaning of photographic retractors; a survey, clinical and laboratory study. *British Dental Journal,* **208**, 306 - 307.

Weber, D. J., Rutala, W. A., Miller, M. B., Huslage, K., and Sickbert-Bennett, E. (2010). Role of hospital surfaces in the transmission of emerging health care-associated pathogens: norovirus, Clostridium difficile, and Acinetobacter species. *American Journal of Infection Control,* **35**(5 supplement 1), S25-S33.

Westergard, E. J., Romito, L. M., Kowolik, M. J., and Palenik, C. J. (2011). Controlling bacterial contamination of dental impression guns. *Journal of the America Dental Association,* **142**(11), 1269-1274.

Willis, M. S., Harris, L. E., and Hergenrader, P. J. (2008). On traditional dental extraction: case reports from Dinka and Nuer en route to restoration. *British Dental Journal,* **204**(3), 121-124.

World Health Organization (2005). Health care waste management: The eight steps along the waste stream. *Health care waste management*. Retrieved from www.healthcarewaste.org/en/127_hcw_steps.html.

World Health Organization (2008). Traditional medicine: Fact sheet N°134 Retrieved 28 April, 2013, from http://www.who.int/mediacentre/factsheets/fs134/en/index.html.

World Health Organization (2009a). Guide to implementation: A guide to the implementation of the WHO multimodal hand hygiene improvement strategy. Save lives clean your hands. *Patient safety: A world alliance for safer health care* Retrieved 3 August, 2012, from WHO_IER_PSP_2009.02_eng.pdf.

World Health Organization (2009b). The WHO Guidelines on Hand Hygiene in Health Care 2009. *First Global Patient Safety Challenge: Clean Care is Safer Care* Retrieved 3 August, 2012, from http://whqlibdoc.who.int/publications/2009/9789241597906_eng.pdf.

Yüzbasioglu, E., Saraç, D., Canbaz, S. Y., Saraç, S., and Cengiz, S. (2009). A survey of cross-infection control procedures: knowledge and attitudes of Turkish dentists. *Journal of Applied Oral Sciences,* **17**(6), 565-569.

# CHAPTER 5

# Theoretical framework that underpins the development of an audit-feedback instrument for oral health care facilities in South Africa

**Summary**

*A theoretical framework for development of the audit-feedback instrument for oral health care facilities in South Africa has been developed. The researcher undertook a systematic review of the literature on audit-feedback instruments with reference to infection prevention and control in oral health care. Where applicable, literature on the practical application of audit-feedback instruments used in other health care disciplines was also scrutinised. Thereafter, the selected literature was appraised, based upon pre-determined criteria. These criteria were constructed taking into account the variety of South African oral health care facilities, which includes public and private oral health care, and a diversity of training levels for oral health care personnel. The literature search revealed the existence of 10 audit-feedback instruments, five dedicated to oral health care and five to other health care disciplines. The Infection Prevention Society Dental Audit Tool was the only audit-feedback instrument that adhered to all the appraisal criteria, except for the required use of simple language. This audit tool will be used as the foundation for the development of the audit-feedback instrument for South Africa, taking cognisance of the need for simple language.*

***Keywords:*** *Audit tool; dental; oral health care; infection control; infection prevention and control*

## 5.1 Introduction

As in many other health care disciplines, oral health care workers (OHCWs) are required to demonstrate the ability to understand and apply the principles of occupational health and safety when undertaking infection prevention and control in oral health care facilities (Ayatollahi*, et al.*, 2012; Szymańska and Sitkowska, 2012). These applications necessitate compliance with infection prevention and control recommendations and the guidelines related to oral health care (Centers for Disease Control and

Prevention, 2003; Kohn*, et al.*, 2004; Department of Health United Kingdom, 2013a, 2013b). Unlike in general health care or hospital care, the oral health care environment presents unique challenges, such as a high risk for potential blood borne pathogen exposure due to continuous exposure to sprays and spatter generated during dental procedures, as well as the continuous contact with traumatised tissue, saliva and blood (Gross*, et al.*, 1992; Kohn*, et al.*, 2003; Harrel and Molinari, 2004; Bradley*, et al.*, 2013; Close*, et al.*, 2013; Department of Health United Kingdom, 2013a; Manarte-Monteiroa*, et al.*, 2013). In a recent report on breaches in infection prevention and control in oral health facilities in the USA, more than 7000 patients were recalled over a 6-year period after exposure to the human immunodeficiency virus (HIV), hepatitis B, and hepatitis C (Centers for Disease Control, 2013). Unfortunately, such incidents result in increased negative publicity and media reports, often fuelling patient anxiety and fear when visiting oral health care facilities. On the other hand, it also emphasises the importance of the strict application of infection prevention precautions in oral health care.

In South Africa, the 2005 Nelson Mandela Foundation Report raised public and professional concerns after its confirmation that infection control practices in oral health care facilities were inadequate, and that vulnerable patients were exposed to the risk of HIV transmission (McKay, 2005). The report stated that visible and invisible blood had been detected in oral health care environments and on clean instruments in such facilities. It was concluded that this was the result of a breakdown in basic infection prevention and control processes, occurring in South Africa over an extended period of time (Shisana*, et al.*, 2005).

None of the South African infection prevention and control policies, regulations or guidelines sufficiently addresses the specific conditions or requirements for oral health care. In his budget speech on May 2011, the Minister of Health announced that the South African health system is failing to meet its millennium development goals (Department of Health Republic of South Africa, 2011). The National Infection Prevention and Control Policy and Strategy sets minimum national standards for the effective prevention and management of health care associated infections (National Department of Health, 2007). However, these standards do not specifically address the oral health care environment as such. The Norms, Standards and Practice Guidelines for Primary Oral Health Care comprises of a few pages, listing succinct guidelines for infection control in primary oral health care facilities (National Department of Health, 2005). These documents provide only a brief guideline for infection prevention and control, without detailed instructions covering the variety of oral health care procedures; diversity of training levels for oral health care personnel; or the availability of resources in rural and urban facilities, including

public and private oral health care facilities. In particular, no mechanisms or audit procedures to measure compliance with infection prevention and control guidelines are available in South Africa.

An audit is a systematic, critical analysis of the quality of oral health care, including the procedures, all processes, any intervention, the use of resources and the resulting outcome, as assessed by oral care professionals (Redfearn, 2012). In the United Kingdom, the Care Quality Commission (CQC) compiled a new compliance assessment tool in 2010, in which infection control and cleanliness are among the essential outcomes covered (Care Quality Commission, 2010). Redfearn (2012) referred to the importance of this outcome for the dental team in his audit presentation "Audit and the Dental Team". According to the CQC, "*The new system is focused on outcomes rather than systems and processes, and places the views and experiences of people who use services at its centre*". Furthermore, audit has been identified as a quality improvement process that aims to improve patient care through a systematic review of care, measured against explicit criteria (Malleshi, et al., 2012). The audit cycle process involves various stages, including preparing the audit, selecting the criteria, measuring performance, identifying areas for improvement, implementing improvements, and re-auditing (Figure 5.1).

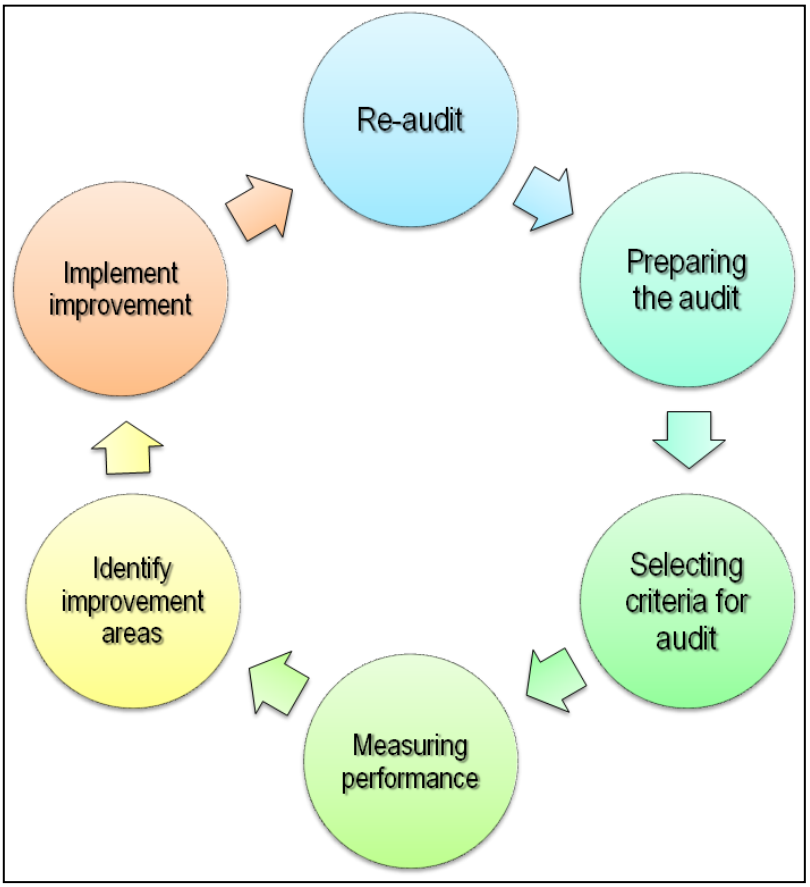



**FIGURE 5.1: Audit feedback cycle**

The development of an infection prevention and control audit-feedback instrument (AFI) and the ultimate practical application thereof for the health care providers, will contribute to a safer environment in oral health care facilities in South Africa. Thus, the purpose of an audit-feedback instrument is to provide a practical tool that can be applied by a variety of oral health care workers in oral health care facilities to ensure safe practice.

## 5.2 Literature review on existing audit-feedback instruments

The following electronic databases were searched, including Medline (EBSCOhost), Academic Search Premier (EBSCOhost), Science Direct, SA ePublications, SACAT, ISAP by the National Library of South Africa, as well as theses and dissertations at universities for the period since January 2008. The search terms initially included the terms “infection prevention and control” together with “dental audit tool.” Thereafter, the search was broadened to address “dental audit tools” disregarding “infection prevention and control”. Finally, the search was further refined to investigate infection prevention and control audit tools from other health care disciplines. The literature search is depicted in Figure 5.2.

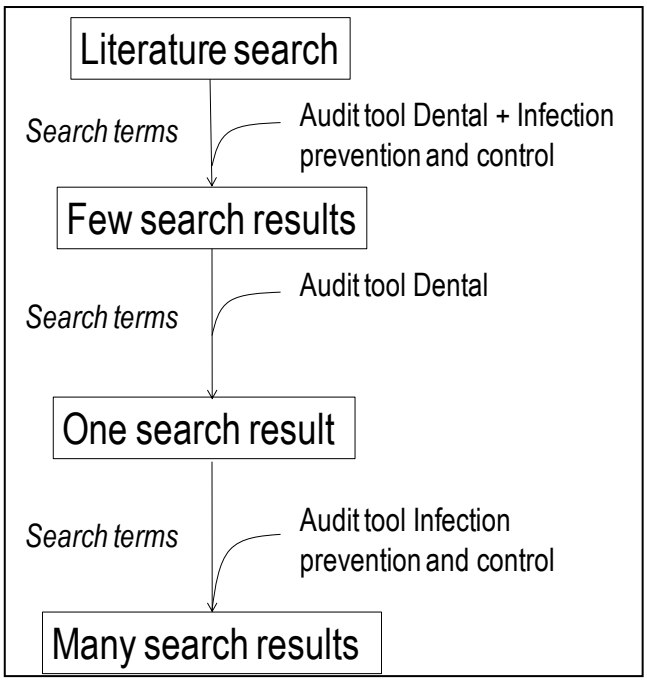



**FIGURE 5.2: Search process of audit tool literature**

The audit-feedback instruments that had been identified in the literature search were firstly screened for the presence of the focus areas addressed in the CDC Guidelines for infection control in dental health-care settings (2003), as well as in the new Department of Health United Kingdom (2013) Health Technical Memorandum 01-05: Decontamination in primary care dental practices. Thereafter, the selected literature was appraised based on the pre-determined criteria. These criteria were constructed taking into account the variety of oral health care facilities, which includes public and private oral health care and the diversity of training levels of oral health care personnel (Table 5.1).

**TABLE 5.1: Criteria for the appraisal of the literature**

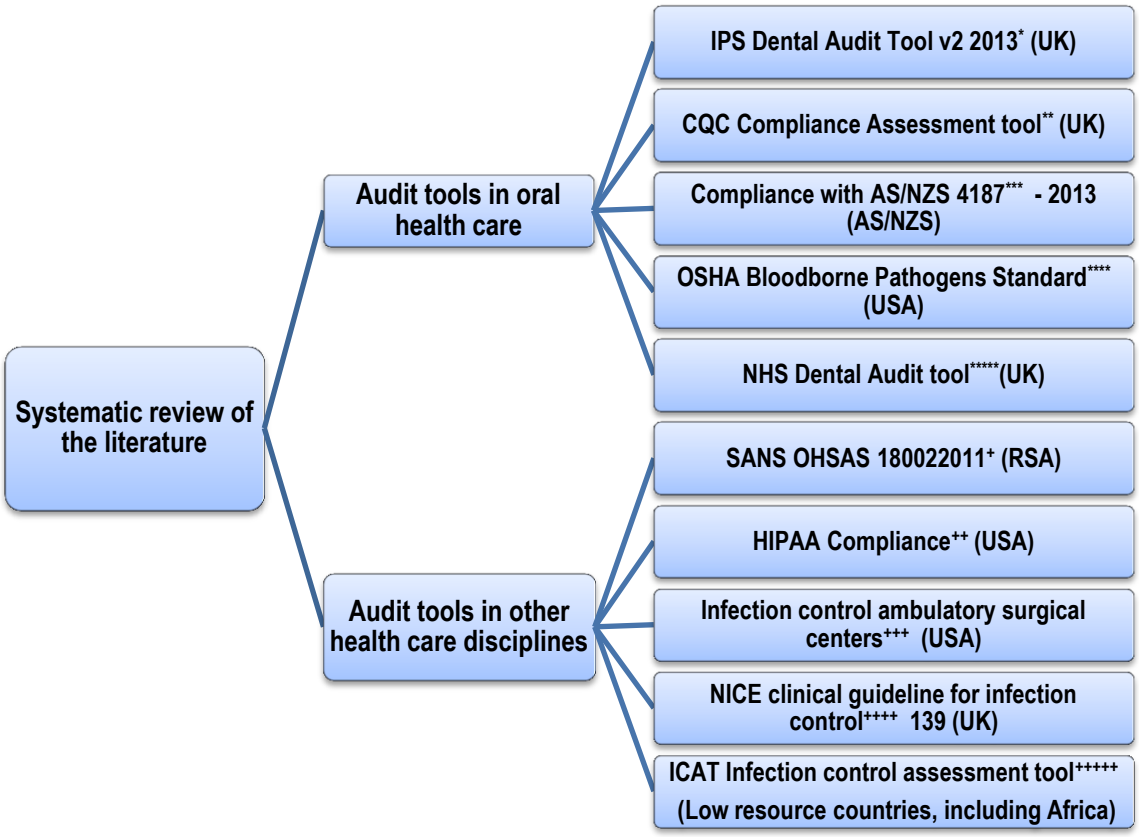
| Appraisal criterion | Justification |
|---|---|
| Illustrate compliance with infection prevention and control in the oral health care facility | This criterion was used for the initial selection of appropriate literature on the practical application of audit-feedback instruments in oral health care. |
| Simple language | An audit-feedback instrument was assessed in terms of the language used. In South African oral health care facilities users of the audit-feedback instrument would demonstrate a variety of levels of education, including cleaners, without any formal qualification, to practitioners with post graduate qualifications. Furthermore, in South Africa English is not the first language of many of the OHCWs. |
| Electronic calculations | An audit-feedback instrument was assessed for the use of electronic calculations to demonstrate the level of compliance. |
| User friendly | An audit-feedback instrument was assessed for its user-friendly application. A variety of OHCWs with different level of education, including dental practitioners, dental therapists, dental assistants, oral hygienists, dental technicians, dental students, dental practice managers, as well as employers and executive managers, would be using the audit-feedback instrument. Therefore a user-friendly instrument is required. |
| Feedback for managers | An audit-feedback instrument should provide understandable feedback to managers, to ensure that appropriate corrective actions can be implemented, if necessary. |
| Education opportunities for OHCWs | An audit-feedback instrument should provide knowledge and information to facilitate infection prevention and control in oral health care facilities, and support existing knowledge. |
| Improvement opportunities in the oral health care facility | An audit-feedback instrument should provide knowledge and information to ensure of quality and improved services in oral health care facilities. |

OHCWs = Oral health care workers

## 5.3 Results

The multi-phased literature search revealed the existence of 10 audit-feedback instruments, of which five were dedicated to oral health care and five to other health care disciplines. Of the 10 audit-feedback instruments selected, one originated in Africa, (for low resource countries), while the rest were from the United Kingdom, Australia / New Zealand and United States of America (Figure 5.3). None of the audit-feedback instruments developed to be used in Africa addressed infection prevention and control in oral health care facilities. However, the Infection Control Assessment Tool (ICAT) was developed by the United States Agency for International Development (USAID) for hospitals in low resource countries, including Africa, where limited resources may influence compliance with infection prevention and control (Strengthening Pharmaceutical Systems, 2009). Unfortunately, the specific demands and circumstances of infection prevention and control in oral health care facilities are not specifically dealt with in the ICAT.

The SANS OHSAS 180022011 were developed in South Africa as guidelines to manage occupational health and safety, and to implement the OHSAS 18001:2007 (South African National Standard, 2011).




*IPS Dental Audit Tool v2 (Infection Prevention Society, 2013)

**CQC Compliance Assessment tool (Care Quality Commission, 2014)

***Compliance with AS/NZS 4187 (Bacalja, 2013)

**** OSHA Bloodborne Pathogens Standard (American Dental Association; U.S. Department of Labour)

*****NHS Dental Audit tool (Department of Health and Infection Prevention Society, 2009)

+SANS OHSAS 180022011 (South African National Standard, 2011)

++ HIPAA Compliance (American Dental Association, 2013; U.S. Department of Health and Human Services, 2014)

+++Infection control ambulatory surgical centers (Centers for Disease Control, 2011)

++++NICE clinical guideline for infection control (NICE, 2012)

+++++ICAT Infection control assessment tool (Strengthening Pharmaceutical Systems, 2009)

**FIGURE 5.3: List of selected audit-feedback instruments**

After identification, the 10 selected audit-feedback instruments were assessed using the devised appraisal criteria. All selected audit-feedback instruments demonstrated mechanisms to provide feedback for managers (Table 5.2). The Infection Prevention Society (IPS) Dental audit tool was the only audit-feedback instrument that adhered to all the appraisal criteria, except for the required use of *simple language* (Infection Prevention Society, 2013). Most of the audit-feedback instruments can be

used by facilities as a *self-assessment* instrument. However, only two of the oral health care audit-feedback instruments provided a framework for *training* and *improvement of infection prevention and control compliance*.

**TABLE 5.2: Appraisal of selected audit-feedback instruments against specific criteria**

| | | Assessment criteria | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **Audit-feedback instrument** | Country of origin | Simple language | Self administered | Electronic calculations | User friendly for all OHCWs | Feedback for managers | Illustrate IC compliance in OHC | Education opportunity for OHCWs | Improvement opportunity n OHC |
| **Oral health care** | **IPS Dental Audit Tool** | **UK** | X | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| | **CQC Compliance Assessment tool** | **UK** | X | X | X | X | ✓ | X | X | X |
| | **AS/NZS 4187 2013 - GRICG infection control compliance audit** | **AS / NZS** | X | ✓ | X | X | ✓ | X | X | X |
| | **OSHA Blood borne Pathogens Standard 2012** | **USA** | X | X | X | X | ✓ | X | ✓ | ✓ |
| | **NHS Dental Audit tool** | **UK** | ✓ | ✓ | X | ✓ | ✓ | X | X | X |
| **Other health care disciplines** | **SANS OHSAS 180022011** | **RSA** | X | ✓ | X | X | ✓ | X | X | X |
| | **HIPAA Compliance** | **USA** | X | ✓ | X | X | ✓ | X | X | X |
| | **Infection control in ambulatory surgical centers** | **USA** | X | ✓ | X | X | ✓ | X | X | X |
| | **NICE clinical guideline for infection control 139** | **UK** | X | ✓ | X | X | ✓ | X | X | X |
| | **ICAT Infection control assessment tool** | **Low resource countries including Africa** | ✓ | ✓ | ✓ | X | ✓ | X | X | X |

## 5.4 Conclusion

In the researcher's opinion, the IPS Dental Tool version 2 (2013) is the most appropriate tool to form the basis for the development of an audit-feedback instrument for South Africa. This tool is a good example of a user-friendly, self administrating, electronic tool that provides feedback to managers, and opportunity for education and improvement in oral health care facilities. However, this tool is written in a highly technical and all-embracing language. Even though the NHS Dental Audit Tool (Department of Health and Infection Prevention Society, 2009) has been written as a self-assessment tool in quite a simple language, it still cannot be used as an example for the development of an audit-feedback instrument for South Africa, as the level of the language used is beyond the comprehension of many of the non-English speaking South African oral health care workers. Therefore, when developing an audit-feedback instrument for South Africa, particular attention should be given to the use of simple language.

## 5.5 References

American Dental Association ADA Complete OSHA Compliance Kit - K011. Retrieved from http://catalog.ada.org/productcatalog/399/OSHA-Infection-Control/ADA-Complete-OSHA-Compliance-Kit/K011.

American Dental Association (2013). The ADA Complete HIPAA Compliance Kit (J598). Retrieved 23 April, 2014, from http://catalog.ada.org/productcatalog/596/HIPAA/The-ADA-Complete-HIPAA-Compliance-Kit/J598.

Ayatollahi, J., Ayatollahi, F., Ardekani, A. M., Bahrololoomi, R., Ayatollahi, J., Ayatollahi, A., and Owlia, M. B. (2012). Occupational hazards to dental staff. *Dental Research Journal,* **9**(1), 2-7.

Bacalja, W. (2013, April 2013 ). GRICG - Dental Audit: Clinical Units Dental Practice 7. Retrieved 16 December, 2013, from http://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=0CCcQFjAA&url=http%3A%2F%2Fwww.grhc.org.au%2Fdocument-library%2Fdoc_download%2F375-gricg-dental-audit-april-2013-version-7&ei=gYBVU6AWo9jsBtvRgIgG&usg=AFQjCNHBTQfrRe3GlTrQyBeooW8BEP7sBQ&bvm=bv.65058239,d.ZGU&cad=rja.

Bradley, K., Fox, J., Wilson, J., Harris, T., Van Buskirk, K., and Schaefli, N. (2013). *Investigation of Healthcare-Associated Hepatitis C Virus Transmission in a Dental Surgical Clinic -- Oklahoma, 2013*. Paper presented at the 2013 Annual CSTE Conference - Epi on the Edge. from https://cste.confex.com/cste/2013/webprogram/Paper2450.html.

Care Quality Commission (2010). Provider compliance assessment tool. *Essential Standards* Retrieved 22 June, 2013, from http://www.cqc.org.uk/sites/default/files/media/documents/RP_PoC1B_100601_20100917_v5_00_Guidance_on_Provider_Compliance_Assessment.pdf.

Care Quality Commission (2014, 17 September 2010). Provider compliance assessment tool Retrieved 3 March, 2014, from http://www.cqc.org.uk/organisations-we-regulate/registered-services/how-we-monitor-compliance/gathering-information/provid.

Centers for Disease Control (2011). Infection Prevention Checklist for Outpatient Settings: Minimum Expectations for Safe Care. Retrieved 2013-04-03, from Centers for Disease Control and Prevention: http://www.cdc.gov/HAI/pdfs/guidelines/ambulatory-care-checklist-07-2011.pdf.

Centers for Disease Control (2013, 6 June 2013). Patient Notification Toolkit Retrieved 29 September, 2013, from http://www.cdc.gov/injectionsafety/pntoolkit/index.html.

Centers for Disease Control and Prevention (2003). Guidelines for infection control in dental health-care settings - 2003. [Recommendations and reports]. *Morbidity and Mortality Weekly Report,* **52**(Number RR-17), 1-68.

Close, R. M., Gray, S., Bennett, S., Appleby, S., Khana, F., Payned, C., and Olivere, I. (2013). What are the costs and benefits of patient notification exercises following poor infection control practices in dentistry? *Public Health*. Retrieved from http://www.sciencedirect.com/science/article/pii/S0033350613001649. doi:http://dx.doi.org/10.1016/j.puhe.2013.04.029.

Department of Health and Infection Prevention Society (2009). Local self-assessment audit implementation of HTM 01-05: decontamination of primary care dental practice and related infection prevention and control issues. Retrieved 16 December, 2013, from http://www.dhsspsni.gov.uk/htm_01-05_audit_tool.pdf.

Department of Health Republic of South Africa (2011). *Human resources for health South Africa. The HRH Strategy for the Health Sector: 2012/13 – 2016/17* from http://www.doh.gov.za/docs/stratdocs/2011/hrh_strategy.pdf.

Department of Health United Kingdom (2013a). Health Technical Memorandum 01-05: Decontamination in primary care dental practices. *Health Technical Memoranda*, 1-98. Retrieved from https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/170689/HTM_01-05_2013.pdf.

Department of Health United Kingdom (2013b). Health Technical Memorandum 07-01: Safe management of healthcare waste. *Health Technical Memoranda, 2013*, 1-187. Retrieved from https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/167976/HTM_07-01_Final.pdf.

Gross, K. B., Overman, P. R., Cobb, C., and Brockmann, S. (1992). Aerosol generation by two ultrasonic scalers and one sonic scaler: a comparative study. *Journal of Dental Hygiene,* **66**(7), 314-318.

Harrel, S. K., and Molinari, J. (2004). Aerosols and splatter in dentistry: A brief review of the literature and infection control implications. *Journal of the America Dental Association,* **135**(April), 429-437.

Infection Prevention Society (2013, 22 June 2013). Dental Audit Tool 2013 Edition. *IPS Infection Prevention Society* Second. Retrieved 16 December, 2013, from http://www.ips.uk.net/DentalAuditTool/2013%20Question%20Set.pdf.

Kohn, W. G., Collins, A. S., Cleveland, J. L., Harte, J. A., Eklund, K. J., and Malvitz, D. M. (2003). Centers for Disease Control and Prevention (CDC). Guidelines for infection control in dental health-care settings - 2003. *Morbidity and Mortality Weekly Report,* **52**(RR-17), 1-61.

Kohn, W. G., Harte, J. A., Malvitz, D. M., Collins, A. S., Cleveland, J. L., and Eklund, K. J. (2004). Guidelines for infection control in dental health care settings--2003. *Journal of the America Dental Association,* **135**(1), 33-47.

Malleshi, S. N., Joshi, M., Nair, S. K., and Ashraf, I. (2012, 2 September 2013). Clinical audit in dentistry: From a concept to an initiation. *Dental Research Journal* Retrieved 2 September, 2013, from http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3612211/?report=printable.

Manarte-Monteiroa, P., Carvalhoa, A., Pinab, C., Oliveiraa, H., and Manso, M. C. (2013). Air quality assessment during dental practice: Aerosols bacterial counts in an universitary clinic. *Revista Portuguesa de Estomatologia, Medicina Dentária e Cirurgia Maxilofacial,* **54**(1), 2-7.

McKay, E. (2005). *Results of a research report into HIV risk exposure of young children (2-9) to HIV in the Free State province* (Media release): Nelson Mandela Foundation.

National Department of Health (2005). *Department of Health National norms, standards and practice guidelines for primary oral health care. South Africa: 24 June 2005. Directorate Oral Health*.

National Department of Health (2007). The National Infection Prevention and Control Policy and Strategy, Department of Health, Republic of South Africa.

NICE (2012). Infection: prevention and control of healthcare-associated infections in primary and community care (CG139). Retrieved 16 December, 2013, from http://guidance.nice.org.uk/CG139.

Redfearn, I. (2012). Audit and the dental team. *Lancaster Audit Presentation 2012*. Retrieved from http://www.nwpgmd.nhs.uk/dentistry/courses/docs/Microsoft%20PowerPoint%20-%20Lancaster%20Audit%20Presentation%202012%20%282%29%20for%20upload%20%5BCompatibility%20Mode%5D.pdf.

Shisana, O., Mehtar, S., Mosala, T., Zungu-Dirwayi, M., Rehle, T., Dana, P., Colvin, M., Parker, W., Connolly, C., Dunbar, R., and Gxamza, F. (2005). *HIV risk exposure in children: A study of 2–9 year-olds served by public health facilities in the Free State, South Africa*. Cape Town: Human Sciences Research Council Press.

South African National Standard (2011). Occupational health and safety management systems - Guidelines for the implementation of OHSAS 18001:2007, *SANS OHSAS 18002:2011 Edition 1* (Vol. 5RB5, pp. 1-91). Pretoria: SABS Standards Division.

Strengthening Pharmaceutical Systems (2009). Infection Control Assessment Tool, 2nd Edition. *U.S. Agency for International Development by the Strengthening Pharmaceutical Systems Program. Arlington, VA: Management Sciences for Health*.

Szymańska, J., and Sitkowska, J. (2012). Bacterial hazards in a dental office: An update review. *African Journal of Microbiology Research,* **6**(8), 1642-1650.

U.S. Department of Health and Human Services (2014). Health Information Privacy: Audit Program Protocol Retrieved 16 December, 2013, from http://www.hhs.gov/ocr/privacy/hipaa/enforcement/audit/protocol.html.

U.S. Department of Labour. 1910 Occupational Safety and Health Standards: Bloodborne pathogens. Retrieved 23 April, 2014, from https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=10051.

# CHAPTER 6

# Construction of an audit-feedback instrument for oral health care in South Africa


## Summary

*This chapter highlights many gaps and a need to improve compliance with infection prevention and control in South African oral health care facilities. Audit-feedback instruments measuring compliance with infection prevention and control precautions are successfully applied worldwide. A systematic review of the literature on audit-feedback instruments with reference to infection prevention and control was undertaken. In a multi-phased literature search, 10 audit-feedback instruments were selected - five dedicated to oral health care and five to other health care disciplines. These audit-feedback instruments were scrutinised for user friendliness, the use of simple language, electronic calculations and feedback possibilities. In addition, a review of the recommendations and guidelines applied in developed countries was carried out in order to create the content supporting all aspects of infection prevention and control in oral health care facilities. The logical order of the content used in the Centers for Disease Control Guidelines for Infection Control for Dental Health Care Settings 2003, and detail taken from United Kingdom documents were used as the basis to create the audit-feedback instrument (AFI). The Infection Prevention Society Dental Tool, version 2 (2013) from the United Kingdom, was identified as the most appropriate structural example for the development of a South African AFI. The newly proposed AFI covers 11 focus areas, including administrative controls; personnel protection controls; environmental- and work controls; surface contamination management; equipment maintenance, service or repair; air- and waterline management; personal protective equipment usage; personal and hand hygiene practices; sterilisation practices; safe sharps handling and waste management.*


***Keywords:*** *Audit tool; dental; oral health care; infection control compliance*

## 6.1 Introduction

Audit-feedback instruments measuring compliance with infection prevention and control precautions are successfully applied worldwide (SUPPORT, 2008; Strengthening Pharmaceutical Systems, 2009; NICE, 2012; Infection Prevention Society, 2013). In a multi-phased literature search, 10 audit-feedback instruments were selected, of which five were dedicated to oral health care and five to general health care disciplines (Chapter 5). After scrutinising the 10 audit-feedback instruments for their user friendliness, use of simple language, electronic calculations and feedback possibilities, the Infection Prevention Society (IPS) Dental Tool version 2 (2013) from the United Kingdom (UK) was identified as the most appropriate structural example for the development of a South African audit-feedback instrument (AFI) (Infection Prevention Society, 2013).

A review of the recommendations and guidelines used in developed countries was undertaken as basis for the content supporting all aspects of infection prevention and control in oral health care facilities. This content was then used to construct a South African AFI.

## 6.2 Methods

### *6.2.1 Development of content guidelines in developing the AFI*

Many first world countries, including the United States of America (USA), United Kingdom (UK), Australia and New Zealand (AS / NZS), have specific recommendations and guidelines for oral health care professionals that guide them with regard to the best practices in preventing and controlling disease transmission:

- In the USA, the Centers for Disease Control (CDC) Guidelines for Infection Control for Dental Health Care Settings, 2003, and Disinfection and Sterilization in Healthcare Facilities, 2008, are used.
- In the UK, the British Dental Association (BDA) Sheet A12: Infection control in dentistry and Department of Health's HTM 01-05 are applied.
- In AS / NZS, the Australian and New Zealand Standard 4815:2006 is used.

These recommendations and guidelines were initially scrutinised to assess which provide the most comprehensive coverage of infection prevention and control precautions in oral health care (Table 6.1). Thereafter, the documents were evaluated further for language use, logical work order and other aspects that may be of use when constructing an AFI. Both the USA and UK documents were most

informative, although the use of scientific and highly technical language would be beyond the understanding of many South African oral health care workers, for whom English is not their first language of use. The UK documents provided insights into the association between the guiding documents and an audit-feedback instrument. The AS / NZS document is mainly written as a Standard, rather than a directive providing recommendations and guidelines for infection prevention and control. This document provided limited coverage of aspects regarding infection prevention and control as applied in oral health care facilities, focussing only on sterilisation and maintenance of the hygienic environment.

**TABLE 6.1: Scrutiny of USA, UK and AS / NZS recommendations and guidelines for infection prevention and control**

| **Centers for Disease Control (CDC)**<br>(Guidelines for Infection Control for Dental Health Care Settings, 2003 and Disinfection and Sterilization in Healthcare Facilities, 2008) | **British Dental Association (BDA) UK Department of Health**<br>(Sheet A12: Infection control in dentistry, 2011 and DoH's HTM 01-05 / 07, 2013) | **Standards Australia / Standards New Zealand**<br>(AS / NZS 4815, 2006) |
|---|---|---|
| • Comprehensive coverage of infection prevention and control precautions in oral health care<br>• Scientific, evidence-based content<br>• Standard operating procedures are provided<br>• Practical, logical work order<br>• Use of scientific and highly technical language | • Comprehensive coverage of infection prevention and control precautions in oral health care<br>• Focus linked to an audit tool<br>• Use of scientific and highly technical language | • Coverage only of sterilisation and hygienic maintenance of the environment<br>• Use of highly technical language |

The information in the USA and UK documents was assessed again for their potential use as supporting documents for the construction of a South African AFI. The scientific and highly technical contents of these documents necessitated the development of recommendations and guidelines more suitable for the South African context, considering the diversity of training levels of personnel, the vast differences in available resources between rural and urban facilities, and the miscellany of public and private oral health care facilities, and the unique burden of disease.

The logical order of the CDC guideline for infection control in dentistry (Centers for Disease Control and Prevention, 2003) and the comprehensive detail of the contents were used to guide the construction of the AFI guidelines for infection prevention and control. The contents were further supplemented with

detail taken from the UK documents (British Dental Association, 2011; Department of Health United Kingdom, 2013a, 2013b).

The following criteria were used to support the development of these recommendations and guidelines:

- Comprehensive coverage of infection prevention and control in oral health care
- The practical logical order applied by the CDC documents (Centers for Disease Control and Prevention, 2003)
- South African legislation and regulations
- Simplicity of language.

The infection prevention and control guidelines used as supporting document for the construction of the AFI have been included in Appendix C.

### *6.2.2 Construction of the AFI*

The AFI was constructed using the formatting criteria proposed in Chapter 5, as well as the contents of existing infection prevention and control guidelines, written for the South African context.

## 6.3 Outcome

### *6.3.1 Introduction*

The AFI commences with a section “About this audit-feedback instrument”, providing the reader with instructions on how to use the instrument. This section is followed by a form to be completed, requesting general demographic details about the facility being audited, and details about the auditor(s) responsible for the auditing process. This form is followed by scoring tables, which address the different focus areas of infection prevention and control:

Focus area 1: Administrative Controls
Focus area 2: Personnel Protection Controls
Focus area 3: Environmental- and Work Controls
Focus area 4: Surface Contamination Management
Focus area 5: Equipment Maintenance
Focus area 6: Air- and Waterline Management
Focus area 7: Personal Protective Equipment Usage
Focus area 8: Personal- and Hand Hygiene Practices

Focus area 9: Sterilisation Practices

Focus area 10: Safe Sharps Handling

Focus area 11: Waste Management

Page 2 provides the overall average score of the audit, which is calculated using the arithmetic mean of the 11 focus areas.

### *6.3.2 Audit-feedback instrument - Instructions*

**About this audit-feedback instrument:**

This instrument is intended to assist oral health care teams to audit and monitor compliance to best practices in infection prevention and control precautions.

Instructions on how to complete this audit-feedback instrument:

- It is recommended that every oral health care team should complete this audit twice a year.
- On page 1, the Introduction page, supply details of your specific facility and respond YES or NO to questions, or tick where appropriate and write down details of the facility as asked.
- Page 2 provides a colour link to the different focus areas of the audit-feedback instrument.
- Results / findings for each focus area will be transferred to the score table on page 2 and a final score calculated by the spreadsheet.
- After completion of the audit-feedback instrument, you will receive a report of the findings.
- It is imperative to identify gaps in systems or to point out processes that are not working satisfactorily. Notes can be added in the comments columns provided. This will allow the facility manager to identify priority areas that may need remedial action.

### 6.3.3 *Audit-feedback instrument – demographic details*

**Please complete the details requested below;**
**or choose from the list (indicate your choice by ticking "X" in the appropriate box):**

## ORAL HEALTH CARE FACILITY DETAILS:

**1. Type of facility:**

| | | | | | |
|---|---|---|---|---|---|
| Private practice (solo Dr) | | Public health clinic | | Number of Drs | |
| Private practice (multi Dr) | | Mobile clinic | | | |
| Private clinic / centre | | Training institution | | | |
| Other | | Specify type: | | | |

**2. Name of the person completing this audit form:** _____

Contact details: _____ Capacity: _____

**3. Date when this audit was completed:** _____

**4. Does your facility have an infection prevention and control coordinator?**

Yes ☐ No ☐ If Yes, specify name: _____

**5. The person overseeing quality control re infection prevention and control of this facility:**

| | | | |
|---|---|---|---|
| Practitioner (self) | | Oral hygienist | |
| Dental assistant | | Cleaning person | |
| Dental therapist | | Central sterilisation nurse | |
| Other | | Specify designation other: | |

**6. Have personnel attended infection prevention and control training during the past calendar year?**

Yes ☐ No ☐ If Yes, specify: _____

**7. Name of the facility:** _____ **Manager:** _____

| | | | |
|---|---|---|---|
| Postal address: | | | |
| | | Postal Code: | |
| Tel no: | ( ) | | |
| Fax no: | ( ) | | |
| Cell number: | | | |
| E-mail: | | | |
| Contact person: | | Capacity: | |

### *6.3.4 Audit-feedback instrument – Score tables*

## SCORE TABLE – INDEX TO AUDIT FOCUS AREAS

This sheet acts as an index for all the focus areas in the audit-feedback instrument. Each focus area on this page provides a direct link to the focus area page. As the audit-feedback instrument is completed, the final scores are calculated automatically.

| | **FOCUS AREA** | **%** |
|---|---|---|
| 1. | Administrative Controls | 0.0 |
| 2. | Personnel Protection Controls | 0.0 |
| 3. | Environmental- and Work Controls | 0.0 |
| 4. | Surface Contamination Management | 0.0 |
| 5. | Equipment Maintenance | 0.0 |
| 6. | Air- and Waterline Management | 0.0 |
| 7. | Personal Protective Equipment Usage | 0.0 |
| 8. | Personal- and Hand Hygiene Practices | 0.0 |
| 9. | Sterilisation Practices | 0.0 |
| 10. | Safe Sharps Handling | 0.0 |
| 11. | Waste Management | 0.0 |
| | **Overall average score** | **0.0** |

## FOCUS AREA 1 – ADMINISTRATIVE CONTROLS

| | | YES | NO | N/A | Comments |
|---|---|---|---|---|---|
| **1.** | **Does the facility keep the following reference documents?**<br>Constitution of the Republic of South Africa Act, 108 of 1996 | | | | |
| | Occupational Health and Safety Act, 85 of 1993 | | | | |
| | National Environmental Management: Waste Act, 59 of 2008 | | | | |
| | Environmental Conservation Act, 73 of 1989 | | | | |
| | Compensation for Occupational Injuries and Health Diseases Act, 130 of 1993 | | | | |
| | Hazardous Substances Act, 15 of 1973 | | | | |
| | Human Tissue Act, 65 of 1983 | | | | |
| | Health Professions Act, 56 of 1974 | | | | |
| | Skills Development Levies Act, 9 of 1999 | | | | |
| | Code of Good Practice on key aspects of HIV and AIDS and Employment Regulation | | | | |
| | Consumer Protection Act of 2008 | | | | |
| **2.** | **Does the facility keep the following administrative documentation?**<br>Annual chemical inventory | | | | |
| | Material Safety Data Sheets (MSDSs) for all chemicals used | | | | |
| | Equipment monitoring and maintenance records | | | | |
| **3.** | **Does the facility have the following infection prevention and control measures in place?**<br>Written standard operating procedures for infection prevention and control | | | | |
| | Easy access to standard operating procedures for infection prevention and control | | | | |
| | Annual review and update of the standard operating procedures for infection prevention and control | | | | |
| | A designated supervisor / coordinator for infection prevention and control | | | | |
| **4.** | **Does the facility keep the following records of sterilisation, verification and monitoring?**<br>Sterilisation logs with dates and times of the individual loads | | | | |
| | Users' manual for the specific steriliser utilised | | | | |
| | Physical parameters of sterilising equipment observed | | | | |
| | Proof of use of chemical indicators | | | | |
| | Proof of use / results of the biological indicators | | | | |
| **5.** | **Does the facility keep the following records of health care risk waste management?**<br>Description of waste categories | | | | |
| | Total quantities and categories of waste transported | | | | |
| | Waste shipping dates | | | | |
| | Details of independent waste transporter used – address and permit- or ID number | | | | |
| | Signed documentation of the representative accepting the waste for transport and disposal | | | | |
| | SCORE | 0 | 0 | 0 | |
| | SCORE % | 0 | 0 | 0 | |
| | | 0 | | | |

## FOCUS AREA 2 – PERSONNEL PROTECTION CONTROLS

| | | YES | NO | N/A | Comments |
|---|---|---|---|---|---|
| **1.** | **Do personnel undergo training in standard precautions and operating procedures as follows?**<br>Within the first 3 months from date of appointment | | | | |
| | In standard infection prevention and control precautions, provided at least annually | | | | |
| | When new tasks, procedures or equipment affect occupational exposure | | | | |
| **2.** | **Does the facility have written registers and records of training sessions for at least three years?** | | | | |
| **3.** | **Does the facility have updated records of the following?**<br>Each personnel member's risk category | | | | |
| | Updated confidential health record of all personnel members | | | | |
| | Hepatitis B vaccination (3 dose series, with booster every 5 years) | | | | |
| | MMR (measles / mumps / rubella) vaccination | | | | |
| | Tetanus vaccination (with booster every 10 years) | | | | |
| | Annual influenza (flu) vaccination | | | | |
| **4.** | **Does the facility have a written protocol for medical conditions, work related illness and work restrictions?** | | | | |
| | Do personnel members know when they are excluded from duties involving patient care? | | | | |
| **5.** | **Does the facility have a written protocol for occupational exposures or incidents?** | | | | |
| | Is every occupational exposure or incident recorded, e.g. sharps injuries? | | | | |
| | Is there record of post-exposure management? | | | | |
| | Is there record of medical follow-up? | | | | |
| | SCORE | 0 | 0 | 0 | |
| | SCORE % | 0 | 0 | 0 | |
| | | 0 | | | |

## FOCUS AREA 3 – ENVIRONMENTAL- AND WORK CONTROLS

| | | YES | NO | N/A | Comments |
|---|---|---|---|---|---|
| **1.** | **Does the facility have a specific written protocol and arrangement for medical emergencies?** | | | | |
| | Are emergency contact details displayed in each clinical room, e.g. next to the telephone? | | | | |
| **2.** | **Does the facility have a written protocol for safe working practices?** | | | | |
| | Are standard infection prevention and control precautions applied in all patient procedures? | | | | |
| **3.** | **Does the facility have a specific written protocol for application of disposable / single-use items?** | | | | |
| **4.** | **Does the facility take measures to reduce bacteria laden aerosols at chair side?** | | | | |
| | Do all patients brush their teeth and use mouth rinse prior to procedures? | | | | |
| | Do personnel wear face shields / visors when using the ultrasonic scaler, high-speed handpiece or surgical equipment? | | | | |
| | Is high-volume evacuation applied when using dental handpieces or other spatter generating devices? | | | | |
| | Are disposable / single-use items applied as far as possible? | | | | |
| | Is dental dam applied when restorative procedures are done? | | | | |
| | Are the ultrasonic cleaner or other containers with chemicals covered with a lid? | | | | |
| **5.** | **Does the facility apply the following environmental controls:**<br>Risk areas are clearly marked with the biohazard sign | | | | |
| | Are all containers with contaminated items clearly marked with the biohazard sign? | | | | |
| | Are new devices with injury protection considered for use in the facility at least annually? | | | | |
| | Are non-managerial employees also involved in the process of identifying safer devices for use? | | | | |
| | Are written records of the inputs from employees during evaluation of safer devices available? | | | | |
| **6.** | **Does the facility apply the following work practice controls:**<br>Identify and change unsafe work practices? | | | | |
| | Review the circumstances surrounding adverse events, personnel / patient injuries and “near miss” incidents? | | | | |
| | Are there written records of suggested improvements to prevent recurring incidents? | | | | |
| **7.** | **Is the following treatment planning and time-management applied during patient care:**<br>Aseptic retrieval of items from containers or drawers by using sterile forceps? | | | | |
| | Barrier protection of drawer handles? | | | | |
| | Unit dosing of disposables, consumables, instruments and materials for standard procedures? | | | | |

| | | | | | |
|---|---|---|---|---|---|
| **8.** | **Is the design of areas in the facility adapted to accommodate one directional traffic flow and prevention of cross-contamination with the following:**<br>Instrument processing is done in a separate / designated area | | | | |
| | The processing area is divided into separate zones to facilitate working from 'dirty' to 'clean' | | | | |
| | Barrier protection is applied to frequent-touch areas? | | | | |
| | Wrapped, processed (sterile / surgically clean) items stored in a designated clean, dry, enclosed area | | | | |
| | SCORE | 0 | 0 | 0 | |
| | SCORE % | 0 | 0 | 0 | |
| | | 0 | | | |

## FOCUS AREA 4 – SURFACE CONTAMINATION MANAGEMENT

| | | YES | NO | N/A | Comments |
|---|---|---|---|---|---|
| **1.** | **Does the facility have a *written* protocol for management of clinical contact surfaces, e.g. an environmental cleaning or housekeeping policy / procedure?** | | | | |
| | Are protective barriers such as clear plastic wrap, foil, bags, sheets, tubing, plastic-backed paper or other moisture resistant materials applied on clinical touch, transfer, splash, splatter and droplet surfaces? | | | | |
| | Are protective barriers for clinical contact surfaces replaced routinely? | | | | |
| | If contaminated, are clinical contact surfaces cleaned and disinfected before placing new barriers? | | | | |
| **2.** | **Does the facility have a *written* schedule for cleaning of housekeeping surfaces?** | | | | |
| | Are all housekeeping surfaces e.g. floors, walls and basins cleaned according to policy? | | | | |
| | Is cleaning equipment, e.g. mops, pads and cloths cleaned after each use? | | | | |
| | Is cleaning equipment e.g. mops, pads and cloths stored dry? | | | | |
| **3.** | **Does the facility have a *written* protocol for management of radiographic equipment and surfaces?** | | | | |
| | Are manufacturers' instructions followed for cleaning, disinfection, and / or sterilisation of radiographic devices? | | | | |
| | Are protective barriers used on digital sensors during use on a patient? | | | | |
| | Are protective barriers removed after each use? | | | | |
| | Are sensors disinfected with an intermediate-level disinfectant after each use? | | | | |

| | | | | | |
|---|---|---|---|---|---|
| **4.** | **Does the facility have a *written* protocol for appliances and materials entering or leaving the premises?** | | | | |
| | Are laboratory items used on patients, such as dentures, cleaned and sterilised? | | | | |
| | Are impression materials cleaned and disinfected prior to being sent to the laboratory? | | | | |
| | Are impressions and other patient care items transported in waterproof bags / closed containers? | | | | |
| | Are biopsy specimens placed in a sturdy, leak proof container for transport? | | | | |
| **5.** | **Are surfaces of dental chairs in a good state of repair?** | | | | |
| | If YES, are their covers and surfaces visibly clean? | | | | |
| 6. | Are the floor surfaces of the clinical-, processing and laboratories without carpeting? | | | | |
| 7. | Are furniture of the clinical-, processing areas and laboratories without cloth upholstery? | | | | |
| 8. | Can surfaces in clinical areas be wiped or washed? | | | | |
| 9. | Are the kitchen and personnel areas used exclusively for refreshment and recreational purposes? | | | | |
| **10.** | **Can the toys provided to patients be wiped or machine washed?** | | | | |
| | If YES, are these clean and in good state of repair? | | | | |
| **11.** | **Have personnel been instructed on selecting appropriate chemical disinfectants to clean surface contamination?** | | | | |
| | If YES, is intermediate-level disinfectant available to deal with blood spillage? | | | | |
| | If YES, are fresh mixtures of germicides prepared according to the manufactures' guidelines? | | | | |
| 12. | Are containers washed inside and disinfected before re-filling again? | | | | |
| 13. | Are chemical disinfectants used only for heat liable equipment and surfaces? | | | | |
| 14. | Are disinfectants allowed to remain on surfaces for the contact time prescribed by the manufactures? | | | | |
| | SCORE | 0 | 0 | 0 | |
| | SCORE % | 0 | 0 | 0 | |
| | | 0 | | | |

# SUGGESTED LIST OF ITEMS FOR HOUSEKEEPING

| 1. | RECEPTION / WAITING ROOM & ADMINISTRATIVE AREAS | YES | NO | N/A | Comments |
|---|---|---|---|---|---|
| | Carpets visibly clean | | | | |
| | Windows and window sills visibly clean | | | | |
| | Floors and walls visibly clean | | | | |
| | Fresh air and ventilation maintained | | | | |
| | Furniture visibly clean and in good state of repair | | | | |
| | Telephones visibly clean | | | | |
| | Doors / door handles visibly clean | | | | |
| | Lights and fittings visibly clean | | | | |
| | Toys / decorations can be wiped or machine washable; visibly clean and in good state of repair | | | | |
| | Room is uncluttered and free from extraneous items | | | | |
| **2.** | **PASSAGE / CORRIDORS** | **YES** | **NO** | **N/A** | **Comments** |
| | Floors and walls visibly clean / well maintained | | | | |
| | Air vent visibly clean / well maintained | | | | |
| | Doors visibly clean / well maintained | | | | |
| | Light and fittings visibly clean / well maintained | | | | |
| | Windows and window sills visibly clean / well maintained | | | | |
| | No waste stored in passages / corners | | | | |
| **3.** | **STORE ROOMS** | **YES** | **NO** | **N/A** | **Comments** |
| | Shelves visibly clean / well maintained | | | | |
| | Floors and walls visibly clean / well maintained | | | | |
| | Equipment visibly clean / well maintained | | | | |
| | No stock stored directly on floor | | | | |
| | Door locked | | | | |
| **4.** | **PERSONNEL LOUNGE / EATING AREAS** | **YES** | **NO** | **N/A** | **Comments** |
| | Basins visibly clean inside and outside / well maintained | | | | |
| | Soap dispenser visibly clean and soap available / well maintained | | | | |
| | Plug and plug hole visibly clean | | | | |
| | Basin pipes visibly clean / well maintained | | | | |
| | Paper towels available | | | | |
| | Waste bins visibly clean and lined with correct colour plastic liner | | | | |
| | No dirty crockery and cutlery on work surfaces | | | | |
| | Kettle / urn visibly clean / well maintained | | | | |
| | Furniture visibly clean / well maintained | | | | |
| **5.** | **KITCHEN/S** | **YES** | **NO** | **N/A** | **Comments** |
| | Floors and walls visibly clean / well maintained | | | | |
| | Fridge visibly clean and used functionally correct (2-8°C) | | | | |
| | Waste bins visibly clean and lined with correct colour plastic liner | | | | |
| | Cupboards visibly clean and neat / well maintained | | | | |
| | No unnecessary equipment in the kitchen | | | | |
| | Kettle / urn and other equipment visibly clean and neat / well maintained | | | | |

| 6. | OFFICES | YES | NO | N/A | Comments |
|---|---|---|---|---|---|
| | Carpets visibly clean / well maintained | | | | |
| | Floors and walls visibly clean / well maintained | | | | |
| | Window and window sills visibly clean / well maintained | | | | |
| | Air conditioners / vents visibly clean and filters maintained | | | | |
| | Furniture visibly clean / well maintained | | | | |
| | Doors visibly clean / well maintained | | | | |
| | Waste bins visibly clean and lined with correct colour plastic liner | | | | |
| **7.** | **STERILISATION AREA** | **YES** | **NO** | **N/A** | **Comments** |
| | Floors and walls visibly clean and dry / well maintained | | | | |
| | Hand washing facilities visibly clean / well maintained | | | | |
| | Instrument washing facilities visibly clean / well maintained | | | | |
| | Holding solutions and detergents replaced daily | | | | |
| | Soap dispenser visibly clean / well maintained and soap available | | | | |
| | Clean, dry paper towels available | | | | |
| | Waste bins clean and lined with correct colour plastic liner | | | | |
| | Sharps container available and lined with correct colour plastic liner | | | | |
| | Sharps container replaced when filled up to 2/3 fill line | | | | |
| | Lubrication for handpieces and forceps used / available | | | | |
| **8.** | **BATHROOM / TOILET AREAS (PERSONNEL AND PATIENTS)** | **YES** | **NO** | **N/A** | **Comments** |
| | Floors, cupboards and walls visibly clean and dry / well maintained | | | | |
| | Hand washing facilities and basins visibly clean / well maintained | | | | |
| | Soap dispenser visibly clean / well maintained and soap available | | | | |
| | Clean, dry paper towels available | | | | |
| | Waste bins visibly clean and lines with correct colour plastic liner | | | | |
| | Toilet facilities visibly clean – including under the ring / well maintained | | | | |
| | Mirrors visibly clean / well maintained | | | | |
| | Lights and fittings visibly clean and I working order | | | | |
| | Doors visibly clean and in working order | | | | |
| | Fresh air and ventilation ensured and maintained | | | | |
| | Toilet paper available | | | | |
| **9.** | **CLINICAL OR PROCEDURAL AREAS** | **YES** | **NO** | **N/A** | **Comments** |
| | All horizontal surfaces are dust free and visibly clean / well maintained | | | | |
| | Floors and walls visibly clean and dry / well maintained | | | | |
| | Hand washing facilities and basins visibly clean / well maintained | | | | |
| | Soap dispenser visibly clean / well maintained and soap available | | | | |
| | Clean, dry paper towels available | | | | |
| | Room is uncluttered and free from items on countertops | | | | |
| | Windows and window sills visibly clean / well maintained | | | | |
| | Fresh air and ventilation ensured and maintained | | | | |
| | Dental chair, headrest and stools are visibly clean and in good repair | | | | |
| | Telephones visibly clean / well maintained | | | | |

| | | | | | |
|---|---|---|---|---|---|
| | Doors / door handles visibly clean / well maintained | | | | |
| | Lights and fittings visibly clean | | | | |
| | Waste bins visibly clean and lined with correct colour plastic liners | | | | |
| | Sharps container available & lined with correct colour plastic liners | | | | |
| **10.** | **LABORATORY** | **YES** | **NO** | **N/A** | **Comments** |
| | Local exhaust is maintained in areas where grinding, dry polishing, or buffing occurs | | | | |
| | All horizontal surfaces are dust free and visibly clean / well maintained | | | | |
| | Floors and walls visibly clean and dry / well maintained | | | | |
| | Hand washing facilities and basins visibly clean / well maintained | | | | |
| | Soap dispenser visibly clean / well maintained and soap available | | | | |
| | Clean, dry paper towels available | | | | |
| | Room is uncluttered and free from items on countertops | | | | |
| | Windows and window sills visibly clean / well maintained | | | | |
| | Fresh air and ventilation ensured and maintained | | | | |
| | Chair, storing facilities and equipment are visibly clean and in good repair | | | | |
| | Telephones visibly clean/ well maintained | | | | |
| | Doors visibly clean / well maintained | | | | |
| | Lights and fittings visibly clean / well maintained | | | | |
| | Waste bins visibly clean and lined with correct colour plastic liners | | | | |
| | Sharps container available & lined with correct colour plastic liner | | | | |
| **11.** | **OTHER** | **YES** | **NO** | **N/A** | **Comments** |
| | All posters on walls are wipeable and visibly clean | | | | |
| | Notice boards visibly clean / well maintained | | | | |
| **12.** | **EQUIPMENT** | **YES** | **NO** | **N/A** | **Comments** |
| | Cleaning materials / containers are clean and labelled | | | | |
| | Cleaning equipment clean / well maintained | | | | |
| | Colour coding applied correctly | | | | |
| | Stored visibly clean and dry | | | | |
| | Store room floors and walls visibly clean / well maintained | | | | |
| | Basin visibly clean inside and outside / well maintained | | | | |
| | Mops and brooms visibly clean / well maintained | | | | |
| | Buckets visibly clean and dry / well maintained | | | | |
| | Dusting equipment visibly clean / well maintained | | | | |
| | Waste bin visibly clean / well maintained | | | | |
| | Plastic bags available (all 4 colours) | | | | |
| | Vacuum cleaner visibly clean / well maintained | | | | |
| | Buffing machine visibly clean / well maintained | | | | |
| | SCORE | 0 | 0 | 0 | |
| | SCORE % | 0 | 0 | 0 | |
| | | | 0 | | |

## FOCUS AREA 5 – EQUIPMENT MAINTENANCE, SERVICE OR REPAIR

| | | YES | NO | N/A | Comments |
|---|---|---|---|---|---|
| 1. | Do personnel know where to locate the manufacturer's user guides on equipment? | | | | |
| 2. | Is the cleaning and sterilising of equipment on a planned / scheduled maintenance programme? | | | | |
| | Is there evidence of the routine monitoring, calibration and performance testing by a trained service technician? | | | | |
| 3. | Is sterilising equipment checked both physically / chemically and the results recorded daily / sessionally? | | | | |
| | Is there written record of the monitoring kept for a minimum legal period, e.g. 5 years? | | | | |
| 4. | Is sterilising equipment checked biologically at least weekly and the results recorded? | | | | |
| | Is there written record of the monitoring? | | | | |
| 5. | Is sterilising equipment visibly clean and in good state of repair? | | | | |
| 6. | Are visibly clean and sterile instruments stored separately in sealed containers / packets? | | | | |
| 7. | Are ultrasonic cleaners emptied daily and kept dry overnight? | | | | |
| 8. | Is the spittoon flushed and decontaminated after each patient? | | | | |
| 9. | Is the suction machine decontaminated between each use and kept visibly clean and dry? | | | | |
| 10. | Is the cleaning equipment checked physically daily and the results recorded? | | | | |
| | Is there written record of the monitoring? | | | | |
| | SCORE | 0 | 0 | 0 | |
| | SCORE % | 0 | 0 | 0 | |
| | | 0 | | | |

## FOCUS AREA 6 – AIR- AND WATERLINE MANAGEMENT

| | | YES | NO | N/A | Comments |
|---|---|---|---|---|---|
| 1. | Are all air / water lines flushed with air / water for 2-3 minutes each morning? | | | | |
| 2. | Are all air / water lines flushed with air / water for 20 to 30 seconds after use on each patient? | | | | |
| 3. | Is there proof that that the facility has installed anti-retraction valves in all the dental units? | | | | |
| 4. | Are closed water reservoir systems used in all the dental units? | | | | |
| | Is there written technical record of regular water reservoir system maintenance? | | | | |
| 5. | Are all chair side line-filters visibly clean? | | | | |
| | Is there written record of the maintenance of the above by the cleaner? | | | | |
| 6. | Is there proof that sterile irrigating solutions or saline delivery systems are used for all surgical procedures? | | | | |
| 7. | Does the facility have a system in place to regularly monitor water quality? | | | | |
| | Is there written record of the water quality testing? | | | | |
| 8. | Is there proof that personnel are trained on effective waterline treatment measures? | | | | |
| 9. | Does the facility have a written action plan in case of a boil water alert? | | | | |
| | Is there written record of regular training / follow-up training in case of a boil water alert? | | | | |
| 10. | Is there proof that handpieces and other dental unit instruments are cleaned and heat-sterilised after each patient use? | | | | |
| 11. | Are patients advised to keep their lips open around the tip of the saliva ejector while evacuating oral fluids? | | | | |
| 12. | Is there proof that new disposable air / water syringe tips are used for each patient procedure? | | | | |
| | SCORE | 0 | 0 | 0 | |
| | SCORE % | 0 | 0 | 0 | |
| | | | 0 | | |

## FOCUS AREA 7 – PERSONAL PROTECTIVE EQUIPMENT (PPE)

| | | YES | NO | N/A | Comments |
|---|---|---|---|---|---|
| 1. | Is there proof that PPE (gloves, masks, eyewear and clothing) is provided to at-risk personnel? | | | | |
| | If YES, are these available in appropriate sizes? | | | | |
| | Is there proof that alternative equipment is available for persons with latex sensitivities? | | | | |
| 2. | Is there proof that all PPE is provided at no cost to at-risk personnel? | | | | |
| 3. | Is there proof that the same types of PPE are worn for all patient care procedures, regardless of medical history? | | | | |
| 4. | Is there proof that personnel have been instructed on the appropriate sequence of putting on and removal of PPE? | | | | |
| 5. | Is there proof that all clinical personnel put on gloves and mask for each patient procedure? | | | | |
| 6. | Are sterile gloves available for use during surgical treatments? | | | | |
| 7. | Are disposable plastic over gloves available for personnel? | | | | |
| 8. | Is there proof that disposable gloves are changed between every patient treatment? | | | | |
| 9. | Is there proof that gloves are worn by personnel when handling saliva contaminated radiographic film packets? | | | | |
| 10. | Is there proof that puncture-resistant utility gloves, a mask and eyewear are worn when cleaning and disinfecting used equipment? | | | | |
| 11. | Is there proof that puncture resistant utility gloves are worn when hand scrubbing instruments? | | | | |
| 12. | Is there proof that puncture resistant utility gloves and protective clothing is worn when handling waste? | | | | |
| 13. | Is there proof that eye protection with solid side shields or a face shield is worn during patient care? | | | | |
| 14. | Is there proof that patients are provided with eye protection to wear during dental procedures? | | | | |
| 15. | Is there proof that the patients' protective eyewear is cleaned following every patient treatment? | | | | |
| 16. | Is there proof that disposable masks are changed between each patient treatment? | | | | |
| 17. | Is there proof that high-filtration surgical masks are worn when doing laser / electro surgery? | | | | |
| 18. | Is there proof that full face shields are worn when doing laser / electro surgery? | | | | |
| 19. | Is there proof that smoke exhaust systems with a high-efficiency filter is used to remove laser-plume particles? | | | | |
| 20. | Is laundering / washing of protective clothing managed by facility? | | | | |
| 21. | Are there facilities available that protective clothing can be changed and stored at the facility? | | | | |
| 22. | Is there proof that disposable plastic aprons are freely available daily for personnel? | | | | |
| | SCORE | 0 | 0 | 0 | |
| | SCORE % | 0 | 0 | 0 | |
| | | 0 | | | |

## FOCUS AREA 8 – PERSONAL- AND HAND HYGIENE PRACTICES

| | | YES | NO | N/A | Comments |
|---|---|---|---|---|---|
| 1. | Is there proof that the personnel have been instructed on the importance and frequency of hand hygiene application? | | | | |
| 2. | Is there proof that personnel have been instructed and assessed on routine hand washing technique? | | | | |
| 3. | Is there proof that personnel have been instructed on the use of alcohol hand rub or hand sanitizer before, during and after patient contact? | | | | |
| 4. | Is there proof that personnel have been instructed on surgical hand asepsis? | | | | |
| 5. | Is there proof that personnel do remove jewellery, e.g. watches, rings with stones from hands before patient contact? | | | | |
| 6. | Do personnel daily work with short, neatly trimmed nails? | | | | |
| 7. | Are personnel hands free from artificial nails while on duty? | | | | |
| 8. | Is personal hand lotion, in individual containers for each personnel member, used to prevent the skin dryness associated with hand washing? | | | | |
| 9. | Are the hand lotions used free of petroleum and other oil skin softeners? | | | | |
| 10. | Is the equipment automated or foot / elbow-operated to avoid hand contact and cross-contamination? | | | | |
| | Are automated or foot / elbow-operated taps installed? | | | | |
| | Are liquid hand hygiene products applied by automated / elbow dispensers? | | | | |
| | Are disposable paper towels used to dry hands? | | | | |
| 11. | Are routine hand wash areas free from nail brushes? | | | | |
| 12. | Is there ease of access to hand washing facilities? | | | | |
| 13. | Are the hand wash basins in the clinical areas free from used equipment / instruments? | | | | |
| 14. | Are hand wash basins in the clinical areas free from drinking utensils? | | | | |
| | SCORE | 0 | 0 | 0 | |
| | SCORE % | 0 | 0 | 0 | |
| | | 0 | | | |

## FOCUS AREA 9 – STERILISATION PRACTICES

| | | YES | NO | N/A | Comments |
|---|---|---|---|---|---|
| 1. | Is the processing area physically divided into separate areas for receiving and cleaning equipment? | | | | |
| 2. | Is the area physically divided into separate areas for preparation and packaging of equipment? | | | | |
| 3. | Is the area physically divided into separate areas for sterilisation and storage of supplies / equipment? | | | | |
| 4. | Is there proof that contaminated instruments are transported in covered containers? | | | | |
| 5. | Is there proof that instruments / devices are appropriately cleaned of all visible blood / contamination before sterilisation or disinfection? | | | | |
| 6. | If used instruments cannot be cleaned immediately, is there proof that instruments are placed in a holding / enzymatic solution? | | | | |
| 7. | Is there proof that the holding solution is changed at least twice daily or as necessary, when cloudy or contaminated? | | | | |
| 8. | Is there proof that cleaning is routinely done in an automated device, e.g. an ultrasonic cleaner or thermal washer-disinfector? | | | | |
| 9. | Is there proof that puncture-resistant utility gloves are worn when handling contaminated sharp instruments? | | | | |
| 10. | Is there proof that a long-handled brush is used when instruments must be scrubbed by hand? | | | | |
| 11. | Is there proof that instruments are held below the waterline to minimise splashing when scrubbed by hand? | | | | |
| 12. | Is there proof that no more than 1-2 instruments are handled at a time, should instruments be scrubbed by hand? | | | | |
| 13. | Is there proof that hinged instruments are opened and unlocked prior to sterilisation? | | | | |
| 14. | Is there proof that lubrication or rust inhibitors are applied to instruments / handpieces, prior to sterilisation? | | | | |
| 15. | Is there proof that cassettes are utilised to avoid hand contact and promote safer processing of contaminated instruments? | | | | |
| 16. | Is there proof that instruments and supplies are packed as functional sets to use for specific procedures? | | | | |
| 17. | Is there proof that instruments are appropriately packed prior to sterilisation? | | | | |
| 18. | Is there proof that the packing material used is compatible with the sterilisation process? | | | | |
| 19. | Is there proof that the sterile contents are re-cleaned, re-packed, and re-sterilised if packaging has been compromised? | | | | |
| 20. | Is there proof that the processing area facilitates drying without compromising the integrity of packs / sterility? | | | | |
| 21. | Is there proof that implantable devices are always packed for sterilisation before use? | | | | |
| 22. | Is there proof that the facility uses spore tests to monitor and guarantee effective sterilisation for every implantable device? | | | | |
| | SCORE | 0 | 0 | 0 | |
| | SCORE % | 0 | 0 | 0 | |
| | | 0 | | | |

## FOCUS AREA 10 – SAFE SHARPS HANDLING

| | | YES | NO | N/A | Comments |
|---|---|---|---|---|---|
| **1.** | **Have all personnel received training in relation to sharps or safe sharps handling techniques?** | | | | |
| | Is there proof that operators use caution when handling sharps? | | | | |
| | Do operators use a mirror / retractor instead of their fingers to retract tissue during procedures? | | | | |
| | Is there proof that re-sheathing devises / safe techniques are used for recapping used dental needles? | | | | |
| | Is there proof that precautionary measure is applied when handling contaminated instruments? | | | | |
| | Is there proof that personnel are trained regarding what action to take following a needlestick / sharps injury? | | | | |
| **2.** | **Does the facility have a readily-accessible sharps injury protocol in place?** | | | | |
| | In case of emergency, do all the personnel know where to obtain the written information? | | | | |
| **3.** | **Is there a sharps container available in every patient treatment- and instrument processing area?** | | | | |
| | Are sharps containers located close to the point of use? | | | | |
| | Are sharps containers leak proof and puncture resistant? | | | | |
| | Are sharps containers positioned safely out of reach of children and visitors (e.g. wall-mounted)? | | | | |
| | Do all sharps containers have lids that can be securely closed when full to prevent spilling if dropped? | | | | |
| | Are sharps containers free from protruding sharps (less than 2/3 full)? | | | | |
| | Is there proof that sharps containers are disposed of as soon as the contents reach the fill line (2/3 full)? | | | | |
| 4. | Is there proof that disposable needles and disposable syringes are discarded directly after patient use? | | | | |
| 5. | Is there proof that any medication administered by syringe is given to only one patient each time? | | | | |
| 6. | Is there proof that *single-dose* vials of parenteral medications are used whenever possible? | | | | |
| 7. | Is there proof that any medication remaining in a single-dose vial is discarded with the vial after each patient use? | | | | |
| 8. | Is there proof that the access diaphragm (rubber stopper) is disinfected with 70% alcohol and allowed to dry before inserting any device into a multi-dose vial? | | | | |
| 9. | Is there proof that only sterile devices are used to access multiple-dose vials? | | | | |
| 10. | Is there proof that endodontic files are discarded after single patient use? | | | | |
| | SCORE | 0 | 0 | 0 | |
| | SCORE % | 0 | 0 | 0 | |
| | | | 0 | | |

# FOCUS AREA 11 – WASTE MANAGEMENT

| | | YES | NO | N/A | Comments |
|---|---|---|---|---|---|
| **1.** | **Does the facility have the following health care risk waste management protocols freely available:**<br>A *written* health care risk waste management plan? | | | | |
| | *Written* health care risk waste segregation categories? | | | | |
| | National code of practice using SABS colour-coded health care risk waste segregation categories? | | | | |
| **2.** | **Is health care risk waste disposed of by using designated containers?** | | | | |
| | Is there proof that hazardous health care risk waste is placed in red bags within labelled containers? | | | | |
| | Is there proof that disposable PPE is discarded as hazardous waste into red bags? | | | | |
| | If YES, is there proof that extracted teeth without amalgam fillings are disposed of as hazardous waste? | | | | |
| | Is there proof that extracted teeth with amalgam fillings are disposed of into marked containers that will *NOT* be incinerated? | | | | |
| | Is there proof that amalgam waste is secured for metal recovery in a separate, marked container? | | | | |
| | Is there proof that lead foil and fixer is secured for metal recovery in separate, marked containers? | | | | |
| | Is there proof that hazardous health care waste containers are securely tied / closed before removal? | | | | |
| | Is there proof that sharps are disposed of in leak proof, puncture-resistant containers at the point of use? | | | | |
| | Is there proof that general / household waste is disposed of into black or clear bags? | | | | |
| | Is there proof that waste bins in clinical and instrument processing areas are in good working order? | | | | |
| **3.** | **Does the facility have a designated, secure area where waste awaiting collection is stored?** | | | | |
| | Is the area locked and inaccessible to unauthorised persons? | | | | |
| | Is the area visibly clean and well maintained? | | | | |
| | Is the area visibly pest free? | | | | |
| **4.** | **Does the facility have evidence of continuous, scheduled collection of health care risk waste, e.g. collection certificates?** | | | | |
| | Are there signed records of collection by a registered company? | | | | |
| **5.** | **Does the facility have evidence of legal disposal of health care risk waste, e.g. incineration certificates?** | | | | |
| | SCORE | 0 | 0 | 0 | |
| | SCORE % | 0 | 0 | 0 | |
| | | | 0 | | |

## 6.4 Discussion and conclusion

The newly proposed audit-feedback instrument covers 11 important focus areas and provides an instrument for managers and oral health care workers to monitor their own compliance with infection prevention and control guidelines within their facilities. The comprehensive nature of the instrument should ensure that no area of possible exposure to infection is overlooked. Results from the audits will provide managers and oral health care workers with sufficient information on infection prevention and control to be able to implement remedial action and improve problem areas. In the long run, if the audit-feedback instrument is applied as suggested, it should ensure a national improvement and sustainable infection prevention and control compliance in oral health care facilities throughout South Africa.

## 6.5 References

British Dental Association (2011). *Advice sheet A12 Infection control in dentistry (England).* (Vol. **April**). London: British Dental Association.

Centers for Disease Control and Prevention (2003). Guidelines for infection control in dental health-care settings - 2003. [Recommendations and reports]. *Morbidity and Mortality Weekly Report,* **52**(Number RR-17), 1-68.

Department of Health United Kingdom (2013a). Health Technical Memorandum 01-05: Decontamination in primary care dental practices. *Health Technical Memoranda*, 1-98. Retrieved from https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/170689/HTM_01-05_2013.pdf.

Department of Health United Kingdom (2013b). Health Technical Memorandum 07-01: Safe management of healthcare waste. *Health Technical Memoranda, 2013*, 1-187. Retrieved from https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/167976/HTM_07-01_Final.pdf.

Infection Prevention Society (2013, 22 June 2013). *Dental Audit Tool 2013 Edition*. *IPS Infection Prevention Society*. Second. Retrieved 16 December 2013, from http://www.ips.uk.net/DentalAuditTool/2013%20Question%20Set.pdf.

NICE (2012). *Infection: prevention and control of healthcare-associated infections in primary and community care (CG139).* Retrieved 16 December 2013, from http://guidance.nice.org.uk/CG139.

Strengthening Pharmaceutical Systems (2009). Infection Control Assessment Tool, 2nd Edition. *U.S. Agency for International Development by the Strengthening Pharmaceutical Systems Program. Arlington, VA: Management Sciences for Health*.

SUPPORT (2008). Audit and feedback - Does providing healthcare professionals with data about their performance improve their practice? *SUPPORT Summary of a systematic review, August*(2008). Retrieved from http://www.iecs.org.ar/support/iecs-frame-visor-publicaciones.php?cod_publicacion=4&archivo_pdf=20080909103941_4.pdf&origen_publicacion=publicaciones.

# CHAPTER 7

# Assessment of the audit-feedback instrument for oral health care facilities in South Africa


## Summary

*The audit-feedback instrument (AFI) was developed to monitor the adherence of South African oral health care facilities with compliance to infection prevention and control precautions. The assessment of the AFI was conducted on a population of oral health care facilities in South Africa, mainly to test its workability in the varied South African oral health care configurations and environments. A purposive selection strategy was followed, selecting 50 easily accessible South African oral health care facilities. Results from 49 completed AFIs revealed demographic details and information on infection prevention and control practices for the 11 AFI focus areas: Administrative controls; personnel protection controls; environmental- and work controls; surface contamination management; equipment maintenance; air- and waterline management; personal protective equipment usage; personal- and hand hygiene practices; sterilisation practices; sharps handling and waste management. None of the participating facilities demonstrated 100% compliance. Notably, administrative controls and air- and waterline management scored the lowest mean values; 31% and 36% respectively, while personal- and hand hygiene practices and waste management performed the best, at respectively 75% and 63%. The general lack of compliance with infection prevention and control precautions in the participating oral health care facilities clearly poses a safety hazard to both patients and oral health care workers. These findings thus demonstrate the urgent need for a monitoring system, such as the AFI, to be instituted in South African oral health care facilities.*


***Keywords:*** *Audit, dental; oral health care; compliance with infection prevention and control precautions*

## 7.1 Introduction

In 1993, Marianos recommended that, in the absence of formal recommendations and guidelines for infection prevention and control precautions, South African dental practitioners should adhere to the infection control guidelines issued by the Centers for Disease Control and Prevention (CDC) of the United States of America (Marianos, 1993; CDC, 2003). However, many health care facilities in South Africa lacked even the most basic infection control requirements, such as water and electricity (Edward-Miller, 1998), as a result challenging adherence to any form of international recommendation or guideline.

In this study, an audit-feedback instrument (AFI) was developed to assess the compliance of South African oral health care facilities with accepted minimum standard infection prevention and control practices. The AFI calculates mean scores of performance in 11 infection prevention and control focus areas. These scores are then be used as indicators of areas requiring attention or remediation.

The aim of this study was to assess the audit-feedback instrument (AFI) that was developed specifically for South African conditions (as reflected in Chapters 5 and 6). The assessment of the AFI was conducted on a population of oral health care facilities in South Africa, mainly to test its workability in the varied oral health care configurations and environments.

## 7.2 Methods

A purposive selection strategy was followed, aimed at selecting 50 easily accessible South African oral health care facilities. This deliberate, non-random sample represented the different practice configurations found in South Africa. The strategy for sampling and data collection included the following:

- Representative of oral health care facilities in rural and urban areas; including single practitioner-, multi-practitioner oral health care facilities; private dental clinics and governmental dental clinics; as well as exemplars of oral health care training institutions was included in the study.
- The number of each type of oral health care facility included depended upon the availability, accessibility, resources and time available. Therefore, the selected oral health care facilities represented a convenience sample.

- Once the oral health care facilities had been identified, appropriate permissions were obtained from managers and gatekeepers. Initial contact was made telephonically, after which an appointment was scheduled for the completion of the AFI.
- The completion of the AFI followed a structured and facilitated face-to-face process. All responses were recorded by the researcher.

Summary statistics were calculated and the compliance with infection prevention and control measures were determined using four compliance categories (Table 7.1). These categories were developed from the colour categories applied for the assessment of drinking water safety in South Africa (WRC*, et al.*, 1998).

**TABLE 7.1: Compliance categories and colour coding for infection prevention and control practices in oral health care facilities**

| Category classification | Compliance categories (%) | Category description | Colour code |
|---|---|---|---|
| Target | 100 | Target | |
| Close to target | ≥80 - <100 | Compliance | |
| Poor | ≥50 - <80 | Poor compliance | |
| Unacceptable | <50 | Unacceptable compliance | |

Every oral health care facility should aim for 100% compliance.

## 7.3 Results

Of the 50 selected oral health care facilities, 49 completed an AFI. The AFI collected information regarding the demographic details of each of the participating oral health care facilities, as well as data on infection prevention and control practices in the 11 focus areas.

### 7.3.1 Demographic details of the sample population

#### 7.3.1.1 Main provider and practice details

The majority of the oral health care facilities that participated and were assessed in this study were from the private sector. The majority of the main service providers (dental practitioners and dental therapists) in each instance had been in practice for more than 20 years (44.8%) (Figure 7.1). The qualifications of the main service provider from each participating institution were representative of all five dental faculties in South Africa. Only a few of these providers were qualified outside of South African borders. On the other hand, approximately 25% of the main service providers were recently qualified, with less than five years experience in clinical practice.

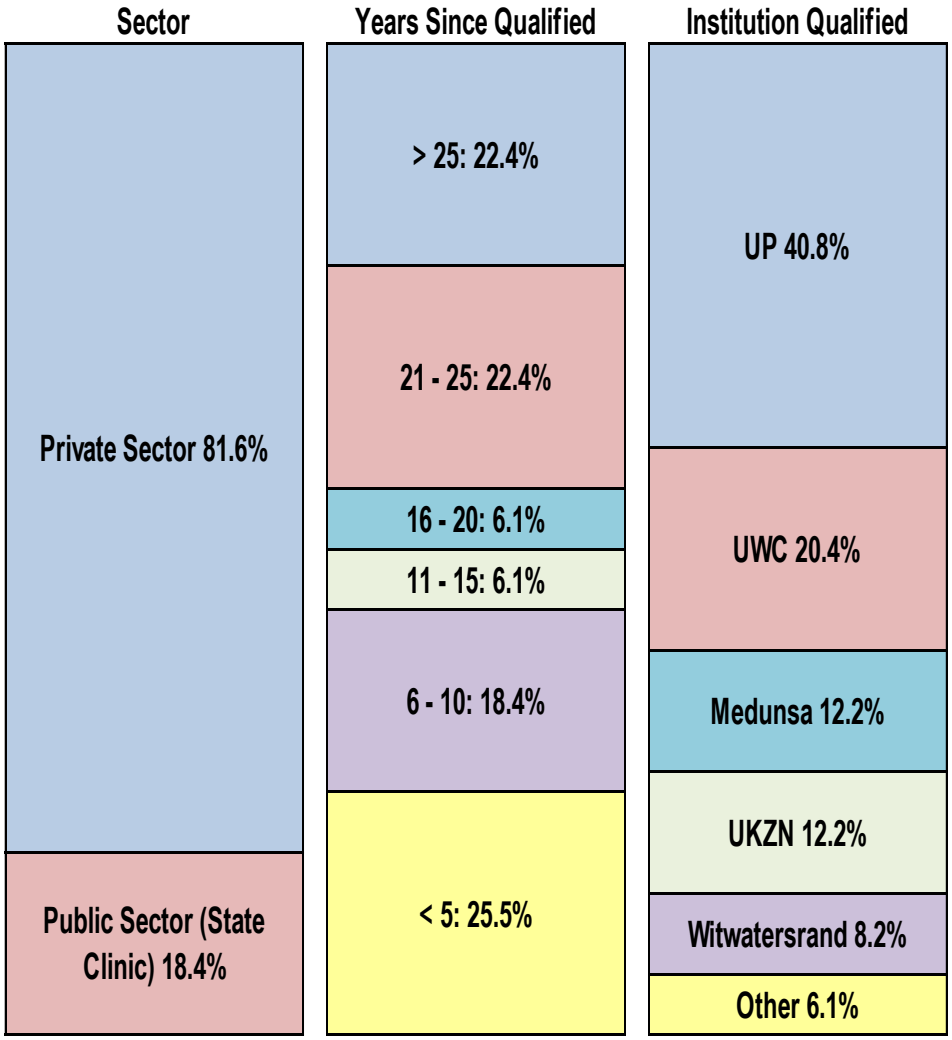



**FIGURE 7.1: Main provider and practice details**

#### *7.3.1.2 Audit respondent details*

More than two-thirds of the respondents were male, representing eight of the 11 official South African languages, with Afrikaans being the most prevalent. The ages of the respondents were spread more or less evenly over the different age group categories, except for a number of respondents that were over the age of 65. Most of the research information was obtained from the dental practitioner, while in a few of the oral health care facilities, other members of the oral health care team assisted with the completion of the AFI.

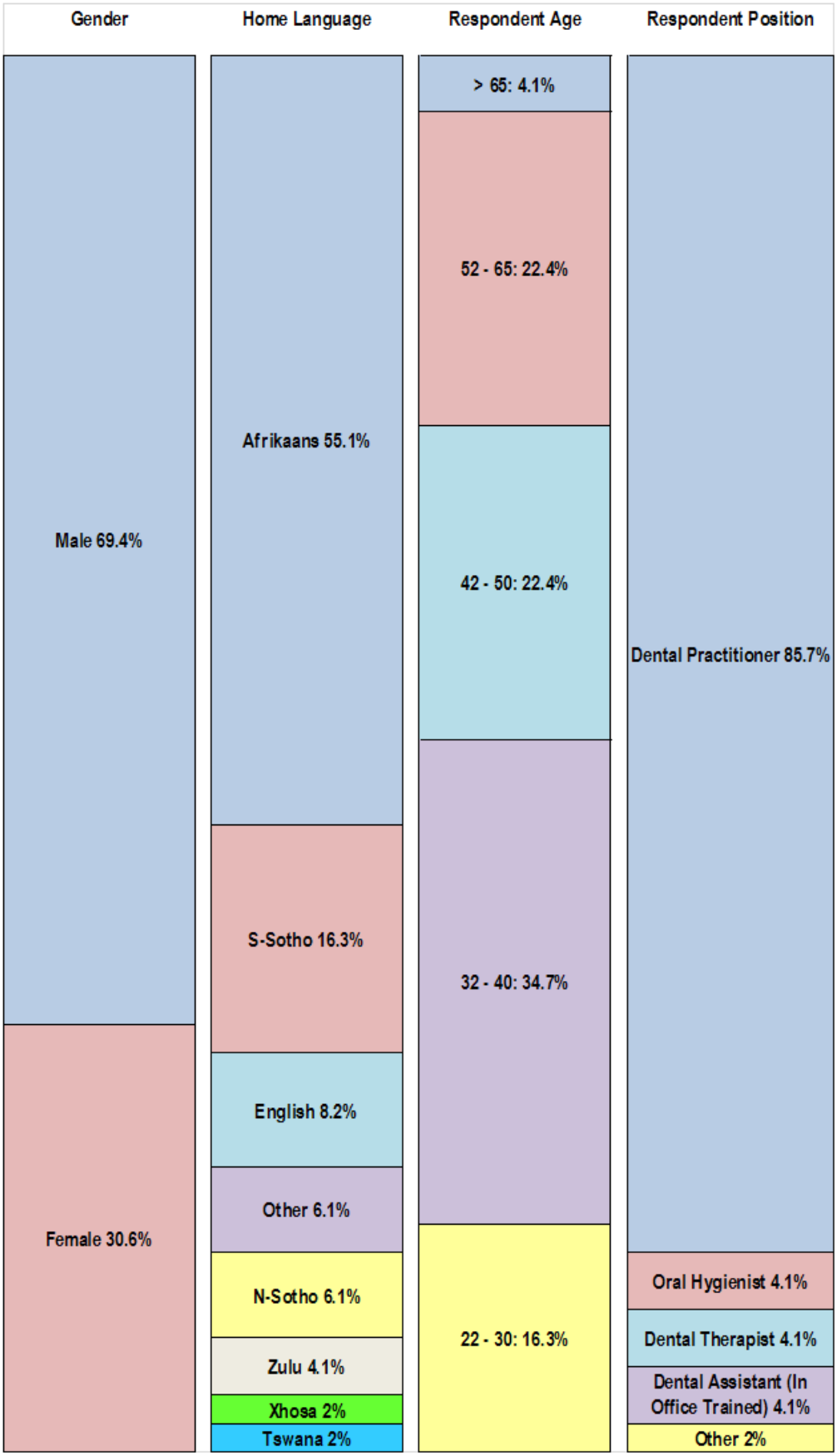



**FIGURE 7.2: Responder details**

### 7.3.2 Audit results

#### 7.3.2.1 Audit results of individual participating facilities

Overall audit performance varied greatly between the 11 focus areas, as well as among the participating facilities. Only seven of the participating facilities achieved *Target* (Blue) in one or more focus areas (Table 7.2). More than half of the facilities exhibited *Poor* (Yellow) and *Unacceptable* (Red) compliance for most of the focus areas. One facility (ID #1) reached *Target* (Blue) in four focus areas, demonstrating the highest mean percentage of 80.8% (*close to target*). However, the performance of this facility in the focus areas *Administrative controls* and *Personnel protection controls* was categorised as *Unacceptable* (Red). Of all the 49 participating facilities, facility ID #1 was the only facility with a reasonable overall performance reaching *close to Target*. The overall performance of the remainder of the facilities was categorised as *Poor* (47%) or *Unacceptable* (51%).

## TABLE 7.2: Detailed audit results of the 49 oral health care facilities ranked by mean % scores

| Facility ID number | Administrative controls score | Administrative controls % score | Personnel protection controls score | Personnel protection controls % score | Environmental- & work controls score | Environmental- & work controls% score | Surface contamination management score | Surface contamination management % score | Equipment maintenance score | Equipment maintenance % score | Air- waterlines management score | Air- waterlines management % score | PPE usage score | PPE usage % score | Personal- and hand hygiene practices score | Personal- and hand hygiene practices % score | Sterilisation practices score | Sterilisation practices % score | Safe sharps handling score | Safe sharps handling % score | Waste management score | Waste management % score | Total facility score out of 240 | Mean facility % score |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 12 | 43 | 1 | 6 | 23 | 82 | 27 | 84 | 12 | 86 | 14 | 88 | 23 | 96 | 17 | 100 | 22 | 100 | 22 | 100 | 21 | 100 | 194 | 80.8 |
| 34 | 11 | 39 | 7 | 44 | 22 | 79 | 30 | 94 | 10 | 71 | 6 | 38 | 18 | 75 | 15 | 88 | 18 | 82 | 22 | 100 | 12 | 57 | 171 | 71.3 |
| 39 | 23 | 82 | 13 | 81 | 28 | 100 | 32 | 100 | 8 | 57 | 4 | 25 | 8 | 33 | 10 | 59 | 11 | 50 | 22 | 100 | 12 | 57 | 171 | 71.3 |
| 28 | 15 | 54 | 9 | 56 | 23 | 82 | 23 | 72 | 8 | 57 | 13 | 81 | 17 | 71 | 17 | 100 | 15 | 68 | 17 | 77 | 9 | 43 | 166 | 69.2 |
| 46 | 17 | 61 | 5 | 31 | 19 | 68 | 22 | 69 | 11 | 79 | 9 | 56 | 18 | 75 | 15 | 88 | 17 | 77 | 14 | 64 | 19 | 90 | 166 | 69.2 |
| 49 | 17 | 61 | 5 | 31 | 19 | 68 | 22 | 69 | 11 | 79 | 10 | 63 | 18 | 75 | 15 | 88 | 16 | 73 | 14 | 64 | 19 | 90 | 166 | 69.2 |
| 47 | 17 | 61 | 5 | 31 | 19 | 68 | 22 | 69 | 11 | 79 | 9 | 56 | 18 | 75 | 15 | 88 | 16 | 73 | 14 | 64 | 19 | 90 | 165 | 68.8 |
| 48 | 17 | 61 | 5 | 31 | 19 | 68 | 22 | 69 | 11 | 79 | 9 | 56 | 18 | 75 | 15 | 88 | 16 | 73 | 14 | 64 | 19 | 90 | 165 | 68.8 |
| 50 | 17 | 61 | 5 | 31 | 19 | 68 | 22 | 69 | 11 | 79 | 9 | 56 | 18 | 75 | 15 | 88 | 16 | 73 | 14 | 64 | 19 | 90 | 165 | 68.8 |
| 29 | 19 | 68 | 13 | 81 | 16 | 57 | 15 | 47 | 10 | 71 | 8 | 50 | 16 | 67 | 12 | 71 | 13 | 59 | 16 | 73 | 17 | 81 | 155 | 64.6 |
| 38 | 24 | 86 | 14 | 88 | 20 | 71 | 17 | 53 | 4 | 29 | 5 | 31 | 12 | 50 | 14 | 82 | 9 | 41 | 18 | 82 | 15 | 71 | 152 | 63.3 |
| 27 | 10 | 36 | 7 | 44 | 12 | 43 | 24 | 75 | 10 | 71 | 5 | 31 | 18 | 75 | 15 | 88 | 15 | 68 | 15 | 68 | 17 | 81 | 148 | 61.7 |
| 44 | 11 | 39 | 5 | 31 | 18 | 64 | 24 | 75 | 10 | 71 | 7 | 44 | 11 | 46 | 15 | 88 | 14 | 64 | 14 | 64 | 14 | 67 | 143 | 59.6 |
| 17 | 23 | 82 | 10 | 63 | 13 | 46 | 16 | 50 | 8 | 57 | 3 | 19 | 12 | 50 | 10 | 59 | 15 | 68 | 13 | 59 | 19 | 90 | 142 | 59.2 |
| 43 | 11 | 39 | 5 | 31 | 18 | 64 | 24 | 75 | 10 | 71 | 6 | 38 | 11 | 46 | 15 | 88 | 14 | 64 | 14 | 64 | 14 | 67 | 142 | 59.2 |
| 45 | 11 | 39 | 5 | 31 | 18 | 64 | 24 | 75 | 10 | 71 | 6 | 38 | 11 | 46 | 15 | 88 | 14 | 64 | 14 | 64 | 14 | 67 | 142 | 59.2 |
| 20 | 19 | 68 | 4 | 25 | 15 | 54 | 21 | 66 | 10 | 71 | 6 | 38 | 9 | 38 | 7 | 41 | 11 | 50 | 17 | 77 | 17 | 81 | 136 | 56.7 |
| 21 | 7 | 25 | 5 | 31 | 18 | 64 | 21 | 66 | 6 | 43 | 7 | 44 | 15 | 63 | 16 | 94 | 11 | 50 | 15 | 68 | 15 | 71 | 136 | 56.7 |
| 19 | 5 | 18 | 3 | 19 | 15 | 54 | 23 | 72 | 6 | 43 | 5 | 31 | 15 | 63 | 14 | 82 | 15 | 68 | 14 | 64 | 17 | 81 | 132 | 55.0 |
| 25 | 7 | 25 | 5 | 31 | 20 | 71 | 15 | 47 | 7 | 50 | 6 | 38 | 14 | 58 | 13 | 76 | 16 | 73 | 14 | 64 | 15 | 71 | 132 | 55.0 |
| 6 | 1 | 4 | 1 | 6 | 4 | 14 | 23 | 72 | 7 | 50 | 9 | 56 | 15 | 63 | 17 | 100 | 19 | 86 | 16 | 73 | 16 | 76 | 128 | 53.3 |
| 30 | 6 | 21 | 3 | 19 | 15 | 54 | 21 | 66 | 8 | 57 | 6 | 38 | 11 | 46 | 14 | 82 | 15 | 68 | 12 | 55 | 16 | 76 | 127 | 52.9 |
| 10 | 18 | 64 | 10 | 63 | 12 | 43 | 14 | 44 | 4 | 29 | 5 | 31 | 11 | 46 | 11 | 65 | 7 | 32 | 14 | 64 | 16 | 76 | 122 | 50.8 |
| 9 | 19 | 68 | 9 | 56 | 12 | 43 | 14 | 44 | 4 | 29 | 4 | 25 | 11 | 46 | 11 | 65 | 7 | 32 | 14 | 64 | 15 | 71 | 120 | 50.0 |
| 11 | 16 | 57 | 9 | 56 | 12 | 43 | 14 | 44 | 4 | 29 | 5 | 31 | 12 | 50 | 10 | 59 | 7 | 32 | 14 | 64 | 15 | 71 | 118 | 49.2 |

| Facility ID number | Administrative controls score | Administrative controls % score | Personnel protection controls score | Personnel protection controls % score | Environmental- & work controls score | Environmental- & work controls % score | Surface contamination management score | Surface contamination management % score | Equipment maintenance score | Equipment maintenance % score | Air- waterlines management score | Air- waterlines management % score | PPE usage score | PPE usage% score | Personal- and hand hygiene practices score | Personal- and hand hygiene practices % score | Sterilisation practices score | Sterilisation practices % score | Safe sharps handling score | Safe sharps handling % score | Waste management score | Waste management % score | Facility score | Facility % score |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 16 | 7 | 25 | 6 | 38 | 13 | 46 | 22 | 69 | 4 | 29 | 1 | 6 | 12 | 50 | 11 | 65 | 15 | 68 | 9 | 41 | 16 | 76 | 116 | 48.3 |
| 22 | 2 | 7 | 3 | 19 | 11 | 39 | 24 | 75 | 6 | 43 | 6 | 38 | 11 | 46 | 10 | 59 | 13 | 59 | 13 | 59 | 17 | 81 | 116 | 48.3 |
| 2 | 7 | 25 | 3 | 19 | 14 | 50 | 23 | 72 | 5 | 36 | 8 | 50 | 11 | 46 | 14 | 82 | 4 | 18 | 16 | 73 | 10 | 48 | 115 | 47.9 |
| 36 | 4 | 14 | 3 | 19 | 12 | 43 | 16 | 50 | 6 | 43 | 7 | 44 | 14 | 58 | 17 | 100 | 7 | 32 | 13 | 59 | 16 | 76 | 115 | 47.9 |
| 23 | 2 | 7 | 3 | 19 | 11 | 39 | 21 | 66 | 6 | 43 | 4 | 25 | 11 | 46 | 9 | 53 | 13 | 59 | 13 | 59 | 17 | 81 | 110 | 45.8 |
| 33 | 5 | 18 | 1 | 6 | 13 | 46 | 21 | 66 | 5 | 36 | 3 | 19 | 8 | 33 | 11 | 65 | 11 | 50 | 15 | 68 | 16 | 76 | 109 | 45.4 |
| 8 | 5 | 18 | 3 | 19 | 6 | 21 | 19 | 59 | 7 | 50 | 8 | 50 | 12 | 50 | 12 | 71 | 5 | 23 | 14 | 64 | 16 | 76 | 107 | 44.6 |
| 3 | 7 | 25 | 4 | 25 | 14 | 50 | 19 | 59 | 6 | 43 | 1 | 6 | 11 | 46 | 14 | 82 | 4 | 18 | 16 | 73 | 10 | 48 | 106 | 44.2 |
| 26 | 6 | 21 | 3 | 19 | 11 | 39 | 16 | 50 | 7 | 50 | 7 | 44 | 8 | 33 | 13 | 76 | 12 | 55 | 12 | 55 | 11 | 52 | 106 | 44.2 |
| 41 | 7 | 25 | 3 | 19 | 6 | 21 | 20 | 63 | 7 | 50 | 4 | 25 | 11 | 46 | 15 | 88 | 11 | 50 | 14 | 64 | 8 | 38 | 106 | 44.2 |
| 31 | 6 | 21 | 3 | 19 | 14 | 50 | 0 | 0 | 8 | 57 | 6 | 38 | 10 | 42 | 14 | 82 | 15 | 68 | 12 | 55 | 16 | 76 | 104 | 43.3 |
| 35 | 5 | 18 | 1 | 6 | 11 | 39 | 18 | 56 | 5 | 36 | 3 | 19 | 8 | 33 | 12 | 71 | 10 | 45 | 13 | 59 | 15 | 71 | 101 | 42.1 |
| 32 | 7 | 25 | 1 | 6 | 7 | 25 | 11 | 34 | 5 | 36 | 2 | 13 | 10 | 42 | 10 | 59 | 12 | 55 | 15 | 68 | 19 | 90 | 99 | 41.3 |
| 18 | 6 | 21 | 4 | 25 | 7 | 25 | 12 | 38 | 5 | 36 | 6 | 38 | 8 | 33 | 10 | 59 | 12 | 55 | 15 | 68 | 10 | 48 | 95 | 39.6 |
| 24 | 1 | 4 | 3 | 19 | 11 | 39 | 20 | 63 | 4 | 29 | 4 | 25 | 9 | 38 | 12 | 71 | 8 | 36 | 12 | 55 | 7 | 33 | 91 | 37.9 |
| 42 | 2 | 7 | 3 | 19 | 9 | 32 | 13 | 41 | 6 | 43 | 5 | 31 | 13 | 54 | 12 | 71 | 14 | 64 | 7 | 32 | 6 | 29 | 90 | 37.5 |
| 13 | 0 | 0 | 0 | 0 | 9 | 32 | 20 | 63 | 6 | 43 | 6 | 38 | 10 | 42 | 15 | 88 | 12 | 55 | 8 | 36 | 3 | 14 | 89 | 37.1 |
| 37 | 1 | 4 | 2 | 13 | 8 | 29 | 16 | 50 | 6 | 43 | 4 | 25 | 9 | 38 | 12 | 71 | 9 | 41 | 12 | 55 | 8 | 38 | 87 | 36.3 |
| 12 | 0 | 0 | 0 | 0 | 7 | 25 | 21 | 66 | 5 | 36 | 6 | 38 | 13 | 54 | 10 | 59 | 15 | 68 | 6 | 27 | 0 | 0 | 83 | 34.6 |
| 15 | 1 | 4 | 1 | 6 | 6 | 21 | 19 | 59 | 5 | 36 | 4 | 25 | 11 | 46 | 17 | 100 | 14 | 64 | 4 | 18 | 0 | 0 | 82 | 34.2 |
| 4 | 1 | 4 | 0 | 0 | 10 | 36 | 16 | 50 | 3 | 21 | 3 | 19 | 10 | 42 | 9 | 53 | 4 | 18 | 11 | 50 | 11 | 52 | 78 | 32.5 |
| 5 | 1 | 4 | 0 | 0 | 10 | 36 | 16 | 50 | 3 | 21 | 3 | 19 | 10 | 42 | 9 | 53 | 4 | 18 | 11 | 50 | 11 | 52 | 78 | 32.5 |
| 14 | 0 | 0 | 0 | 0 | 9 | 32 | 20 | 63 | 5 | 36 | 4 | 25 | 10 | 42 | 6 | 35 | 11 | 50 | 3 | 14 | 2 | 10 | 70 | 29.2 |
| 40 | 0 | 0 | 3 | 19 | 4 | 14 | 13 | 41 | 3 | 21 | 4 | 25 | 10 | 42 | 9 | 53 | 0 | 0 | 2 | 9 | 6 | 29 | 54 | 22.5 |
| **Sum** | 436 | | 216 | | 662 | | 948 | | 339 | | 285 | | 610 | | 626 | | 584 | | 653 | | 652 | | | |
| **Mean score** | 8.9 | | 4.4 | | 13.5 | | 19.3 | | 6.9 | | 5.8 | | 12.4 | | 12.8 | | 11.9 | | 13.3 | | 13.3 | | | |
| **Mean %** | | 31.8 | | 27.6 | | 48.3 | | 60.5 | | 49.4 | | 36.4 | | 51.9 | | 75.2 | | 54.2 | | 60.6 | | 63.4 | | 51.1 |
| **Nr of Questions** | | 28 | | 16 | | 28 | | 32 | | 14 | | 16 | | 24 | | 17 | | 22 | | 22 | | 21 | 240 | |

### 7.3.2.2 Audit results of focus areas

The overall mean performance on the 11 focus areas was calculated and categorised according to the different compliance categories. The focus area, *Personal- and hand hygiene practices* outperformed all the other focus areas, but still scored *Poor* compliance (Table 7.3). Similar, with a lesser score on this result, the compliance of *Waste management, Safe sharps handling, Surface contamination management, Sterilisation practices, Personnel protection controls,* and *PPE usage* was also *Poor*. The most neglected focus areas in this study were *Administrative controls* and *Air- waterlines management,* followed by two focus areas, *Environmental- and work controls* and *Equipment maintenance.* The overall mean score of all facilities over all focus areas was just larger than 50%.

**TABLE 7.3: Summary of audit results of the 49 oral health care facilities**

| Focus area | Questions per focus area | Number of facilities - Blue compliance category* | Number of facilities - Green compliance category* | Number of facilities - Yellow compliance | Number of facilities - Red compliance category * | Mean % score |
|---|---|---|---|---|---|---|
| Administrative Controls | 28 | 0 | 3 | 11 | 35 | **31.1** |
| Personnel Protection Controls | 16 | 0 | 3 | 5 | 41 | **51.9** |
| Environmental- and Work Controls | 28 | 1 | 2 | 19 | 27 | **48.3** |
| Surface Contamination Management | 32 | 1 | 2 | 36 | 10 | **60.5** |
| Equipment Maintenance | 14 | 0 | 1 | 22 | 26 | **49.4** |
| Air- and Waterline Management | 16 | 0 | 2 | 9 | 38 | **36.4** |
| Personal Protective Equipment Usage | 24 | 0 | 1 | 21 | 27 | **51.9** |
| Personal- and Hand Hygiene Practices | 17 | 5 | 19 | 23 | 2 | **75.2** |
| Sterilisation Practices | 22 | 1 | 2 | 32 | 14 | **54.2** |
| Safe Sharps Handling | 22 | 3 | 1 | 38 | 7 | **60.6** |
| Waste Management | 21 | 1 | 13 | 22 | 13 | **63.4** |
| Number of facilities per categories (%) (Total = 49 facilities × 11 focus areas = 539) | | 12 (2.2%) | 50 (9.3%) | 235 (43.6%) | 242 (44.9%) | **51.1** |

*= Number of facilities counted in the compliance category

A comparison of the compliance performance between participating government clinics (public sector) and private oral health care facilities (private sector) was made to gain insight into the overall attention paid to infection prevention and control in these two types of facility. Although only a limited number of government clinics participated in the study, their overall performance revealed better compliance than that of the private sector (Table 7.4). The data further revealed that in government clinics, focus areas *Administrative controls* and *Personnel protection controls*, the government clinics outperformed the

private sector by more than 40%. Both sectors paid reasonable attention to *Personal- and hand hygiene practices* and *Waste management, however.* Notable is the relatively high compliance rate obtained for *Safe sharps handling* in government clinics.

**TABLE 7.4: Summary of audit results of the forty-nine oral health care facilities**

| Focus area | Percentage compliance | |
|---|---|---|
| | Government dental clinics (n = 8) | Private facilities (n = 41) |
| Administrative Controls | 66.1 | 25.1 |
| Personnel Protection Controls | 64.1 | 20.4 |
| Environmental- and Work Controls | 53.6 | 47.2 |
| Surface Contamination Management | 52.3 | 62.0 |
| Equipment Maintenance | 42.0 | 50.9 |
| Air- and Waterline Management | 31.3 | 37.3 |
| Personal Protective Equipment Usage | 46.9 | 52.8 |
| Personal- and Hand Hygiene Practices | 64.7 | 77.2 |
| Sterilisation Practices | 46.0 | 55.8 |
| Safe Sharps Handling | 71.6 | 58.4 |
| Waste Management | 70.8 | 61.6 |
| Mean compliance across focus areas (%) | 56.0 | 50.2 |

### *7.3.2.3 Comparison of audit results with target*

To provide a more visual perspective of the results obtained in this study, a horizontal bar graph has been drawn. This graph demonstrates the overall range of compliance of the participating facilities to the *Target* expectation of 100% (Figure 7.3). The data collected in this study reveals that the mainly clinical focus areas of the participating facilities appeared to fall within the better compliancy categories, while the less clinical focus areas lie in the less compliant categories.

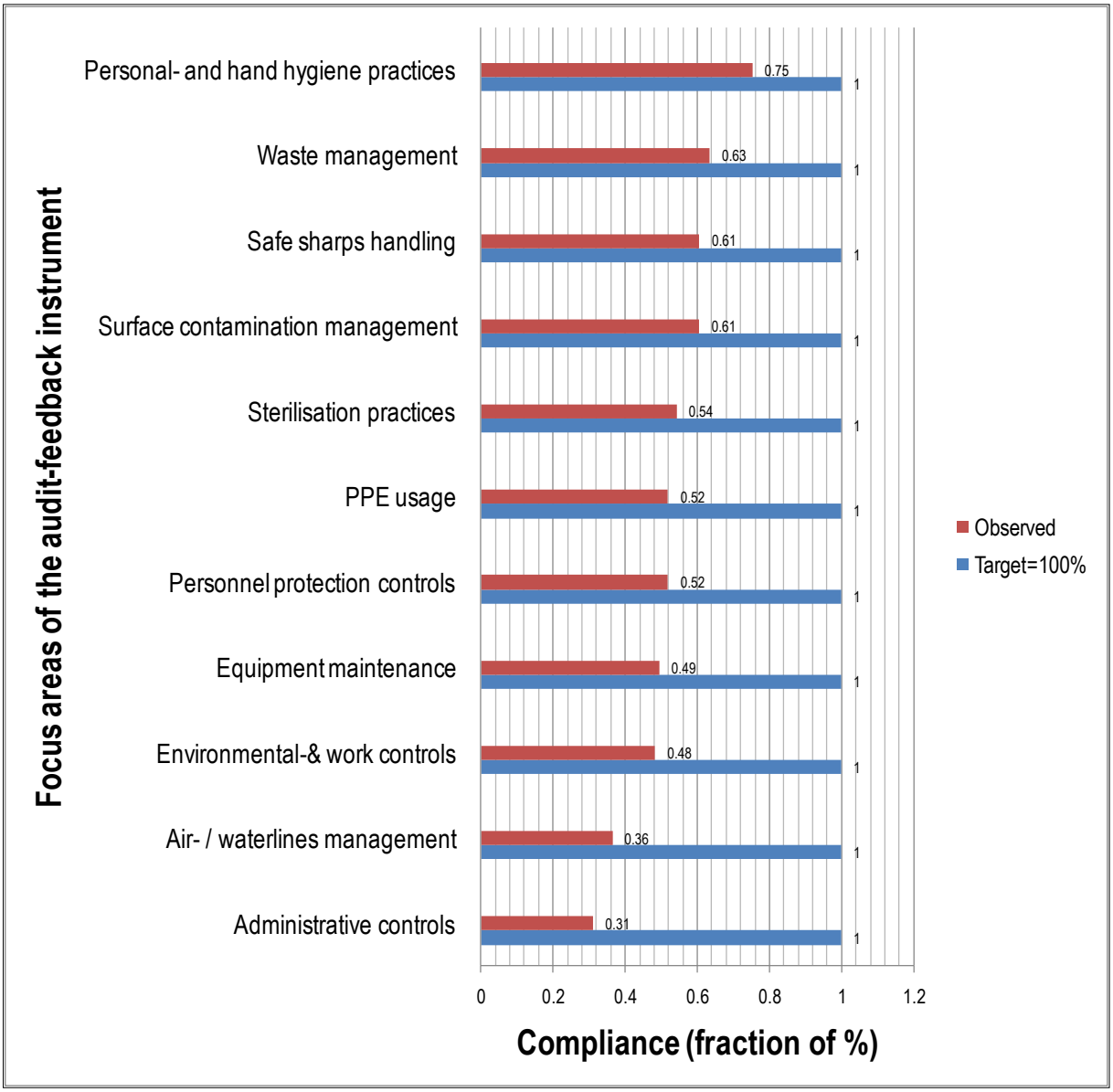



**FIGURE 7.3: Overall compliance performance of the audit-feedback instrument with observed results of the 11 focus areas, ranked from high to low**

A spider plot was constructed to create a pictorial overview of the compliance performance of the participating facilities in the different focus areas. The relatively small size of the central red outlined shape highlights the lack of compliance across all focus areas, when compared to the target of 100% (outer blue circle). The spider plot highlights the alarming low compliance of *Administrative controls personnel, Protection controls* and *Air- / waterline management.*

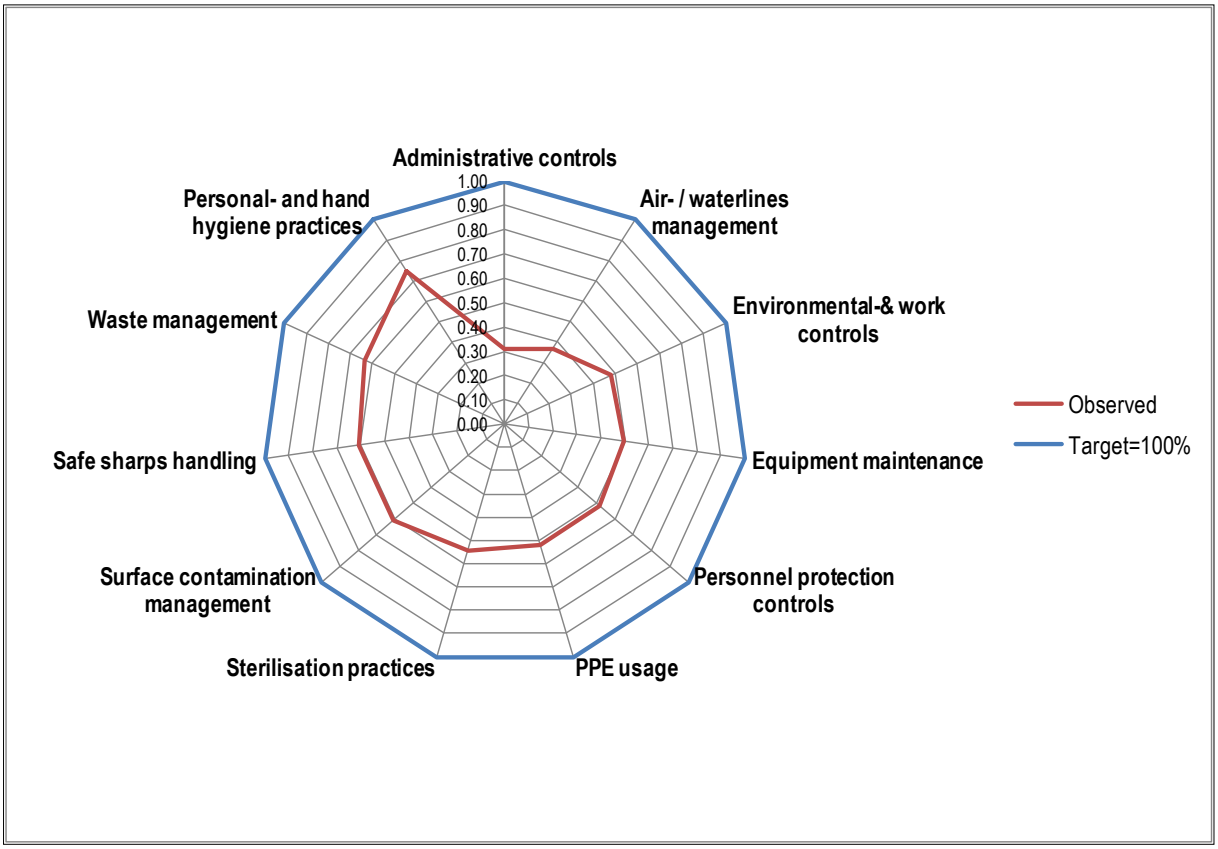



**FIGURE 7.4: Comparison of overall mean compliance performance across the different focus areas, with a target of 100% (1.00)**

## 7.4 Discussion and conclusions

The findings in this chapter highlight the many shortcomings on a national level, and a need to improve compliance with infection prevention and control in all South African oral health care facilities. Although some measure of infection prevention and control precautions are executed in all oral health care facilities, the fact remains that unless these precautions are not properly and constantly applied, with the same set standard for each potentially exposing clinical procedure, it defeats the purpose of the precautions (Mehtar, 2008; Ziady and Small, 2013).

The study has revealed that the newly developed AFI could be applied to a wide variety of different configurations of oral health care facilities. Contrary to the use of scientific and highly technical language found in other audit instruments (American Dental Association, 2013; GRICG, 2013; Infection Prevention Society, 2013), the use of simple, understandable language and ease of interpretation was reported as an advantage by the participating facility managers, employers and the other members of oral health care teams who completed the AFI.

This AFI was able to provide information covering the overall compliance of a facility, as well as the individual compliance of each of the 11 focus areas. These focus areas represent the range of areas presently indicating compliance to international infection prevention and control precautions in oral health care facilities. This comprehensive analysis of compliance performance enables individual facilities to identify areas of concern and shortcomings in their own workplace, and should thus enable them to implement remedial or improvement action.

In this study, the new AFI provided data about compliance performance with infection prevention and control guidelines in the oral health care facilities in both public and private sectors. The overall compliance of facilities was low, falling mostly into the categories of *Poor* or *Unacceptable* compliance, supporting the earlier research findings in South Africa (Yengopal*, et al.*, 2001; Oosthuysen, 2003; Mehtar*, et al.*, 2007; Nemutandani*, et al.*, 2007; Nemutandani, 2008; Oosthuysen*, et al.*, 2010; Chikte*, et al.*, 2011). It was interesting to note that the overall compliance performance of the public sector was greater than that in the private sector. This could be due to the fact that the public sector is officially regulated by quality control and accreditation bodies such as the Council of Health Services Accreditation of South Africa (COHSASA), while the public sector presently still has a choice of voluntarily COHSASA accreditation or not.

The AFI has also provided detailed information regarding the individual compliance performance in the 11 different focus areas in the checklist. It is not surprising that the focus area of *Personal and hand hygiene* demonstrated the highest compliance score, particularly in the light of quite extensive media coverage and promotional initiatives to take preventive measures against disease transmission and injury (Centers for Disease Control and Prevention, 2002; World Health Organization, 2006, 2009a, 2009b). Recently, the CDC indicated that double gloving during surgical procedures would be included in the newly proposed guidelines for 2015, highlighting the importance of more effective prevention of the risk of disease transmission and injury during these procedures (Fluent and Pawloski, 2014). However, taking into account the overall results, only half of the participating facilities fell in the *Close to target* category on the single most important infection prevention and control procedure, namely *Personal and hand hygiene.* The more resource-requiring categories, for example *Environmental- and work controls, Surface contamination management, Sterilisation practices, Safe sharps handling* and *Waste management* fell into the *Poor* compliance category*,* with only three facilities compliant with *Safe sharps handling,* and one each under the other categories. For *PPE usage,* which includes the availability and use of essential personal barriers such as protective clothing, eyewear, masks and gloves to shield personnel and patients during oral health care procedures, all facilities except one fell in

the *Poor* compliance or *Unacceptable* compliance categories. In developing countries, the availability of basic resources such as electricity and water are daily clinical challenges (Edward-Miller, 1998). This often supports the notion that the lack of resources in developing countries is used as reason for non compliance with protective precautions (Puttaiah*, et al.*, 2010; Rimkuvienë*, et al.*, 2011).

At the core of any oral health care facility are its personnel. With the specific burden of prevalent disease in South Africa, it is therefore difficult to comprehend the lack of attention that is paid to personnel health, focus area *Personnel protection controls*, in all the participating facilities, but particularly so in the private sector. Furthermore, attention to this focus area requires far less resources than many of the other focus areas (Marie, 1994; Slater, 2001).

The overall poor general management in facilities is demonstrated by the exceptional low score of the focus area *Administrative controls, again* more so in the private sector. This emphasises the lack of record keeping, including proof of the minimum legislative safety or health requirements of all kinds in participating oral health care facilities. This poor result is underscored by the fact that none of the participating facilities complied with *Administrative controls* or *Personnel protection controls.*

The general lack of compliance with infection prevention and control precautions in the participating oral health care facilities clearly poses a safety hazard to both the patients and the oral health care workers. This study clearly demonstrates the urgent need for a monitoring system, such as the newly developed AFI, to be instituted in South African oral health care facilities.

## 7.5 References

American Dental Association (2013). *The ADA Complete HIPAA Compliance Kit (J598).* Retrieved 23 April 2014, from http://catalog.ada.org/productcatalog/596/HIPAA/The-ADA-Complete-HIPAA-Compliance-Kit/J598.

CDC (2003). Guidelines for infection control in dental health-care settings - 2003. [Recommendations and reports]. *Morbidity and Mortality Weekly Report,* **52**(Number RR-17), 1-68.

Centers for Disease Control and Prevention (2002). Guideline for hand hygiene in health-care settings. *Morbidity and Mortality Weekly Report,* **51**(RR-16).

Chikte, U. M., Khondowe, O., and Gildenhuys, I. (2011). A case study of a dental receptionist diagnosed with Legionnaires' disease. *South African Dental Journal,* **66**(6), 284-287.

Edward-Miller, J. (1998). Measuring quality of care in South African clinics and hospitals *South African Health Review* (Vol. 51, pp. Chapter 14). Durban: Health Systems Trust.

Fluent, M. T., and Pawloski, C. L. (2014, May 2014). *CDC Infection Control in Dental Health-Care Settings: Looking Ahead to 2015* Retrieved 25 May 2014, from http://www.ineedce.com/coursereview.aspx?url=2592%2FPDF%2F1405cei_Fluent_web.pdf&scid=15327.

GRICG (2013). GRICG infection control compliance audit: clinical units dental practice. *2013*(7), 1-13. Retrieved from http://www.google.co.za/url?sa=t&rct=j&q=&esrc=s&source=web&cd=20&cad=rja&ved=0CFgQFjAJOAo&url=http%3A%2F%2Fwww.grhc.org.au%2Fdocument-library%2Fdoc_download%2F375-gricg-dental-audit-april-2013-version-7&ei=i_7FUZ3WKYeL7AamzoHACw&usg=AFQjCNHBTQfrRe3GlTrQyBeooW8BEP7sBQ&bvm=bv.48293060,d.ZGU.

Infection Prevention Society (2013, 22 June 2013). *Dental Audit Tool 2013 Edition*. *IPS Infection Prevention Society*. Second. Retrieved 16 December 2013, from http://www.ips.uk.net/DentalAuditTool/2013%20Question%20Set.pdf.

Marianos, D. W. (1993). Recommended infection control practices for dentistry ,1993: practitioner's corner. *Journal of the Dental Association of South Africa,* **48**(10), 577-582.

Marie, R. J. (1994). *The cost of infection control and OSHA compliance within dental group practice.* Walden University, ProQuest Dissertations and Theses.

Mehtar, S. (2008). Lowbury Lecture 2007: infection prevention and control strategies for tuberculosis in developing countries and lessons learnt from Africa. *Journal of Hospital Infection,* **69**(4), 321-327.

Mehtar, S., Shisana, O., Mosala, T., and Dunbar, R. (2007). Infection control practices in public dental care services: findings from one South African Province. *Journal of Hospital Infection,* **66**, 65-70.

Nemutandani, M. S. (2008). *Occupational exposures among dental assistants in Limpopo dental clinics.* University of Witwatersrand Johannesburg.

Nemutandani, M. S., Yengopal, V., Rudolph, M. J., and Tsotsi, N. M. (2007). Occupational exposures among dental assistants in public health care facilities, Limpopo Province. *South African Dental Journal,* **62**(8), 348-355.

Oosthuysen, J. (2003). *Infection control techniques used in South African dental practices. Thesis MTech: Biomedical Technology.* Central University of Technology, Free State, Bloemfontein.

Oosthuysen, J., Potgieter, E., and Blignaut, E. (2010). Compliance with infection control recommendations in South African dental practices: a review of studies published between 1990 and 2007. *International Dental Journal,* **60**(3), 181–189.

Puttaiah, R., Shetty, S., Bedi, R., and Verma, M. (2010). Dental infection control in India at the turn of the century. *World Journal of Dentistry,* **1**(1), 1-6.

Rimkuvienë, J., Pûrienë, A., Peèiulienë, V., and Zaleckas, L. (2011). Use of personal protective equipment among Lithuanian dentists. *Sveikatos Mokslai,* **21**(2), 29-36.

Slater, F. (2001). Cost-effective infection control success story: A case presentation. *Emerging Infectious Diseases,* **7**(2), 293-294.

World Health Organization (2006, April 2007). *World Health Organization Guidelines on Hand Hygiene in Healthcare (Advanced Draft) - Global patient safety challenge 2005 - 2006: "Clean care is safer care"*. *World Alliance for patient safety* Retrieved 21 August 2007, from http://www.who.int/patientsafety.

World Health Organization (2009a). *Guide to implementation: A guide to the implementation of the WHO multimodal hand hygiene improvement strategy. Save lives clean your hands. Patient safety: A world alliance for safer health care* Retrieved 3 August 2012, from WHO_IER_PSP_2009.02_eng.pdf.

World Health Organization (2009b). *The WHO Guidelines on Hand Hygiene in Health Care 2009*. *First Global Patient Safety Challenge: Clean Care is Safer Care* Retrieved 3 August 2012, from http://whqlibdoc.who.int/publications/2009/9789241597906_eng.pdf.

WRC, DWAF, and DoH (1998). *Quality of domestic water supplies Volume 1: Assessment Guide* (2 ed. Vol. **One**). Pretoria: Water Research Commission, Department of Water Affairs and Forestry, and Department of Health South Africa.

Yengopal, V., Naidoo, S., and Chikte, U. M. (2001). Infection control among dentists in private practice in Durban. *South African Dental Journal,* **56**(12), 580-584.

Ziady, L. E., and Small, N. (2013). *Prevent and control infection for safer healthcare practice* (Second ed.). Cape Town, South Africa: Juta and Co Ltd.

# CHAPTER 8

# Conclusions and recommendations

## 8.1 Introduction

Dr Aaron Motsoaledi, South African Minister of Health, stated in 2011 (Department of Health Republic of South Africa, 2011) that: ”The importance of providing quality health services is non negotiable. Better quality of care is fundamental in improving South Africa’s current poor health outcomes and in restoring patient and staff confidence in the public and private health care system.” The Minister further stated that continuous assessment should be undertaken to ensure compliance with standards. Ms MP Matsoso, Director General of the South African National Department of Health, elaborated on the Minister’s statement by identifying the need for an assessment instrument / tool for managers that makes it clear what is expected of them (Department of Health Republic of South Africa, 2011, 2012). She highlighted several priority areas requiring urgent attention, of which the improvement of the hygiene of health facilities, patient safety and the prevention of acquired infections are most obvious and urgent. These priority areas relate directly to the oral health profession. The AFI developed in this study will go a long way to creating a platform for assessment and monitoring compliance to infection prevention and control precautions in South African oral health care facilities.

The major outcome of this study is the development of an audit-feedback instrument that provides oral health care workers and facility managers with authentic, usable information, creating a realistic reflection of their compliance with infection prevention and control precautions. This AFI is able to provide information on overall compliance with infection prevention and control precautions, individual compliance in specific focus areas and is a means to identify areas of concern and shortcomings that require remedial action.

## 8.2 Future research and recommendations

The testing phase of the AFI highlighted areas requiring further research. Suggested follow-up research includes studying the following:

- The extent of compliance or lack of compliance across all infection prevention and control focus areas in South African oral health care facilities.

- Comparison of compliance or lack of compliance with infection prevention and control precautions between the public and private oral health care sectors.
- A more in-depth study of the compliance or lack of compliance within particular focus areas of infection prevention and control in specified facilities; particularly between more resource-requiring and resource-requiring focus areas.
- Overcoming challenges to implement and sustain infection prevention and control precautions in oral health care, particularly in facilities with limited resources.
- Obtaining feedback from the users of the AFI.

The implementation of an AFI in South African oral health care requires devising a roll-out plan or operational strategy. The approach of such a plan or strategy should be holistic, covering infection prevention and control in a broad context. Elements that should to be contained in such a plan / strategy should include:

- The development of an Internet-based services ecosystem, providing website services such as:
    - An AFI that provides compliance data, statistics and graphical perspectives.
    - A blogging facility providing the latest information on infection prevention and control precautions in oral health care.
    - Resources providing literature and documents on policies, regulations and guidelines related to infection prevention and control in oral health care.
    - Arrangements of continuous professional development (CPD) opportunities for oral health care workers.
    - Training material that can be drawn from the website.
- Refining of the guidelines used in this study into a user-friendly document that can be used as a resource in all oral health care facilities.
- Creating an awareness about the existence of an infection prevention and control services ecosystem which should include:
    - Publication in the South African Dental Association Journal.
    - Communicating with National Health and the professional bodies.

A fully operational infection and control services ecosystem should go a long way towards meeting the Minister of Health's high expectations about providing quality outcomes regarding infection prevention and control clinical practices in South African oral health care.

## 8.3 References

Department of Health Republic of South Africa (2011). *National Core Standards for Health Establishments in South Africa; "Towards quality care for patients".* Retrieved 6 October 2012, from http://www.sarrahsouthafrica.org/DOCUMENTS/NationalQualityAssuranceDocuments.aspx.

Department of Health Republic of South Africa (2012). National Core Standards for Health Establishments: 7 domains of quality healthcare. *86E84d01 National Core Standards for Health Establishments.pdf*. Retrieved from www.doh.gov.za/docs/posters/2012/domainsposter.pdf.

# LIST OF APPENDIXES

## Appendix A

**A copy of the original .pdf document of the publication Oosthuysen, J., Potgieter, E., and Blignaut, E. Compliance with infection control recommendations in South African dental practices: A review of studies published between 1990 and 2007. *International Dental Journal,* 60(3), 181–189.**

International Dental Journal (2010) 60, 181-189

# Compliance with infection control recommendations in South African dental practices: a review of studies published between 1990 and 2007

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In a country where the prevalence of infectious diseases ranks among the highest in the world, infection control in health care facilities should not be debatable. This unfortunately does not seem to be the case in South African oral health care facilities. This study is a systematic review of available literature on the adherence of South African oral health care professionals to infection control recommendations. Nine focus areas were investigated with regard to infection control practices: knowledge of infectious occupational hazards; personal hygiene and care of hands; correct application of personal protective equipment; use of environmental barriers and disposable items; sterilisation (recirculation) of instruments and handpieces; disinfection (surfaces) and sound housekeeping; management of waste disposal; quality control of dental unit waterlines, biofilms and water; as well as other special considerations. Although South African studies are limited and most of them relied on self-reports, which could have resulted in a serious overestimation of compliance, even these studies indicate serious shortcomings with regard to infection control practices in oral health care facilities in this country. This review highlights opportunity for improvement. Furthermore, it identifies possibilities for future research in infection control and also opportunities to improve infection control education for all oral health care workers in the country.

*Key words: Infection control, infectious diseases, oral health care, occupational hazards, personal hygiene, personal protective equipment, environmental barriers, sterilisation, disinfection, dental instruments, waste disposal, dental unit waterlines, biofilms, water*

Since 1993, it has been recommended that South African dental practitioners adhere to the infection control (IC) guidelines issued by the US Centers for Disease Control and Prevention (CDC)[1]. In 1998, however, Edward-Miller reported that many health care facilities in South Africa lacked even basic infection control requirements such as water and electricity[2], therefore making it impossible to adhere to any form of recommendation.

It has been estimated that one drop of saliva may contain up to 600,000 bacteria[3] and in no other profession are people in such continuous contact with traumatised tissue, saliva and blood, thus increasing the risk of disease transmission[4]. In South Africa, however, the term 'high risk' takes on a new meaning should one consider the exceptionally high prevalence of infectious diseases in this country. Human immunodeficiency virus (HIV) infection among antenatal clinic attendees


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was 29.1% in 2006[5]. The Hepatitis B carrier rate had previously been estimated at 10-15% for rural populations and at 1-10% for urban populations[6]. Karim *et al.*[7] reported that 81% of females and 86% of males in their study tested positive for at least one hepatitis B serological marker; indicating an infection at some stage of their lives[7]. Although the hepatitis B infection rate should improve as a result of the fact that children born since 1995[5] are being immunised as part of the routine immunisation programme most of the adult population in this country, however, is still not immunised. Furthermore, South Africa records a tuberculosis infection rate among the highest in the world[8]. Oral health care professionals (OHCPs) should therefore be even more cautious of cross-infection and display a higher degree of compliance with current protective guidelines than many other medical colleagues. It is alarming, however, that in South Africa there are still many oral health care workers (OHCWs) who admit to not taking adequate steps to prevent cross-infection[9-24].

In 2005, both public and professional concern were raised after a media release by the Nelson Mandela Foundation[25], confirming that infection control practices in oral health care facilities were inadequate. Visible as well as invisible blood was detected in the facilities and on dental instruments. It was concluded that this was the result of a breakdown in infection control processes that had occurred in South Africa over an extended period of time[26].

This review of published research aims to determine to what extent South African OHCPs adhere to national infection control recommendations, and thereby to identify possible shortcomings. Knowledge of the latter could indicate a strategy for the improvement of infection control in oral health care facilities.

## Research materials and methods

Various strategies were followed to identify information on IC research, published between 1990 and 2007, and applicable to South Africa only. This review of adherence to infection control practices included all OHCWs, namely dental practitioners, dental therapists, dental assistants, oral hygienists and students.

The outcome measures used as the baseline for infection control practices were selected according to international recommendations by the British Dental Association[27], CDC[1] and the Australian and New Zealand Dental Associations[28].

These outcomes focus on and include: knowledge of infectious hazards, personal hygiene and care of hands; wearing of personal protective equipment; environmental barriers; sterilisation (recirculation) of instruments and handpieces; disinfection (surfaces) and housekeeping; waste disposal; quality control and maintenance of dental unit waterlines, biofilms and water supply; and other special considerations.

Electronic databases were searched, including Medline (EBSCOhost), Academic Search Premier (EBSCOhost), Science Direct, SA ePublications, SACAT, ISAP by the National Library of South Africa, NEXUS current and completed research, UCTD (Theses and Dissertations at South African universities) and the South African Dental Association's publication library for the period 1990 till the end of September 2007. The search produced 77 publications of which 16 were selected. Publications containing quantitative data were selected, while those containing mere recommendations were excluded.

## Results and discussion

In addition to the discussion below, key findings by the various authors are summarised in *Tables 1* and *2*.

### *Focus area one: knowledge of infectious hazards*

As a standard precaution infection control guidelines and recommendations stipulate that the blood and body fluids of all patients should be treated as potentially infectious[1,27,28]. Lack of knowledge of hazards associated with infectious conditions was considered the reason oral health care providers took additional precautions when they treated confirmed HIV/AIDS patients as opposed to patients suffering from other infectious conditions[22,23,29]. Interesting to note was that respondents believed they could differentiate between infected and uninfected patients by just looking at them and that older dentists thought they were more at risk when working on an HIV-infected patient as compared to a hepatitis B-infected patient[22,23]. The majority of non-clinical personnel working in clinics thought that HIV infection could be transmitted through mosquito bites[21]. De Kock and Van Wyk[21] found that 26.8% of respondents did not know the difference between disinfection and sterilisation. Oosthuysen reported that 87% of respondents regarded each patient as a potential source of cross-infection[15], yet only 27.6% possessed an infection control manual with detailed protocols for sterilisation, exposure control or infection control techniques. In the Free State public dental care facilities 57.1% of respondents indicated that they had not received any infection control training in the past two years and that none of the clinics had devised any official infection control policy[14]. Only 30% of the respondents in this study knew that they had to wash their hands after removing gloves. Forty per cent, 27% and 10% respectively, believed gluteraldehyde, Jik® and Dettol® possessed sterilising properties[14]. Nemutandani *et al.*[30] reported that 49.1% of the dental assistants in his study had been given no formal training in infection control.

**Table 1** Reported use of barrier protection[15]

| | Gloves % | Masks % | Protective eyewear % |
|---|---|---|---|
| Practitioners | | | |
| Always | 88.4 | 83.5 | 55 |
| Sometimes | 9.3 | 11.2 | 20.6 |
| Never | 0.9 | 3.7 | 15.3 |
| Other | 1 | 1.2 | 8.7 |
| No response | 0.4 | 0.4 | 0.4 |
| Assistants | | | |
| Always | 65.8 | 50.4 | 21.6 |
| Sometimes | 28.7 | 29 | 23.7 |
| Never | 3.2 | 15.4 | 50.6 |
| Other | 1.9 | 4.3 | 3.4 |
| No response | 0.4 | 0.9 | 0.7 |

**Table 2** A comparison of infection control procedures among dentists in South Africa (adapted from Yengopal, Naidoo and Chikte, 2001[50])

| Aspects Surveyed | Naidoo (1994/5) % | Yengopal, Naidoo and Chikte (1999/2000) % | Oosthuysen (2001) % |
|---|---|---|---|
| Routine glove use | 87 | 97.1 | 88.4 |
| Routine mask use | 65 | 82 | 83.5 |
| Routine eyewear use | 64 | 53 | 55 |
| Autoclave use | 68 | 89.7 | 84.5 |
| Slow speed handpiece autoclaving | 28 | 39 | |
| High speed handpiece autoclaving | | 45.6 | } 43.8 |
| Rubber dam use | 2 | 40.6 | |
| Needlestick injury (previous 6 months) | 18 | 13.8 | |
| Use of a post-exposure sharps protocol | 6 | 33.3 | 27.7 |
| Recapping needles (two-handed technique) | 74 | 84.1 | |
| Hepatitis vaccine | 70 | 88.2 | |
| Disinfect impressions | 4 | 53.7 | |
| Disinfect appliances | | 52.4 | |
| Proper waste disposal | 75 | 95.4 | |
| Cross-infection control for burs | 92 | 93.3 | |
| Cross-infection control for curing light source | 76 | 91 | |
| Decontaminate – | | | |
| work surfaces, | 90 | 98.5 | |
| floor in surgery | 70 | 80.6 | |
| Cross-infection control for 3-in-1 tips | 84 | 96.2 | |
| Standard precautions, expensive but necessary | 68 | 52.9 | |

Several other studies on various aspects of infection control reported the need for further training in and knowledge about standard precautions and infection control in South Africa[9-24].

### *Focus area two: personal hygiene and care of hands*

Hand hygiene (e.g. hand washing, hand antisepsis, or surgical hand antisepsis) substantially reduces the numbers of potential pathogens on the hands and is considered the single most important procedure for reducing the risk of transmitting organisms to patients and OHCWs[1]. In South Africa several reports of inadequate compliance to this important infection control procedure have been recorded. Taps were operated mainly by hand (84%) and only 12% by elbow or 4% by foot[11]. The water supply in public dental clinics was found to be inadequate[21]. The majority of oral health care workers (83.2%) used an anti-bacterial liquid soap to wash their hands; however, a bar of soap was still the product of choice among 10.0% of respondents[15].

Although 86.6% of respondents acknowledged that hand washing is critical before and after patient contact, only 21.7% were observed doing it, indicating a considerable gap between the knowledge of this procedure and the actual clinical practice[14]. The failure to translate knowledge into practice on such an important aspect emphasises an urgent need for further education and training in this area among South African OHCPs, and possibly across the globe. In a study conducted in the Limpopo province only 50% of dental assistants washed their hands before and after putting on gloves[30]. Hand basins were used not only for hand washing, but also for cleaning dental equipment and discarding body fluids, as well as being a supply of water for patients[14]. It was found that 34.8% of oral health care workers wore jewellery while treating patients[14].

### *Focus area three: personal protective equipment*

From the results of the study conducted in 1992, it would seem that OHCPs realised the importance of the routine use of gloves, masks and protective eyewear, recording an increase of 87%, 80% and 63% to 98%, 94% and 92% respectively when they were treating a known HIV-positive patient[20]. South African OHCPs cited high costs as reasons for not sustaining adherence to infection control measures[16,21]. Although private dental practitioners are charging patients for the use of barrier protection, not all were found to actually use these measures[10] or to change them between patients[15].

Gloves were found not to be available at all, or in insufficient quantities, in 21.4% of clinics, to change after every patient[21]. This was substantiated by Methar *et al.*[14] where a shortage was reported in 30% of clinics.

Routine glove use was reported by 88.4%, 87% and 97.1% of respondents in three studies conducted among Durban OHCPs[10,11,18]. Similarly, Oosthuysen[15] reported that most practitioners (88.4%) routinely wear gloves, as summarised in *Table 1*. The use of gloves by the dental assistant (65.8%) did not compare favourably with that of the dental practitioner (88.4%); 92% of the dental assistants in the Limpopo study reported wearing gloves[30].

Although the majority of respondents (89.1%) reported changing of gloves for each patient, some respondents (2.2%) also indicated washing gloved hands a few times and thus using the same pair of gloves for more than one patient[12,15]. Disregarding skin reactions to gloves being frequently reported by OHCPs[12], only latex gloves were available in clinics, irrespective of the procedures to be performed or the infection control risk involved[14]. Despite dental practitioners being aware of the necessity to wear gloves, masks and protective eyewear, the majority were found to only wear gloves[22,23].

To maintain high filterability, it is recommended that masks should be replaced before they become moist, preferably every 20 minutes[1,27,28,31]. Oosthuysen[15] found that 83.5% of practitioners wore masks, as opposed to only 50.4% of their assistants, during patient treatment. The reasons furnished for wearing masks were to prevent the transmission of respiratory infections, or in the event of patients or practitioners possibly suffering from halitosis. Only 30.4% of respondents changed their masks with every patient, meaning that masks were only replaced when visibly contaminated, soiled, wet, or stained. The frequency of changing masks varied from each patient, to every 2nd, 3rd, 4th, 5th or 10th patient, morning and afternoon, daily, after four to five days or even once a week[15]. In 1994 Naidoo[10] reported that 65% of practitioners wore masks, which is considerably less than the 83.5% reported by Oosthuysen in *Table 1*[15].

The fact that so few dental assistants are wearing masks is a cause for concern since they are exposed to the same occupational hazards as dentists and oral hygienists. It should be emphasised that masks should be worn by all OHCPs, including dental assistants, during patient treatment sessions and changed after each patient, or more frequently should the mask become visibly soiled or wet.

Protective eyewear not only prevents infection, but also physical injury from aerosols, spattering and accidental trauma caused by flying debris. It is therefore advisable that operators, practitioners, hygienists and assistants, as well as patients, use protective eyewear to prevent trauma and infections[32]. Similar to the findings regarding masks, Oosthuysen reported that 15% of practitioners wore protective eyewear, while 50.6% of their assistants never did so (*Table 1*)[15]. Naidoo, in 1994, reported that that 64% of dentists used protective eyewear, as opposed to the 52.9% found in a study by Yengopal *et al.*[10,11,18]. In 2007 it was reported that 78.6% of OHCWs knew they have to wear eye protection, but observation revealed that only 17.4% were actually doing so[14]. This does not compare well with international studies in which a 80.8-82.0% compliance was reported[33,34].

Protective clothing or the wearing of a uniform has only been discussed in four studies[9,12,14,21]. Rudolph and Ogunbodede[21] reported that 'laundered' protective uniforms were rarely available in dental clinics. De Kock and Van Wyk[35] reported the use of disposable gowns to be very low (3.6%), while 42.8% of those who wore washable gowns did not remove these uniforms before leaving the surgery or clinic, thus exposing the community and family members to potentially infectious agents. Other studies support the fact that the wearing of protective clothing was inadequate (17.4%) and furthermore that these items were neither clean nor replaced regularly[9,14].

### *Focus area four: environmental barriers*

The constant touching of surfaces has been identified in dentistry as a special issue of concern[1]. Furthermore,

one needs to differentiate between clinical contact surfaces and general housekeeping surfaces. The clinical contact surfaces may often become contaminated with patient matter and thus present a risk for exposure and potential for disease transmission. Only one survey determined the use of protective barriers on equipment and it was found that only 23.3% of oral hygienists applied such barriers[12]. This could indicate a serious lack of resources to inform South African OHCWs concerning the effective and correct application of the recommended environmental barriers.

### *Focus area five: sterilisation*

Most instruments used during dental procedures are in contact with the oral mucosa and/or penetrate tissue. This requires that re-usable instruments be thoroughly cleaned and sterilised with standardised methods that can be routinely monitored and verified[36]. Dental practitioners (69%) reported that their patients expressed concerns about contracting AIDS through dental procedures and asked questions about sterilisation practices[20]. Between 68.0-89.7% of respondents in three major studies reported that they autoclaved instruments[10,11,15,18]. Dry heat ovens or hot air sterilisers were used by 6%, 1% used chemical vapour and 4% used liquid sterilisation with chemicals only[15]. Boiling water was the method of choice among 22% of respondents[10,11,15]. Disinfection is still widely used to process critical instruments[9-11,14,15]. More than 50% of respondents reported incorrect processing of equipment and instruments[12]; more than 10% reported not having autoclaves in public dental clinics[21]; while 48.9% of respondents were not aware of the operational parameters (time, temperature and pressure) of their autoclaves[15]. Items were not disassembled prior to disinfection and sterilisation; 24.64% of dental items were found to be contaminated with blood immediately prior to being used on patients, with 19.4% of instruments revealing visible blood and extraction forceps recording the highest counts[9,14].

Scrubbing instruments by hand has been indicated as the preferred method (55.6%) for pre-sterilisation debridement[15]. Although manual cleaning is simple and cheap, the time involved in cleaning instruments properly and the added risk of injury by contaminated instruments cannot be ignored. It may therefore be appropriate to encourage more practitioners to make use of automated cleaners in order to protect staff members and improve cross-infection control, as recommended by the CDC[1].

Sterilisation failure rates have been recorded in many countries, including the USA 15%, Norway 33%, Germany 23%, Canada 4%, Denmark 2.3% to 7.3%, and UK 2%[40], emphasising the need for regular testing of effectiveness of autoclaves. The CDC recommends that equipment should be monitored for its ability to attain all the physical parameters of the sterilisation process and should include a combination of mechanical, chemical, and biological indicators[1]. Although the majority of respondents (70%) in the study by Oosthuysen indicated checking the effectiveness of their autoclaves, they do so by either observing gauges/lights on the autoclave only (31.2%), or by using commercially available colour changing strips/tapes (14.8%). Of the practitioners 90.9% indicated they never use biological or other tests to monitor autoclave effectiveness[15]. In the survey among oral hygienists only 1.8% of respondents confirmed using biological tests to monitor autoclave effectiveness[12].

Reliable and clear identification of sterilised instruments and other sterilised material is essential. Each facility should have a stock rotation policy in order to rotate stored sterile packages and use the oldest packs first[37]. Shelf life of the stored packets is thus event-related, indicating why sterilisation packages should be marked with the date of processing and which steriliser was used, as well as for identification purposes, in case of sterilisation failure[41]. The shelf-life of sterile packages depends upon the integrity of the package material and the environment where these packages are stored, as these surfaces and equipment can also become contaminated by direct contact or simply being exposed to air, expired air and dust[42].

The extent to which disinfection is still used to process critical instruments, together with the absence of verifiable proof of the success of each sterilisation cycle, is alarming and practitioners should be made aware of the serious consequences this could hold in the event of a complaint or query by patients.

### *Focus area six: disinfection (surfaces) and sound housekeeping*

Environmental surfaces become contaminated not only by aerosol generated by dental equipment, but through direct touch, expired air or dust. It is important to realise that the effectiveness of a disinfecting solution depends on various factors, including the concentration and nature of contaminating microorganisms, the concentration of the chemical, the exposure time and the amount of accumulated bioburden[39]. Although 93.8% and 83.0% of respondents indicated disinfection of working areas and handles of lights, the availability of chemicals have been indicated as a problem by 37% of respondents[21]. Yengopal, *et al.*[18] reported that rinsing with water only was the preferred method for the disinfection of appliances (60.6%) and impressions (66.7%). Limited data are available on the use of disinfectants by South African OHCPs, which offers an opportunity for further investigation.

### Focus area seven: waste management

Knowledge of a waste management policy seems to be lacking amongst OHCWs in South Africa, as evidenced by the findings that only 26.7% of those questioned were aware that such a policy exists[9,14], 25% of respondents disposed of sharps in the normal waste[10,11] and almost 50% of respondents did not have a waste disposal policy[21]. Although 96% of respondents indicated immediate disposal of used needles, 15.2% employed no special waste disposal system for sharps and needles[21]. Only one respondent indicated wearing gloves during handling of waste while in only 39% of cases waste was segregated according to the appropriate colour coding[14].

### Focus area eight: dental unit waterlines, biofilms and water quality

It was encouraging to note that 76% of respondents flushed their waterlines after treating a patient[21]. In the survey of infection control procedures applied by oral hygienists, 50% reported flushing waterlines (30 seconds after each patient and 3 minutes at the beginning and end of the working day[12]. Even with anti-retraction valves, flushing of devices for a minimum of 20 to 30 seconds after each patient is recommended[1]. However, mechanical flushing alone cannot control contamination in waterlines[43].

To date, no published scientific evidence confirms a serious health risk for patients or OHCPs from contact with contaminated dental water, but researchers have found pathogens such as *Pseudomonas aeruginosa*, *Legionella* and non-tuberculosis *Mycobacterium* in dental unit tubing[44]. Exposing patients or personnel to water of poor microbiological quality is inconsistent with accepted infection control principles[45]. A reason for concern is the increasing number of vulnerable patients, for example the elderly, those with chronic conditions such as diabetes, people being treated for cancer, and patients with compromised immune systems[46]. No South African studies exist showing compliance with the various recommendations with regards to control of biofilms in the thin tubing and waterlines of the dental units and the quality of the water delivered through these systems[47]. In addition no South African studies exist concerning the availability and use of infection control policies and standard operating procedures in cases of 'boil water alerts in South Africa[47].

### Focus area nine: Special considerations

Special considerations include: dental handpieces and other devices attached to air and waterlines; single-use or disposable devices (including saliva ejectors; dental radiology; pre-procedural mouth rinses; the dental laboratory; *Mycobacterium tuberculosis*; Creutzfeldt-Jakob disease and other prion diseases; and vaccination of OHCPs.

### Dental handpieces and other devices attached to air and waterlines

A special area of concern in dentistry is bacterial contamination of dental handpieces and the methods applied to ensure safe application to patients after use[13,49]. The CDC recommends routine use of heat sterilisation after every patient wherever possible, i.e. steam under pressure or autoclaving, dry heat, or heat/chemical vapour, for all high-speed dental handpieces, low-speed handpiece components used intra-orally, and re-usable prophylaxis angles[1]. More than half of respondents (53.0%) reported that their preferred method for recycling handpieces was wiping with or soaking in a liquid chemical disinfectant[15], whereas between 28% and 39% autoclaved slow handpieces, and 43.8% and 45.6% the high speed handpieces[10,11,15,18]. Only 17% autoclaved their handpieces after every patient use[15]. Autoclaving handpieces is not a common procedure in South Africa and this indicates an urgent need for motivation to routinely follow this procedure[12]. These South African figures are extremely low when compared to international figures of 76.9-95.0% for routine heat sterilisation of handpieces[33]. Lack of sufficient handpieces and fear of equipment failure resulting from the heat of the sterilisation process are reasons provided for a reluctance to comply[50].

Dreyer and Hauman demonstrated that internal surfaces of dental handpieces become contaminated during normal dental procedures, with water-lines within the handpiece displaying the heaviest contamination, and concluded that autoclaving handpieces would possibly be the only effective way to sterilise both internal and external surfaces[13].

In a study conducted among dentists regarding their awareness of tuberculosis (TB), Naidoo and Mahommed[19] reported that two thirds of dentists sterilised suction and the 3-in one syringe tips. This indicates a need to promote the disposal of these items as the effective sterilisation thereof is extremely difficult.

### Single-use or disposable devices (including saliva ejectors and 3-in-1 tips)

It was found that 1.5% of responding dentists re-used needles and 6.2% re-used cartridges and although these numbers are low:

*'These practices are totally unacceptable from a moral, ethical and infection control point of view'*[50].

It is suggested that further observational studies and other methods be applied to assess incorrect use or compliance with the correct practices. The use of a rubber dam as an infection control practice should be promoted since it is recommended for controlling the generation of saliva contaminated aerosol[42]. However, the use of rubber dam where possible may well minimise some forms of cross-infection, but should

not be seen as an alternative to the measures described based on heat sterilisation, to eliminate cross-infection. Between 2.0%-40.6% of dentists were found to use a rubber dam as an infection control practice[10,18,19].

### Pre-procedural mouthrinses

The CDC lists the use of pre-procedural mouth rinses as part of standard precautions to reduce the risk of cross-infection[1]. This can be most beneficial prior to a procedure that requires the use of a polishing cup/brush or ultrasonic scaler, because a rubber dam cannot be used in such cases to control aerosols and spatter. With the aid of a dental assistant, high volume evacuation can be utilised as an additional infection control procedure[51].

### Dental radiology

No publications concerning infection control during dental radiographic procedures have been documented in South Africa. Intra-oral x-ray film which is enclosed in a disposable plastic envelope is available. Following exposure of the film in its envelope it can be taken out of its disposable plastic outer envelope and processed without concern of any possible contamination.

### Dental laboratory

Dentists did not disinfect impressions (46.3%) and appliances (47.6%) before sending them to the dental laboratory[50]. In an earlier study Naidoo reported that 96% of respondents did not disinfect impressions[10]. However, rinsing with water as the preferred method for disinfection of appliances (60.6%) and impressions (66.7%) does not comply with recommendations[1]. With regard to this aspect, in addition there seems to be a lack of effective communication and coordination between the laboratory and oral health care facility to ensure that appropriate cleaning and disinfection procedures are performed and appliances and prostheses delivered to the patient are free of contamination.

### Mycobacterium tuberculosis

The prevalence of tuberculosis (TB) in South Africa is one of the highest in the world and accounts for 80% of all notifiable diseases in the country[19]. Only these authors have reported on this uniquely South African occupational hazard for OHCPs and the requirement to increase knowledge, and alter attitudes and behaviour in order to prevent transmission and management of this infection in oral health care facilities.

### Creutzfeldt-Jakob disease (CJD) and other prion diseases

No published data on the occurrence of this condition or presence of prions in South Africa could be found in the literature that was searched.

### Sharps injuries and post-exposure management

With the particularly high prevalence of HIV/AIDS in South Africa[5], the lack of use of antiretroviral agents as post exposure prophylaxis (PEP) after injuries caused by sharps is incomprehensible, complicated further by the lack of personnel capable of carrying out a proper risk assessment and counselling[16]. Many OHCPs work in remote rural areas and were only able to access PEP several days after an exposure incident - although the ideal time to start with PEP is within two hours of the exposure[16]. This state of affairs was confirmed in a survey in the Free State, in which only 6.7% of clinics had a sharps injury protocol at hand, although in 50% of cases staff was not aware of such a protocol. Meanwhile 43% of respondents said they were of the opinion that they could receive PEP within four hours after a sharps incident[9,14]. Of these respondents 26.6% reported a sharps injury in the past three years while administering local anaesthesia or while using two-handed re-capping of the needle[9,14]. Yengopal[18] reported that 13.8% of dentists had experienced a needle stick injury in the previous six months, with 84.1% of such dentists using the two-handed technique to recap needles. It is recommended that one never recaps a needle using both hands, nor point any sharp object at any part of the body[1]. Two-thirds of the injured dentists did not follow any specific protocol subsequent to their injury[50].

### Hepatitis B vaccinations

The hepatitis B carrier rate in South Africa is very high[6]. All OHCPs and cleaners in the oral health care facility are constantly exposed to traumatised tissue, saliva and blood. Nevertheless, few studies have reported on hepatitis B immunisations among OHCPs in South Africa. Depending on antibody status, hepatitis B immunisations must be repeated every five years, yet Rudolph and Ogunbodede reported that almost 50% of dentists in their study had not received any hepatitis B vaccination in the previous 3 years[21]. De Kock and Van Wyk reported that while only 7.1% of hygienists had never been immunised, 26.8% required a booster. Among dentists, 88% had been immunised, of which 59.1% had been given a booster. Only 38.8% of the rest of their staff were immunised[50]. In 2007 it was reported that 62.7% of dental assistants in the Limpopo province had not been immunised at all[30]. In none of the studies was the immunisation status of cleaning staff determined.

## Conclusion

Although studies on compliance with infection control guidelines exist, many aspects of this issue have not been studied. Of those which have been accorded attention to, the following problem areas were identified in order to improve compliance to infection control recommendations in South Africa:

Although gloves are worn they are not replaced for every patient and hands are not washed before and after donning them. Masks are worn by most dentists, but not their assistants, and are not replaced after every patient. Protective eyewear and clothing are not worn and cleaning of uniforms seems to be a problem. Hand scrubbing of instruments is still widely used. Most practitioners use autoclaves, but 90% of them have never used a biological indicator and many still use disinfectants. Boiling water is still used to sterilise appliances and waste segregation is not undertaken correctly. Handpieces are not sterilised between all patients and single-use items are re-used. Most of the dental practitioners seem to be immunised against hepatitis B, but many do not maintain boosters and most of the dental assistants are not immunised, while no data are available regarding cleaners. Also rural OHCPs do not have immediate access to PEP after sharps injuries. Waterlines are flushed, but no data are available with regards to the quality of the water from dental units used in South Africa.

With two exceptions, all other studies among South African OHCPs relied on self-reports, and consequently these results may represent a serious overestimation of correct behaviour. Despite this possibility, even these results indicate that a considerable gap exists between what is expected and the actual clinical performance by South African oral health care providers concerning infection control recommendations. Controlling diseases and preventing infections from spreading are more crucial than ever, and doing so is the responsibility of every member of the oral health care team. This review highlights opportunities for improvement and further research.

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## References

1. CDC. Guidelines for infection control in dental health-care settings - 2003. *Morbidity and Mortality Weekly Report* 2003 19 December; **52**(Number RR-17):1-68.
2. Edward-Miller, J. Measuring quality of care in South African clinics and hospitals. South African Health Review. Durban: Health Systems Trust; 1998. p. Chapter 14.
3. Hovius M. Disinfection and sterilisation: the duties and responsibilities of dentists and dental hygienists. *Int Dent J* 1992 **42**: 241-244.
4. Harfst SA. Personal Barrier Protection. *Dent Clinics North Amer* 1991 **35**: 357-366.
5. National Department of Health. National HIV and syphilis prevalence survey South Africa 2006: Summary report 2007.
6. Jentsch U. A review of opportunistic infections in Africa: current topics. *South African J Epidemiol Infection* 1997 **12**: 28-32.
7. Karim SSA, Thejpal R, Singh B. High prevalence of Hepatitis B virus infection in rural black adults in Mseleni, South Africa. *Amer J Public Health* 1989 **79**: 893-894.
8. World Health Organization. Global tuberculosis control: surveillance, planning, financing. WHO report 2008. 2008 2008;WHO/HTM/TB/2008.393.
9. Shisana O, Mehtar S, Mosala T *et al.* HIV risk exposure in children: A study of 2–9 year-olds served by public health facilities in the Free State, South Africa. Commissioned by the Nelson Mandela Foundation. Cape Town: Human Sciences Research Council Press 2005.
10. Naidoo S. Dentists and cross-infection [Dissertation]: University of the Western Cape; 1994.
11. Naidoo S. Dentists and cross-infection. *J Dent Assoc South Africa* 1997 **52**: 165-167.
12. de Kock K, van Wyk CW. Infection control in South African oral hygiene practice. *South African Dent J* 2001 **56**:584-587.
13. Dreyer AG, Hauman CHJ. Bacterial contamination of dental handpieces. *South African Dent J* 2001 **56**: 510-512.
14. Mehtar S, Shisana O, Mosala T *et al.* Infection control practices in public dental care services: findings from one South African Province. *J Hospital Infection* 2007 **66**: 65-70.
15. Oosthuysen J. Infection control techniques used in South African dental practices [Dissertation]. Bloemfontein: Central University of Technology, Free State; 2003.
16. Ogunbodede EO, Rudolph MJ. Policies and protocols for preventing transmission of HIV infection in oral health care in South Africa. *South African Dent J* 2002 **57**: 469-475.
17. Yengopal V. Evidence based dentistry - some updates to help in practice. How well do dental health care workers adhere to infection control guidelines for dentistry? *South African Dent J* 2003 **58**.
18. Yengopal V, Naidoo S, Chikte UM. Infection control among dentists in private practice in Durban. *South African Dent J* 2001 **56**: 580-584.
19. Naidoo S, Mahommed A. Knowledge, attitudes, behaviour and prevalence of TB infection among dentists in the western Cape. *South African Dent J* 2002 **57**: 476-478.
20. Darling M, Arendorf T, Samaranayake LP. Oral care of HIV-infected patients: the knowledge and attitudes of South African dentists. *J Dent Assoc South Africa* 1992 **47**: 399-402.
21. Rudolph MJ, Ogunbodede EO. HIV infection and oral health care in South Africa. *South African Dent J* 1999 **54**: 594-601.
22. Lapidus A, Sandler M. HIV and the dental profession. *J Dent Assoc South Africa* 1997 **52**: 721-726.
23. Lapidus AH. HIV and the dental profession [Dissertation]. Johannesburg: University of the Witwatersrand; 1995.
24. Kopsala JT. Infection control in public dental care settings [Dissertation]. Johannesburg: University of the Witwatersrand; 2003.
25. McKay E. Results of a research report into HIV risk exposure of young children (2-9) to HIV in the Free State province. Media release: Nelson Mandela Foundation2005 5 April 2005.

26. Shisana O, Mehtar S, Mosala T *et al.* HIV risk exposure in children: A study of 2–9 year-olds served by public health facilities in the Free State, South Africa. Cape Town: Human Sciences Research Council Press2005.
27. British Dental Association. Infection control in dentistry. Advice sheet A12. London: BDA; 2003.
28. Australian/New Zealand Standard. Office-based health care facilities - Reprocessing of reusable medical and surgical instruments and equipment, and maintenance of the associated environment. In: New Zealand, SAS, editor.: Jointly published by Standards Australia, GPO Box 476, Sydney, NSW 2001 and Standards New Zealand, Private Bag 2439, Wellington 6020; 2006.
29. Gordon BL, Burke FJ, Bagg J *et al.* Systematic review of adherence to infection control guidelines in dentistry. *J Dent* 2001 **29**: 509-516.
30. Nemutandani MS, Yengopal V, Rudolph MJ *et al.* Occupational exposures among dental assistants in public health care facilities, Limpopo Province. *South African Dent J* 2007 **62**: 348-355.
31. Miller CH, Palenik CJ. *Infection Control and Management of Hazardous Materials for the Dental Team*. Third ed. St. Louis, Missouri: Elsevier Mosby; 2005.
32. Davis C, Young NS. Disease transmission theory and control of contamination and bloodborne pathogens. In: Woodall, IR, editor. *Comprehensive dental hygiene care*. Missouri: Mosby; 1993.
33. McCarthy GM, Koval JJ, MacDonald JK. Compliance with recommended infection control procedures among Canadian dentists: Results of a national survey. *Amer Infect Control* 1999 **27**: 377-384.
34. Gershon RM, Karkashian C, Vlahov D *et al.* Correlates of infection control practices in dentistry. *Am J Infect Control* 1998 **26**: 29-34.
35. de Kock, K, van Wyk, CW. Infection control in South African oral hygiene practice. *South African Dent J* 2001 **56**: 584-587.
36. Crawford JJ. Infection control. In: Sturdevant, CM, Roberson, TM, Heymann, HO, Sturdevant, JR, editors. *The art and science of operative dentistry*. 3rd Edition. St Louis: Mosby; 1994.
37. OSAP. Instrument reprocessing. *Infection Control in Practice*. 2003 6.
38. De Paola LG. Instrument management Part 2: sterilization, biological monitoring and storage in the dental office. *The Infection Control Forum* 2006 4(1).
39. Molinari JA, Rosen S, Runnels RR. Heat sterilization and monitoring. In: Cottone, JA, Terezhalmy, GT, Molinari, JA, editors. *Practical infection control in dentistry*. 2nd Edition. Baltimore: Williams & Wilkins; 1996. p. 149-60.
40. Burke FJT, Coulter WA, Cheng SW *et al.* Autoclave performance and practitioner knowledge of autoclave use: a survey of selected UK practices. *Quintessence Int* 1998 **29**: 231-238.
41. Scarlett MI. Disinfection and sterilization: a primer. *Dentaltown* 2007 2007 **7**: 52-60.
42. Eklund KJ, Bednarsh H, Haaland CO. OSAP *Interact infection control and safety training system*. 2nd ed. Bassett, K, Long, TM, editors. Annapolis, 2002.
43. OSAP. From policy to practice: OSAP's Guide to the Guidelines: OSAP; 2004.
44. Szymanska J. Microbiological risk factors in dentistry. Current status of knowledge. *Ann Agric Environ Med* 2005 **12**: 157-163.
45. ADA. Council on Scientific Affairs. Dental unit waterlines: approaching the year 2000. *J Am Dent Assoc* 1999 130: 1653-1664.
46. Webber LM. Bloodborne viruses and occupational exposure in the dental setting. *South African Dent J* 2000 **55**: 494-496.
47. Mills SE. The dental unit waterline controversy: defusing the myths, defining the solutions. *J Am Dent Assoc* 2000 **131**: 1427-1441.
48. Potgieter E, Hiemstra AH, Barnes, BJ *et al.* Eds. Drinking water: Microbiological monitoring and management; a case study. The Second IASTED International Conference on Water Resources Management; 2007 20-22 August 2007; Honolulu, Hawaii, USA: Acta Press.
49. Bossmann K. Hygienic maintenance of dental handpieces and turbines : clinical information. *J Dent Assoc South Africa* 1990 **50**: 416-417.
50. Yengopal V, Naidoo S, Chikte UM. Infection control among dentists in private practice in Durban. *South African Dent J* 2001 **56**: 580-584.
51. Yengopal V. The use of essential oil mouthwashes as preprocedural rinses for infection control. *South African Dent J* 2004 **59**: 247-8, 250.


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## Appendix B

**A copy of the original .pdf document of the publication Oosthuysen, J., Potgieter, E., and Fossey, A. Compliance with infection prevention and control in oral health-care facilities: a global perspective*. International Dental Journal, September 2014***
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REVIEW ARTICLE

International Dental Journal

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# Compliance with infection prevention and control in oral health-care facilities: a global perspective

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Many publications are available on the topic of compliance with infection prevention and control in oral health-care facilities all over the world. The approaches of developing and developed countries show wide variation, but the principles of infection prevention and control are the same globally. This study is a systematic review and global perspective of the available literature on infection prevention and control in oral health-care facilities. Nine focus areas on compliance with infection-control measures were investigated: knowledge of infectious occupational hazards; personal hygiene and care of hands; correct application of personal protective equipment; use of environmental barriers and disposable items; sterilisation (recirculation) of instruments and handpieces; disinfection (surfaces) and housekeeping; management of waste disposal; quality control of dental unit waterlines, biofilms and water; and some special considerations. Various international studies from developed countries have reported highly scientific evidence-based information. In developed countries, the resources for infection prevention and control are freely available, which is not the case in developing countries. The studies in developing countries also indicate serious shortcomings with regard to infection prevention and control knowledge and education in oral health-care facilities. This review highlights the fact that availability of resources will always be a challenge, but more so in developing countries. This presents unique challenges and the opportunity for innovative thinking to promote infection prevention and control.

***Key words:*** *Dentistry, dental, oral health care, infection control, compliance with guidelines*

## INTRODUCTION

During the early 1980s, most oral health-care workers (OHCWs) practiced oral health care without wearing gloves, masks or eye protection[1]. The identification of infection with the human immunodeficiency virus (HIV) in 1981, which resulted in acquired immune-deficiency syndrome (AIDS), possibly had one of the most significant impacts on the oral health-care profession[2,3]. At that time, the routes of transmission and biology of HIV were poorly understood. As a direct result of the growing HIV/AIDS epidemic, infection control, especially in the clinical oral health-care environment, changed almost overnight. More than three decades later, patient profiles have changed considerably, and treatment regimens have thus adapted towards early diagnosis and preventive approaches[2]. Today, there is generally a better understanding of disease transmission and prevention in oral health care, which has led to a greater focus on practising infection prevention and control[4].

Oral health-care facilities have led the way in implementing infection-control practices by routinely incorporating hand hygiene and sterilisation procedures[3]. This has contributed positively to the reduction of various disease-transmission challenges. Additionally, since the mid-1980s, before any of the other health professions, oral health-care facilities have rapidly incorporated hepatitis B virus (HBV) vaccinations for personnel members[3].

A systematic review of studies published from January 2008 to September 2013 that address compliance with infection-control guidelines and recommendations in developed as well as in developing countries, was undertaken, and will be reflected in this article.

## RESEARCH MATERIALS AND METHODS

As just noted, a systematic review of global literature addressing infection-control compliance in oral health care was undertaken. A similar review has previously

been published, covering the same literature and applicable to South Africa, but only up to 2007[5]. The present review covers global studies published from January 2008 to September 2013. It focuses particularly on adherence to infection-control practices and includes all the categories of OHCWs, namely dental practitioners, dental therapists, dental assistants, oral hygienists and students.

International electronic databases were searched, including Medline (EBSCOhost), Academic Search Premier (EBSCOhost), Science Direct, SA ePublications, SACAT and ISAP (by the National Library of South Africa), as well as the theses and dissertations from universities for the period January 2008 to September 2013. The search terms included, 'infection control', 'dentistry', 'dental', 'oral health' and 'compliance'. Responses to these search terms were then searched again, in more depth. The search produced 19,681 publications, of which 176 were selected containing quantitative data, while those containing mere recommendations were excluded (*Figure 1*). All selected publications were further scrutinised for adherence to the following questions:

- Does the literature provide details on infection control in oral health care?
- Can the contents of the selected literature be applied for compliance with infection control in oral health-care facilities?

The outcome measures used as the baseline for infection-control practices are similar to those used in the earlier publication[5]. These outcome measures were selected according to international recommendations of the British Dental Association, the United States Centers for Disease Control and Prevention (CDC) and the Australian Dental Association[6–10]. The outcomes focused on: knowledge of infectious hazards, personal hygiene and care of hands; wearing of personal protective equipment; environmental barriers; sterilisation (recirculation) of instruments and handpieces; disinfection (surfaces) and housekeeping; waste disposal; quality control and maintenance of dental unit waterlines, biofilms and water supply; and other special considerations.

## COMPLIANCE WITH INFECTION CONTROL IN DENTISTRY: A 5-YEAR REVIEW OF STUDIES IN DEVELOPED AND DEVELOPING COUNTRIES

### Focus area one: Knowledge of infectious hazards

Current epidemiological data outline the risk of exposure and possibility of transmitting diseases when providing oral health-care treatment[11]. The World Dental Federation (FDI) thus recommends that all oral health-care professionals keep their knowledge and skills current. With the application of up-to-date knowledge and skills, transmission of infectious diseases could be managed in oral health-care facilities[11]. As stated, three decades ago it was the fear of the HIV/AIDS epidemic that motivated infection-control preventive measures[2,12]. Today, recommendations, guidelines and policy statements assist oral health-care professionals to prevent and control infectious risks by routinely following standard infection-control precautions[6–8,11,13–17].

Recent media reports on breaches of infection control in USA oral health-care facilities have increased public concern[18–20]. Compliance with infection control and factors associated with the implementation of CDC infection-control guidelines were investigated by Cleveland *et al.* from the USA[21]. The authors linked compliance with infection control to continuous professional education through various modes/events of education[21]. Examples of the modes of learning and education included workshops, journal articles and Internet-based learning. Furthermore, Cleveland *et al.*[21] reported that younger dental practitioners, who had been in their current practice for less than 30 years, were more likely to implement infection-control guidelines. Exposure to more intensive and varying types of infection-control education were highlighted as possible reasons for better compliance among younger oral health-care practitioners[21]. Apart from the age of practitioners, it was also reported that the size of facilities played a role in compliance with infection control. The results indicated that larger facilities, employing nine or more oral health-care practitioners and other personnel, were more likely to have implemented guidelines and also to have more knowledge to comply with infection control when compared with solo or smaller facilities[21].

Educational methods in infection-control procedures were questioned in a study from the UK, in which 77% of personnel confirmed that they had received specific training in this field. However, it should be noted that training for instrument-decontamination procedures was provided for mainly by demonstration (97%) or observed practice (88%)[22]. In addition to these results, the majority of dental assistant and dental practitioner responders from the same study were unfamiliar with the international indicator symbol for a single-use item[22]. This has highlighted the need for theoretical and practical education and training in infection control.

Cleveland *et al.*[21] investigated the knowledge about surgical irrigation methods in the USA. They found that dental practitioners were aware that they should use sterile water or saline during surgical procedures. However, only about half of the dental practitioners ever used sterile water or sterile saline during surgical procedures, such as gingivectomy, extraction of an impacted third molar, soft-tissue biopsy or bone recontouring.

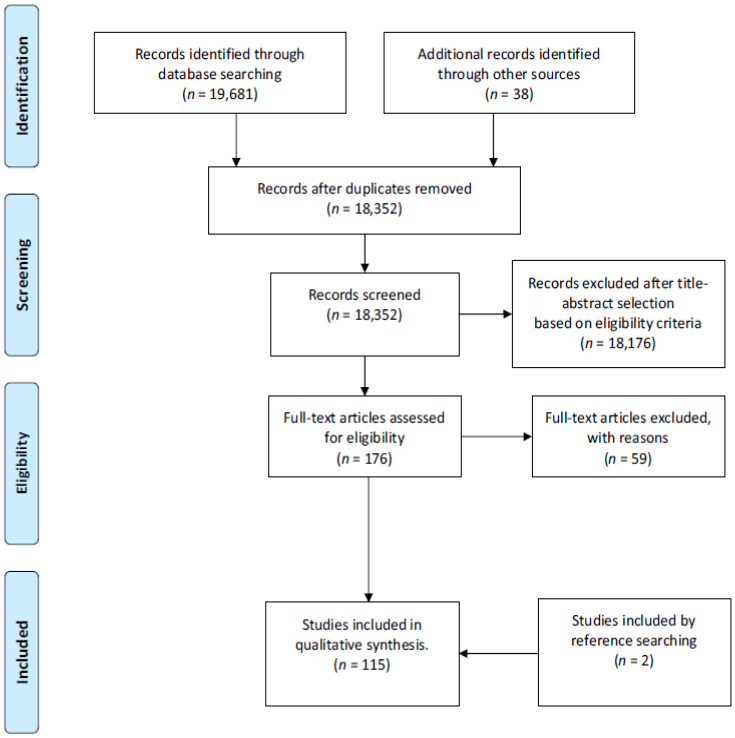


*Figure 1.* PRISMA 2009 flow diagram (Moher *et al.*, 2009)[117].

Basic knowledge of infection prevention and control varies among countries. In a study investigating the education and knowledge of Turkish dental practitioners, only 43% of participants were able to define 'cross-infection' correctly[23]. In Brazil, education and knowledge was agreed to contribute to improved infection-control attitudes and behaviour[24]. However, upon further investigation of the compliance with infection control, the results in practice were worrying[24]. Similarly, findings in India indicated that oral health-care professionals have good knowledge of infection control[25]. However, the authors admitted that the compliance levels with infection control were low. Singh *et al.*[26] concluded that infection-control guideline training among oral health-care personnel and cooperation with local hazardous waste-disposal authorities were identified as priorities.

An association was made between the knowledge of infection control and the injuries that occurred among Taiwanese dental practitioners[27]. The results from this study indicated that the overall knowledge of infection-control procedures among dental practitioners was insufficient. Cheng *et al.*[27] reported that, although younger dental practitioners had fewer needlestick and sharps injuries, those oral health-care providers routinely exposed to injuries tended to be more concerned about knowledge of infectious hazards and compliance with infection prevention and safety measures. Studies among oral health-care providers and dental students in the USA reported a lack of understanding of the basics of infection prevention and control[28].

## Focus area two: personal hygiene and care of hands

Personal hygiene and care of hands have been identified as the most important infection-control precautions to prevent transmission of diseases[29,30]. Transfer of health care-associated cross-infections has been linked to the hands of health-care workers in an estimated 20–40% of cases[31]. To enable OHCWs to execute routine hand hygiene before and after each patient contact session, the minimum requirements include the availability of clean water, adequate handwashing facilities, patient-placement facilities, correct storage of sterile supplies and other conditions relevant to the physical working environment[32]. Fixed hand-hygiene facilities, including separate basins for instrument cleaning, hand hygiene and patient rinsing, are some of the routine challenges for providing patient care[33]. These challenges are doubly experienced when community oral health-care procedures are executed in mobile dental units or community centres, such as schools or other venues[34]. These facilities are usually not specifically designed or equipped for oral health-care procedures.

In 2002, new evidence-based practices for hand hygiene in health care were published by the CDC[35]. This guideline promotes the use of alcohol-based hand-sanitisers or hand rubs to be utilised as replacement for routine washing with soap and water, particularly when hand-wash basins are not available. The use of these products is contraindicated when hands are visibly contaminated[35]. During 2009, the World Health Organisation (WHO) endorsed these guidelines to improve hand-hygiene practices throughout all health-care facilities[32].

In addition, findings from Europe indicate that oral health-care professionals there do not wash their hands according to the CDC recommendations for oral health-care facilities[30,36]. However, as a result of the implementation of the Protection Against Infection Act in Germany, a decrease of errors in hand hygiene, and an increase in the use of skin antiseptics and surface disinfection, were reported[37].

Adequate hand-hygiene practices, such as frequent use of soap and water and sometimes alcohol-based hand sanitisers, were maintained by more than 75% of oral health-care practitioners investigated in the USA[38]. In the UK it was reported that compliance with hand hygiene was not high enough, and, when applied, the methods used were outdated[22]. Results of hand-hygiene practices in this UK study point out that bar soaps were still used and nail brushes were present in 22% of facilities[22]. In actual fact, the use of bar soaps and nail brushes is discouraged in current UK guidelines/recommendations[15].

Studies on personal hygiene and the care of hands in oral health-care facilities in developing countries are limited. In one study, Nigerian respondents strongly agreed that the transmission of diseases to patients can be prevented through application of appropriate hand hygiene[33]. In Brazil, the use of soap and paper towels in public oral health-care facilities was found to be significantly less than in private practices ($P < 0.001$)[39]. Bar soaps used in oral health-care facilities in India were found to be contaminated with organisms such as *Pseudomonas aeruginosa*, *Acinetobacter*, *Enterobacter* spp, *Staphylococcus aureus* and *Staphylococcus epidermidis* in more than 90% of the samples taken[40]. This supports the use of automated soap dispensers and liquid hand hygiene products, as recommended in the 2003 CDC guidelines for oral health care, which actively discourages the use of bar soaps.

The use of mobile devices in oral health-care facilities, especially while busy with patient-care procedures, is also a concern. The results of a study in India revealed that mobile phones may act as an infection risk in oral health-care facilities, as frequent touching heavily contaminates these devices with pathogens[41]. Therefore, it is important for educators to instruct OHCWs to limit the touching of personal mobile devices, and to avoid interruptions during contaminating treatment procedures. Higher compliance with hand-hygiene practices and routine surface disinfection of mobile devices should further be advocated.

### Focus area three: personal protective equipment

The areas most vulnerable and at risk for transmission of diseases include the eyes, face and hands of OHCWs[42]. Personal protective equipment (PPE), including protective clothing, masks, protective eyewear and disposable gloves, should be worn during any clinical contact. PPE acts as an important safety barrier to prevent exposure of the skin and mucous membranes of the OHCWs[43]. This theory embraces the broader concept of 'standard precautions', as incorporated in current infection-control recommendations[36].

At the foundation of any infection-control programme is the use of standard precautions, which includes wearing PPE, which should be applied at all times in oral health-care procedures, regardless of a patient's suspected or confirmed medical history of infection[44]. When used appropriately and in combination with other protective measures, PPE forms an effective barrier against transmission of any infection[15,36].

Studies found that the use of PPE among Lithuanian dentists, particularly the use of gloves and changing of gloves after each patient, was relatively high (85%)[45]. In contrast, although the general level of use of masks was high, changing of those masks was low (28%). In this study, the use of protective eyewear/face shields was less than 50%[45]. Furthermore, in a Russian study, the results indicated that many dental practitioners used double gloving after being informed of patients' infectious conditions[46]. Similarly, in India, most dental practitioners included additional precautions when patients indicated a medical history of infection. However, in some cases, treatment was refused (21%)[47].

In Brazil, the wearing of PPE was evaluated over a 10-year time period. In 1995, more than 95% of students wore protective clothing, face masks and rubber gloves during all patient procedures[24]. However, the wearing of protective eyewear was considerably less (66.1%). After reassessing the use of PPE in 2005, similar results were obtained for the wearing of protective clothing, face masks and rubber gloves. However, a decline of 11% in the use of protective eyewear is of particular concern[24].

In a US study, a large percentage of respondents, including students and professional OHCWs, incorrectly indicated that gloves provided full protection[28]. Furthermore, some students and professional OHCWs also mistakenly believed that gloves provide adequate

protection as long as they are not visibly torn. Some respondents also stated that they never changed gloves in lengthy procedures, some of which lasted for up to 3 hours[28].

Research has shown that the unpredictable perforation rate of gloves presents specific challenges, particularly during high-exposure procedures such as oral and maxillofacial surgery[48]. The results of a Japanese study suggested that double gloving may offer a protection rate of up to 95%[48]. In a study in Iran, improved compliance was reported for the use of double gloving while performing intravenous procedures and working in emergency areas[49].

Constant use of gloves also has health implications. An increase in allergic reactions, as a result of continuous contact with the latex content of gloves and other protective products, has been noted among many OHCWs and patients[28]. As a result, products manufactured from new materials, such as vinyl and nitrile, have been introduced to avoid these allergic reactions[50].

In contrast to the case in developed countries, in developing countries affordability, unavailability, limited resources and shortage of equipment have been put forward as reasons for low compliance with PPE guidelines[45,47,51].

### Focus area four: environmental barriers

The production of aerosols and spatters during oral health-care procedures, such as while operating high-speed dental handpieces and ultrasonic scalers, has been well documented[52–57]. These aerosols, as well as spatters, have been identified as potentially hazardous, as they may contain infectious agents originating from the patient's oral cavity or the dental unit waterlines[52,57,58]. As a preventive measure against infectious material from the oral health-care environment, and to minimise contamination of surfaces and equipment by the hands of oral health-care workers, protective environmental barriers should be applied on frequently touched areas.

Changing environmental barriers for every patient can be costly and impractical in some clinical environments, such as during screening or orthodontic follow-up appointments. Costs are determined by the number and amount of clinical contact surfaces to be covered, as well as the number of patients treated during a working day[59]. The relative risk of exposure, effectiveness of the barrier, time and cost will ultimately determine the choice of protection applied. For example, it was determined that inexpensive food-wrap material is an equally effective environmental barrier as some expensive, commercially available, environmental barrier products[60].

However, the effects of environmental barriers on the power output results from dental light-curing units after application, is one area that presents challenges. The physical changes to the output of light-curing tips should be monitored. The thickness and translucency of the barrier may have a negative effect on the curing depth in light-activated resin-composite procedures[60].

The National Dental Practice-Based Research Network Collaborative Group in the USA reported on the use of a rubber dam during root canal treatment and suggested that improved infection control, patient protection and treatment efficacy were some of the advantages offered by the rubber dam[61]. A significant reduction of spatter during treatments with the application of a combination rubber dam and high-volume evacuation was reported[62].

### Focus area five: sterilisation

Sterilisation includes the safe and effective recycling of instruments as a key element of any infection prevention and control programme[63]. The Spaulding Classification Scheme is a rational approach to disinfection and sterilisation that is used by all health-care professionals as a guide for the decontamination and reprocessing of items[63]. The gold standard recommended for sterilisation of heat-tolerant instruments or devices is vacuum autoclaving[63,64]. It is also recommended that dental handpieces be steam autoclaved[15,17,36]. Most instruments used in oral health-care facilities today are heat tolerant and can thus be heat sterilised[65]. Application of liquid chemical sterilants is only intended for the processing of heat-sensitive instruments and for instruments with acute cutting edges[6,36,43,63,64].

Effective instrument processing depends on systematic processes, involving a sequence of specific steps. These processes should ideally be executed in a specific, separate area, designed to promote routine workflow from 'dirty' towards 'clean' areas[14]. During these processes the following should be considered as equally important aspects: occupational health and safety issues; the processing of different instrument types, equipment and supplies; sterilisation verification; and stock control[17,36,63].

Current global recommendations suggest that automated cleaning devices and ultrasonic baths should be utilised to facilitate a thorough cleaning process before sterilisation[15,17,36,63]. In Germany, however, contradictory results indicated that some dental materials, such as cement, can only be removed manually or with an ultrasonic bath[66]. These results thus contrast current regulations as enforced in the UK, where the use of a washer-disinfector is compulsory[15].

Various studies have reported on the effectiveness of cleaning, disinfection and sterilisation of instruments. In a study among 30 oral health-care facilities in south-west England, processed instruments, such as

matrix bands with retainers, diamond and stainless-steel burs, extraction forceps and hand scalers, were investigated[67]. The best dental instrument cleaning result was obtained after automated washer-disinfector cleaning. A study in Poland investigated cleaning methods in 43 oral health-care facilities. The results indicated that manual cleaning and ultrasonic baths were applied in more than 50% of the facilities, whilst only 23% used washer-disinfectors[68].

Studies on the sterilisation methods used for critical instruments have revealed varying results. A Russian study revealed that dental practitioners had a poor understanding of Spaulding's classification[46]. In spite of that, most Russian practitioners indicated that they always pre-packed instruments and applied sterilisation for critical instruments. This study also revealed that many practitioners used autoclaves (72%) and dry heat sterilisers (64%), while glass-bead sterilisers were still in use in more than a third of the investigated practices. Alcohol is still widely used for disinfection (83%).

Findings from India indicated that many practitioners used autoclaves[47]. However, the results from this study revealed that the majority used locally manufactured pressure cookers for sterilisation and thus never packed instruments for sterilisation and storage[47]. Further reports from India also indicated that many dentists (71%) used boiling water as the sterilising medium[26]. In Turkey, the majority of dental practitioners used dry heat sterilisation, although autoclave (47%) and other sterilisation methods, such as chemical solutions (35%) and boiling water (2%), were also applied[23]. A study from Brazil revealed that autoclaves were used by more than 60% of the dental practitioners[69]. However, many practitioners (83%) did not use chemical and biological indicators to verify effective sterilisation[69]. Similarly, Indian practitioners never used biological indicators to verify steriliser efficiency[47]. Results from Poland indicated that all sterilisation processes were performed in steam autoclaves, and a third verified sterilisation using chemical indicators. Biological verification was rarely carried out[68]. These reports confirm earlier reports from Poland, identifying the need to improve monitoring and documentation of sterilisation processes[70].

In Africa and Asia, procedures by traditional healers, including tooth extractions, have been performed for centuries, often without any western technologies, such as radiographs, pharmaceuticals or surgical instruments[71]. WHO reports state that more than 80% of some Asian and African countries rely on traditional healers and indigenous knowledge for their primary health care[72]. It has been reported that patients prefer treatment by traditional healers because it is inexpensive, and there is a 93% satisfaction rate with the treatment provided[73]. In Cameroon, however, cases of extraction of teeth by traditional healers, using crude and dirty instruments without any sterilisation, has been reported[73]. It is of concern that many traditional medicine practices have often been adopted in different cultures and regions without international standards or guidelines. Tooth extractions without infection prevention and control could be potentially life-threatening for both oral care workers and patients.

### Focus area six: disinfection (surfaces) and housekeeping

Disinfection is defined as the physical or chemical destruction of microorganisms, including pathogens[43]. Disinfection is a less lethal process than sterilisation because it destroys most, but not necessarily all, pathogens; for example, it does not destroy bacterial spores[43]. Effective use of disinfectants first requires effective dilution of the chemical product and second that the product is applied for an adequate period of contact time, as indicated by the manufacturer[6,36]. These instructions need to be followed meticulously to prevent incorrect use or ineffective application.

In different oral health-care facilities, different intra-oral and extra-oral surfaces present different challenges to decontaminate or clean effectively[8]. The most difficult surface to clean is textured vinyl, followed by smooth vinyl, enamelled metal, service line rubber hosing and brushed aluminium[74]. In a study in Italy it was demonstrated that, when applying disinfection and cleaning with a sodium-lauryl-sulphate-based detergent (the wipe–rinse method), the application was cost effective and practical[59]. This study also illustrated equivalence with placement of disposable barriers to reduce methicillin-resistant *S. aureus* (MRSA) contamination on dental chairs[59]. Patel *et al.*[75] identified computers, keyboards and other components positioned near the patient treatment areas as a potential risk for cross-infection from and to patients and operators. However, findings from the study indicated that routine cleaning, followed by disinfection with 70% isopropanol wipes, reduced the microbial load on computer keys by at least 96%[75]. Another challenge for cleaning has been identified in orthodontic facilities, where decontamination of photographic retractors, often manufactured from heat-sensitive material, has been reported as being technique sensitive[76]. The findings indicate that the application of a washer-disinfector for the retractors is most effective[76].

In a Brazilian study, surface contamination with *S. aureus* was investigated around patients, dental students and in the oral health-care environment[77]. By far, the majority of microbial colonies (74%) were obtained from the nose, tongue and hands of patients.

The results also clearly indicated that dental students were already contaminated before commencement of the clinical appointment, with the highest colony counts found on gloved hands, followed by the tongue and ungloved hands[77]. Upon investigation of the clinical oral health care environment during this study, the count of *S. aureus* colonies significantly increased to 10.3% contamination of the surfaces, where 575 colonies were identified after the appointment ($P < 0.05$), of which the store room and auxiliary table were the most contaminated[77]. These results could be a result of the intense circulation of people in the clinical dental area, as well as the use of high-speed dental handpieces during dental appointments. It is speculated that much of the *S. aureus* contamination detected in the clinical environment came from direct contact, skin exfoliation or improper handling of equipment[77].

A record of evidence of work relating to decontamination or general housekeeping should be maintained for audit purposes[15]. Results from Poland revealed incorrect documentation of instrument and surface decontamination in oral health-care facilities[68]. Further findings from Poland also indicated three common failures during disinfection, namely multiple re-use of disinfectant by topping up disinfectant instead of using freshly prepared mixture, continuously adding additional instruments to the disinfectant and not following the manufacturers' instructions[70].

No specific data are available on housekeeping in oral health-care facilities, which offers an opportunity for further investigation.

### Focus area seven: waste management

Waste generated in oral health-care facilities, including sharps and other infectious waste, is classified as hazardous and poses a serious risk to human health and the general environment[78]. Most countries have their own classification of hazardous or health-care risk waste, which often includes infectious waste, pathological waste, sharps, chemical waste and radioactive waste. To reduce the risk of hazardous waste to human health and the general environment, the WHO has defined eight steps to manage health-care waste, including waste minimisation, waste generation, waste segregation, intermediate storage, centralised storage, external transport, treatment and disposal[79]. By segregating waste, oral health-care facilities can reduce the hazardous waste that requires special treatment and safe disposal.

In the UK it was reported that the segregation and disposal of health-care risk waste in oral health-care facilities was carried out according to waste-management guidelines[22]. However, one exception was noted in this study, namely that anaesthetic cartridges were disposed of in plastic bags rather than in rigid puncture-proof sharps containers[22]. Furthermore, studies from the UK also reported that all orthodontic facilities used 'yellow bags' to dispose of clinical waste and had puncture-proof sharps containers, which were in accordance with waste-management recommendations[80].

Waste from oral health-care facilities poses an infectious risk. In Malaysia, various types of bacterial agents, including *Enterobacter* spp., *Salmonella* spp., *Klebsiella* spp., *Pseudomonas* spp., *Serratia* spp., *Proteus mirabilis*, *Escherichia* spp., *Staphylococcus* spp., *Enterococcus* spp. and *Streptococcus* spp., were detected in waste collected from oral health-care facilities[81,82]. The results of a specific Indian study are particularly worrying, as the majority of general dentists included (67%) had disposed of hazardous waste, such as syringes, blades and ampoules, in normal dustbins, which were emptied in domestic municipal waste[26].

### Focus area eight: dental unit waterlines, biofilms and water quality

The water in dental unit waterlines is often contaminated with high concentrations of bacterial agents. Bacteria multiply and cling to the inner walls of the waterline plastic tubing, which continues to accumulate into biofilms[83,84]. Biofilm formation in waterlines can be removed by breaking the biofilm into individual bacteria through a cleaning and decontamination process, such as flushing or purging the air- and water lines routinely[84]. Results from Germany indicated that when the water quality is also tested, this may be helpful, as mould contamination can provide a sign of biofilm formation before a high total colony count is obtained[85].

Contaminated dental unit water, used during oral health-care treatment, could be potentially life-threatening to vulnerable people such as the immunocompromised, the elderly and people with chronic conditions, such as diabetes, cancer, AIDS or tuberculosis (TB)[86]. In February 2011, an 82-year-old woman, with no underlying disease, was admitted to an intensive care unit in Italy with fever and respiratory distress[87]. Two days later she died as a result of Legionnaires' disease. Her death was attributed to the presence of *Legionella pneumophila* in dental unit waterlines, a high-speed handpiece and the oral health-care facility's taps[87]. Pathogenic bacterial agents, such as *Legionella* and *Pseudomonas* spp., have been the reason for increasing concern and a topic of discussion over the past four decades[15,43,88–90].

### Special considerations

Special considerations include aspects directed at dental handpieces and other devices attached to air and

waterlines; single-use or disposable devices, including saliva ejectors; pre-procedural mouth rinses; dental radiology; the dental laboratory; *Mycobacterium tuberculosis*; the risk of contracting Creutzfeldt–Jakob and other prion diseases; sharps injuries and postexposure management; and the vaccination of OHCWs.

### *Dental handpieces and other devices attached to air- and waterlines*

OHCWs involved in clinical procedures are exposed to the sprays and spatters generated during oral health-care procedures. The sprays and spatters produced by dental unit handpieces have the potential to transmit pathogenic agents through airborne or waterborne modes[91,92]. The CDC states that 'handpieces that cannot be heat sterilised should not be used' during oral health-care procedures[6]. According to the UK Department of Health[17] and Rutala *et al.*[63], vacuum autoclaving is recommended to achieve sterility of instruments, such as dental handpieces with lumens, cavities or indentations. A Polish study revealed that one-third of the dental practitioners questioned used non-vacuum autoclaving (type B) for dental handpieces[68]. In Scotland, decontamination and autoclaving of handpieces between patients were investigated in a study involving 179 oral health-care facilities[93]. The results indicated that most of the practitioners (97%) autoclaved their handpieces between patient treatments. However, the majority of respondents manually decontaminated their dental handpieces externally with a disinfectant wipe rather than washing them, and then processed them in type N bench top steam sterilisers[93]. In a study among dentists in Beijing, autoclaving of dental handpieces between patients increased from 41% to 96% in a 10-year survey[94].

The use of non-water-soluble lubricants in handpieces may be problematic. Such lubricants may block the narrow lumen and also prevent effective cleaning of the inner parts of the handpieces before sterilisation. Furthermore, processed handpieces are recontaminated if lubricated after sterilisation. A Scottish study showed that most handpieces were lubricated with non-water-soluble lubricants after cleaning and before sterilisation (91%), and a number (24%) of participants also lubricated handpieces after sterilisation[93].

### *Single-use or disposable devices*

Application of single-use or disposable devices has become common in oral health care[42]. Examples of single-use or disposable devices include prophylaxis cups and brushes, saliva ejectors, high-volume evacuator tips, hypodermic syringes, needles, blades, endodontic irrigation tips/needles, plastic impression trays, air/water syringe tips, gloves and masks, among others. These items are not designed by their manufacturers to be cleaned and reused, and are thus classified as single-use or disposable items.

A study in the UK revealed that 23% of oral health-care facilities gave guidance on when to choose single-use as opposed to reusable instruments when both were commercially available. For 47% of facilities there was an internal policy on the re-use of devices labelled as single use, of which only 37% specified that re-use was never allowed[22].

### *Pre-procedural mouth rinses*

The major source of pathogens in oral health-care facilities is the oral cavities of patients, each laden with high concentrations of oral microbial flora[95]. Having patients rinse with a pre-procedural mouth rinse has been proven as an effective precautionary infection-control measure to reduce the microbial counts in the oral cavity[43]. It has been shown, in an Indian study, that bacterial cross-infection from dental aerosols can be reduced when chlorhexidine is used as a simple, non-expensive and effective pre-procedural rinse, before procedures with ultrasonic scalers and high-speed handpieces[96]. A Brazilian study confirmed this and showed that rinses containing 0.05% cetylpyridinium chloride (CPC), 0.12% chlorhexidine and water were equally effective in lowering the bacterial counts[97]. Because CPC has fewer side effects than chlorhexidine, it could be considered as a good choice for pre-procedural rinsing[97].

### *Dental radiology*

Sensors used during digital intra-oral radiography are heat sensitive and cannot be autoclaved. Thus, to prevent cross-contamination, protective barrier envelopes that cover the sensors are used while capturing the radiographs[98]. The sensors, contained inside the plastic barrier envelopes, always remain a potential source of contamination with saliva. Recommendations suggest disinfection of the digital intra-oral radiography sensors and equipment upon removal of the contaminated outer envelope, and the aseptic re-placement of a new protective envelope[36]. A Canadian study revealed that contamination of digital sensors can still occur owing to the compromised integrity of the protective envelopes and the techniques applied during placement and removal of the envelopes, despite various precautions to prevent cross-infection[98]. An Iranian study indicated significant differences between the bacterial counts on radiographic equipment and surrounding surfaces before and after disinfection[99]. In a comparison of four disinfectant products, Deconex demonstrated the highest disinfectant efficacy on radiographic equipment and the surrounding surfaces[99].

### *Dental laboratory*

Materials or instruments/equipment transferred to and received from the dental laboratory, such as impression materials, impression trays and dispensers, have the potential to transmit disease[100]. It has been reported that impression material cartridges and handgun dispensers are easily and heavily contaminated with pathogenic agents, such as MRSA, during clinical prosthetic procedures[100]. This places oral health-care workers, as well as dental laboratory personnel, at risk for acquiring infections that are difficult to treat or possibly life-limiting. All standard precautions, such as careful handling of sharp instruments, hand washing, use of protective barriers and wearing of PPE (such as gloves, masks, protective eyewear and protective clothing) for infection prevention and control should therefore also be extended to the dental laboratory[36].

For optimal consumer protection, clear communication between oral health-care facilities and dental laboratories is crucial. It is generally recommended that the responsibility of the cleaning and disinfection of impressions, before despatching to dental laboratories, should lie with the dental practitioner[8]. The same applies to dental technicians when sending completed products and dispensers, such as prosthetic or orthodontic appliances and impression trays, among others, back to the oral health-care facility[8].

Impression decontamination and disinfection practices among oral health-care practitioners and dental technicians have been investigated in a number of studies. Results from the UK indicated that 37% of participants rinsed impressions with water and 3% brushed debris away before disinfection[101]. Although 75% of the participating practitioners had claimed that they informed dental laboratories of impression disinfection, the large majority (95%) of participating dental technicians still received blood-contaminated impressions[101].

Approximately 61% of dental-practitioner participants in studies in Russia indicated that they disinfected impressions[46]. A study in Saudi Arabia to evaluate the efficacy of sodium hypochlorite (1:10) and iodophor disinfectants, found sodium hypochlorite to be highly effective when applied to alginate impressions[102]. Furthermore, the results indicated that gypsum does not have any inherent antibacterial properties. The presence of opportunistic pathogenic organisms, such as streptococci (100%), staphylococci (65.4%), *Candida* (46.2%), MRSA (15.4%) and *P. aeruginosa* (7.7%), which could be life-threatening to immune-compromised persons, was demonstrated on selective agar cultures from impressions and gypsum casts in a study among Japanese dentists[103]. Upon investigating different Japanese disinfecting methods on alginate impressions, the findings suggested that application of a solution of 0.5% sodium hypochlorite for 15 minutes was a feasible disinfection method[104].

Proper disinfection of impressions thus provides adequate cross-contamination protection between the oral health-care facility and the dental laboratory[102]. A study of Iranian dental laboratories revealed that the most popular chemical materials used by dental technicians for disinfection included household bleach, glutaraldehyde and alcohol[105]. Alarming results from this study also indicated that dental technicians rarely wore gloves (14%) and protective eyewear (8%) while handling used equipment. Only half of the technicians in this study had been vaccinated against HBV.

## Mycobacterium tuberculosis

Transmission of *M. tuberculosis* occurs through aerosols generated by coughing, sneezing and speaking[106]. *M. tuberculosis* can remain airborne within small droplets for several hours, and susceptible individuals can still become infected[43]. Some countries have policies or recommendations that oral health-care workers should avoid treating patients with suspicious symptoms of TB until it is confirmed the patient does not have TB, or is not infectious[107]. If emergency oral health-care treatment needs to be executed on suspected TB patients, respiratory protection such as N95, N99 or N100 respirators should be worn[107].

The incidence of *M. tuberculosis* infection among oral health-care patients was assessed at a large tertiary hospital in Nigeria. Ten out of 78 sputum samples tested positive for *M. tuberculosis*[108]. These findings emphasise the risk of active TB cases among patients and the need to implement specific infection-prevention precautions and policies for TB in oral health-care facilities. Particular challenges identified in training institutions, hospitals and public health-care facilities include a lack of TB-specific infection-control training and a need for infrastructure improvement and better ventilation systems in existing and new facilities[109].

### *Creutzfeldt–Jakob and other prion diseases*

Creutzfeldt–Jakob disease (CJD) is caused by a proteinaceous infectious agent, or prion, which has an unusual resistance to standard methods of decontamination[110]. A variant form of CJD (vCJD), acquired from cattle, has recently been identified as a hazard for all health-care professions, especially those exposed to blood and nerve tissue. The potential risk of further human-to-human transmission of the disease through contaminated instruments is a further concern[64]. Recently, a study in the UK indicated that

the risk of vCJD transmission during oral health-care procedures was higher than previously expected[111]. This study also revealed transmission of vCJD after exposure of a patient's gingival tissues to a contaminated endodontic file, and not just from nerve tissue exposure, as previously suggested.

A study in south England compared the different cleaning methods applied in oral health-care facilities[67]. The study measured the amounts of protein left on different types of instruments after manual cleaning, manual cleaning plus ultrasonic bath cleaning and use of the automated washer-disinfector. Several shortcomings were observed in all three methods, which could be indicative of the potential risk of transmitting CJD between patients[67]. Although current evidence suggests that the possibility of prion contamination from dental instruments may be low, this may not be the case should endodontic instruments and reamers be applied[15]. When a strict and reliable cleaning regime cannot be executed for endodontic instruments and reamers, the application of a single-use, disposable policy may be the safer alternative[15].

### *Sharps injuries and post-exposure management*

The highest risk of infection is associated with accidental punctures with used and/or contaminated needles, or injuries with sharp instruments[91]. The most common occupational risks to which oral health-care workers and dental patients are exposed include exposure to blood-borne pathogens, in particular HBV, hepatitis C virus (HCV) and HIV[43,112,113].

The nature of oral health care easily results in exposure incidents. In 2012, Cleveland *et al.* from the CDC reported that 6% of dental practitioners and 14% of other oral health-care personnel had experienced at least one or more percutaneous injuries in the 12 months before the study. In a second study among dental students in the USA, percutaneous injuries had occurred in 88% of the respondents[114]. In a nationwide survey among dental practitioners in Taiwan, the results indicated that the risk of occupational needlestick and sharps injuries increased in correlation to practitioner age[27]. In a study conducted with dental students in Shiraz, Iran, 73% of the participants experienced needlestick and sharps injuries in the 12 months before the study[49]. More than half of the injuries occurred during patient treatment procedures, of which needle re-capping was the most frequent problem. More alarming, however, is the fact that 85% of the respondents did not report their injury after it happened[49]. The reasons indicated for non-reporting included not knowing the mechanism of reporting, not realising that all needlestick injuries required reporting and evaluation, as well as not knowing who to report to[49]. In a study of oral health-care facilities in Brazil, occupational accidents caused by cutting and piercing objects were reported by half of the participating facilities[69]. Of all the respondents, only 26% had had specialised follow-up medical appointments after the accidents[69].

### *Vaccination of OHCWs*

HBV transmission is the greatest infectious risk to which dental patients or members of the oral health-care team can be exposed[91]. In Brazil, vaccination against HBV and post-vaccination tests among oral health-care practitioners raised concerns[115]. The results of the study revealed that, although 74% of the respondents had received all three doses of the vaccine as required, only 15% had undergone the follow-up post-vaccination test[115]. In Nigeria, compliance with the recommended HBV immunisations was poor[116]. Of all respondents, 20% had received three doses of the hepatitis B vaccine, 49% had received either two doses or a single dose and 31.4% were not vaccinated. The reasons reported by the respondents who were not vaccinated as recommended, included lack of opportunity for vaccination and the fear of side effects of the vaccines[116].

## CONCLUSION

Many publications are available on the topic of compliance with infection prevention and control practices in oral health-care facilities all over the world. The approaches in developing and developed countries vary widely, although the principles of infection prevention and control are the same globally. The availability of resources is, and will always be, a challenge, perhaps more so in developing countries. This review has indicated serious deviations in the compliance with infection-control guidelines and recommendations internationally. Although there was often good knowledge and high compliance with infection-control guidelines in developed countries, the lack of knowledge and compliance with infection-control guidelines in developing countries is low and particularly disturbing.

In both developed and developing countries, hand hygiene and the care of hands were not consistently carried out according to international recommendations. The fact of frequent touching in oral health care has been identified as an area of specific concern, and should, similarly to all other health-care professions, be addressed as one of the most important infection-control areas. The use and common application of modern technology, including digital devices, mobile devices and cell phones in oral health-care facilities, and the potential for cross-contamination between the patient's oral cavity and these appliances, presents a further challenge, as frequent touching may heavily

contaminate these devices with pathogens. The younger generation of oral health-care professionals seem to comply better with the wearing of personal protective equipment, but areas of some concern are not replacing these between every patient. Affordability, unavailability, limited resources and shortage of equipment/supplies have been indicated as reasons for non-compliance with the routine use of PPE in developing countries.

The application of protective environmental barriers is widely promoted and applied in developed countries, but the lack of relevant studies in developing countries could conceal serious shortcomings. In spite of guidelines promoting the safety of workers and many studies indicating that the best instrument-cleaning results are obtained in an automated washer-disinfector, manual cleaning is still widely used. Most participant practitioners used autoclaves, but the majority in developing countries had never used biological indicators, and many still use chemical solutions for reprocessing of critical instruments. In many developing countries, boiling water is widely used to 'sterilise' appliances and alcohol is still utilised for disinfection, while used handpieces are not sterilised between all patients and single-use items are reused.

Additionally, wide-ranging research has indicated that waste segregation and disposal is undertaken incorrectly. Whilst immunisation against hepatitis B has improved among oral health-care personnel, many do not maintain immunity with boosters or carry out postvaccine testing. The hygiene and maintenance of waterlines and the use of sterile water or saline during surgical procedures are areas of notable concern. No data are available with regard to the quality of the water from dental units that are used in developing countries. In dental laboratories, poor compliance with clinical infection-control and -prevention practices, and inadequate knowledge about the topic among technicians, are serious problems.

Finally, although developed countries obviously have more resources, there are some areas in which specific reports on compliance with their infection prevention and control precautions show functional shortcomings. The more significant areas identified as such include the application of environmental barriers, quality control and maintenance of dental unit waterlines and water supply, the development of biofilms and some special considerations. The special considerations that require further investigation include pre-procedural rinses, radiology, the treatment of, or protection from, patients with TB, the risk of Creutzfeldt–Jakob and other prion diseases, as well as the timely vaccination of OHCWs. At present, in most developing countries the application of infection prevention and control measures, or the lack thereof in oral health-care facilities, is nothing short of a nightmare and in many instances is an outright health and safety hazard to both patients and OHCWs.

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## REFERENCES

1. De Paola LG. Infectious diseases in the oral healthcare environment. Inside Dental Assisting [serial on the Internet]. 2012; November/December: Available from: http://ida.cdeworld.com/courses/4636.
2. Kaste LM, Bednarsh H. The third decade of HIV/AIDS: a brief epidemiologic update for dentistry. *J Can Dent Assoc* 2007/2008 73: 941–944.
3. Molinari JA, Harte JA. *Cottone's Practical Infection Control in Dentistry*, 3rd ed. Baltimore, Philadelphia: Lippincott, Williams and Wilkens, a Wolters Kluwer business; 2010.
4. Kuhar DT, Henderson DK, Struble KA *et al.*, US Public Health Service Working Group. Updated US public health service guidelines for the management of occupational exposures to human immunodeficiency virus and recommendations for postexposure prophylaxis. *Infect Control Hosp Epidemiol* [serial on the Internet] 2013 34: 875–892. Available from: http://www.jstor.org/stable/10.1086/672271.
5. Oosthuysen J, Potgieter E, Blignaut E. Compliance with infection control recommendations in South African dental practices: a review of studies published between 1990 and 2007. *Int Dent J* 2010 60: 181–189.
6. Centers for Disease Control. Guideline for Disinfection and Sterilization in Healthcare Facilities, 2008. 2008 [cited 2013 3 April]; Available from: http://www.cdc.gov/ncidod/dhqp/pdf/guidelines/Disinfection_Nov_2008.pdf.
7. Australian Dental Association. *Australian Dental Association Guidelines for Infection Control*, Second ed, Vol. II (Fryer FS, editor). St Leonards, Australia: Australian Dental Association Inc; 2012. p. 1–50. Available from: http://www.ada.org.au/app_cmslib/media/lib/1203/m356702_v1_infection%20control%20guidelines%202012.pdf.
8. British Dental Association. *Advice Sheet A12 Infection Control in Dentistry (England)*. London: British Dental Association; 2011.
9. Guide to Infection Prevention for Outpatient Settings: Minimum Expectations for Safe Care [database on the Internet]. Centers for Disease Control and Prevention. 2011 [cited 2013-04-03]. Available from: http://www.cdc.gov/HAI/pdfs/guidelines/standatds-of-ambulatory-care-7-2011.pdf.

10. Infection Prevention Checklist for Outpatient Settings: Minimum Expectations for Safe Care [database on the Internet]. Centers for Disease Control and Prevention. 2011 [cited 2013-04-03]. Available from: http://www.cdc.gov/HAI/pdfs/guidelines/ambulatory-care-checklist-07-2011.pdf.
11. Fédération Dentaire Internationale. *FDI Policy Statement on Infection Control in Dental Practice: Merging of 'Human Immunodeficiency Virus Infection and Other Blood Borne Infections (2000)', 'Infection Control in Dentistry' (2007), and 'Sterilization and Cross Infection Control in the Dental Practice' (2005)*. Revised version adopted by the General Assembly: 4th September 2009, Singapore: FDI World Dental Federation; 2009 [cited 2013 9 February]; Available from: http://www.fdiworldental.org/media/11259/Infection-control-in-dental-practice-2009.pdf.
12. Amritraj A, Rajan PS, Shenoy N *et al.* Awareness among young dentists about transmission of HIV and preventive measures. *Int J Bioassays* [serial on the Internet] 2013 [cited 2013 April] 2: 701–704. Available from: http://ebioscholar.com/ojs/index.php/ijb/article/view/283.
13. Australian/New Zealand Standard. Office-based health care facilities – Reprocessing of reusable medical and surgical instruments and equipment, and maintenance of the associated environment. In: New Zealand, SAS, editor.: Jointly published by Standards Australia, GPO Box 476, Sydney, NSW 2001 and Standards New Zealand, Private Bag 2439, Wellington 6020; 2006.
14. British Dental Association. *Infection Control in Dentistry. Advice Sheet A12 of the British Dental Association*. London: British Dental Association; 2003.
15. Department of Health United Kingdom. Health Technical Memorandum 01-05: Decontamination in primary care dental practices. Health Technical Memoranda [serial on the Internet]. 2013 [cited 2013 26 March]: Available from: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/170689/HTM_01-05_2013.pdf.
16. Department of Health United Kingdom. Health Technical Memorandum 07-01: Safe management of healthcare waste. Health Technical Memoranda [serial on the Internet]. 2013 [cited 2013 20 March]; 2013: Available from: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/167976/HTM_07-01_Final.pdf.
17. Department of Health United Kingdom. Health Technical Memorandum 01-05 Decontamination in primary care dental practices. *Health Technical Memorandum 01-05*. 2008 (Oct 2008):1-60.
18. Michmershuizen F. Dental associations respond to infection control breach in Oklahoma. *Dental Tribune – The World's Dental Newspaper*. 2013 4 April.
19. Bradley K, Fox J, Wilson J *et al.* Investigation of Healthcare-Associated Hepatitis C Virus Transmission in a Dental Surgical Clinic – Oklahoma, 2013. 2013 Annual CSTE Conference - Epi on the Edge; June 2013; Pasadena California. http://www.csteconference.org/2013.
20. Eaton K. *Tulsa Oral Surgeon Accused in Health Scare Sued*. Oklahoma City (AP): Associated Press; 2013, [cited 2013 7 September]; Available from: http://www.sfgate.com/news/article/Tulsa-oral-surgeon-accused-in-health-scare-sued-4786971.php.
21. Cleveland J, Foster M, Barker L *et al.* Advancing infection control in dental care settings: factors associated with dentists' implementation of guidelines from the Centers for Disease Control and Prevention. *J Am Dent Assoc* 2012 143: 1127–1138.
22. Smith A, Creanor S, Hurrell D *et al.* Management of infection control in dental practice. *J Hosp Infect* 2009 71: 353–358.
23. Yüzbasioglu E, Saraç D, Canbaz SY *et al.* A survey of cross-infection control procedures: knowledge and attitudes of Turkish dentists. *J Appl Oral Sci* 2009 17: 565–569.
24. De Abreu MHNG, Lopes-Terre MC, Braz LF *et al.* Attitudes and behavior of dental students concerning infection control rules: a study with a 10-year interval. *Braz Dent J* 2009 20: 221–225.
25. Jain M, Sawla L, Mathur A *et al.* Knowledge, attitude and practice towards droplet and airborne isolation precautions amongs dental health care professionals in India. *Med Oral Patol Oral Cir Bucal* 2010 15: e957–e961.
26. Singh BP, Khan SA, Agrawal N *et al.* Current biomedical waste management practices and cross-infection control procedures of dentists in India. *Int Dent J* 2012 62: 111–116.
27. Cheng HC, Su CY, Yen AM *et al.* Factors affecting occupational exposure to needlestick and sharps injuries among dentists in Taiwan: A nationwide survey. *Public Library of Science* 2012 7: e34911. Available from http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0034911#pone-0034911-g001.
28. Kanjirath PP, Coplen AE, Chapman JC *et al.* Effectiveness of gloves and infection control in dentistry: student and provider perspectives. *J Dent Educ* 2009 73: 571–580.
29. World Health Organization. *Guide to Implementation: A Guide to the Implementation of the WHO Multimodal Hand Hygiene Improvement Strategy. Save Lives Clean Your Hands*. Geneva, Switzerland: WHO Press; 2009, [cited 2012 3 August]; Available from: WHO_IER_PSP_2009.02_eng.pdf.
30. De Amorim-Finzi MB, Cury MVC, Costa CRR *et al.* Rate of compliance with hand hygiene by dental healthcare personnel (DHCP) within a dentistry healthcare first aid facility. *Eur J Dent* 2010 4: 233–237.
31. Weber DJ, Rutala WA, Miller MB *et al.* Role of hospital surfaces in the transmission of emerging health care-associated pathogens: norovirus, Clostridium difficile, and Acinetobacter species. *Am J Infect Control* 2010 35(5 supplement 1): S25–S33.
32. World Health Organization. *The WHO Guidelines on Hand Hygiene in Health Care 2009*. Geneva, Switzerland: WHO Press; 2009, [cited 2012 3 August]; Available from: http://whqlibdoc.who.int/publications/2009/9789241597906_eng.pdf.
33. Omogbai JJ, Azodo CC, Ehizele AO *et al.* Hand hygiene amongst dental professionals in a tertiary dental clinic. *Afr J Clin Experiment Microbiol* 2011 12: 9–14.
34. Radcliffe RA, Bixler D, Moorman A *et al.* Hepatitis B virus transmissions associated with a portable dental clinic, West Virginia, 2009. *J Am Dent Assoc* 2013 144: 1110–1118.
35. Centers for Disease Control and Prevention. Guideline for hand hygiene in health-care settings. *Morb Mortal Wkly Rep* 2002 51: (RR-16) 1–85.
36. Centers for Disease Control and Prevention. Guidelines for infection control in dental health-care settings – 2003. *Morb Mortal Wkly Rep* 2003 52: (Number RR-17) 1–68.
37. Heudorf U, Eikmann T, Exner M. Ten years' German Protection against Infection Act: evaluation of the implementation of infection control visits in the ambulatory medical setting. *Bundesgesundheitsblatt Gesundheitsforschung Gesundheitsschutz* 2013 56: 455–465.
38. Myers R, Larson E, Cheng B *et al.* Hand hygiene among general practice dentists: a survey of knowledge, attitudes and practices. *J Am Dent Assoc* [serial on the Internet] 2008 139: 948–957.
39. Bellissimo-Rodrigues WT, Bellissimo-Rodrigues F, Machado AA. Infection control practices among a cohort of Brazilian dentists. *Int Dent J* 2009 59: 53–58.
40. Pradeep S, Aravindhan TR, Chinnaiah R *et al.* Bar soaps in dental clinic might be a bacterial reservoir. *Int J Contemp Dent* 2011 2: 115–120.
41. Singh S, Acharya S, Bhat M *et al.* Mobile phone hygiene: potential risks posed by use in the clinics of an Indian dental school. *J Dent Educ* 2010 74: 1153–1158.

42. Martin MV, Fulford MR, Preston AJ. *Quintessentials of Dental Practice, Clinical Practice Number 3 Infection Control for the Dental Team*. Nairn HFW, editor. London: Quintessence Publishing Co. Ltd.; 2009.
43. Kohn WG, Collins AS, Cleveland JL *et al.* Centers for Disease Control and Prevention (CDC). Guidelines for infection control in dental health-care settings - 2003. *Morb Mortal Wkly Rep* 2003 52 (RR-17): 1–61.
44. Harte JA. Standard and transmission-based precautions: an update for dentistry. *J Am Dent Assoc* 2010 141: 572–581.
45. Rimkuvienë J, Pûrienë A, Peèiulienë V *et al.* Use of personal protective equipment among Lithuanian dentists. *Sveikatos Mokslai* 2011 21: 29–36.
46. Budnyak MA, Gurevich KG, Fabrikant KG *et al.* Dental infection control and occupational safety in the Russian Federation. *J Contemp Dent Pract* 2012 13: 703–712.
47. Puttaiah R, Shetty S, Bedi R *et al.* Dental infection control in India at the turn of the century. *World J Dent* 2010 1: 1–6.
48. Kuroyanagi N, Nagao T, Sakuma H *et al.* Risk of surgical glove perforation in oral and maxillofacial surgery. *Int J Oral Maxillofac Surg* 2012 41: 1014–1019.
49. Askarian M, Malekmakan L, Memish ZA *et al.* Prevalence of needle stick injuries among dental, nursing and midwifery students in Shiraz, Iran. *GMS Krankenhaushygiene Interdisziplinär* [serial on the Internet]. 2012 [cited 2012 4 April] 7: Doc05. Available from: http://www.egms.de/pdf/journals/dgkh/2012-7/dgkh000189.pdf.
50. Coplen A, Chapman J, Kanjirath P *et al.*, editors. Nitrile, latex, and vinyl gloves permeabiliy testing using serratia marcescens. Presentation at the Clinical Research Symposium on Clinical Research to Clinical Practice: September 11–13, 2008. Managing Challenges at the Cutting Edge; 2008; University of Michigan.
51. Uti OG, Agbelusi GA, Jeboda SO *et al.* Infection control knowledge and practices related to HIV among Nigerian dentists. *J Infect Dev Countries* 2009 3: 604–610.
52. Gross KB, Overman PR, Cobb C *et al.* Aerosol generation by two ultrasonic scalers and one sonic scaler: a comparative study. *J Dent Hyg* 1992 66: 314–318.
53. Micik RE, Miller RL, Mazzarella MA *et al.* Studies on dental aerobiology, part I: bacterial aerosols generated during dental procedures. *J Dent Res* 1969 48: 49–56.
54. Miller RL. Generation of airborne infection by high speed dental equipment. *J Am Soc Prev Dent* 1976 6: 14–17.
55. Miller RL, Micik RE, Abel C *et al.* Studies on dental aerobiology, part II: microbial splatter discharged from the oral cavity of dental patients. *J Dent Res* 1971 50: 621–625.
56. Holbrook WP, Muir KF, Macphee IT *et al.* Bacteriological investigation of the aerosol from ultrasonic scalers. *Br Dent J* 1978 144: 245–247.
57. Larato DC, Ruskin PF, Martin A *et al.* Effect of a dental air turbine drill on the bacterial counts in air. *J Prosthet Dent* 1966 16: 758–765.
58. Harrel SK, Molinari J. Aerosols and splatter in dentistry: a brief review of the literature and infection control implications. *J Am Dent Assoc* 2004 135: 429–437.
59. Petti S, Polimeni A, Dancer SJ. Effect of disposable barriers, disinfection, and cleaning on controlling methicillin-resistant Staphylococcus aureus environmental contamination. *Am J Infect Control* 2012 21: 1–5.
60. Dunne S. Summary of: the effect of disposable infection control barriers and physical damage on the power output of light curing units and light curing tips. *Br Dent J* 2011 210: 358–359.
61. Anabtawi MF, Gilbert GH, Bauer MR *et al.* Rubber dam use during root canal treatment. Findings from the Dental Practice-Based Research Network. *J Am Dent Assoc* 2013 144: 179–186.
62. Dahlke WO, Cottam MR, Herring MC *et al.* Evaluation of the spatter-reduction effectiveness of two dry-field isolation techniques. *J Am Dent Assoc* 2012 143: 1199–1204.
63. Rutala WA, Weber DJ, HICPAC. *Guideline for Disinfection and Sterilization in Healthcare Facilities, 2008*. Atlanta, Georgia: Centers for Disease Control and Prevention, Department of Health and Human Services; 2008.
64. Rutala WA, Weber DJ. Guideline for disinfection and sterilization of prion-contaminated medical instruments. *Infect Control Hosp Epidemiol* 2010 31: 107–117.
65. Scarlett MI. Disinfection and sterilization: a primer. *Dentaltown* 2007 July 2007: 52–60.
66. Franz A, Bristela M, Stauffer F. Reprocessing of dental instruments in washer-disinfectors: does a representative test soil exist in dentistry? *GMS Krankenhaushygiene Interdisziplinär* [serial on the Internet]. 2012 [cited 2012 4 April] 7: 1–6. Available from: http://www.egms.de/pdf/journals/dgkh/2012-7/dgkh000197.pdf.
67. Bagg J. Summary of: a quantitative assessment of residual protein levels on dental instruments reprocessed by manual, ultrasonic and automated cleaning methods. *Br Dent J* 2011 210: 418–419.
68. Röhm-Rodowald E, Jakimiak B, Chojecka A *et al.* Assessment of decontamination processes: cleaning, disinfection and sterilization in dental practice in Poland in the years 2011-2012. *Przegląd Epidemiologiczny* 2012 66: 635–641.
69. Matsuda JK, Grinbaum RS, Davidowicz H. The assessment of infection control in dental practices in the municipality of São Paulo. *Braz J Infect Dis* 2011 15: 45–51.
70. Podgórska M, Jakimiak B, Röhm-Rodowald E *et al.* Assessment of disinfection and sterilization processes in dental practice as an important factors in prevention of infections. *Przegląd Epidemiologiczny* 2009 63: 545–550.
71. Willis MS, Harris LE, Hergenrader PJ. On traditional dental extraction: case reports from Dinka and Nuer en route to restoration. *Br Dent J* 2008 204: 121–124.
72. World Health Organization. *Traditional Medicine: Fact Sheet N°134*. Geneva: World Health Organization Media Centre; 2008 [cited 2013 28 April]; Available from: http://www.who.int/mediacentre/factsheets/fs134/en/index.html.
73. Agbor AM, Singh S, Mbia AM. The role of traditional healers in tooth extractions in Lekie Division, Cameroon. *J Ethnobiol Ethnomed* [serial on the Internet]. 2011 7: 1–8. Available from: http://www.ethnobiomed.com/content/7/1/15.
74. Palenik CJ. The effect of long-term disinfection on clinical contact surfaces. *J Am Dent Assoc* 2012 143: 472–477.
75. Patel S, Porter K, Sammons RL. Are computer keyboards a cross-infection risk in a dental clinic? *J Infect Prev* [serial on the Internet] 2010 [cited 2010 8 October] 11: 206–211. Available from: http://bji.sagepub.com/content/11/6/206.full.pdf+html.
76. Walker J. Summary of: the cleaning of photographic retractors; a survey, clinical and laboratory study. *Br Dent J* 2010 208: 306–307.
77. Negrini T, Duque C, De Oliveira ACM *et al. Staphylococcus Aureus* contamination in a pediatric dental clinic. *J Clin Pediatric Dentistry* 2009 34: 13–18.
78. Eberle J, Allain L, Nersesian P. *Logistics of Health Care Waste Management: Information and Approaches for Developing Country Settings*. Arlington, VA: USAID Deliver Project, Task Order 1 from the US Agency for International Development; 2009.
79. World Health Organization. *Safe management of wastes from health-care activities*, Second ed., Vol. II (Chartier Y,

Emmanual J, Pieper U, Prüss A., Rushbrook P, Stringer R, Townend W, Wilbum S and Zghondi R, editors). Geneva, Switzerland: WHO Press; 2014. p. 1–329. Available from http://apps.who.int/iris/bitstream/10665/85349/1/9789241548564_eng.pdf?ua=1.

80. Shah R, Collins JM, Hodge TM *et al.* A national study of cross infection control: 'are we clean enough?'. *Br Dent J* 2009 207: 267–274.
81. Hossain S, Rahman NNNA, Balakrishnan V *et al.* Infectious risk assessment of unsafe handling practices and management of clinical solid waste. *Int J Environ Res Public Health* [serial on the Internet] 2013 [cited 2013 31 January] 10: 556–567. Available from: www.mdpi.com/journal/ijerph.
82. Vieira CD, De Carvalho MAR, De Menezes Cussiol NA *et al.* Count, identification and antimicrobial susceptibility of bacteria recovered from dental solid waste in Brazil. *Waste Manag (Oxford)* 2011 31: 1327–1332.
83. Miller CH, Palenik CJ, editors. *Infection Control and Management of Hazardous Materials for the Dental Team*, 4th ed. St. Louis, Missouri: Elsevier Mosby; 2010.
84. Schmidtke DW. Efficacy of Sterisil in the treatment of dental unit waterlines. Thesis: Master of Science. Birmingham, Alabama: The University of Alabama at Birmingham; 2011.
85. Kramer A, Assadian O, Bachfeld D *et al.* Purge- and intensive-purge decontamination of dental units contaminated with biofilm. *GMS Krankenhaushygiene Interdisziplinär* [serial on the Internet]. 2012 [cited 2012 4 April] 7: 1–4. Available from: http://www.egms.de/pdf/journals/dgkh/2012-7/dgkh000195.pdf.
86. Samaranayake L. *Essential Microbiology for Dentistry*, 4th ed. Taylor, A, editor. Hong Kong: Churchill Livingstone Elsevier; 2012.
87. Ricci ML, Fontana S, Pinci F *et al.* Pneumonia associated with a dental unit waterline. *Lancet* 2012 379: 684.
88. Garg SK, Mittal S, Kaur P. Dental unit waterline management: historical perspectives and current trends. *J Investig Clin Dent* [serial on the Internet] 2012 [cited 2012 27 August] 3: 247–252. Available from:/doi/10.1111/j.2041-1626.2012.00135.x/pdf.
89. Coleman DC, O'Donnell MJ, Shore AC *et al.* Biofilm problems in dental unit water systems and its practical control. *J Appl Microbiol* 2009 106: 1424–1437.
90. Singh TS, Mabe OD. Review: occupational exposure to endotoxin from contaminated dental unit waterlines. *S Afr Dent J* 2009 64: 8–14.
91. Laheij AMGA, Kistler JO, Belibasakis GN *et al.* Healthcare-associated viral and bacterial infections in dentistry. European Oral Microbiology Workshop (EOMW) 2011: CoAction; 2012 [cited 2013 20 April]; Available from: http://dx.doi.org/10.3402/jom.v4i0.17659.
92. Cristina ML, Spagnolo AM, Sartini M *et al.* Evaluation of the risk of infection through exposure to aerosols and spatters in dentistry. *Am J Infect Control* [serial on the Internet]. 2008 [cited 2008 4 April] 36: 304–307. Available from: http://www.ajicjournal.org/article/S0196-6553%2807%2900807-3/pdf.
93. Smith GW, Smith AJ, Creanor S *et al.* Survey of the decontamination and maintenance of dental handpieces in general dental practice. *Br Dent J* 2009 207: E7; discussion 160-161.
94. Su J, Deng X-H, Sun Z. A 10-year survey of compliance with recommended procedures for infection control by dentists in Beijing. *Int Dent J* 2012 62: 148–153.
95. Aravind NKS, Reddy S, Manjunath C *et al.* Complete care to cure: an update of the current knowledge of infection control in dental practice. *Ann Essen Dent* 2012 4: 43–49.
96. Purohit B, Priya H, Acharya S *et al.* Efficacy of pre-procedural rinsing in reducing aerosol contamination during dental procedures. *J Infect Prev* 2009 10: 90.
97. Feres M, Figueiredo LC, Faveri M *et al.* The effectiveness of a preprocedural mouthrinse containing cetylpyridinium chloride in reducing bacteria in the dental office. *J Am Dent Assoc* 2010 141: 415–422.
98. MacDonald DS, Waterfield JD. Infection control in digital intraoral radiography: evaluation of microbiological contamination of photostimulable phosphor plates in barrier envelopes. *J Can Dent Assoc* 2011 77: 1–5.
99. Ardakani FE, Zandi H, Mohammadi Z *et al.* Comparing the disinfecting efficacies of Micro 10, Deconex, Alprocid and Microzid AF on the microorganisms on radiographic equipments. *J Dent Res Dent Clin Dent Prospects* 2008 2: 48–52.
100. Westergard EJ, Romito LM, Kowolik MJ *et al.* Controlling bacterial contamination of dental impression guns. *J Am Dent Assoc* 2011 142: 1269–1274.
101. Almortadi N, Chadwick RG. Disinfection of dental impressions - compliance to accepted standards. *Br Dent J* 2010 209: 607–611.
102. Haralur SB, Al-Dowah OS, Gana NS *et al.* Effect of alginate chemical disinfection on bacterial count over gypsum cast. *J Adv Prosthetics* 2012 2012: 84–88.
103. Egusa H, Watamoto T, Abe K *et al.* An analysis of the persistent presence of opportunistic pathogens on patient-derived dental impressions and gypsum casts. *Int J Prosthetics* 2010 21: 62–68.
104. Hiraguchi H, Kaketani M, Hirose H *et al.* Effect of immersion disinfection of alginate impressions in sodium hypochlorite solution on the dimensional changes of stone models. *Dent Mater J* 2012 31: 280–286.
105. Hashemipour M, Mosharafian S, Mohammadalizadeh S *et al.* Evaluation of infection control situation among dental laboratories in Kerman. *J Isfahan Dent School* 2008 4: 18–24.
106. Jensen PA, Lambert LA, Iademarco MF *et al.*, Centers for Disease Control and Prevention. Guidelines for preventing the transmission of Mycobacterium tuberculosis in healthcare settings, 2005. *Morb Mortal Wkly Rep* 2005 54 (RR-17): 1–142.
107. Cleveland JL, Robison VA, Panlilio AL. Tuberculosis epidemiology, diagnosis and infection control recommendations for dental settings: an update on the centers for disease control and prevention guidelines. *J Am Dent Assoc* 2009 140: 1092–1099.
108. Cadmus SI, Okoje VN, Taiwo BO *et al.* Exposure of dentists to *Mycobacterium tuberculosis*, Ibadan, Nigeria. *Emerg Infect Dis* 2010 2010: 1479–1481.
109. Mphahlele MT, Tudor C, Van der Walt M *et al.* An infection control audit in 10 primary health-care facilities in the Western Cape Province of South Africa. *Int J Infect Control* 2012 8: 1–5.
110. Azarpazhooh A, Leake JL. Prions in dentistry–what are they, should we be concerned, and what can we do? *J Can Dent Assoc* 2006 Feb 72: 53–60.
111. Kirby E, Dickinson J, Vassey M *et al.* Bioassay studies support the potential for iatrogenic transmission of variant Creutzfeldt Jakob Disease through dental procedures. PLoS One [serial on the Internet]. 2012 [cited 2012 30 November] 7: e49850. Available from: http://www.plosone.org.
112. Kohli A, Puttaiah R. *Dental Infection Control and Occupational Safety for Oral Health Professionals*. New Delhi, India: Thompson Printers; 2008.
113. Healthcare-associated hepatitis B and C outbreaks reported to the Centers for Disease Control and Prevention (CDC) in 2008–2011. [database on the Internet]. CDC. 2013 [cited 10 February 2013]. Available from: http://www.cdc.gov/hepatitis/Outbreaks/HealthcareHepOutbreakTable.htm.

114. Myers JE, Myers R, Wheat ME *et al.* Dental students and bloodborne pathogens: occupational exposures, knowledge, and attitudes. *J Dent Educ* 2012 76: 479–486.

115. Resende VLS, Abreu MHG, Paiva SM *et al.* Research concerns regarding hepatitis B vaccination and post-vaccination test among Brazilian dentists. *Virol J* [serial on the Internet] 2010 7: 1–9. Available from: http://www.virologyj.com/content/7/1/154.

116. Azodo CC, Ehizele AO, Uche I *et al.* Hepatitis-B vaccination status among dental surgeons in Benin City, Nigeria. *Ann Med Health Sci Res* 2012 2: 24–28.

117. Moher D, Liberati A, Tetzlaff J, Altman DG. The PRISMA Group. Preferred reporting items for systematic reviews and meta-analyses: The PRISMA Statement. *PLoS Med* 6: e1000097. *British Medical Journal* 2009 2009: 332–336.

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# Appendix C

# Ethical clearance certificate from MEDUNSA

**RESEARCH ETHICS & PUBLICATIONS COMMITTEE**

**FACULTY OF DENTISTRY - MEDUNSA**

**CLEARANCE CERTIFICATE**

| |
|---|
| **CHIEF RESEARCHER:** MS J OOSTHUYSEN |
| **PROJECT:**<br>"THE DEVELOPMENT OF INFECTION CONTROL GUIDELINES FOR ORAL HEALTH CARE PROVIDERS IN SOUTH AFRICA" |
| **Other Researcher(s)/Supervisor(s)**<br>Supervisor: Prof E Blignaut<br>Co-supervisor: Dr E Potgieter |
| **DEPARTMENT(S):**<br>Stomatological Studies |
| **DECISION OF REPC:**<br>Approved |
| **PROJECT REGISTRATION NUMBER:**<br>DP 07/05 |
| **CHAIRPERSON OF REPC OF FBD:**<br>Prof Blignaut |
| **DATE:** 04 APRIL 2005 |
| Cc: **Head of Department**<br>**Supervisor**<br>**Co-Supervisor** |
| **NOTE: Any major changes should be resubmitted to REPC**<br>**Please quote the protocol number in inquiries** |

# Appendix D

# Infection prevention and control guidelines for South African oral health care facilities

# INFECTION PREVENTION AND CONTROL GUIDELINES

Focus Area 1: Administrative Controls

Focus Area 2: Personnel Protection Controls

Focus Area 3: Environmental- And Work Controls

Focus Area 4: Surface Contamination Management

Focus Area 5: Equipment Maintenance

Focus Area 6: Air- And Waterline Management

Focus Area 7: Personal Protective Equipment Usage

Focus Area 8: Personal- And Hand Hygiene Practices

Focus Area 9: Sterilisation Practices

Focus Area 10: Safe Sharps Handling

Focus Area 11: Waste Management

## Focus Area 1: Administrative Controls

**Why?** All employers have a legal responsibility to provide a safe environment in the workplace. In the clinical environment of health care, oral health care workers (OHCWs) and patients may be exposed to an increased infectious risk and many health hazards.

**What?** In a public confession of their commitment, many health care professionals take the Hippocratic Oath, stating ("The Hippocratic Oath,"):
*"I do solemnly swear, by whatever I hold most sacred, that I will be loyal to the Profession … and just and generous to its members …*
*… I will care for my patients and their families as I would have them care for me and my family."*
Administrative controls involve documentation informing the OHCWs of their legal and ethical duties, but also provide a trial of evidence confirming compliance in the facility.

**How?**
1.1 Fulfilling the legal responsibility to provide a safe environment in the workplace.
1.2 Recordkeeping of the legislative documentation applicable to infection control practices.
1.3 Maintaining an audit trail of evidence.
1.4 Applying standard precautions as a rule for any contact with a patient.

## Assessment content

1. *Reference documents are available*
Constitution of the Republic of South Africa Act, 108 of 1996
Occupational Health and Safety Act, 85 of 1993
National Environmental Management: Waste Act, 59 of 2008
Environmental Conservation Act, 73 of 1989
Compensation for Occupational Injuries and Health Diseases Act, 130 of 1993
Hazardous Substances Act, 15 of 1973
Human Tissue Act, 65 of 1983
Health Professions Act, 56 of 1974
Skills Development Levies Act, 9 of 1999
Code of Good Practice on Key Aspects of HIV and AIDS and Employment Regulation
Consumer Protection Act of 2008

2. *Administrative documents are available*
   Annual chemical inventory
   Material Safety Data Sheets (MSDSs) for all chemicals on the premises
   Equipment monitoring and maintenance records

3. *Infection control measures are available*
   Written standard operating procedures
   Ease of access to standard operating procedures
   Annual review and update of the standard operating procedures
   A designated supervisor / coordinator
   Training regarding infection prevention and control practices

4. *Records of sterilisation, verification and monitoring of equipment are available*
   Specific steriliser(s) utilised
   Physical parameters of sterilising equipment observed
   Evidence of the chemical indicators
   Results of the biological indicators

5. *Records of health care risk waste management are available*
   Description of waste categories
   Total quantities and categories of health care risk waste transported
   Waste shipping dates
   Details of the independent waste service provider (transporter) used – address and permit, ID number
   Signed documentation of the service provider representative accepting the waste for transport and disposal

## Focus Area 2: Personnel Protection Controls

**Why?** Personnel protection controls are instituted to protect all oral health care workers (OHCWs) and patients from being exposed to hazardous risks, which include infectious hazards, chemical hazards, physical hazards and waste materials.

**What?** Personnel protection control programmes protect OHCWs from routine exposure to risk factors within oral health care facilities.

**How?**
2.1 Monitoring health of OHCWs
2.2 Training of OHCWs
2.3 Implementing infection control programme(s)
2.4 Keeping and maintaining health and safety records of employees

## Assessment content

1. *Personnel training records re standard precautions and operating procedures are available*
   Training within 3 months after appointment
   Training in infection control measures is provided at least annually
   Training when new tasks, procedures or equipment affect occupational exposure risk

2. *Written registers and records of training sessions are kept for at least three years*

3. *Updated records are available*
   Records contain each personnel member's risk category
   Records contain updated confidential health and safety records for all personnel members
   Records contain Hepatitis B vaccination record (3 dose series, with booster every 5 years)
   Records contain MMR (measles / mumps / rubella) vaccination record
   Records contain Tetanus vaccination record (with booster every 10 years)
   Records contain Annual influenza (flu) vaccination record

4. *Written protocol is available re medical conditions, work related illness and work restrictions*
   Personnel members know when they are excluded from duties involving patient care

5. *Written protocol is available for occupational exposures or incidents*
   Record of every occupational exposure or incident individually documented, e.g. sharps injuries
   Record of post-exposure management and medical follow-up

## Focus Area 3: Environmental- and Work Controls

**Why?** Environmental- and work controls are instituted to protect all OHCWs in and around the workplace. These controls minimise the spread of infections and reduce the risk of accidental injury to personnel, patients, visitors, and exposure of the community. In the work environment, OHCWs are constantly in contact with traumatised tissue, saliva and blood; they work with sharp instruments, and are constantly exposed to sprays and spatter of blood and body fluids from dental handpieces and other equipment. These exposures may lead to the transmission of infectious microorganisms and agents posing a health risk to OHCWs and patients.

**What?** The environment of an oral health care facility includes daily exposures to all surfaces, the water supply and waste, as well as a constant exposure to saliva, blood and other potentially infectious material (OPIM). Environmental controls prevent the spread and reduce the concentration of bacteria-laden aerosols. These controls address three main themes: Key design features of the environment to improve safety or removal of hazards; management of contamination of surfaces and the handling of health care risk waste. Environmental controls also include the use of instruments and equipment that eliminate or isolate hazards. Safe work practice controls guide the manner in which personnel perform given tasks. This ultimately results in safer behaviour and includes procedures that reduce the likelihood of exposure to potentially infectious materials.

**How?**
3.1 Implementing environmental controls and safe work practices
3.2 Preventing chairside exposures
3.3 Post-exposure management
3.4 Single use or disposable items
3.5 Treatment planning and time management

## Assessment content

1. *Written protocol and arrangement is available for medical emergencies*
   Display emergency contact details in each clinical room, e.g. next to the telephone

2. *Written protocol is available for safe working practices*
   Apply standard precautions for all patient procedures

3. *Written protocol is available for application of disposable/single-use items*

4. *Measures to reduce bacteria laden aerosols at chair side*
   Check if patients' brush their teeth and use mouth rinse prior to procedures
   Personnel wear face shields / visors when using an ultrasonic scaler, high-speed handpiece or surgical equipment
   Check if high-volume evacuation is applied when using the dental handpiece or other spatter-generating devices
   Check if disposable / single-use items are used appropriately
   Check if a dental dam is applied in restorative or endodontic procedures
   Check if an ultrasonic cleaner or other container(s) with chemicals are adequately covered

5. *Environmental controls*
   Risk areas are clearly marked with a biohazard sign
   Containers with contaminated items are clearly marked with a biohazard sign
   Annual revision and update to select devices with improved injury protection
   Non-managerial employees assist with identification of safer devices for future use
   Record of employee inputs in the evaluation of safer devices is available

6. W*ork practice controls*
   Identify and change unsafe work practices regularly, e.g. monthly OHS inspection reports compiled
   Review the circumstances surrounding injuries and "near miss" incidents (OHS representative's investigation of incidents and written reports)
   Record of incidents and suggested improvements is available

7. *Treatment planning and time-management is applied during patient care*
   Aseptic retrieval of items from containers or drawers by using sterile forceps
   Barrier protection of drawer handles
   Unit dosing of disposables, consumables, instruments and materials for standard procedures

8. *Design of areas in the facility, is adapted to accommodate traffic flow and prevent cross-contamination:*
   Instrument processing is done in a separate and designated area
   Processing areas are divided into separate zones to facilitate working from 'dirty' to 'clean'
   Barrier protection is applied on the 'frequent touch' areas
   Wrapped, processed items are stored in a designated clean, dry, enclosed area

## Focus Area 4: Surface Contamination Management

**Why?** During most patient treatment procedures, spatter and aerosols are produced as a direct result due to using air and water driven equipment. The surfaces in and around the dental unit, where oral health care procedures are executed, become contaminated with aerosol spatter, and after touching surfaces with gloved hands. The constant exposure and contamination of the surfaces in oral health care facilities are of particular concern, as these surfaces become colonised with infectious agents, resulting in potential reservoirs for disease transmission. The degree and frequency of hand contact, together with the potential for cross-contamination of surfaces by saliva and other body fluids while performing procedures in and around the oral cavity, is therefore an important potential health hazard to be managed.

**What?** Surface contamination management involves programmes that protect OHCWs and patients from being exposed to risk factors within an oral health care facility. The frequently touched contact areas in and around the clinical dental unit, where oral health care procedures are executed, become heavily contaminated. Such areas include light handles and switches, dental unit switches, buttons of the 3-in-1 syringe, ultrasonic handle, and the control buttons of the dental chair. These frequently touched areas often cannot be disinfected easily and effectively between patients, but can be covered with protective barriers such as clear plastic cling wrap, aluminium foil or impervious plastic sleeves. These barriers must be removed quickly and effectively to decontaminate the treatment area between patient treatments, before being safely disposed of with the other health care risk waste items.

Surface cleaning prevents transmission of infection via direct contact with hands and equipment, but is more labour intensive and takes more time to execute. In the event of spillage of blood or other body fluids, a method of one step cleaning and disinfection is necessary for effective decontamination. The CDC has divided the surfaces in health care facilities into two categories; namely clinical contact surfaces and housekeeping surfaces (CDC, 2008). The management of both these potentially contaminated surfaces is an important measure to prevent disease transmission. Comprehensible distinction should be made between clinical contact and housekeeping surfaces, because the decontamination treatments of these surfaces would distinctly differ. Barrier protective coverings could be applied, and if not barrier-protected, surfaces should be disinfected between patients with an intermediate- or low-level disinfectant with TB, HBV and HIV destruction capabilities.

**How?**
- 4.1 Managing clinical contact surfaces
- 4.2 Managing housekeeping surfaces
- 4.3 Deciding whether to use barriers or disinfectants
- 4.4 Selecting chemical germicides

## Assessment content

1. *Written protocol is available for the management of clinical contact surfaces*
   Protective barriers are applied to clinical touch, transfer, splash, splatter and droplet surfaces
   Protective barriers for clinical contact surfaces are replaced routinely
   Contaminated clinical contact surfaces are cleaned and disinfected before placing new barriers

2. *Written schedule is available for cleaning housekeeping surfaces*
   All housekeeping surfaces e.g. floors, walls and basins are clean
   All cleaning equipment, e.g. mops / pads and cloths are cleaned after use
   All cleaning equipment e.g. mops /pads and cloths are stored dry

3. *Written protocol is available for management of radiographic equipment and surfaces*
   Manufacturer instructions are followed for cleaning, disinfection, and / or sterilisation of radiographic devices
   Protective barriers are applied to digital sensors before use on a patient
   Protective barriers are removed after each use
   Sensors are disinfected with an intermediate-level disinfectant after use

4. *Written protocol is available for appliances and materials entering or leaving the premises*
   Laboratory items that are used on patient, such as dentures, are cleaned and sterilised after each use
   Impression material is cleaned and disinfected prior to being sent to the laboratory
   Impressions and other used patient care items are transported in waterproof bags / closed containers
   Biopsy specimens are placed in a sturdy, leak proof container prior to transport

5. *Surfaces of dental chairs are in a good state of repair*
   Covers and surfaces are clean

6. *Floor surfaces of the clinical-, processing and laboratories have no carpeting*

7. *Furniture upholstery of the clinical-, processing areas and laboratories are impermeable and washable*

8. *Surfaces in clinical areas are washable*

9. *Kitchen and personnel areas are used exclusively for refreshment and recreational purposes*

10. *Washable or machine washable toys*
    Toys are clean and in a good state of repair

11. *Personnel are instructed on selecting chemical disinfectants to clean surface contamination*
    Intermediate-level disinfectant is available to deal with blood spillage
    Fresh mixtures of germicides are prepared according to the manufactures' guidelines

12. *Containers are cleaned and disinfected before re-filling again*

13. Appropriate *chemical disinfectants are used only for heat liable equipment and surfaces*

14. *Disinfectants are allowed to remain on surfaces for the contact time stated by the manufactures*

15. *Suggested items to be included in a checklist to maintain general housekeeping*

1. RECEPTION / WAITING ROOM AND ADMINISTRATIVE AREAS
   For example: Carpets are visibly clean
   Windows and window sills are visibly clean
   Floors and walls are visibly clean
   Fresh air and ventilation is maintained
   Furniture is visibly clean and in good state of repair
   Telephones are visibly clean
   Doors and door handles are visibly clean
   Lights and fittings are visibly clean
   Toys / decorations are washable or machine washable; visibly clean and in good state of repair
   Room is uncluttered and free from extraneous items

2. PASSAGE / CORRIDORS
   Floors and walls are visibly clean
   Air vent is visibly clean
   Doors and handles are visibly clean
   Light and fittings are visibly clean
   Windows and window sills are visibly clean
   No waste is stored in passages / corners

3. STORE ROOMS
   Shelves are visibly clean
   Floors and walls are visibly clean
   Equipment is visibly clean
   No stock is stored directly on floor
   Door is locked

4. PERSONNEL LOUNGE / RECREATION AREAS
   Basins are visibly clean inside and outside
   Soap dispenser is visibly clean and soap is available
   Plug is available, and plug and plug hole are visibly clean
   Basin pipes are visibly clean
   Paper towels are available
   Waste bins are visibly clean and lined with correct colour plastic liner
   No dirty crockery and cutlery is found
   Kettle / urn are visibly clean
   Furniture is visibly clean

5. KITCHEN/S
   Floors and walls are visibly clean
   Fridge is visibly clean and functionally correctly used
   Waste bins are visibly clean and lined with correct colour plastic liner
   Cupboards are visibly clean and neat
   No unnecessary equipment found in the kitchen
   Kettle / urn and other equipment is visibly clean and neat

6. OFFICES
   - Carpets are visibly clean
   - Floors and walls are visibly clean
   - Window and window sills are visibly clean
   - Air conditioners / vents are visibly clean and filters are maintained
   - Furniture is visibly clean (and wood is oiled / polished if necessary)
   - Doors are visibly clean
   - Waste bins are visibly clean and lined with correct colour plastic liner

7. STERILISATION AREA
   - Floors and walls are visibly clean and dry
   - Hand washing facilities are visibly clean
   - Instrument washing facilities are visibly clean
   - Holding solutions and detergents are replaced daily
   - Soap dispenser is visibly clean and soap is available
   - Clean, dry paper towels are available
   - Waste bins are visibly clean and lined with correct colour plastic liner
   - Sharps container is available and lined with correct colour plastic liner
   - Sharps container is replaced when filled up to 2/3 fill line
   - Lubrication for handpieces and forceps is available

8. BATHROOM / TOILET AREAS (PERSONNEL AND PATIENTS)
   - Floors, cupboards and walls clean and dry
   - Hand washing facilities and basins are visibly clean
   - Soap dispenser is visibly clean and soap is available
   - Clean, dry paper towels are available
   - Waste bins are visibly clean and lines with correct colour plastic liner
   - Toilet facilities are visibly clean – including under the ring
   - Mirrors are visibly clean
   - Lights and fittings are visibly clean and in working order
   - Doors and handles are visibly clean and in working order
   - Fresh air and ventilation is maintained
   - Toilet paper is available

9. CLINICAL OR PROCEDURAL AREAS
   - All horizontal surfaces are dust free and visibly clean
   - Floors and walls are visibly clean and dry
   - Hand washing facilities and basins are visibly clean
   - Soap dispenser is visibly clean and soap is available
   - Clean, dry paper towels are available
   - Room is uncluttered and free from loose items on countertops
   - Windows and window sills are visibly clean
   - Fresh air and ventilation is maintained
   - Dental chair, head rest and stools are visibly clean and in a good state of repair
   - Telephones are visibly clean
   - Doors and handles are visibly clean
   - Lights and fittings are visibly clean
   - Waste bins are visibly clean and lined with correct colour plastic liner
   - Sharps container is available and lined with correct colour plastic liner

10. LABORATORY

Local exhaust is maintained in areas where grinding, dry polishing, or buffing occurs
All horizontal surfaces are dust free and visibly clean
Floors and walls are visibly clean and dry
Hand washing facilities and basins are visibly clean
Soap dispenser is visibly clean and soap is available
Clean, dry paper towels is available
Room is uncluttered and free from loose items on countertops
Windows and window sills are visibly clean
Fresh air and ventilation is maintained
Chair, storing facilities and equipment are visibly clean and in a good state of repair
Telephones are visibly clean
Doors and door handles are visibly clean
Lights and fittings are visibly clean
Waste bins are visibly clean and lined with correct colour plastic liner
Sharps container are available and lined with correct colour plastic liner

11. OTHER

All posters on walls are wipeable and clean
Notice boards are visibly clean and neat

12. EQUIPMENT

Cleaning materials / containers are visibly clean and correctly labelled
Cleaning equipment is visibly clean
Colour coding is applied correctly
Cleaning equipment is stored clean and dry
Store room floors and walls are visibly clean
Equipment wash basin is visibly clean inside and outside
Mops and brooms are visibly clean
Buckets are visibly clean and dry
Dusting equipment is visibly clean
Waste bin are visibly clean
Plastic bags are available (all 4 colours)
Vacuum cleaner is visibly clean and functioning well
Buffing machine is visibly clean and functioning well

## Focus Area 5: Equipment Maintenance

**Why?** All technical equipment or apparatus in health care facilities should be monitored, calibrated, and serviced routinely to prevent malfunction and failure of safety precautions. All health care employers that use equipment are legally obligated to ensure that a maintenance schedule is in place for equipment used in an oral health care facility. Documented evidence of routine performance testing, maintenance, service and / or repair should be kept as proof that the equipment is maintained and therefore function correctly, risks of cross-contamination are kept to a minimum and a clean environment is continuously maintained.

**What?** Maintenance, service or repair involves programmes that ensure efficient and effective functioning of essential equipment in the oral health care facility. An audit trail of evidence of equipment testing and maintenance, based on the user history of the equipment, may be a piece of crucial documentation in case of any complaint filed against the facility.

**How?** 5.1 Maintenance and service of sterilisers and associated equipment
5.2 Recordkeeping of maintenance and service data for a minimum period of 5 years

## Assessment content

1. *Manufacturer's user guides on equipment are available and easily accessible*

2. *Cleaning and sterilising equipment are on a planned / scheduled maintenance programme*
   Monitoring, calibration and performance testing by the service technician is done regularly

3. *Sterilising equipment is checked physically / chemically and the results recorded daily / sessionally, then filed for a period of five years*
   *Written record of monitoring*

4. *Sterilising equipment is checked biologically and the results are recorded at least weekly*
   Written record of monitoring, then filed for a period of at least five years

5. *Sterilising equipment* is visibly *clean and in a good state of repair*

6. *Cleaned and sterile instruments are stored in sealed containers / packs*

7. *Ultrasonic cleaners are emptied daily and kept dry overnight*

8. *Spittoon is flushed and decontaminated after each patient*

9. *Suction machine is decontaminated between uses and kept clean and dry*

10. *Cleaning equipment is checked physically and the results are recorded*
    Written record of monitoring is completed, then filed for a period of at least five years

## Focus Area 6: Air- and Waterline Management

**Why?** Most dental unit waterline systems consist of a complex maze of waterlines, control blocks, valves, barbs and connectors of various sizes, and manufactured from a variety of metals, plastics and rubbers. The delivery of water and air during oral health care procedures is an essential coolant in the working site, especially while using the high-speed handpiece that operates at speeds faster than 400 000 revolutions per minute (rpm). In most oral health care facilities, the water that is used for oral health care treatment is delivered directly from the municipal water supply. Very few facilities are equipped with bottled or self-contained water systems, to which the treatment water or irrigants are added. The inside surfaces of the thin plastic tubing of the waterlines become heavily contaminated with high counts of bacteria, fungi, viruses and protozoa. This evolving biofilm allows infectious agents to survive and thrive in the waterlines, leading to concern about the possible health effects on oral health care workers and patients exposed to dental unit water. Unless specifically designed procedures are performed to prevent, eliminate, trap or destroy biofilms in dental unit waterlines, the colonization of these lines with infectious microorganisms cannot be avoided.

**What?** The formation of biofilms in liquid environments is a common phenomenon. The specific design and structure of the narrow tubing or lumen of dental unit air and waterlines, and the typical way water is used during oral health care procedures, exacerbates the problem. Air and waterline management involves programmes that would monitor and ensure that the quality of the water used during oral health care procedures is of an acceptable standard to prevent health hazards to personnel and patients exposed to it. Water of poor microbial quality is not consistent with accepted infection prevention or control recommendations. Mechanisms to keep the water clean and prevent any microbial growth need to be maintained to ensure delivery of an acceptable standard of dental unit water. Dental treatment water or irrigants should contain less than 500 cfu/ml of heterotrophic mesophilic microorganisms. Apart from the microbial quality, the water should not have high endotoxin content and should at least be of a similar quality to drinking water. Patients and personnel with HIV/AIDS, diabetes, transplant recipients, chemotherapy patients, and those with a weakened immune system are more susceptible to microbial contaminants found in water (Ricci*, et al.*, 2012).

Many dental units, in particular some older models, are directly connected to the municipal water supply. Although it is generally accepted that this water supply is of good quality as it is treated water, this may not always be true. For example, Bloemfontein, a large city in the Free State Province of South Africa, experienced a boil-water alert in 2007 (Roos, 2007). For the two weeks during which the alert applied, city consumers and oral health care providers were in a state of panic, and all the water for human consumption or use had to be boiled. Very few citizens realised the implications of such an alert and health care providers were caught unprepared to deal with the situation. With the ever-increasing reports on poor water quality in South Africa, oral health care providers need to take note of the serious health hazard a boil water alert implies, not only for their patients, but also for their own protection.

Various semi-critical items of oral health care equipment, that touch the mucous membranes, are attached to the air or waterlines of a dental unit. Among these devices are high- and low-speed handpieces, prophylaxis angles, ultrasonic and sonic scaling tips, air abrasion devices, and air and water syringe tips. Studies have indicated that not only do the outer surfaces of handpieces become heavily contaminated during oral health care procedures, there is also a increased possibility for the retention of viruses and bacteria inside the high-speed and prophylaxis handpieces.

**How?** 6.1 Maintenance of dental unit water
6.2 Monitoring water quality
6.3 Applying dental waterline treatment protocol
6.4 Response to boil water advisories
6.5 Maintenance of dental handpieces and equipment attached to air / waterlines

## Assessment content

1. *Air / water lines are flushed each morning before the start of a patient list*

2. *Air / water lines are flushed with air or water after each patient use*

3. *Anti-retraction valves are installed in the dental units*

4. *A closed water reservoir systems is used in the dental units*
Maintenance record is available

5. *Chairside line-filters are clean*
Written record is available of the maintenance of line-filters

6. *Sterile irrigating solutions or saline delivery systems are used during all surgical procedures*

7. *Water quality monitoring is done regularly*
Written record of water quality is available

8. *Personnel are trained about effective waterline treatment measures*

9. *Written action plan* is available *in case of a boil water alert*
Written record of the training provided in case of a boil water alert is available

10. *Handpieces and other dental unit instruments are cleaned and heat-sterilised after each patient use*

11. *Patients are advised not to close their lips around the tip of the saliva ejector to evacuate oral fluids*

12. *Air / water syringe tips are single-use disposable items that are discarded after use*

## Focus Area 7: Personal Protective Equipment Usage

**Why?** Personal protective equipment (PPE) is a major component of standard and transmission-based infection prevention and control precautions. In the oral health care setting in particular, PPE should be worn to protect the skin and mucous membranes from exposure to potentially infectious and hazardous materials contained in the spray and spatter where oral health care procedures are executed. PPE provides a physical barrier between the body and the source of contamination. When used routinely and properly, PPE can be very effective in providing protection against possible exposure.

**What?** PPE routinely used in oral health care include outer protective clothing, masks, protective eyewear, face-shields, single-use-disposable gloves, and sterile or non-sterile and utility gloves. According the Occupational Health and Safety regulations, all OHCWs who are at risk of exposure to potentially infectious or hazardous material must wear PPE, as these protect both the OHCWS and patients from exposure to blood, body fluids and chemical hazards.

**How?**
7.1 Types of PPE that are applied in oral health care
7.2 Putting on and removing PPE
7.3 Preventing and managing reaction to gloves and other latex products
7.4 Preventing exposure during procedures involving surgery
7.5 Providing protection when exposed to laser / electro-surgery plumes or surgical smoke

## Assessment content

1. What *PPE (gloves, masks, eyewear and clothing) is provided to at-risk personnel?*

2. Is *PPE provided at no cost to at-risk personnel?*

3. *Same types of PPE are worn for all patient care procedures, regardless of the individual's medical history*

4. *Personnel are instructed in the appropriate sequence of putting on and removal of PPE*

5. *Clinical personnel do wear gloves and masks for each patient procedure*

6. *Sterile gloves are available for use during surgical treatments*

7. *Disposable plastic over gloves are available for personnel when required*

8. *Disposable gloves are changed between every patient treatment*

9. *Gloves are worn by personnel when handling saliva contaminated radiographic film packets*

10. *Puncture-resistant utility gloves, masks, and eyewear are worn when cleaning and disinfecting used cutting / sharp equipment*

11. *Puncture-resistant utility gloves are worn when hand scrubbing instruments*

12. *Puncture-resistant utility gloves and protective clothing is worn when handling health care risk waste*

13. *Eye protection with solid side shields or a face shield is worn during patient care*

14. *Patients are provided with eye protection to wear during dental procedures*

15. *Patient protective eyewear is cleaned following every patient treatment*

16. *Disposable masks are changed between every patient treatment*

17. *High-filtration surgical masks are applied when using laser / electro-surgery*

18. *Full face shields are worn when using laser / electro-surgery*

19. *Smoke exhaust systems with a high-efficiency filter are used to remove laser-plume particles*

20. *Laundering / washing of protective clothing is managed by the facility*

21. *Protective clothing can be changed and stored at the facility*

22. *Disposable plastic aprons are available for personnel*

## Focus Area 8: Personal- and Hand Hygiene Practices

**Why?** Hand hygiene has been singled out as the most important way to reduce the risk of disease transmission in health care settings. Studies have indicated that when hand hygiene improves, health care associated infections decline. In oral health care there is frequent touching of many different surfaces, often contaminated with saliva and other potentially infectious materials. This increases the risk of disease transmission. Although OHCWs often wear gloves and other PPE as precaution, it should not be considered to be a substitute for proper hand hygiene.

**What?** Cleaning is a very important first step in any skin decontamination or disinfection process. Surfaces in the oral health care facility become contaminated from patient material, either by direct spray or spatter generated during oral health care procedures, or through contact with the oral health care personnel's gloved hands. These surfaces can then secondarily contaminate other instruments, equipment, hands or gloves. Besides cleaning and decontaminating instruments or environmental surfaces, OHCWS should diligently practice personal hygiene, including frequent hand hygiene practices throughout the working day. Hand hygiene includes proper hand washing, hand asepsis and surgical hand hygiene procedures.

**How?**
8.1 Personal hygiene practices
8.2 Hand hygiene practices
8.3 Fingernails and artificial nails
8.4 Jewellery and other hand hygiene considerations

## Assessment content

1. *Personnel are instructed on the importance and frequency of hand hygiene application in the workplace*

2. *Personnel are instructed regarding the routine hand washing technique*

3. *Personnel are instructed regarding the use of alcohol hand rub or hand sanitiser*

4. *Personnel are instructed on surgical hand asepsis*

5. *Personnel do remove jewellery, e.g. watches, rings from hands before wearing gloves*

6. *Personnel do have short, neatly trimmed nails*

7. *Personnel hands are free from artificial nails*

8. *Individual hand lotions are used to prevent skin dryness associated with hand washing*

9. *Hand lotions are free of petroleum and other oil-based skin softeners*

10. *Equipment is automated or foot / elbow-operated to avoid hand contact and cross-contamination*
    Automated or foot / elbow-operated taps have been installed
    Liquid hand hygiene products are applied by automated dispensers
    Disposable paper towels are used to dry hands

11. *No nail brushes are found in the hand wash areas*

12. *Easy access to hand washing facilities is possible as basins are open and clear*

13. *Basins in the clinical areas are free from the clutter of used equipment / instruments*

14. *Basins in the clinical areas are free from the clutter of drinking utensils*

## Focus Area 9: Sterilisation Practices

**Why?** Most instruments that are used during oral health care procedures become contaminated when they are in contact with mucosa, body fluids and / or penetrate tissue. Contaminated instruments must therefore be decontaminated and sterilised before safe re-use (Crawford, 1994). When selecting procedures or products to perform sterilisation or disinfection procedures, the aim is to effectively break the chain of infection (Scarlett, 2007). Each oral health care facility should apply a validated instrument sterilisation process that *monitors and documents* conditions for the prevention of disease transmission (CDC, 2003). It is most desirable to sterilise ***all*** instruments, handpieces and other supplies and equipment that are used for invasive procedures inside the oral cavity (CDC, 2003; Scarlett, 2007).

**What?** Sterilisation practices involve programmes that refer to a validated process, intended to destroy all viable microorganisms, including resistant bacterial spores. The sterilisation process is presently the only acceptable clinical method that ensures safe re-use of instruments in oral health care.

**How?**
- 9.1 Applying the modified CDC / Spaulding Classification
- 9.2 Sterilisation methods in oral health care
- 9.3 Sterilisation processes
- 9.4 Cleaning methods of instruments and equipment in oral health care
- 9.5 Monitoring sterilisers and sterilisation failure / troubleshooting
- 9.6 Processing heat sensitive items with liquid chemical sterilants

## Assessment content

1. *Processing area is physically divided into separate areas for receiving and cleaning*

2. *Area is physically divided into separate areas for preparation and packaging*

3. *Area is physically divided into separate areas for sterilisation and storage*

4. *Contaminated instruments are transported in covered, marked containers*

5. *Instruments / devices are cleaned of all visible blood / contamination before sterilisation or disinfection*

6. *Instruments that cannot be cleaned immediately are placed in a holding / enzymatic solution*

7. *Holding solutions are changed at least twice daily or more often, if cloudy or contaminated*

8. *Cleaning is routinely done in an automated device e.g. ultrasonic cleaner or thermal washer / disinfector*

9. *Puncture-resistant utility gloves are worn when handling contaminated instruments*

10. *Long-handled brushes are used when instruments must be scrubbed by hand*

11. *Instruments are held below the waterline to minimize splashing when scrubbed by hand*

12. *No more than 1-2 instruments are handled at a time when instruments must be scrubbed by hand*

13. *Hinged / articulated instruments are opened and unlocked / disassembled prior to sterilisation*

14. *Lubrication or rust inhibitors are applied to instruments / handpieces prior to sterilisation*

15. *Cassettes are utilized to avoid hand contact and promote safer processing of contaminated instruments*

16. *Instruments and supplies are packed into functional sets to use for specific procedures*

17. *Instruments are packed prior to sterilisation*

18. *Packing material is compatible with the sterilisation process used*

19. *The contents are re-cleaned, re-packed, and re-sterilised if packaging has been compromised*

20. *The Processing area facilitates drying without compromising the integrity / sterility of the packs*

21. *Implantable devises are always packed just before sterilisation*

22. *Use of spore tests is applied to each steriliser load to monitor and guarantee sterilised efficacy of every implantable device*

## Focus Area 10: Safe Sharps Handling

**Why?** All contaminated sharps are a potential source for infection. Incorrect handling of sharps may result in penetrating injuries. Contaminated needles and other contaminated used sharp items need to be disposed of correctly. Failure to dispose of used sharps into approved sharps containers poses a real health hazard, not only to oral health care workers in the workplace, but also to community members who may be accidentally exposed to these sharps.

**What?** Safe sharps handling implies programmes that incorporate safer work practices and environmental controls, to organise and secure instruments in the oral health care environment. Improved engineering controls can remove or isolate hazards that relate to sharps in the workplace. Any injury or incidents that do occur should be reviewed and reported in order to suggest and implement preventive measures or improvements. Effective communication among the members of the oral health care team will promote a culture of safety.

**How?**
10.1 Sharps used in oral health care
10.2 Parenteral medications
10.3 Safe disposal of sharps
10.4 Burs and endodontic files

## Assessment content

1. *Personnel have received training in regard to safe handling techniques or sharps*
   Operators use caution when handling sharps
   Operators use a mirror / retractor instead of their fingers to retract tissue during procedures
   Re-sheathing devices / safety techniques are used for recapping used dental needles
   Precautionary measure are applied when handling contaminated instruments
   Personnel are trained on what action to take following a needlestick / sharps-related injury

2. *A readily-accessible sharps injury protocol is in place*
   In case of emergency, all personnel know where to obtain the written information

3. *Sharps containers are available in every patient treatment- and instrument processing areas*
   Sharps containers are located close to the point of use
   Sharps containers are leak proof and puncture-resistant
   Sharps containers are positioned safely (e.g. wall-mounted), out of reach of children and visitors
   Sharps containers have lids that can be securely closed to prevent spilling if dropped
   Sharps containers are free from protruding sharps (less than 2/3 full)
   Sharps containers are removed as soon as the contents reach the fill line (2/3 full)

4. *Disposable needles and disposable syringes are discarded directly into a sharps container after use on a patient*

5. *Medication from any syringe is administered to one patient only*

6. *Single-dose vials of parenteral medications are used whenever possible*

7. *After use on a patient, any medication remaining in a single-dose vial is discarded together with the vial*

8. *Vial access diaphragms / rubber stoppers are cleansed with 70% alcohol which is allowed to dry before inserting a device into a multi-dose vial*

9. *Only sterile devices are used to access multiple-dose vials*

10. *Endodontic files are discarded after use on a single patient*

## Focus Area 11: Waste Management

**Why?** All types of health care waste (HCW) are generated at oral health care facilities, including hazardous health care risk waste (HCRW) and also general health care (household) waste (SABS, 2004). Special emphasis is placed on HCRW, which poses the greatest risk to health, safety and the environment, depending on the particular type of HCRW, how it is handled, as well as the manner in which exposure might take place. Health care general waste is classified as non-hazardous and is thus not considered a risk. The disposal of the HCRW generated in oral health care facilities can have adverse effects on the health and well being of the personnel of the facility, its patients, any visitors and the general public, if not properly managed.

**What?** Waste management programmes involve the proper handling and disposal of waste generated in the oral health care facility. Waste management minimises the spread of infections and reduces the risk of accidental injury.

**How?** 11.1 Classification of waste
11.2 Segregation of health care waste and colour coding
11.3 Waste management activities in oral health care facilities
11.4 Disposal and management of extracted teeth

## Assessment content

1. *Waste management protocols are available*
   Written waste management plan is available
   Written waste segregation categories are applied
   National code of practice with the SABS colour-coded waste segregation categories is applied in the facility

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2. *Waste is disposed of using the correct designated containers*
   Hazardous health care waste is placed in red bags / liners inside labelled containers
   Disposable used PPE is discarded as hazardous waste in red bags
   Extracted teeth without amalgam fillings are disposed of as hazardous waste
   Extracted teeth with amalgam fillings are disposed of in containers that will NOT be incinerated
   Amalgam waste is secured for metal recovery inside a separate, marked container
   Lead foil and fixer is secured for metal recovery inside separate, marked containers
   Hazardous health care risk waste containers are securely tied / closed before removal
   Sharps are disposed of in leak proof, puncture-resistant containers, at the point of use
   General / household waste is disposed of in black or clear bags
   Bins in clinical and instrument processing areas are visibly clean and in good working order

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3. *A designated, secure area is identified where waste waiting collection is stored*
   Area is locked and inaccessible to unauthorised persons
   Area is visibly clean
   Area visibly pest free

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4. *Proof of continuous, scheduled collection of health care waste is available*
   Signed records of collection / collection certificates by an accredited, registered service provider / company

5. *Proof of legal disposal of health care risk waste in available, e.g. numbered incineration /disposal certificates are available*

# Appendix E

# Certificate of language editing

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29th May 2014

**INFECTION PREVENTION AND CONTROL AUDIT-FEEDBACK INSTRUMENT FOR ORAL HEALTH CARE IN SOUTH AFRICA**

(D Tech thesis in Biomedical Technology, Faculty of Health- and Environmental Sciences, Central University of Technology, Free State).

*To whom it may concern*

This is to confirm that I, Laura Ester Ziady, assisted Ms Jeanné Oosthuysen with language editing for a D Tech thesis in Biomedical Technology, namely: *Infection Prevention and Control Audit-Feedback Instrument For Oral Health Care In South Africa*.

My Curriculum Vitae has been made available to the student.

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